



Assessing Geographic Information Systems Use In Marketing Applications For The Wood Products Industry



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Abstract

Geographical Information Systems (GIS) is a growing technology but its uptake by the wood products industry is still largely limited to biomass mapping and logistics domains. The primary purpose of this paper is to explore ways in which GIS can be applied to marketing domain in the wood products industry. Toward that end, this paper develops a GIS database for primary and secondary wood products in Virginia. Using cluster analysis, space relationships, and case study techniques, we also propose how GIS can be applied to various elements of a company's marketing mix: product, place, price, and promotion.

Keywords: geographic information systems, marketing, wood products industry

1.0 Introduction

The primary purpose of strategy is to help companies find a fit with its environment (Hoffman et al. 2005). A good way for a company to adapt to its ever-changing environment is through a strong marketing mix strategy (Hoffman et al. 2005) that includes decisions related to product, place, promotion, and price. Marketers continue to explore application of the internet and information systems to develop new and innovative marketing mix strategies. For example, contemporary companies try to leverage social media to enhance their electronic marketing, channels of communication, selling skills, and distribution of products and services.

Still many procurement and distribution managers continue to limit their attention to logistics aspects in order to decrease cost and increase asset utilization. A common tool to assist logistic and distribution functions

is Geographic Information Systems (GIS). However, there is little information on GIS applications outside the realm of mapping and logistics. As some authors have indicated (Longley & Graham 1995, Clarke & Flaherty 2005), it seems that spatial analysis or GIS, have enormous potential to be incorporated in strategic planning, including the marketing process. Current knowledge regarding GIS applications in the marketing process focused on aspects such as marketing mix implementation (Hess, Rubin & West 2004) and several investigations regarding applications of GIS in marketing have demonstrated the relationship of the two parts—GIS and marketing (Wu & Rathswohl 2010, ESRI 2010, USC 2011, Johnson 2010, Musyoka et al. 2007, SCGIS 2008, Miller 2007). In addition, most significant studies suggest that the significance of GIS in marketing applications can be validated by the use of marketing mix variables: product, price, place, and promotion (Hess, Rubin & West 2004, Clarke & Flaherty 2005). For example, a product could be designed to target a niche market with specific demographics such as ethnicity and socioeconomic status. Depending on the select niche market for that product, the product's price needs to be determined considering distribution, delivery, competition and demand. In addition, GIS

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could also be used to establish the best way to distribute (*place*) the product as well as the best strategy to *promote* the product.

It has been documented that GIS is helpful in the development of marketing mix elements (Hess, Rubin & West 2004). Researchers consider that a holistic implementation of marketing strategies based on the marketing mix elements could benefit wood products companies in areas such as strategic planning and implementation, product development, management of manufacturing cost, lead times, and asset allocation (Wu & Rathswohl 2010, Musyoka et al. 2007). The goal of this research is to advance an understanding and application of GIS application in marketing mix realms in the wood products industry. Three specific objectives were formulated to achieve this goal. First, an industry GIS dataset was obtained and validated through a survey. Second, clustering techniques based on GIS data were used to evaluate and identify potential marketing opportunities, and third, expert input and literature review were used to propose specific strategies to promote GIS application in marketing mix elements.

2.0 Literature Review

2.1 Marketing

According to the American Marketing Association (AMA 2016), marketing is defined as “the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large.” Armstrong & Kotler (2005) defined marketing as the process of telling and selling products to satisfy customer needs. Marketing is a process by which consumers (individuals and groups) obtain what they want and need by creating value in the product and exchanging value with others. Moore & Pareek (2006) mentioned that marketing has two goals: (1) to attract new customers by emphasizing the value of the product or service offered by the company and (2) to retain the customer interested and keep satisfying the customer with old and new products and services.

An important milestone in the history of Marketing is the separation from the production of goods to its consumption that happened during the industrial revolution (Kotler 1999). During the production orientation era, the focus was on producing at the lowest possible

cost, as producers were able to sell everything they were able to produce. After the turn of the first half of the 20th century, marketing was more focused on sales rather than production. At this time, there was more competition and it became important to communicate, advertise, and to appropriately brand products. At this point, marketing was still a support process but was more focused on distribution and communication with the goal to convince customers that one product was better than another (Bartels 1988). After the 1960s, the marketing orientation era was born. Marketers began to get involved in the strategy development of the organizations so that; decisions about what to produce, distribution channels, pricing, and how to advertise were now part of the marketing department functions.

