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Department of **Harvesting & Wood Science**

The University of British Columbia
Vancouver, Canada

Date **November 09, 1995**
ABSTRACT

Oriented Strand Board (OSB) is a commodity wood based structural panel that is well established in North American forest products markets. OSB is subject to the cyclical nature of commodity forest products and at the time this research was initiated structural panel markets were oversupplied and operating margins were poor. Although OSB is a direct substitute for plywood in home construction, OSB does not have the same degree of geographic or end-use diversification as plywood.

At the time this research project was undertaken in 1990-91, there were growing concerns about the long-term availability of tropical hardwoods from Pacific Rim countries that supply the Japanese panel market. Japan consumes nearly 10 million cubic metres of finished structural panel products per year for use primarily in concrete forming, packaging and crating, and home construction. Two million cubic metres of finished panels are imported annually from other Pacific Rim countries and the remaining 8 million cubic metres is produced domestically. Almost all domestic Japanese structural panel production is produced with imported logs.

The vast majority of the panels consumed in Japan are 3 foot wide by 6 or 8 foot long. This is in contrast to the typical 4 foot wide by 8 foot long panel used in North America. Consequently, North American plywood mills with four foot wide panel production systems are not equipped to meet the marketing challenge in Japan. However, the potential for 9 foot and 12 foot wide press and forming lines in the OSB industry provides a unique opportunity to make significant inroads into the Japanese market.

Since 1990-91, the OSB industry has nearly completed an entire economic cycle. For the years 1993 through 1995, the industry has recorded exceptionally high industry operating rates and profitability.
This has attracted massive investment that will result in unprecedented capacity additions with the potential to create tremendous fallout in the North American panel production industry.

Substantial competitive advantages permit OSB producers to provide a comparable product for approximately 60 percent of the cost of plywood and, consequently, most of the fallout will occur in the plywood producing sector. Nonetheless, prices will be under prolonged pressure and OSB producers are well aware of the benefits that come with product and market diversification. For these reasons, the need for market research in Japan is as pertinent today as it was in 1990-91.

This research is qualitative in nature insofar as it outlines a methodology for quantifying the determinance of product attributes. Product attributes - such as price, colour, or size - are considered to be determinant to the purchasing decision if they are both important to the purchaser and discriminate between alternative products. It is posited that determinant product attributes are those that are used in the evaluation process of a purchasing decision.

When determinant attributes are combined with customer perceptions of how an individual product performs on the determinant attributes, one is able to make predictions regarding purchasing predispositions. One means of combining determinance and perception is through the use of a model that helps market researchers assess a product's strengths and weaknesses on selected attributes and formulate appropriate responses in the market place. A simple linear summative multi-attribute model was used that combined the importance weight given to the product attributes with the purchaser's belief as to the extent to which the determinant attributes are offered by each product.

The respondents for this project were Japanese companies actively involved in the import, wholesale and retail distribution, and end-use of structural panels in Japan. Interviewing a large number of respondents in this highly concentrated, industrial market would have been financially prohibitive
and the alternative was to interview a representative cross-section of firms in the industry. To compensate for the inter-company size discrepancies (i.e., volume of panels handled), a useful data treatment called post-hoc probability proportional to size (PPS) sampling was employed in order to provide unbiased weights for subsequent data analysis.

The three panel products chosen for comparison in this study were Lauan plywood, North American softwood plywood, and OSB. The following ten salient panel product attributes were chosen:

1) Competitive Price  
2) Thickness Swell  
3) Linear Expansion  
4) Physical Strength  
5) Panel Size  
6) Long-term Supply  
7) Manufacturer's Reputation  
8) Physical Appearance  
9) Nail Holding Strength  
10) Overall Quality

A comparison of the original sample and the PPS sample served to highlight a difference between the small firms and the large firms in the study. Specifically, the determinant attributes identified for the smaller firms in the study were panel size, price, and thickness swell (in decreasing order of determinance). On the other hand, the determinant attributes identified for the larger firms were panel size, thickness swell, and overall quality.

The linear summative multi-attribute model was used to predict purchasing preferences for the three panel products chosen for comparison. Using the PPS sample population, Lauan was the preferred choice, softwood plywood the second choice, and OSB was the third choice panel. When the model was run on a subset of the original sample population that included only the small firms in the study, OSB became the preferred choice, Lauan was the second choice, and softwood plywood was the third choice. This further highlighted the difference between the small and large firms in the study. This observation suggests that a logical entry strategy into the Japanese market would to bypass the
large trading houses and market OSB either to the smaller firms or to the firms further down the
distribution chain that tend to be smaller in size.

Lastly, the diagnostic features of the model were used to conduct sensitivity analyses designed to
predict the impact on purchasing preferences with changes in the perception of OSB performance on
the determinant attributes. The results of these analyses showed that when the OSB perception score
for panel size was increased, or if perception scores for both thickness swell and overall quality were
increased, then OSB replaced softwood plywood as the second choice product. Lauan plywood
remained the preferred product in all cases for the PPS sample population.
TABLE OF CONTENTS

ABSTRACT .......................................................................................................................... ii

LIST OF TABLES ................................................................................................................ vii

LIST OF FIGURES .............................................................................................................. viii

LIST OF APPENDICES ...................................................................................................... ix

ACKNOWLEDGMENTS ....................................................................................................... x

1.0 BACKGROUND ............................................................................................................ 1

2.0 PROBLEM STATEMENT ............................................................................................. 5

3.0 RESEARCH OBJECTIVES .......................................................................................... 8

4.0 LITERATURE REVIEW ............................................................................................... 9

4.1 REVIEW OF STRUCTURAL PANEL MARKETS ....................................................... 9

4.1.1 North America ........................................................................................................ 9

4.1.2 Export Markets ...................................................................................................... 14

4.2 CHALLENGES FACING THE STRUCTURAL PANEL INDUSTRY .................................. 21

4.3 MARKET PULL, TECHNOLOGY PUSH, AND TECHNOLOGY DIFFUSION ............... 22

4.4 STATISTICAL METHODOLOGY .............................................................................. 26

4.4.1 Determinant Attributes ....................................................................................... 27

4.4.2 A Multi-Attribute Modeling of Purchasing Predisposition's ... ......................... 30

5.0 JAPANESE PANEL MARKETS: ASSESSING PRODUCT REQUIREMENTS ............. 32

5.1 RESEARCH METHODOLOGY .................................................................................. 32

5.1.1 Research Design .................................................................................................... 32

5.1.2 Sampling Procedure ............................................................................................ 34

5.1.3 Respondent Description ....................................................................................... 37

5.2 DATA COLLECTION .................................................................................................. 38

5.2.1 Methodology ......................................................................................................... 38

6.0 RESEARCH RESULTS .............................................................................................. 40

6.1 DEMOGRAPHICS AND DESCRIPTIVE STATISTICS ............................................. 40

6.2 PRIMARY DATA ANALYSIS ..................................................................................... 46

6.2.1 Determinant Attributes ....................................................................................... 46

6.2.2 Respondent Perceptions ....................................................................................... 54

6.2.3 Linear Summative Multi-Attribute Model ............................................................ 55

6.2.4 Predictive Use of the Linear Summative Multi-Attribute Model ......................... 59

7.0 SUMMARY ............................................................................................................... 64

BIBLIOGRAPHY ............................................................................................................. 66

APPENDIX ONE .............................................................................................................. 69
LIST OF TABLES

Table One - North American Structural Panel Capacity .............................................. 13
Table Two - Japanese Housing Starts (1983 - 1993) .................................................. 18
Table Three - Typical Japanese Panel Sizes and End-uses ......................................... 19
Table Four - Summary of Standardized Determinance Scores .................................... 52
Table Five - Summary of Standardized Respondent Perceptions .................................. 55
Table Six - Summary of Multi-Attribute Modeling ......................................................... 57
Table Seven - Sensitivity Analyses Using Linear Summative Multi-Attribute Model ........ 62
LIST OF FIGURES

Figure One - Overview of Research Design ................................................................. 33
Figure Two - Pictorial Representation of the PPS Sampling Technique ......................... 37
Figure Three - Classification Of Firms ....................................................................... 40
Figure Four - OSB Purchasing Disposition .................................................................. 41
Figure Five - Structural Panel Sources (Imported vs. Domestic) .................................. 42
Figure Six - Origin Of Structural Panel Imports ......................................................... 43
Figure Seven - Dimensions of Panels Purchased by Firms Surveyed ......................... 44
Figure Eight - Structural Panel End Use ................................................................. 45
Figure Nine - Five Highest Determinance Scores (Raw Data Set) ............................ 50
Figure Ten - Five Lowest Determinance Scores (Raw Data Set) ............................... 50
Figure Eleven - Five Highest Determinance Scores (PPS Data Set) ........................... 51
Figure Twelve - Five Lowest Determinance Scores (PPS Data Set) .......................... 52
LIST OF APPENDICES

Appendix One - Sample Survey Questionnaire

.................................................................69
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1.0 BACKGROUND

The 1980's ushered in a decade of sustained growth for Oriented Strand Board (OSB) in North America. From 1980 to 1990, annual Canadian OSB consumption increased 245 percent to 2.21 billion square feet - 3/8" thick basis (BSF) while market share of the Canadian structural panel market rose by more than 20 percent to nearly 50 percent. During the same period, OSB consumption in the United States increased 190 percent to 6.40 BSF annually and market share of the U.S. structural panel market rose by more than 20 percent to nearly 25 percent [RISI - Wood Products Year Book (1993)]. In both Canada and the United States, plywood makes up the balance of the structural panel market.

The reasons for the growth in OSB market share were:

1. *Diminishing supply of high quality logs for the production of plywood and the corresponding increase in the cost of those logs,*

2. *Plentiful supply of logs for the production of OSB and a corresponding stable price for those logs, and*

3. *Significantly lower labour costs per unit of production for OSB compared to plywood.*

During most of this period, strong housing markets absorbed the growth in the OSB industry without significant adverse consequences for plywood manufacturers. By 1989-90, however, North American housing starts were in decline, structural panel markets were oversupplied, and market prices weak. Concurrently, timber shortages and rising timber and production costs in the U.S. Pacific Northwest and coastal British Columbia timber
producing regions were eroding the ability of many plywood manufacturers to survive an economic recession.

When the North American economy entered recession in 1990-91, the impact on the OSB and plywood producing sectors was significant. Profitability in the OSB industry was sharply reduced and plant closures and production curtailments occurred at the higher cost operations. In the plywood industry the effects of the recession were more profound, as most manufacturers were producing well below normal operating rates (exacerbated by the competition with OSB) and experienced substantial financial losses. The shortage of timber and poor prospects for long term profitability forced many plywood producers to curtail operations and many plants were permanently closed [RISI North American Panelboard Mill Capacity 1981-1994 (1994)].

The American Plywood Association (APA) estimates that 4.83 billion square feet of western softwood plywood production was permanently lost during the period from 1987 to 1993. Similarly, British Columbia plywood manufacturers rationalized their production facilities to match the available timber supply and the region's plywood production fell by approximately 0.194 BSF during the same period [RISI, North American Panelboard Mill Capacity 1981-1994].

As the North American economy began a slow recovery in 1992, the structural panel industry returned to profitability. With a 1995 demand/capacity ratio of approximately 0.89, the North American panel market is relatively in balance. By 1997, however, North American OSB producers will add up to 8.6 BSF of new capacity. During the same period, North American demand is expected to remain unchanged. This situation could result in plywood production contracting by 5.6 BSF, or 29 percent [Clear Vision Associates (March 1995)].
The majority of the new OSB production will be marketed as sheathing grade panels for North America, and yet new market opportunities do exist and some manufacturers will undoubtedly pursue the development of specialty products and/or export markets. For these reasons Japan is often cited as having tremendous market potential for OSB, however, the Japanese market is very discriminating with respect to quality, and to date, has been slow to accept OSB.

Plywood production in Japan presently accounts for 80 percent of total demand, while the remaining 20 percent is supplied by imported panels. However, nearly all of the plywood produced domestically is done so with imported timber. Parallel to the North American experience, the traditional Japanese Lauan plywood product faces increasing timber costs and manufacturing costs. Furthermore, global environmental awareness is reducing the available timber supply from the world’s tropical rain forests used to produce Lauan plywood.

It is expected that southsea timber exports to Japan will fall by 20 to 30 percent in 1995 (Japan Lumber Journal, June 20, 1994). Although some of this shortfall will be covered by exports from other timber producing regions, Japanese panel production will fall and it will be necessary to import more finished panels. Consequently, the shortage of traditional plywood products in Japan will create a significant opportunity for North American OSB.

How effective North American OSB producers are in capitalizing on this opportunity depends on internal and external factors. The external factors include the rate of decline in southsea timber exports and the supply response from other timber producing regions (both timber and finished panel products). The internal factors include product development
programs and market research initiatives geared towards the Japanese market and this is the subject of this research project.

When this research project was conceived in 1990-91, many of the supply side and export trends were only just emerging. Since that time, the structural panel market in Japan has responded to the declining timber supply from traditional sources by exploring alternative timber sources and species, as well as alternative products. In fact, there is considerable optimism on the part of North American OSB producers (particularly in Canada) regarding market opportunities for OSB in the Japanese market. This optimism has manifest itself in the construction of new OSB plants capable of manufacturing for both the North American and Japanese market.

By the end of the first quarter in 1996, five new OSB mills (four in Western Canada and one in the Southern United States) will be in production and will have the ability to manufacture traditional 3 foot wide panels for Japan. All of these mills have aggressive marketing plans that anticipate exporting significant volumes to Japan and other Pacific Rim markets.

Although this research was initiated nearly five years ago, a considerable amount of information has been collected since that time to ensure that the research objectives remained relevant. Considering the developments in the North American OSB industry and Japanese panel markets, the need for this type of research is as relevant and important today as it was in 1990.
2.0 PROBLEM STATEMENT

"Companies achieve competitive advantage through acts of innovation. Innovation anticipates both domestic and foreign needs and can be manifested in a new product design, a new production process, or a new marketing approach. Some innovations create competitive advantage by perceiving an entirely new market opportunity or by serving a market segment that others have ignored. [Porter (1990)]"

With planned OSB capacity additions, the North American structural panel market will be in a significant oversupply situation by 1997. Consequently, the outlook for structural panel markets is for renewed price competitiveness. This will drive OSB producers to explore new markets in search of higher and more stable market returns. This can be accomplished by developing new products for new end-uses, or by developing export markets for existing end-uses. Regardless, either approach requires an assessment of the desired product attributes for the intended target market.

However, product and market development is both expensive and risky, and many small and medium size companies lack the required technical expertise internally. Consequently, it is often only the very large integrated forest companies that have the necessary human and capital resources to devote to research and development programs, and even this is no guarantee for success. Since the research and development of new products typically represents a greater scientific challenge and cost than market development, the mainstream industry focus will be to explore market opportunities for OSB in export markets.
New product standards and customer expectations often accompany new markets, which entails some degree of product refinement. The need for product refinement is predicated on the axiom that a new product offering must render tangible advantages, otherwise, the market may simply reject the new product in favor of existing products. Hence, as an exporter of OSB to Japan, it is important to identify and quantify product attributes to refine and optimally position the product in the market.

The evaluation process used by the customer to assess alternative products involves the customer making trade-offs (e.g., a customer might make a trade-off between product price and performance). The better a product meets the customer's overall needs and expectations, the more likely is the purchase and the higher is the potential purchase price.

Market research that effectively identifies and defines desired product attributes serves to focus innovation. First, competitive advantages will be created by meeting the customers' needs better than other product offerings. And second, competitive advantages can be maintained through the use of periodic market research to reassess customer needs and adapting the product when necessary to meet changing needs.

Effective market and product development is a continuous process that creates competitive advantages, and most importantly maintains them. As new entrants to the OSB industry begin to penetrate new markets (such as Japan), individual firms can "manage" their markets through market research and product refinement in an attempt to maintain their long-term competitiveness.

This research project was undertaken to demonstrate a possible means for Canadian OSB manufacturers to undertake market research as a means of focusing the process of innovation
to create competitive advantages for OSB products in the Japanese housing industry. The underlying foundation for this thesis is that competitive advantages can be created and maintained in a cost effective and timely manner by utilizing market research to quantify the importance of selected product attributes for a specific target market.
3.0 **Research Objectives**

Before undertaking this research project, it was known that limited volumes of OSB were being used in the Japanese market. At the time of this research, a number of North American producers were actively marketing OSB in Japan for use as packaging and crating material. Attempts were also being made by these companies to have Japanese home builders adopt OSB panels as wall, floor, and roof sheathing material. Hence, the underlying motive for this research project was to contribute to the market development efforts already underway in the Japanese market. The primary objectives of this research effort were as follows:

1) to gather market information on the use of wood based structural panels in Japan,

2) to define specific product attributes for wood based structural panels and determine their relative importance to Japanese end-users,

3) to develop a multi-attribute model of Japanese purchasing predispositions toward alternative wood based structural panels, and

4) to use the diagnostic properties of the multi-attribute model to make predictions of purchasing preferences when simulating changes in the performance of OSB on specific product attributes.
4.0 LITERATURE REVIEW

4.1 REVIEW OF STRUCTURAL PANEL MARKETS

4.1.1 North America

Initially developed as a replacement for North American softwood plywood, OSB is now positioned as a mass marketed commodity almost exclusively in North America. OSB is produced and sold primarily as a structural sheathing product for use in new home construction and home repair and remodeling. Given the dependence on these two principle end-uses, the demand for OSB is a derived demand and individual companies have little influence on the demand for their product. Notwithstanding this, individual companies can influence the demand for their own products through diversification of markets (i.e., new products for new end-uses or modified products in new markets) and the industry can continue to expect a growing market share as long as competitive advantages are maintained.

With the strong growth of the structural panel industry, market consumption had reached 33.2 BSF by 1989. With the North American recession that followed during 1990 and 1991, the overall demand for structural panels fell by 12.5 percent or 4.17 BSF, and delayed the industry’s plans for capacity additions (along with the allocation of market and product development resources). During this period, industry utilization rates fell to approximately 80 percent and industry earnings decreased sharply [RISI (December 1994)].
As the North American economy improved during 1992-93, so too did the demand for structural panels. Although the actual improvement in housing starts was lackluster, the net decrease in the overall supply of structural panels (caused by the reduction of plywood production) was sufficient to boost industry operating rates and earnings significantly. One of the results was renewed interest in industry expansion, and present estimates indicate that nearly 8.6 BSF of additional OSB capacity will come on line by 1997 [Clear Vision Associates (March 1995)].

OSB manufacturers have significant cost advantages over plywood producers, as a result of an abundant and relatively inexpensive timber resource and more efficient processing facilities. As previously stated, OSB competes directly with sheathing plywood in new home construction and repair and remodeling. Together these two market segments comprise nearly the entire North American structural panel market, and the OSB share is currently estimated at 36 percent and is forecast to reach 53 percent by 1999 [RISI (December 1994)]. Conversely, OSB has retained a relatively smaller share of the other major end-use segments - including industrial, non-residential construction, and export markets - but in recent years the OSB sector has been expanding into these and other specialized areas.

The imminent capacity increase in the OSB industry is expected to have adverse effects on market prices. A mitigating factor in the price competitiveness equation is the possibility of increased domestic and export demand. Reduced timber supplies in the Pacific Rim will provide significant export opportunities for Canadian OSB producers positioned to service those markets. Recognizing the potential market risks, Canadian producers are seeking to improve production efficiencies and to diversify product lines and markets.
OSB now represents more than 70 percent of all Canadian structural panel output and 79 percent of that is exported - 71 percent to the U.S. and 8 percent offshore [RISI (April 1995)]. Domestic demand for Canadian OSB products is not expected to increase substantially, and hence, Canadian manufacturers will become more dependent on export markets. In addition, the U.S. is expected to add domestic production capacity, thereby lessening its reliance on Canadian imports of OSB. Thus, Canadian OSB manufacturers will increasingly be forced to rely on innovative product and market developments for growth opportunities.

Still, most growth expectations for the OSB industry are predicated on an increased demand for structural panel products and for continued substitution for plywood. The assumptions central to these expectations include:

1) a steady increase in the cost of logs for the manufacture of plywood,

2) improved product awareness and building code acceptance,

3) improved performance of OSB products, and

4) lower variable costs for OSB versus plywood.

APA estimates that 4.83 BSF of softwood plywood was permanently lost in the Western U.S. during the period from 1987 to 1993 [APA (April 1994)]. In its 1990 economics report on the structural panel industry, the APA stated:
"Another timber crisis faces the industry. It can be expected that a new round of interest in OSB will result. The history of OSB production serves as a mirror of the future. Because the type of timber which appears to be available for the future, OSB is likely to be the primary structural panel addition to industry's capacity."

In all producing regions in the U.S. and Canada, structural panel production is increasingly made up of OSB. In 1994, Southern panel production reached 17.4 BSF and overall panel production is expected to increase by 2.4 BSF to 19.8 BSF by 1998, despite a 1.7 BSF decrease in plywood production. During the same period, Western U.S. structural panel production is forecast to fall nearly 1.56 BSF to 6.7 BSF. Both the U.S. North East and North Central regions produce OSB only and there is expected to be a 0.18 BSF decrease and a 0.44 BSF increase in production, respectively, from 1994 to 1998.

From 1994 to 1998, total Canadian structural panel production is forecast to increase by 4.4 BSF to 10.43 BSF. In total, more than 50 percent of the expected OSB capacity for North America will originate from Canada. A summary of structural panel production by region is presented in Table One [RISI - Wood Products Review (January 1994)].
### Table One - North American Structural Panel Capacity

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Overall, Western Canada represents approximately 50 percent of the new Canadian production capacity. All but one of the new mills has a strong focus on export markets, specifically Japan and other Pacific Rim markets. Evidence of this trend is demonstrated by the selection of 9 foot and 12 foot wide forming lines and presses capable of efficiently producing both 3 foot and 4 foot wide panels.
4.1.2 Export Markets

Although OSB consumption is greatest in North America, export volumes continue to grow. This trend is the result of rising softwood and tropical hardwood plywood prices and environmental concerns for the world's tropical forests. This situation is not expected to ease and is forecast to accelerate in the future. In Canada, “The offshore share of total OSB exports is held close to 7 percent. However, the potential for higher offshore share is significant, particularly if growth in U.S. markets is more limited than forecast and Canadian OSB producers are forced to look elsewhere for markets.” [RISI (July 1995)].

Canadian and U.S. OSB offshore exports could reach a combined 1.9 BSF by the year 2000 with the majority of this destined for Asian markets [Widman’s World Wood Review (May 1995)]. It is evident to the Canadian OSB industry that offshore export markets will play a significant role in the future. It is hoped that this research effort will demonstrate a means of approaching the development of an emerging OSB market that results in an optimal product offering and accelerates overall market penetration.