2.2 A new era of marketing

The marketing orientation era has been critical in the development of strategic marketing. A marketing orientation is defined by Moorman & Rust (1999) as a process in which all functional areas of the organization participate in incorporating customer’s needs into their strategic processes. Marketing is a business process that can fit into the overall companies’ strategy, decision-making, mission statement, and corporate strategy (Moore & Pareek 2006, Howe & Bratkovich 2005). Marketing should not only fit the company strategy, but organizations can also create their own marketing mix (strategy) to fit their consumer preferences and behavior as well as the goods or services provided by the company. This new marketing orientation has evolved into a holistic concept where everything matters. Early in the 1960s one of the first attempts to integrate marketing with the organization’s operations (manufacturing cost, product design, distribution, and advertisement) was conceived by McCarthy (1964) where the elements of marketing mix were: product, place, price, and promotion (also known as the 4P’s). Under this holistic strategy, marketing is not only directed towards the customer but also towards the company where the organization is fully aware of the strategic goals and the specific tasks to be conducted to remain competitive.

Perhaps the most significant challenge marketer’s face today is to provide solid return of investment on the marketing activities conducted. This new holistic marketing era has been potentiated thanks to critical advancements in information technologies such as internet,

social networking, and data mining (Trainor et al. 2011). Currently marketers can integrate their activities through various information technology platforms to implement more efficient marketing activities. For instance, targeting specific niche groups in order to develop the right product, distribution, pricing, and promotional content is today an easier task thanks to application of information technologies such as geographical information systems (GIS) in these decisions.

2.3 Marketing in the wood products industry

Marketing has been an important support process for the wood products industry sector (Dasmohapatra 2009). Most of the marketing research produced in the last three decades for this industry sector have been focused on marketing strategies to support mature products (Smith & Bush 1994), identification of export barriers (Ifju & Bush 1993, Cohen & Smith 1991, Lyon et al. 2013), understanding of product, consumer, and supplier attributes (Forbes et al. 1994, Hansen & Bush 1999, and Bumgardner, Bush, & West 2000), and specific competitiveness issues (Gazo & Quesada 2005, Bowe, Smith & LaBissoniere 2005, Smith & Olah 2000).

There is no specific research in the literature that has studied the marketing process as a holistic strategic approach in the wood products industry. It seems most of the recent research in marketing for wood products industries, have been isolated attempts to cover only parts of the marketing mix as developed by McCarthy (1964). For example, De Hoop et al. (1997) and Parhizkar & Smith (2008) research on the mapping of wood residues could be classified as focus on product and Anderson et al. (2005) research on consumer behavior in forest products could be connected with price determination. Finally, green advertising research by Grillo, Tokarczyk & Hansen (2008) could be linked to product promotion. Toivonen (1999) presents a case study on the use of information technology in marketing for the Finnish forest industries as perhaps one of the few attempts to study the marketing process in a more holistic approach.

As Dasmohapatra (2009) indicated, the new era of the forest products industry relies on accepting global markets, targeting products to a changing demographic structure and to customer's tastes, to products with environmental taste, innovation, efficient management, trade practices and policies. The recent research on

marketing applied to wood products provides limited insights on how to integrate the marketing process into the strategic process of forest products industries. Moreover, there is very limited research on the use and potential of information technologies such as GIS in the marketing process.

2.4 Geographic Information Systems in the wood products industry

Demers (2009) defined Geographic Information Systems (GIS) as a system designed to input, store, edit, retrieve, analyze, and output geographic data and information. As with all systems, GIS is composed of integrated parts that allow it to perform correctly. These parts include (1) computer hardware and software, (2) space and organization, (3) personnel and (4) data and information (Demers 2009). Combining conventional marketing techniques with geospatial methods might enable users to picture the spatial distribution of data in maps—such as the distribution process, the market diversity—also complementing it with statistical graphs and diagrams that could link marketing and GIS (Musyoka et al. 2007).