4.1.2 (a) Europe

Current wood based panel consumption in Europe is estimated at nearly 8.5 BSF, of which approximately 50 percent is particleboard. European OSB consumption in 1993 was estimated at 0.211 BSF [Interex (1994)], and according to a 'Wood Based Panels' forecast this volume could reach 0.678 BSF by 1995, and 1.13 BSF by the year 2000. Increased export OSB demand in Europe is attributed to:
1) the higher strength of OSB relative to particleboard,

2) higher prices and softwood plywood capacity reductions, and

3) the need to rebuild Eastern Europe's housing infrastructure.

4.1.2 (b) Japan

The drastic decline in Southeast Asian timber supplies represents a significant market potential for OSB. Some of this potential is already being realized by a number of Canadian OSB producers, and the marketing and preparatory work accomplished to date has established a foothold for OSB in Japan.

The market for structural panels in Japan consists of a wide range of high quality Lauan plywood panel products. In 1990, 10.7 BSF of plywood panel products were consumed in Japan [Beizai Weekly (1995)]. Although 70 percent of Japan's plywood is manufactured domestically, the majority of this production is achieved with imported logs from Southeast Asia. The remaining 30 percent of Japan's needs are met with imported Lauan plywood - primarily from Indonesia.

Imported Lauan logs are processed into plywood by domestic plywood manufacturers and Lauan plywood is imported from a number of southeast Asian countries (particularly Indonesia). The long-term supply of Lauan logs and finished plywood from southeast Asia is questionable, however, as evidenced by recent moratoria on logging in a number of countries - including the Philippines and Malaysia - and reduced harvesting of the tropical forests of Indonesia. Recent estimates put forward by industry observers
indicate that the total harvest from the Pacific Rim will decrease by as much as 50 percent over the next 25 years [Widman’s World Wood Review (May 1995)].

According to the Food and Agriculture Organization of the United Nations (FAO), 80 percent of the tropical hardwoods felled are used for fuel or are cleared for agricultural purposes. The remaining 20 percent is used for industrial purposes, of which Japan consumes 30 percent [Japan Lumber Journal (June 1991)]. This dependence on imported plywood and logs, combined with growing concerns over the long-term supply from South East Asia, has prompted many Japanese companies to search for alternative sources of supply.

Attempts are presently underway to further develop the Japanese market for OSB products as a replacement for Lauan and softwood plywood. Overall, the Japanese market for forest products is an important one for Canadian manufacturers (now the second largest, after the United States) and represents a significant opportunity for Canadian OSB products. Although the structural panel market in Japan is mature and commodity based, it represents a significant new source of demand.

Presently, most OSB in the Japanese market is used as packaging and crating material, and its highly competitive price is rapidly making it the product of choice in this end-use. OSB has had limited success as a residential sheathing material, but many Japanese companies are seriously evaluating OSB as an alternative to Lauan. There is also strong potential for specialty OSB panels in Japan, although specialty products were not within the investigative scope of this research project.
Another important end-use segment in Japan is the concrete forming market. In a recent study commissioned by Japanese concrete form users, it was stated that plywood concrete forms were an essential material for construction, but the study stated that the panel was not used to its full potential before being discarded. In fact, concrete forming panels with unprocessed surfaces were used an average of 2.6 times, while those with processed surfaces (i.e., overlaid or coated) were used an average of 4.9 times before being discarded [Japan Lumber Journal (June 1991)].

One of the reasons for this poor utilization is the high cost of transportation and storage in Japan. Prohibitive costs incurred to transport panels to and from job sites, or to store them between jobs means many panels are simply disposed of at the job site after construction [Interex (1994)]. The plywood industry and concrete forming industry are being pressured to use substitute materials, such as softwood plywood and OSB, and domestic manufacturers have indicated that they will attempt to incorporate alternative materials, such as softwood veneers, into their concrete forming panels. Furthermore, many Japanese municipal governments (including Tokyo and Osaka) have taken steps to reduce the use of Lauan plywood on government public works projects.

For use as a home construction material, market investigations indicate that Japanese companies continue to have a cautious approach towards OSB. Ongoing testing is being conducted by companies and trial shipments have been undertaken. Most Japanese companies are now aware of OSB’s strengths and weaknesses and have begun to form definite opinions about the product. Since nearly 80 percent of the structural panel products in Japan are used for home construction, this market segment is obviously an important one. Furthermore, the total number of Japanese housing starts is forecast to
equal or exceed that of North America. Housing starts in Japan from 1983 to 1993 are provided in Table Two.

Table Two - Japanese Housing Starts (1983 - 1993)

<table>
<thead>
<tr>
<th>Year</th>
<th># Housing Starts</th>
<th>Wooden Starts</th>
<th>Non-Wooden Starts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>1,136,794</td>
<td>590,848</td>
<td>545,953</td>
</tr>
<tr>
<td>1984</td>
<td>1,182,286</td>
<td>594,144</td>
<td>593,138</td>
</tr>
<tr>
<td>1985</td>
<td>1,236,072</td>
<td>591,911</td>
<td>644,461</td>
</tr>
<tr>
<td>1986</td>
<td>1,364,049</td>
<td>633,858</td>
<td>730,751</td>
</tr>
<tr>
<td>1987</td>
<td>1,674,300</td>
<td>741,552</td>
<td>932,748</td>
</tr>
<tr>
<td>1988</td>
<td>1,684,644</td>
<td>697,267</td>
<td>987,377</td>
</tr>
<tr>
<td>1989</td>
<td>1,662,612</td>
<td>719,870</td>
<td>942,742</td>
</tr>
<tr>
<td>1990</td>
<td>1,707,109</td>
<td>727,770</td>
<td>979,344</td>
</tr>
<tr>
<td>1991</td>
<td>1,370,126</td>
<td>641,003</td>
<td>746,123</td>
</tr>
<tr>
<td>1992</td>
<td>1,402,590</td>
<td>671,130</td>
<td>731,460</td>
</tr>
<tr>
<td>1993</td>
<td>1,485,684</td>
<td>697,496</td>
<td>788,188</td>
</tr>
</tbody>
</table>

The Japanese structural panel market is unique in that the preferred panel size is a nominal 3 foot wide by 6 foot long and 8 foot long (3 x 6 and 3 x 8) panel. For North American softwood plywood manufacturers, the 3 x 6 panel presents significant production problems due to the lack of a supply of 3 x 6 veneer and unsuitable press sizes. Subsequently, no 3 x 6 plywood is manufactured in North America. Only minor volumes of 4 x 8 North American softwood plywood are used in Japan for North American style homes.

Similarly, North American OSB manufacturers have difficulties producing 3 x 6 panels economically for the Japanese market due to 8 foot wide press and forming lines. The inability of OSB manufacturers to economically produce the desired 3 foot wide panels
is hindering efforts to market the product in Japan. Typical Japanese panel sizes and thicknesses are provided in Table Three.

Table Three - Typical Japanese Panel Sizes and End-uses

<table>
<thead>
<tr>
<th>Panel Size</th>
<th>Panel Thickness</th>
<th>Panel End-use</th>
</tr>
</thead>
<tbody>
<tr>
<td>3' x 6'</td>
<td>9.5 mm</td>
<td>wall sheathing</td>
</tr>
<tr>
<td></td>
<td>11.5 mm</td>
<td>concrete forming</td>
</tr>
<tr>
<td></td>
<td>12.0 mm</td>
<td>concrete forming</td>
</tr>
<tr>
<td></td>
<td>15.0 mm</td>
<td>floor sheathing</td>
</tr>
<tr>
<td></td>
<td>20.0 mm</td>
<td>floor sheathing (apartments)</td>
</tr>
<tr>
<td>3' x 8'</td>
<td>9.0 mm</td>
<td>wall sheathing</td>
</tr>
<tr>
<td></td>
<td>9.5 mm</td>
<td>roof sheathing</td>
</tr>
<tr>
<td>3' x 9'</td>
<td>9.0 mm</td>
<td>wall sheathing</td>
</tr>
</tbody>
</table>

In addition to the typical panel sizes shown above, a variety of thin panels (2.3 mm to 6.0 mm) and thick panels (20.0 mm to 24.0 mm) are also used in Japan for non-structural end-uses (furniture, interior decorative panels, etc.) and structural end-uses (stair treads, industrial flooring, etc.).

Although a few Canadian mills have shipped 3 x 6 panels to Japan, it is difficult to produce these panels efficiently. The 4 foot and 8 foot wide press lines in existing OSB plants results in the creation of a considerable volume of 1 foot or 2 foot wide offcuts. The offcuts are often sold to wooden I-beam manufacturers at a reduced price, or in extreme cases consumed as hog fuel. In either case, the cost of producing the 3 foot wide panel is increased significantly and the selling price to the Japanese customer is high. An alternative approach for mills with an 8 foot wide press line has been to
request Japanese customers to accept 2 x 6 panels along with the 3 x 6 panels. Since not all customers can make use of the 2 x 6 panels, OSB continues to be a difficult product to sell into Japan.

Notwithstanding these problems, some Japanese customers have switched exclusively to OSB panels for their construction needs. Pre-fabricated home builders and 2x4 home builders are also considering the potential for over-size OSB panels. The production line techniques used to construct these homes could utilize larger panels (e.g. 6 x 9, 6 x 12, 9 x 12) to cover large wall, floor, and roof surfaces. Still, the Japanese require panel sizes in 3 foot wide multiples, and North American OSB plants in general are not equipped to produce these sizes.

Notwithstanding size, estimates by Beizai Weekly of Japan indicate that 0.164 BSF of 3 x 6 OSB will be sold in that country in 1995 and that this will increase to 0.435 BSF by 1997. When 3 x 6 OSB panels are made available in Japan, they typically sell at a 10 to 20 percent discount to equivalent Lauan panels. The magnitude of the price discount depends largely on the strength of the overall panel market and rarely exceeds 20 percent. When 3 x 6 OSB is sold into Japan, the prices generally exceed those in North American markets by a substantial margin. However, much of this margin is lost due to the additional costs incurred to produce and 3 x 6 panels with existing equipment.

An opportunity now exists to assess Japanese perceptions and attitudes towards OSB and other panel products and then to quantify Japanese preferences for selected product attributes. This information can then be used to determine which product features to develop for a "Japanese grade" OSB panel and to make the product an acceptable substitute for traditional structural panels in the Japanese home construction industry.
The two most important issues facing the structural panel industry are the availability of a suitable timber supply and over-capacity. Competing interests for the available land base have already caused significant reductions in the timber harvest in the US West, and the trend is expected to continue. The effect of this has been the permanent closure of a number of plywood plants, and it is likely that many more will follow. In the Southern US, increased OSB production has largely offset any capacity reductions in the West, however, pressure to reduce timber harvests in the South is expected to increase and put pressure on Southern panel producers as well. From 1995 to 1999, RISI is forecasting a 30 percent increase in OSB timber costs for the South.

In Canada, timber resources are also under pressure from economic and political forces. Higher cost and lower quality logs available for the manufacture of plywood (particularly in Western Canada) combined with increased competition from OSB has resulted in the closure of a number of plywood production facilities. Similarly, RISI is forecasting a 34 percent increase in OSB wood costs for Eastern Canadian mills.

The impact of over capacity on operating rates and profitability in the structural panel industry is dependent on the industry’s ability to develop new markets and end-uses for its products. Markets for finished panel products are increasing world wide. Developing Pacific-Rim nations require the construction materials to develop modern infrastructures and housing for their growing (and increasingly affluent) populations. In addition, Eastern European countries trying to make the transformation to market economies will require massive volumes of forest products to rebuild their infrastructures.
The challenge for Canadian panel producers will be to create competitive advantages through the use of market research and product innovations.

4.3 Market Pull, Technology Push, and Technology Diffusion

"Innovation without market application squanders limited financial and human resources, and yet long-term marketing success requires innovation" [Kiel (1984)].

The Canadian forest products industry is a major player in global forest product markets. With a small domestic market, Canadian manufacturers have historically relied on export markets for their products. Today, the majority of timber harvested in Canada is derived from public lands and pressure is mounting for forest companies to do more with less. In addition to domestic challenges, global competition is increasing and Canada's forest industry must develop and maintain competitive advantages to create growth opportunities and sustain or improve earnings.

The Canadian forest products industry is a mature industry with the majority of its products competing in commodity markets. In terms of an industry life cycle, maturity is seen as the precursor to stagnation and ultimate decline. Symptoms of maturity - including market saturation, inelastic demand, over capacity, and technological maturity - are typical of the solid wood producing sector and are becoming evident in the relatively newer composite panel industry.
There is evidence that the trend towards industry maturity can be reversed, however, and that an industry's profitability and growth can be restored. Research investigating the role and effects of technology reveals that the application of innovative technologies can revitalize an industry [Dowdy and Nikolchev (1986)]. Furthermore, these and other researchers suggest that companies should consider a wide range of technologies that might impact on their business and to assess the firm's strengths and weaknesses, organizational culture, and competitive environment before deciding which technology(s) to pursue [Kiel (1984), Capon and Glazer (1987)]. In any event, the continuous use of market and product research and development has long been recognized as being instrumental in the creation and maintenance of competitive advantages [Deming (1953)].

More recent research examining the impact of technology on the performance of companies in the forest industry has been completed [Cohen and Sinclair (1990)]. This work examined the strategic impact of adopting innovative processing technologies on the performance of North American lumber and plywood producers, and identified positive relationships between the level of investment in innovative processing technologies and a firm's profitability and growth. Specifically, this research revealed that firms with high levels of technology adoption exhibited average to better than average profitability and gained market share, whilst low level adopters exhibited below average to average profitability and lost market share. Furthermore, the findings concluded that being a technology adopter is not related to a firm's size or its degree of forward integration.

In light of these observations, Canadian forest companies should; first, identify all relevant processing technologies; second, focus on those technologies that are compatible with respect to the firm's technical skills and long-term strategy; third, implement those technologies that will improve the firm's competitive position in the market.
For some firms this will mean implementing technologies that lower production costs. Others may employ technologies to modify existing product lines for export markets, while still others will use new technologies to produce specialty products and/or create niche markets.

Specific trends in new process technology have been identified [Leenders and Wood (1983)] including:

1) a tendency towards smaller operational units,

2) a trend towards greater flexibility,

3) decreasing capital costs per unit produced, and

4) user friendly systems permitting more rapid training and easier maintenance.

Yet the development and/or acquisition of technology is time consuming, expensive, and competes for a firm's limited financial and human resources. Therefore, it is important to manage the relationship between product innovation and technology diffusion in an effort to maximize the benefit from resources committed to the development of new technology.

Traditional theories regarding the process of product innovation and technology diffusion are propelled by one of two distinct yet opposite forces - technology push or market pull. Theories subscribing to the forces of technology push argue that the impetus for innovation and diffusion comes from research and development. Under this scenario, technological refinements or breakthroughs developed in the laboratory are incorporated into the design of new or existing product lines. The modifications are pushed from R&D through to product
design and ultimately to the end-user. For example, in the search for new adhesives, 3M scientists discovered a material that would bind two pieces of paper and still allow them to be separated undamaged. This innovation was eventually transformed into the ubiquitous "Post-It" note.

Alternatively, market pull implies that end-users' demand for improved product attributes is the force that drives innovation and technology diffusion. "Writers on technology have stated that a market, and presumably an appropriate marketing strategy, are essential for the commercial viability of a new technology" [Kiel (1984)]. Recent models of technology transfer, such as Robertson and Gatignon (1989) and Mahajan, Muller and Bass (1990), often omit the impact of market forces on innovation.

The end-users' desire for lower prices, higher quality, better performance, or improved service are examples of the forces that drive manufacturers to refine and/or replace products. End-user requirements for wood products with more uniform strength characteristics resulted in machine stress rated lumber (MSR), laminated veneer lumber (LVL), Parallam™, and 'engineered' wood products such as wood I-beams. However, "marketing writers have paid lip service to technology as the source of new and improved goods and services but have failed to ask how technological strategy and marketing strategy are interrelated" [Kiel (1984)].

More recently, the idea of market pull and technology push working in concert has been explored [Kiel (1984), Capon and Glazer (1987), and Lambkin and Day (1989)]. Marketing information can forewarn of potential threats (or opportunities) to a firm's existing product line, and enable planners to focus on those innovations that directly impact the threat (or opportunity). In this way, marketing and technology resources are merged to enhance the
firm's ability to respond to and create change in the market place. For instance, innovative technologies used by the manufacturers of OSB products have drastically reduced the competitiveness of the plywood industry in North America.

In response, plywood manufacturers are turning to innovative technologies to reduce production costs (e.g. high speed lathes, optimizing lathes, spindleless lathes, veneer composing equipment, and faster curing resins) and to develop markets where plywood has competitive advantages over OSB [Spelter and Sleet (1989)].

In general, any industry operating in any environment where technology has far reaching implications for a firm's long-term competitiveness requires that industry constantly scan the technology horizon for potential threats and opportunities. The symbiotic relationship that exists between innovation and market application also suggests that threats and opportunities can be used to create competitive advantages. In the case of this research project, it is hoped that the identification and quantification of determinant attributes will point to appropriate technologies that will create competitive advantages without squandering limited financial and human resources.

4.4 Statistical Methodology

Given the specific nature of research objectives, the selection of statistical analyses was undertaken a priori to data collection, and the survey questionnaire format and content were designed accordingly. Although other statistical analysis techniques were considered, it was felt that the combination of determinant attributes analysis and multi-attribute model provided simpler, yet meaningful predictions or inferences about end-use preferences.
4.4.1 Determinant Attributes

Among the many theories on business and marketing practices it is widely accepted that a firm's growth and profitability can be maintained and/or improved by providing products that fulfill its customers' needs better and more efficiently than its competitors. Marketing is defined as the development and efficient distribution of goods, services, issues, and concepts for chosen consumer segments. Therefore, identifying the appropriate product to offer a selected customer segment is one of marketing's primary roles.

Fulfilling the customers' needs presupposes an understanding of their needs, expectations, and desires from a product, and implies that the firm recognizes attitudes and preferences towards competing products in the market place. Ultimately, this knowledge of the firm's product(s) and its customers can be the focus of marketing research programs designed to identify the importance of the product attributes that influence purchasing behaviour.

Although a number of product attributes may be important to the buyer, some are thought to be 'determinant' in the purchasing decision. An attribute may be important to the buyer and yet if there is no perceived difference between competing products with respect to that attribute then it is not determinant to the customer's purchasing decision. Conversely, determinant attributes are those attributes that are both important and discriminate between alternative products (i.e., customers do not perceive competing products to possess determinant attributes equally). Thus determinant attributes can be altered to impact the competitive position of the product.
There are a number of alternative methods for identifying determinant attributes. In a review and comparison of techniques [Myers and Alpert (1968), Alpert (1971)], the direct dual questioning technique was found to be the simplest and most direct method for assessing overall preference, and was the method chosen for this study.

As can be deduced from its name, the direct dual questioning technique involves asking the respondents two questions for each product attribute. Specifically, each respondent is first asked how important each attribute is thought to be in determining the choice of product, and then asked how much difference they perceive between competing products on each attribute. This technique also utilizes direct questioning - as opposed to indirect questioning or observation/experimentation techniques.

Direct question techniques require the purchaser to identify those attributes that are important to them in the buying decision. Attributes posited as determinant are based on modal responses or average importance ratings (i.e., high average importance rating is equivalent to determinance). This approach requires two assumptions: first, that respondents are able to identify and articulate the reasons for buying one product over another, and second, that the respondents are willing to provide the real reasons for their purchasing decisions.

Indirect questioning techniques do not ask the respondent directly about his/her choice. Typically, these methods substitute the second person terminology 'you' with third person phrases such as 'most people', or 'other people'. In the industrial marketing context, investigators may ask a respondent for the most important product attributes for most firms, rather than your firm. Indirect questioning is the prominent technique for
motivation research, the inference of 'ideal' attributes, and covariant analysis [Myers and Alpert (1968)].

Identifying determinant attributes through observation and experimentation techniques is one of the oldest methods used [Myers and Alpert (1968)], however, observation techniques are too costly for most circumstances and suffer from the inability to observe beliefs, feelings and preferences. Observation and experimentation are best suited for a narrow range of consumer market research applications, rather than industrial marketing. For this reason, no further discussion is presented on these techniques.

A number of recent marketing studies have used the dual questioning technique [Seward and Sinclair (1988), Stalling and Sinclair (1989), and Bush, Sinclair and Araman (1991)]. The underlying premise for this technique is to account for the two dimensional nature of product attributes. The first dimension of an attribute is its importance to the purchaser, while the second is the perceived difference between products with respect to the attribute. Attributes that are rated high in terms of importance and difference are posited as determinant.

In a comparison of determinant attribute techniques it was concluded that direct questioning was better than indirect questioning, and that dual questioning was slightly more effective than simple (single) questioning. Overall, direct dual questioning was judged to be the most effective method - "giving a simple list of likely determinants of overall preference and having the advantage of not requiring a set of ratings (brand by brand) to identify attributes" [Alpert (1971)]. For this reason, the direct dual questioning technique was used for this research project.
4.4.2 A Multi-Attribute Modeling of Purchasing Predisposition's

The use of multi-attribute models in marketing is well documented in marketing literature [Wilkie and Pessemier (1973), and Hughes (1971)]. In a comprehensive review of various multi-attribute studies Wilkie and Pessemier found that most research studies came to a similar conclusion - that a purchaser's attitudes and perceptions towards alternative products were highly correlated with their purchasing predisposition. Therefore, these models are designed to assist marketers predict future purchasing behaviour for a given product. Admittedly, better and simpler predictors are available (e.g. last period purchase), however multi-attribute modeling provides researchers with a diagnostic tool for assessing purchasing predisposition and subsequent purchasing behaviour. In other words, models help marketing researchers assess a product's strength and weaknesses on selected attributes and formulate appropriate responses in the marketplace (i.e., improving product performance on determinant attributes).

The model utilized in this research study is a simple linear summative model that combines information derived from determinant attribute analysis with respondent perceptions of alternative products with respect to the determinant attributes. More simply stated, the purchaser's attitude towards a product is thought to be a function of:

1) the importance weight given to the product attributes, and

2) the purchasers belief as to the extent to which the determinant attributes are offered by each product.
In developing a multi-attribute model for this research project, a number of issues were felt to be important for reliability and validity, including:

1) the initial specification of attributes,

2) the independence assumptions regarding attributes,

3) the salience vs. importance of attributes, and

4) the number of attributes to include.

A basic summative linear compensatory attribute model was chosen for this research project [Wilkie and Pessemier (1973)] and can be represented as:

\[
A_{jk} = \sum_{i=1}^{n} (I_i k B_{ijk})
\]

where,

\( i \) = attribute or product characteristic

\( j \) = brand or product

\( k \) = purchaser or respondent

\( n \) = number of attributes in the model

such that,

\( A_{jk} \) = purchaser \( k \)'s attitude score for product \( j \)

\( I_{ik} \) = importance weight given attribute \( i \) by consumer \( k \), and

\( B_{ijk} \) = purchaser \( k \)'s belief of the extent to which attribute \( i \) is offered by product \( j \)

For a more complete discussion of the model and related issues, the reader is referred to Wilkie and Pessemier (1973).
5.0 JAPANESE PANEL MARKETS: ASSESSING PRODUCT REQUIREMENTS

5.1 RESEARCH METHODOLOGY

5.1.1 Research Design

The basic research design for this thesis is outlined in Figure One. The original sample population (raw data set) was transformed using Post-hoc Probability Proportional to Size (PPS) sampling and then identical data analyses were conducted on both the raw data set and the PPS data set. PPS sampling has been shown to be a useful data treatment to develop a sufficient sample size for statistical analysis from a small selected, weighted sample in a concentrated industry [Cochran (1977)].