The marketing process is perhaps one of the best fits for applying GIS. In general, marketing emphasizes on demand (customers) and supply (outlets, retail, shopping centers), which are easy to analyze and see in GIS (Toppen & Wapenaar 1994). There have been reports on peer-reviewed articles, news and industry reports about how GIS applications are integrated in the marketing process such as; Customer Marketing Analysis, (Toppen & Wapenaar 1994) Penetration & Winning Strategies (Thompson 2010), Customer Profiling & Customer Behavior (Badea et al. 2009), Business Analysis (Radut 2009), and Market segmentation (Musyoka et al. 2007) among others. Other findings highlight GIS applications on the marketing mix in the retail sector (Nasirin & Birks 2003).

The wood products industry has used GIS application for different purposes such as; surveying and mapping wood residues (De Hoop et al. 1997), planning the use of information technology in marketing (Toivonen 1999), consumer behavior in forest products (Anderson et al. 2005), green advertising in forest sectors (Grillo, Tokarczyk & Hansen 2008), availability of biomass residues for bio-energy production (Parhizkar & Smith 2008), and forest cover changes (Kumar 2011) to mention some. Even though there has been recent research regarding the application of GIS in the wood products industry, those

applications are not commonly related to the marketing strategic planning process. Therefore, more research and models could provide strategies and examples of how to use GIS as a part of the strategic marketing process in wood products industries.

3.0 Methodology

The goal of this research was to advance the understanding of GIS application in developing the elements of the marketing mix. In so doing, we first developed and validated an industry dataset (Objective 1) that includes geographical information of the companies to be studied. We then conducted visualization and analysis of the geographical data in order to determine basic space relationships leading to uncover potential marketing applications (Second objective). The third objective included interviews with GIS experts in other industries in order to benchmark and better understand what potential uses can be outlined when using GIS in developing the elements of the marketing mix (product, price, promotion, and place) in wood products industries.

3.1 GIS database generation

The database is limited to primary and secondary industries in the state of Virginia in the United States of America (USA). In this context, primary industries are defined as industries classified under the North American Industry Classification Code System (NAICS) 321 and secondary industries as NAICS 337. Geographical data regarding primary industries was obtained from the Virginia Department of Forestry (VADOF).

The geographical information for secondary industries was purchased from a third party, Infogroup Academic. This original dataset already included location data and had a total of 1001 companies classified as secondary wood products industries. After revising and validating the initial dataset for empty and inconsistent data, the dataset was reduced to 989 businesses. In addition, the remaining industries in the dataset were surveyed to confirm geographical information data. Even though the dataset provided by Infogroup Academic included location data, it was necessary to confirm and validate the location of each company. In addition to location data, other information was also requested: (1) demographics, (2) raw materials consumption, (3) production of residues and (4) export information. These additional data helps uncover potential opportunities

with suppliers or potential customers when conducting spatial analysis. For example, raw materials needed could be related to suppliers in the area where the company is located. As another example, residue production could also be connected with biomass plants or pellet plants in the area where the companies are located. Procedures for the survey implementation were followed as recommended by Fowler (2002) and Dillman (2000). After the first mailing, a postcard reminder was sent. An online version of the questionnaire was made available to those companies that wished to respond electronically instead of mailing back the questionnaire. Companies that did not respond at all were called to verify their location, confirm they were active, and that they could be classified as secondary or primary wood products industries. Wave analysis was used as the non-response bias technique to test the null hypothesis that the respondents were a valid representation of the sampled population as recommended by Atif, Richards and Bilgin (2012).

After the companies' responses were received, clustering techniques were used to explore space relationships between the primary and secondary companies. Clustering refers to techniques used to classify classes into groups that are relatively homogenous within themselves and heterogeneous between each other on the basis of a set of variables (SAS Institute 2014, Everitt 2011, Milligan 1996). Visualizing the data in cluster format helps the researchers to better understand the environment and the location of the dataset to make better decisions, develop business strategies and to comprehend the entire situation that they are in or they plan to venture.

For this particular research, the K-means (for large datasets) clustering method was selected to perform the clustering analysis due to the large sample size. In combination with cluster analysis techniques, spatial analysis techniques were used to help visualize and interpret the data (Pick 2005, Austin et al. 2013). The choosing mapping tool was online ESRI ARCGIS because it is available to most users having internet access.