For each data set, importance scores and difference scores were used to calculate determinance scores and then identify determinant attributes. Determinant attribute information was subsequently combined with perception scores to construct a linear summative multi-attribute model.

Finally, the multi-attribute model was used to predict the effects of product design changes on customer preferences. It is posited that a multi-attribute model can be used in the refinement of a product's determinant attributes, and thereby improve its competitive position in the market.
Figure One - Overview of Research Design

Judgemental Sample of Fourteen Companies

Raw Data Set

- Importance Score (5 point scale)
- Difference Score (4 point scale)

- Determinance Score (20 point scale)

- DETERMINANT ATTRIBUTES

- Perception Scores (4 point scale)

LINEAR SUMMATIVE MULTI-ATTRIBUTE MODEL

PPS Data Set

- Importance Score (5 point scale)
- Difference Score (4 point scale)

- Determinance Score (20 point scale)

- DETERMINANT ATTRIBUTES

- Perception Scores (4 point scale)

LINEAR SUMMATIVE MULTI-ATTRIBUTE MODEL
5.1.2 Sampling Procedure

A judgmental sample of fourteen Japanese companies was selected with the assistance of Interior Export Lumber Sales Ltd. of Vancouver, B.C. (formerly Seaboard Timber and Plywood Asia Ltd. (Seasia)). The small sample size employed in this research project is typical of industrial research studies of highly concentrated industries - such as the Japanese forest products import/wholesale distribution industry - where a small sample can comprise a significant proportion of the overall population. Under these conditions, one can be confident in obtaining data with substantive practical importance if sufficient care is taken during the selection of the judgmental sample [Karmel and Jain (1987)].

In this research project, a judgmental sample was chosen over a random sample after weighing the trade-off between data validity/reliability and data collection costs. In light of the highly concentrated nature of the target population of Japanese importers and wholesalers, a random sample would not have improved data validity or reliability significantly. Furthermore, the incremental cost of interviewing a large random sample of Japanese companies would have been prohibitive. Given these circumstances, it was felt that the judgmental sampling procedure provided an acceptable trade-off between data quality and data collection costs.

The sampling procedure was designed to yield a representative cross section of Japanese companies involved in the import, distribution, and end-use of wood based structural panel products. The sample included both medium and large importers, wholesalers, and home builders located in Tokyo, Osaka, Sapporo, and Kyoto. As a result of the broad range of companies included in the sample, the potential for introducing significant bias was present. Of particular concern was the effect of weighting the responses from all
companies equally, since there were considerable differences between the volume of structural panels each company handled annually.

To compensate for inter-company volume differences, post-hoc probability proportional to size (PPS) sampling was employed in order to provide unbiased weights for subsequent data analysis. An overview of the PPS sampling carried out for this research follows.

Raw data for all fourteen companies was tabulated with each company's 1990 annual volume of panel purchases and cumulative sum of purchases. The cumulative sum of purchases was converted to cumulative probabilities (probability 0.0 to 1.0), from which a random sample was drawn to create an unbiased data set for determinant attributes analysis and multi-attribute modeling. Sample size determination was based on a two-tail test of significance at the 0.05 level and calculated as follows:

$$n = \frac{(t^2 \cdot s^2)}{E^2}$$

where,

- \(n\) = sample size
- \(t\) = t-score (\(\alpha = 0.05\), degrees of freedom = inf.)
- \(s\) = standard deviation
- \(E\) = desired magnitude of difference between attribute means to detect with statistical t-tests
thus, using normalized data

\[
(2) \quad n = \frac{(1.960^2 \cdot 1^2)}{(0.225^2)} = 75
\]

As can be seen from equation (2), the magnitude of 'E' is pivotal to the calculation of sample size and the selection of an appropriate 'E' is at the discretion of the investigator. However, the relationship between sample size and the sensitivity of the statistical test is such that as the magnitude of 'E' decreases the sample size increases. When sample size becomes very large, the probability of type II error increases. Conversely, when sample size is very small, the probability of type I error increases. Thus, a value of 'E' was chosen that resulted in a trade-off between type I and type II error; this point was approximately \( E = 0.225 \) and yielded a sample size of \( n = 75 \).

Subsequently, a random sample of \( n = 75 \) was drawn (with replacement) from the original sample distribution and resulted in a new sample population (PPS sample) more representative of the overall population. A pictorial representation of the PPS sampling technique is shown in Figure Two and an example of PPS sampling is described as follows:

1. The total volume of panels purchased by the respondents in the sample population is calculated. The representative weight for each company is simply its share of the total volume of panels. If the total volume of panels for the sample population is 100,000 cubic metres, a company that purchases 5,000 cubic metres per year represents 5 percent of the population. Similarly, a company that
purchases 16,000 cubic metres per year represents 16 percent of the population. Furthermore, these companies have a 5 percent and 16 percent chance of being sampled from the sample population.

2. Using random numbers, a total of 75 companies was sampled from the weighted population, with each company being replaced after selection. Companies that purchase a greater volume of panels have a greater chance of being selected. The resulting PPS sample results in a data pool more representative of the overall population than the raw data pool consisting of the 14 companies interviewed.

**Figure Two - Pictorial Representation of the PPS Sampling Technique**

5.1.3 Respondent Description

Interviews were conducted with key management personnel from each of the fourteen Japanese companies selected for the research study. All fourteen companies were
involved in the import and/or wholesale of wood based structural panels, or purchased structural panels for use in home construction. Individual respondents were directly involved in the buying and selling of structural panels for their company and typically, more than one respondent from each company was present during the course of the interview session.

Individual respondents included company presidents and a wide variety of purchasing and sales managers - including departmental/sectional managers, associate managers, assistant managers, general managers, and deputy general managers. Overall, forty-eight percent of the respondents belonged to the general category of senior management and were in a position to directly influence their firm's purchasing criteria.

5.2 DATA COLLECTION

5.2.1 Methodology

Primary data was collected in Japan by conducting personal interviews with managers of fourteen separate companies. A sample questionnaire is included in Appendix One. Although personal interviews can be an expensive and time consuming data collection technique, for this project it was the most appropriate method for a number of reasons.

First, the quantity and quality of data that was sought required in-depth interviews that typically lasted one to two hours each. The use of a mailed written questionnaire would have yielded a very low response rate and overseas telephone interviews would have
been expensive and inappropriate given Japanese business customs and practices. In both cases, written questionnaires and telephone interviews prevent the interviewer from effectively addressing the problem of language barriers.

Second, the technical subject matter and general language difficulties were overcome by the ability to provide immediate clarification during the course of the interview. To facilitate the data collection process, a detailed written questionnaire was developed for use during the interviews. A copy of the questionnaire was provided to the respondents at the outset of the interview in order to clarify specific questions and general topics for discussion. In addition, the questionnaire prevented omissions during the interview process and guided each interview from a logical beginning to end. Overall, the combined discussion and visualization technique was useful for both interviewers and interviewees, and undoubtedly improved data quality.

Finally, the highly concentrated nature of the Japanese industry provided the ability to survey a significant proportion of the industry with relatively few interviews. The ability to complete the interview process in a relatively short period of time minimized an otherwise prohibitive data collection cost.
6.0 RESEARCH RESULTS

6.1 DEMOGRAPHICS AND DESCRIPTIVE STATISTICS

When asked to describe their firm's principle business function, 50 percent of the respondents classified their firm as an importer, 21 percent as a wholesaler, and the remaining 29 percent were classified as home manufacturers (see Figure Three). It is worthwhile mentioning that all of the importers surveyed also performed a wholesale function in the Japanese distribution system.

![Figure Three - Classification Of Firms]

When asked about the usage of OSB, 50 percent of the companies indicated they were 'currently purchasing' the product, 30 percent indicated they were 'considering purchasing', and only 14 percent of the respondents indicated their company had 'no intention of purchasing' OSB at the time (see Figure Four).
The total volume of wood based structural panels consumed in Japan during 1991 was estimated at 10.6 BSF. The total volume of panels handled by all respondent firms in this study was approximately 5.7 BSF, or nearly 54 percent of total Japanese domestic consumption. Adjusting for potential double counting between importers, wholesalers, and home builders, the respondent firms accounted for a total of 5.14 BSF, or just over 48 percent of the total Japanese domestic consumption.

The percentage of imported panels versus domestic panels that each company reported handling varied widely from one firm to the next. In summary, companies reported handling as little as 5 percent and as much as 100 percent imported panels. Of the total volume of panels handled by the respondents, approximately 32 percent were imported versus 68 percent domestic (see Figure Five). This correlates well with the actual figures reported for all structural panel products consumed in Japan of 30 percent imported versus 70 percent domestic (Japan Lumber Journal, July 31, 1993).
Upon further analysis, approximately 88 percent of the imported panels were sourced from other Southeast Asian countries (including Indonesia, Philippines, Malaysia, etc.), 8 percent were from North America, and 4 percent were from other countries (see Figure Six).
The traditional panel size in Japan is a 3 x 6 panel based on the Tatami system. This panel is
the preferred size for sheathing material used in the traditional Japanese post and beam
construction method, and for use in concrete forming markets. Of the 6 million m$^3$ of
domestic plywood produced in 1990, 2.4 million m$^3$ (40 percent) was used as sheathing by
the home construction market segment. Similarly, 40 percent of the imported structural
grade Lauan plywood is used as sheathing material. Typical floor sheathing for single
family style homes is 3 x 6 - 12.0mm thick (some small volumes of 2 x 6 - 12.0mm is used),
although some markets also use 3 x 6 - 15.0mm thick panels. Floor sheathing in apartment
buildings is often 3 x 6 - 20.0mm thick.

Exceptions do exist, particularly for 2 x 4 Platform Frame Construction (PFC) where 3 x 8
and 4 x 8 panels are used for roof and wall sheathing, and minor volumes of 3 x 9 are used
for wall sheathing on ground level walls to construct 9' high ceilings. However, the PFC
market still uses 3 x 6 panels for floor sheathing. A summary of the companies surveyed
shows that 79 percent of the panels purchased were 3 x 6 in dimension, 3 percent were 2 x 8, 3 percent were 4 x 8 and 15 percent were of some other dimension (see Figure Seven).

**Figure Seven - Dimensions of Panels Purchased by Firms Surveyed**

Of the volumes of structural panels firms surveyed, 66 percent was used in traditional Japanese home construction, 12 percent was used in 2x4 home construction, 18 percent in packaging & crating, and 4 percent in concrete forming and other end-uses (see Figure Eight).
The concrete forming market consumes a significant volume of plywood, and it is estimated that this market segment absorbs 2,000,000 m$^3$ per year of 3 x 6 panels - either 11.5mm or 12.0mm thick. Although concrete forming is not shown as an end-use unto itself, the volume of panels consumed is included in the other end-use segments.

As previously discussed, the Japanese concrete forming industry has come under criticism for its inefficient use of concrete forming panels. It is being recommended (and legislated) that the industry promote the use of softwood plywood as a substitute for hardwood plywood - recognizing that plywood concrete forming panels is an essential material for construction works. Many firms have already taken this recommendation one step further and are investigating the use of OSB as a concrete forming panel.
The products chosen for comparison were Lauan plywood, Canadian softwood plywood, and OSB. All of these products were commercially available in the Japanese market at the time of the study. The product attributes for this research study were selected on an apriori basis, supported by discussions with North American forest products marketing organizations operating in Japan. Not shown in any particular order of importance or determinance, the ten attributes chosen were:

1) Competitive Price  
2) Thickness Swell  
3) Linear Expansion  
4) Physical Strength  
5) Panel Size  
6) Long-term Supply  
7) Manufacturer's Reputation  
8) Physical Appearance  
9) Nail Holding Strength  
10) Overall Quality

The respondents were first asked to rate the importance of the ten structural panel attributes on a five point importance scale ranging from 1 = "of no importance" to 5 = "critical". Respondents were then asked to indicate how much difference they felt there was between the three competing products for each of the ten attributes. A four point difference scale was used to indicate the degree of difference ranging from 1 = "very similar" to 4 = "very different". For each respondent, this process yielded an importance score 'x' and a difference score 'y' for each of the ten attributes.

Determinance for each attribute was calculated by multiplying the importance score 'x' by the difference score 'y'. The product 'xy' represents the weighted importance of each
attribute or its **determinance score**. Therefore, the relative importance of each attribute is measured by the determinance score 'xy' on a new scale ranging from 1 to 20 (the product of importance scale and difference scale). Determinant attributes have determinance scores that are high on the 20 point scale, based on their importance to the purchaser and ability to discriminate between competing products.

Determinant attributes were identified using both the original data set and the PPS data set. To adjust for differences in respondent interpretation of the five point importance scale and four point difference scale, raw scores for each respondent were converted to standardized scores. Mean determinance scores were calculated for each attribute and then converted to determinance t-scores - using grand attribute mean and variance figures. Grand attribute mean and variance figures were based on the distribution of standardized mean determinance scores.

A one-tailed z-test was used to identify determinant attributes for the PPS data [Lumpkin et. al. (1985), Alpert (1971)]. Given the small sample size (n=14) of the original data, a one-tailed t-test was used to identify the determinant attributes. Attributes with a determinance score significantly greater than the mean of 0 were posited as determinant attributes. In the analysis of the PPS and original data, the population mean and variance were estimated using the grand mean and variance from each sample.
Algebraically, the calculation of determinance scores is depicted as follows:

\[
D_i = \frac{(P_i L_i - x)}{s}
\]

where,

\[D_i\] = Determinance score for attribute \(i\).

\[P_i\] = Perceived difference between structural panels on attribute \(i\).

\[L_i\] = Importance of attribute \(i\).

\[x\] = Respondent's grand determinance mean (i.e., the mean of \(P^*L\) for all ten attributes.

\[s\] = Standard deviation of \(x\)

Differences between each attribute were tested using a 'z-test' (a 't-test' in the case of data set one) at the 0.05 and 0.01 level of significance. Using the technique outlined, attributes with either very high or very low determinance scores tend to pull the mean towards their sample mean and potentially bias the data [Alpert (1971)]. However, this represents a conservative approach to identifying determinant attributes as the effect of the bias would be to lessen the importance of extreme determinance scores. Proponents of this technique [Alpert (1971), Lumpkin et. al. (1985), and Stalling and Sinclair (1989)] also suggest that this systematic approach to identifying determinant attributes is an improvement over other techniques.

At this time, considerable debate remains, concerning the validity of using statistically based z-tests as an identification technique. Much of the controversy surrounds the analysis of data based on a scale created from the product of the importance and difference scales. Since respondents did not directly answer questions on the combined
importance/difference scale, there is some question whether points on the combined scale are meaningful. One could also question whether parametric statistical tests are valid when a 20 point scale may not provide enough points to reasonably approximate a normal distribution.

One way to address these concerns is to rank the attribute scores in descending order and report the relative importance of attributes. This approach implies that the relative importance of the attributes is important and that rankings are sufficient to serve as a guideline in formulating marketing strategies.

In any event, if the original specification of attributes is thorough and the attributes are salient then discrepancies between determinant attributes will likely be minor, irrespective of identification methodology.

Figure Nine profiles the five attributes with the highest determinance scores in the raw data set. All five attributes have determinance scores greater than the mean of zero, implying that each is relatively important in the purchasing decision. In descending order of determinance, these attributes are Panel Size, Competitive Price, Thickness Swell, Long-term Supply, and Overall Quality. Using a one tailed t-test at the 0.05 level of significance, only the Panel Size, Competitive Price, and Thickness Swell were identified as determinant attributes. At the 0.01 level of significance, only Panel Size and Competitive Price were considered to be determinant.
Figure Nine identifies the attributes with the five highest determinance scores in the raw data set. Each of these five attributes had determinance scores above the mean of zero and are considered relatively important to the purchasing decision. For this set of respondents, Size, Price, Swell, Supply, and Quality are all considered to be determinant attributes.

Figure Ten identifies the attributes with the five lowest determinance scores in the raw data set. Each of these five attributes had determinance scores below the mean of zero and are considered relatively unimportant to the purchasing decision. For this set of respondents, Physical Appearance, Physical Strength, Manufacturer's Reputation, Nail Holding Strength, and Linear Expansion are all considered to be non-determinant attributes.
Figure Eleven identifies the determinant attributes for the PPS data set. All five attributes have determinance scores higher than the mean of zero and, therefore, are relatively important to the purchasing decision. In descending order of determinance these attributes are Panel Size, Thickness Swell, Overall Quality, Long-term Supply, and Physical Appearance. Using a one tailed z-test at the 0.05 level of significance, only Panel Size, Thickness Swell, and Overall Quality are felt to be determinant attributes. At the 0.01 level of significance, only Panel Size and Thickness Swell are still considered determinant attributes.

**Figure Eleven - Five Highest Determinance Scores (PPS Data Set)**

![Bar chart showing standardized determinance scores for Panel Size, Thickness Swell, Overall Quality, Long-term Supply, and Physical Appearance.]

Figure Twelve identifies the remaining five non-determinant attributes for the PPS data set. In descending order, the five most determinant attributes are Competitive Price, Physical Strength, Manufacturer's Reputation, Nail Holding Strength, and Linear Expansion. Although Competitive Price did score above the mean of zero, it was not statistically significant at either the 0.05 or 0.01 level of significance.
Table Four summarizes the standardized determinance scores for both the raw data set and the PPS data set with determinant attributes underlined and shown in bold, italic type (statistically significant at $\alpha = 0.05$).

**Table Four - Summary of Standardized Determinance Scores**

<table>
<thead>
<tr>
<th>Data Set/Attribute</th>
<th>Price</th>
<th>Swell</th>
<th>LinExp</th>
<th>Strength</th>
<th>Size</th>
<th>Supply</th>
<th>MftRep</th>
<th>Appear</th>
<th>NailHold</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Data Set</td>
<td>3.93</td>
<td>2.24</td>
<td>-4.08</td>
<td>-1.94</td>
<td>5.10</td>
<td>1.48</td>
<td>-2.39</td>
<td>-1.69</td>
<td>-3.42</td>
<td>0.77</td>
</tr>
<tr>
<td>PPS Data Set</td>
<td>0.21</td>
<td>4.20</td>
<td>-3.74</td>
<td>-2.78</td>
<td>4.39</td>
<td>1.26</td>
<td>-3.45</td>
<td>0.64</td>
<td>-3.30</td>
<td>2.57</td>
</tr>
</tbody>
</table>

A comparative analysis of the results of the determinant attributes analysis of the raw data set and PPS data set reveals a number of important observations. **First**, Panel Size is the most determinant attribute in the purchasing decision for structural panels for both data sets. This is to be expected since a structural panel without the desired dimensions will have little use to the customer. A structural panel product is only one of many components that make up a home and the load bearing elements and other structural
materials (including the sheathing material) are designed to work as a system and to complement one another. The panel must fit the building system regardless of whether a traditional post and beam construction system or a platform frame system is used.

**Second,** Panel Price appears to be more important to the smaller companies than it is to the larger companies. Specifically, the raw data set reflects a disproportionate weight of the small firms (with respect to purchase volumes) and the determinant attributes analysis indicates that Panel Price is the second most important attribute for this sample group. On the other hand, the weighting of the larger firms in the PPS data set is more in proportion to their consumption, and consequently Panel Price is reduced to the sixth most important attribute and statistically speaking is not determinant.

Two possible explanations for this observation are that the smaller companies actually are more price sensitive than the larger companies, or that the larger firms consider price to be negotiable once long-term relationships for supply are developed. Considering the large volumes of panels purchased by some of the large companies, it is likely that their strong negotiating position diverts price considerations to other attributes - at least initially. In essence, the larger companies assume that their purchasing power will enable them to buy the product cost effectively once a commitment to the product has been made and long-term relationships with suppliers have been established. Judging from actual experience with the larger Japanese importers and trading houses, the latter scenario is the most probable.

**Third,** Thickness Swell is a determinant attribute regardless of firm size. OSB is perceived as being a weak performer on this attribute, indicating that this is an area for significant improvement and a potentially a source of increased competitiveness.
And last, Long-term Supply was not a determinant attribute for either data set. This is somewhat surprising since there was a strong statement of concern from most respondents about the long-term supply of the traditional Lauan plywood product. This sentiment was also reflected in the number of respondents that were either ‘presently purchasing’ or ‘considering purchasing’ OSB. It may be that the collective concern regarding Lauan supply from traditional sources was overstated by the respondents, or that the concern regarding supply was more medium- to long-term in nature.

6.2.2 Respondent Perceptions

Respondents were asked to rate each panel product chosen for comparison in terms of each product attribute. Respondents indicated to what extent they felt the product possessed each product attribute using a four point scale ranging from 1 = “not at all” to 4 = “a high degree”. Respondents' perceptions are summarized in Table Four for both data sets. All data shown is Table Five is standardized and statistically significant values (using a one-tail t-test) are shown in bold type.

OSB was perceived by Japanese purchasers as performing well on Competitive Price and Long-term Supply (statistically significant at $\alpha = 0.05$). Conversely, OSB was perceived as a weak performer on Thickness Swell, Panel Size, and Physical Appearance (statistically significant at $\alpha = 0.05$). The determinant attributes for each data set are shaded.
Table Five - Summary of Standardized Respondent Perceptions

Raw Data Set

<table>
<thead>
<tr>
<th>Panel / Attribute</th>
<th>Price</th>
<th>Swell</th>
<th>LinExp</th>
<th>Strength</th>
<th>Size</th>
<th>Supply</th>
<th>MitRep</th>
<th>Appear</th>
<th>NailHold</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lauan Plywood</td>
<td>-5.32</td>
<td>3.02</td>
<td>0.72</td>
<td>-0.04</td>
<td>1.77</td>
<td>-5.49</td>
<td>0.15</td>
<td>4.30</td>
<td>0.42</td>
<td>0.47</td>
</tr>
<tr>
<td>Softwood Plywood</td>
<td>-3.85</td>
<td>4.67</td>
<td>2.84</td>
<td>-0.61</td>
<td>-4.52</td>
<td>-3.20</td>
<td>1.74</td>
<td>-1.23</td>
<td>2.84</td>
<td>1.32</td>
</tr>
<tr>
<td>OSB</td>
<td>5.43</td>
<td>-4.10</td>
<td>0.56</td>
<td>0.83</td>
<td>-3.15</td>
<td>4.17</td>
<td>0.85</td>
<td>-3.09</td>
<td>0.67</td>
<td>-2.17</td>
</tr>
</tbody>
</table>

PPS Data Set

<table>
<thead>
<tr>
<th>Panel / Attribute</th>
<th>Price</th>
<th>Swell</th>
<th>LinExp</th>
<th>Strength</th>
<th>Size</th>
<th>Supply</th>
<th>MitRep</th>
<th>Appear</th>
<th>NailHold</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lauan Plywood</td>
<td>-4.92</td>
<td>1.51</td>
<td>0.23</td>
<td>0.16</td>
<td>2.05</td>
<td>-5.35</td>
<td>0.23</td>
<td>5.52</td>
<td>0.23</td>
<td>0.35</td>
</tr>
<tr>
<td>Softwood Plywood</td>
<td>-3.80</td>
<td>3.68</td>
<td>2.93</td>
<td>2.26</td>
<td>-5.19</td>
<td>-0.82</td>
<td>2.00</td>
<td>-2.39</td>
<td>2.93</td>
<td>-1.60</td>
</tr>
<tr>
<td>OSB</td>
<td>3.36</td>
<td>-4.16</td>
<td>1.26</td>
<td>0.32</td>
<td>-5.21</td>
<td>5.12</td>
<td>0.17</td>
<td>-2.32</td>
<td>0.57</td>
<td>0.89</td>
</tr>
</tbody>
</table>

6.2.3 Linear Summative Multi-Attribute Model

When faced with a purchasing decision the buyer does not weight all product attributes equally. The determinant attributes are used to assess and discriminate between alternative products.

Determinant attributes analysis can be more informative when respondents also reveal their perceptions of how competing products perform on the determinant attributes. In other words, it is pertinent to ascertain how well a product compares with other products on the determinant attributes and how that comparison impacts the purchasing decision. By combining determinant attributes with customer perceptions, it is possible to model the purchasing decision and to make predictions regarding purchasing intentions.

For this study, the determinant attribute and perception data were used to validate the basic model against observed purchasing behaviour in the Japanese market. Modeling
was undertaken with both the raw data set and the PPS data set, with all attributes included in the model and then with determinant attributes only.

Using the Wilkie and Pessemier linear summative model described in section 4.4.2 to predict purchasing intentions:

\[
A_{jk} = \sum_{i=1}^{n} (I_{ik}B_{ijk})
\]

Attitude score calculations \((A_{jk})\) for all three products were made using standardized attribute scores \((I_{ik})\) and standardized perception scores \((B_{ijk})\) from the raw data set and PPS data set. These calculations were repeated using determinant attribute scores only and the corresponding perception scores for both data sets. This approach was used to assess if predictive ability was lost with the inclusion of all determinant attributes. Table Six summarizes the attitude scores calculated for the following data set and attribute combinations:

\[
\begin{align*}
A) & \quad \text{raw data set, all attributes} \\
B) & \quad \text{raw data set, determinant attributes only} \\
C) & \quad \text{PPS data set, all attributes} \\
D) & \quad \text{PPS data set, determinant attributes only} \\
E) & \quad \text{Small Firms Only, all attributes} \\
F) & \quad \text{Large Firms Only, all attributes}
\end{align*}
\]
Table Six - Summary of Multi-Attribute Modeling

<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Raw Data Set</th>
<th>PPS Data Set</th>
<th>(Small Firms Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A)</td>
<td>(C)</td>
<td>(E)</td>
</tr>
<tr>
<td>All Attributes</td>
<td>(6 total)</td>
<td>(6 total)</td>
<td></td>
</tr>
<tr>
<td>Lauan Plywood</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Softwood Plywood</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Oriented Strand Board</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(Large Firms Only) * (8 total)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determinant Attributes Only</td>
<td>(B)</td>
<td>(D)</td>
<td>(F)</td>
</tr>
<tr>
<td>Lauan Plywood</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Softwood Plywood</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Oriented Strand Board</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

* Rank order preference based upon all ten (10) attributes.

When interpreting attitude scores, one considers the rank order of the scores only. A product that scores twice as high as another does not imply that product is twice as likely to be purchased. The only conclusion that may be drawn is that products with higher attitude scores are more likely to be purchased than products with lower scores.

As shown in Table Six, the attitude scores (Ajk) of each panel product vary depending on whether all attributes or only the determinant attributes are included in the analysis. Attitude scores also varied between the raw data set and the PPS data set. The rank order preference changes when the modeling is performed with determinant attributes only. This observation serves to highlight the underlying principle of determinant attributes analysis that attributes must be important to the purchasing decision and discriminate between alternative products.
A second important observation from Table Six is that there seems to be a difference in preferences between small and large firms. When considering analysis ‘A’ (Data Set One, all attributes), OSB is the preferred product, Lauan plywood is the second choice product, and softwood plywood is the third choice product. When considering analysis ‘C’ (PPS data set, all attributes), Lauan plywood is the preferred product, OSB is the second choice product, and softwood plywood remains the third choice product. Since the primary difference between the two data sets is the proportional weighting in the PPS data set, separate subsets of data were modeled to confirm perceived differences between small and large firms.

Specifically, two subsets of the raw data were used and referred to as analysis ‘E’ and analysis ‘F’. Analysis ‘E’ in Table Six was a data subset that utilized all attributes and included only the firms that handled a relatively small volume of panels (the ‘small firms’). Conversely, analysis ‘F’ in Table Six was a data subset that also utilized all attributes included only the firms that handled a relatively large volume of panels (the ‘large firms’). The results of these subsets confirm that there is a difference in preferences between small and large firms. Analyses ‘A’ and ‘E’ show identical rank order preferences for the three panel products and indicate that small firms prefer OSB over the other products. Analyses ‘D’ and ‘F’ also show identical rank order preferences for the three panel products and indicate that large firms prefer Lauan plywood over OSB and softwood plywood.

On this basis, it appears that smaller consumers are more likely to purchase OSB panels than larger panel consumers. Therefore, an appropriate marketing strategy for Japan would be to target customers further downstream in the distribution channel. The basis for this strategy is that firms further downstream the distribution channel are similar to
the smaller firms that participated in this study. In the past, penetrating the Japanese
distribution system to reach the end-users has been difficult. More recently the trend is
towards North American forest product manufacturers to market their products to
medium and small wholesalers, and directly to home manufacturers.

Based on the PPS data set, Lauan is the preferred panel product in the Japanese market
and is followed by softwood plywood and OSB in descending order of preference
(analysis ‘D’). These results are consistent with actual purchasing patterns in the
Japanese market. If the results from the model are valid, then OSB market share should
increase and surpass that of softwood plywood as the OSB industry improves the quality
of its product and begins to export to the Japanese market. On the basis of the
determinant attributes analysis in section 6.2.3, this process would accelerate with:

1) improved processing technology and production techniques that will permit OSB
manufactures to supply a panel with improved thickness swell properties,

2) the construction of OSB mills with the ability to produce three foot wide panels,
and

3) increasing Japanese concerns over the rising cost and long-term supply of
softwood plywood.

6.2.4 Predictive Use of the Linear Summative Multi-Attribute Model

An important use of the linear summative multi-attribute (LSM) model lies in its
predictive ability and the impact of a change in customer perceptions with respect to
product attributes. As a marketing tool, this provides the ability to ask questions about
the impact of adopting specific technologies or altering marketing strategies (such as
customer education programs) that might impact product performance and hence,
customer perceptions. These questions might include:

1) What if determinant attribute 'x' was enhanced by technological change or
different marketing strategy?

2) Would attribute 'y' become determinant if enhanced by technological change, or
a change in marketing strategy?

3) Would changes in the product attributes be sufficient to make a 'second choice'
product the preferred product, or enable a preferred product to remain such
when challenged by competitive products?

The results from the LSM modeling performed in section 6.2.3 predicted that OSB is the
second choice product after Lauan plywood (the preferred product). Assuming the
respondent perception scores for Lauan plywood and softwood plywood remain
unchanged with respect to the determinant attributes, it is possible to predict the relative
change in purchasing predisposition's for the three panel products when the customer's
perception scores for OSB are increased. For clarification, increasing the OSB
perception score to be "equal to or greater than" Lauan plywood means the OSB
perception score was increased if lower than the Lauan score, or left as it was if higher
than the Lauan score.

The sensitivity analyses were intended to demonstrate the potential for an overall
improvement in customer attitudes towards OSB if the perception scores of OSB were to
increase. By modeling the effects on overall customer preferences of a perceived
improvement in product performance, one can use the resultant information to guide product development and/or formulate customer education programs.

Seven separate analyses were performed on the PPS data set, in which determinant attribute results were combined with perception data in the linear summative multi-attribute model to predict customer preferences. The PPS data set was chosen as the 'base case' scenario, since Lauan was identified as the preferred product by the model.

For each analysis the determinance scores and respondent perception scores for Lauan and softwood plywood were held constant. To predict the effect of a change in customer preference, the determinance scores for OSB were held constant while the perception scores on the determinant attributes (Thickness Swell, Panel Size, and Overall Quality) were increased to a level equal to or greater than those for Lauan plywood.

For analyses one through three, the perception scores for one determinant attribute were increased and the remaining two were held constant (e.g. Thickness Swell - increased, Panel Size - constant, Overall Quality - constant). For analyses four through six, the perception scores for two determinant attributes were increased and the remaining one determinant attribute was held constant (e.g. Thickness Swell - increase, Panel Size - increase, Overall Quality - constant). For seventh and final analysis, the perception scores for all three determinant attributes were increased to a level equal to or greater than Lauan plywood. The results of all seven analyses are summarized in Table Seven.
Table Seven - Sensitivity Analyses Using Linear Summative Multi-Attribute Model

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>OSB Perception Score(s) Increased</th>
<th>Rank Order of Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td>None</td>
<td>1 - Lauan Plywood, 2 - Softwood Plywood, 3 - OSB</td>
</tr>
<tr>
<td>One</td>
<td>Swell</td>
<td>1 - Lauan Plywood, 2 - Softwood Plywood, 3 - OSB</td>
</tr>
<tr>
<td>Two</td>
<td>Size</td>
<td>1 - Lauan Plywood, 2 - OSB, 3 - Softwood Plywood</td>
</tr>
<tr>
<td>Three</td>
<td>Quality</td>
<td>1 - Lauan Plywood, 2 - Softwood Plywood, 3 - OSB</td>
</tr>
<tr>
<td>Four</td>
<td>Swell, Size</td>
<td>1 - Lauan Plywood, 2 - OSB, 3 - Softwood Plywood</td>
</tr>
<tr>
<td>Five</td>
<td>Swell, Quality</td>
<td>1 - Lauan Plywood, 2 - OSB, 3 - Softwood Plywood</td>
</tr>
<tr>
<td>Six</td>
<td>Size, Quality</td>
<td>1 - Lauan Plywood, 2 - OSB, 3 - Softwood Plywood</td>
</tr>
<tr>
<td>Seven</td>
<td>Swell, Size, Quality</td>
<td>1 - Lauan Plywood, 2 - OSB, 3 - Softwood Plywood</td>
</tr>
</tbody>
</table>

When customer perception scores are increased on the product attributes thickness swell or overall quality, there is no observed change in purchasing preference. However, OSB replaces softwood plywood as the second choice product when the perception score for panel size is increased. This observation reflects the significant utility to the customer of having a three foot wide panel product that is used throughout much of the home construction industry in Japan.

When any two perception scores are increased simultaneously there is a similar change in purchasing preferences with OSB replacing softwood plywood as the second choice product. As before, any combination that improves OSB performance on panel size is sufficient to make OSB the second choice panel. Provided that OSB is not perceived to perform better than plywood on the attribute panel size, a simultaneous increase in performance on thickness swell and overall quality is sufficient to make OSB preferred over softwood plywood. Under no circumstances does OSB or softwood plywood displace Lauan plywood as the preferred panel product in the Japanese market.
This indicates that at least two things must happen in order for OSB to make significant inroads into the Japanese market. First, the OSB industry must be able to provide 3 foot wide panels to the Japanese market in a consistent and economical manner. This would immediately make OSB a preferred panel product over North American softwood plywood. Second, the OSB industry must develop a product that performs better on thickness swell. Alternatively or commensurately, the OSB industry could also educate the Japanese consumer on the care of the panel before use and cooperate with the Japanese housing industry to develop new construction techniques that will minimize the effects of thickness swell in service.
7.0 **Summary**

North American OSB markets are facing imminent over-supply due to significant capacity additions due to take place over the next two years. Consequently, Canadian OSB manufacturers must undertake market and product development programs in an effort to mitigate the effects of these capacity additions. To date, the focus is on Japan and other offshore export markets in the Pacific Rim.

This research study investigated the market potential for OSB in the Japanese structural panel market and demonstrated a means for identifying the optimal product offering for a specific target market. Determinant attributes analysis was used to identify product attributes that are both important to the purchasing decision and discriminate between alternative panel products for use in the Japanese home construction industry.

Two distinct customer segments were identified in the Japanese structural panel market - small firms and large firms. The small firms and large firms were differentiated on the basis of the annual volume of panel purchases, and each customer segment identified a unique set of determinant product attributes. For the customer segment purchasing relatively large volumes of panels, the set of determinant attributes identified were Panel Size, Thickness Swell, Overall Quality (from most determinant to least determinant). The determinant attributes for the customer segment purchasing smaller volumes of panels were Panel Size, Price, and Thickness Swell (from most determinant to least determinant).

A linear summative multi-attribute model combined determinant attributes analysis with perceptions of competing products to assess customer purchasing predispositions. The model
was also used to predict changes in customer perceptions resulting from changes to selected product attributes or marketing strategies. The linear summative multi-attribute model indicated that Lauan plywood was the preferred product for the large volume customer segment, whereas the smaller volume customer segment preferred OSB over alternative products.

In performing the sensitivity analyses with the multi-attribute model, it was found that improving customer perception scores for OSB on panel size would make OSB the second choice product. Furthermore, if OSB performance on panel size was not improved, the performance on both remaining determinant attributes (thickness swell and overall quality) must increased in order to make OSB the second choice product. Specifically, improvements in both thickness swell and overall quality were required to make OSB the preferred product over softwood plywood when the perception score for panel size was held constant.

Determinant attributes analysis is a simple, yet valuable tool for identifying product attributes used to assess the product relative to other product offerings. The manufacturer and marketer must try to identify the optimal product offering that will compare favourably with alternative products, or the market may simply reject the product in favour of traditional products. The multi-attribute model can be used to predict the effects of a change in product attributes, or a customer oriented product knowledge campaign, on purchasing preferences.

The techniques used in this research can be used to create and maintain competitive advantages in a manner that efficiently allocates limited financial and human resources available for product and market development.
BIBLIOGRAPHY


Interior Export Lumber Sales Ltd., 1990. OSB Export Market Analysis Prepared for Ainsworth Lumber Company Ltd.


APPENDIX ONE - SAMPLE SURVEY QUESTIONNAIRE.
1. Please check the one category that best describes your company’s involvement in the forest products business (check only ONE):

( ) Importer  
( ) Wholesaler  
( ) Retailer  
( ) Home Manufacturer  
( ) Other (please specify)

2. Please estimate the percent of your wood panels that are imported & domestic:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>Total = 100 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Please estimate the total annual volume of structural panels purchased by your company:

<table>
<thead>
<tr>
<th>Cubic Metres (M3)</th>
<th></th>
</tr>
</thead>
</table>

4. Please estimate what percent of your imported wood panels are from the following countries:

<table>
<thead>
<tr>
<th>Country</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td></td>
</tr>
<tr>
<td>Others (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

| Total = 100 % |       |

5. Please indicate all primary thicknesses of wood panels your company utilizes (fill in percent of total usage in space provided):

<table>
<thead>
<tr>
<th>Thickness</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5 mm</td>
<td></td>
</tr>
<tr>
<td>9.0 mm</td>
<td></td>
</tr>
<tr>
<td>9.5 mm</td>
<td></td>
</tr>
<tr>
<td>11.5 mm (other)</td>
<td></td>
</tr>
<tr>
<td>12.5 mm</td>
<td></td>
</tr>
<tr>
<td>15.0 mm</td>
<td></td>
</tr>
<tr>
<td>18.0 mm</td>
<td></td>
</tr>
<tr>
<td>12.5 mm</td>
<td></td>
</tr>
<tr>
<td>15.0 mm</td>
<td></td>
</tr>
<tr>
<td>18.0 mm</td>
<td></td>
</tr>
</tbody>
</table>

6. Of the total volume of wood panel products handled by your firm, what percent are for:

<table>
<thead>
<tr>
<th>Category</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging &amp; Crating</td>
<td></td>
</tr>
<tr>
<td>Home Construction (traditional)</td>
<td></td>
</tr>
<tr>
<td>Home Construction (2x4 platform)</td>
<td></td>
</tr>
<tr>
<td>Others (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

| Total = 100 % |     |

7. Please estimate what percent of the following panel sizes your company purchases:

<table>
<thead>
<tr>
<th>Panel Size</th>
<th></th>
<th>others (specify):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 x 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 x 8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total = 100 % |     |

8. Is your company presently using or considering using Oriented Strandboard?

( ) Presently Using  
( ) Considering Using  
( ) Not Considering at This Time

9. What do you feel are the primary strengths and weaknesses of existing Oriented Strandboard products?

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>i.</td>
</tr>
<tr>
<td>ii.</td>
<td>ii.</td>
</tr>
<tr>
<td>iii.</td>
<td>iii.</td>
</tr>
</tbody>
</table>
10. When selecting a wood based panel product for use in home construction, which product attributes do you feel are the most important? (Please rank each characteristic on a scale of 1 = OF NO IMPORTANCE to 5 = CRITICAL by checking the ONE appropriate space):

<table>
<thead>
<tr>
<th>ATTRIBUTES</th>
<th>OF NO IMPORTANCE</th>
<th>OF SOME IMPORTANCE</th>
<th>IMPORTANT</th>
<th>VERY IMPORTANT</th>
<th>CRITICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensional Stability - Thickness Swell</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensional Stability - Linear Expansion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of Required Sizes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliable Supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturers Reputation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attractive Appearance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nail Holding Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistent Overall Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. How much DIFFERENCE do you feel there is BETWEEN Luau Plywood, N.A. Softwood Plywood & N.A. Oriented Strandboard, for each of the product attributes? (Please check the ONE space that best corresponds to your opinion, for EACH attribute):

<table>
<thead>
<tr>
<th>ATTRIBUTES</th>
<th>VERY SIMILAR</th>
<th>SIMILAR</th>
<th>DIFFERENT</th>
<th>VERY DIFFERENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensional Stability - Thickness Swell</td>
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<tr>
<td>Dimensional Stability - Linear Expansion</td>
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<tr>
<td>Structural Strength</td>
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<tr>
<td>Availability of Required Sizes</td>
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<tr>
<td>Reliable Supply</td>
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<tr>
<td>Manufacturers Reputation</td>
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<tr>
<td>Attractive Appearance</td>
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<tr>
<td>Nail Holding Strength</td>
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</tr>
<tr>
<td>Consistent Overall Quality</td>
<td></td>
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</tr>
</tbody>
</table>
12. How do each of the following panel products rate in terms of each product attribute? For each product, indicate whether the product possesses that attribute to a HIGH degree (4), CONSIDERABLE degree (3), LIMITED degree (2), or NOT AT ALL (1). Please indicate how you feel about each panel product, regardless of whether you have any experience with the product or not - your opinion is important!

<table>
<thead>
<tr>
<th>The Product Possesses This Attribute to What Degree:</th>
<th>NOT AT ALL (1)</th>
<th>LIMITED DEGREE (2)</th>
<th>CONSIDERABLE DEGREE (3)</th>
<th>HIGH DEGREE (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPETITIVE PRICE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luaun Plywood</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>North American Softwood Plywood</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>North American Oriented Strandboard</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>DIMENSIONAL STABILITY - Thickness Swell</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Luaun Plywood</td>
<td>( )</td>
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<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>North American Softwood Plywood</td>
<td>( )</td>
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<td>( )</td>
<td>( )</td>
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<tr>
<td>North American Oriented Strandboard</td>
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<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>DIMENSIONAL STABILITY - Linear Expansion</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Luaun Plywood</td>
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<tr>
<td>North American Softwood Plywood</td>
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<tr>
<td>North American Oriented Strandboard</td>
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<tr>
<td><strong>STRUCTURAL STRENGTH</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Luaun Plywood</td>
<td>( )</td>
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<td>( )</td>
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<tr>
<td>North American Softwood Plywood</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>North American Oriented Strandboard</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>AVAILABILITY OF REQUIRED SIZES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luaun Plywood</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>North American Softwood Plywood</td>
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<td>( )</td>
</tr>
<tr>
<td>North American Oriented Strandboard</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>RELIABLE SUPPLY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luaun Plywood</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>North American Softwood Plywood</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>North American Oriented Strandboard</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>
### The Product Possesses This Attribute to What Degree:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Luaun Plywood</th>
<th>North American Softwood Plywood</th>
<th>North American Oriented Strandboard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MANUFACTURER'S REPUTATION</strong></td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>ATTRACTIVE APPEARANCE</strong></td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>NAIL HOLDING STRENGTH</strong></td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>CONSISTENT OVERALL QUALITY</strong></td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>

**NOT AT ALL** (1) **LIMITED DEGREE** (2) **CONSIDERABLE DEGREE** (3) **HIGH DEGREE** (4)

Thank you for rating these panel products. We have just one more question for you!!
Please rate each panel product described below on a scale of 1 to 6, where 1 = DEFINITELY WOULD NOT PURCHASE and 6 = DEFINITELY WOULD PURCHASE. Assume that each panel product is well manufactured and meets or exceeds all the grade criteria in the appropriate product standards (only price & thickness swell vary):

**End Use Category:**

- [ ] Home Construction
- [ ] Packaging & Crating
- [ ] Other

<table>
<thead>
<tr>
<th>PRODUCT DESCRIPTION</th>
<th>Definitely Would Not Purchase</th>
<th>Purchase Very Unlikely</th>
<th>Purchase Somewhat Unlikely</th>
<th>Purchase Somewhat Likely</th>
<th>Purchase Very Likely</th>
<th>Definitely Would Purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>Price per Sheet (Y)</td>
<td>Thickness S swell</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) 1000 - 1100</td>
<td>15% &amp; HIGHER</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>b) 1100 - 1200</td>
<td>10 - 14%</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>c) 1200 - 1300</td>
<td>10 - 14%</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>d) 1100 - 1200</td>
<td>4 - 9%</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>e) 900 - 1000</td>
<td>15% &amp; HIGHER</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>f) 1000 - 1100</td>
<td>4 - 9%</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>g) 900 - 1000</td>
<td>4 - 9%</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>h) 1000 - 1100</td>
<td>10 - 14%</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>i) 1100 - 1200</td>
<td>15% &amp; HIGHER</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>j) 1200 - 1300</td>
<td>4 - 9%</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>

**THE END**

THANK YOU FOR PARTICIPATING IN THIS RESEARCH STUDY!!