Finally, structured, in-depth interviews were conducted with three conveniently selected industry GIS experts with the goal to better understand how GIS tools could be used for marketing applications. Structured format helped ensure thematic consistency (Kvale and Brinkmann 2009). Experts were contacted on an individual basis and invited to participate. Interviews were conducted by telephone and written notes were

recorded. The interview protocol included five general questions: demographic information, GIS supplier applications, GIS internal applications, GIS customer applications, and general perceptions on GIS. After the invited candidates agreed to participate, the purpose of the interview was explained as well as the terms of confidentiality, format, and length. When the interview was over, interviewees were notified on how to get in touch with the interviewer and asked them if they had any questions. This procedure is recommended by Kvale and Brinkmann (2009).

4.0 Results and Discussion

4.1 GIS Dataset generation

The primary wood products GIS data was obtained from the VADOF. This dataset is current and the geographic information is in good standing. Location data was tested for accuracy by comparing longitude and latitude with the establishments' current mailing addresses. The dataset of primary wood products industries contains 90 establishments.

The secondary wood products GIS data was obtained through a survey of 989 establishments in the state of Virginia as explained in the methods section. A total of 125 establishments returned the questionnaire. After validating the returned questionnaires, only 108 were considered of good use for further analysis, representing an 11% response rate. A non-respondent analysis was conducted using wave analysis (Atif, Richards, & Bilgin 2012). The proportion of responses received during the first mailing and the second mailing were compared by industry sector using a Chi-square test (with a significance level of 0.05). In this particular case, the second wave of respondents (second mailing) is used as a proxy of the non-respondents. There were no statistical differences in the proportions by industry sector when comparing the first and the second mailing; therefore, the sampled companies are considered a good representation of the entire population being studied.

Given that the objective of the survey was to validate location data and to confirm the industry sector in the original dataset, phone calls were made to the 864 companies that did not respond to the questionnaire. The results of the phone calls are shown in Table 1. The phone call results indicated that 748 of the non-respondent companies were able to confirm their location and validate their industry sector.

Table 1. Phone Survey Response Status

Answered Survey	Phone Survey		Total
	1 st Round	2 nd Round	
Wood Products Industry	334	414	748
Other industry sector	0	116	116
Total	334	530	864

The GIS data (from primary and secondary industries) were used to build a relational database, including an interface to manipulate data and prepare industry reports. A relational database is a collection of data stored in two-dimensional tables that allows for better data management (Sciore 2009).

4.2 Cluster analysis

Cluster analysis is an important technique that helps separate groups or classes by common features. In this case, cluster analysis was used to examine space relationships between primary and secondary industries. As described earlier, there might be certain locations where companies in the same industry sector tend to be agglomerated based on the following factors: supplier availability, customer closeness, labor pools, specific niche markets, competitors, distribution challenges, and potential product offerings to specific regional markets. Based on the first output, there are 946 companies from the primary and secondary wood products sector available. Given the large sample, the most appropriate clustering technique is K-means (SAS Institute 2014).

Figure 1 shows the industries clustered in $k=3$ groups with frequencies of 1=352, 2=350 and 3=244. Even though the size of two of the clusters is very similar, it seems companies could be clustered in smaller groups. When the data is clustered in $k=5$ groups, the number of members per cluster varies even more: 1=298, 2=192, 3=50, 4= 168, 5=238. Companies were also clustered using $k=10$ and similar to $k=5$, the size per group is very dissimilar. It seems that when using $k=3$, the size and composition of the cluster is more uniform and aligned with cluster analysis theory (Milligan 1996).

Following, the dataset was uploaded into online ESRI ArcGIS for further visualization and spatial analysis. Figure 2 shows the distribution of primary (black dots) and secondary industry (yellow dots) by average household income in the state of Virginia where darker green means higher income. This spatial representation indicates that the secondary industry (yellow dots, NAICS 337) tends to cluster in higher income household regions such as

Washington DC, Richmond, Roanoke/Blacksburg Valleys and Virginia Beach, Figure 3 shows a heat map of the distribution of primary industries (NAICS 321) by the type of Virginia Forest. Blue and purple colors indicate regions where hardwood forest is dominant while pink color shows where softwood forest is dominant.

When primary industries are overlaid against the type of forest coverage, it appears to be some level of aggregation along hardwood forested areas (see Figure 3). This observation and the previous space analysis where primary industries do not seem to cluster based on the average household income (Figure 2) might lead

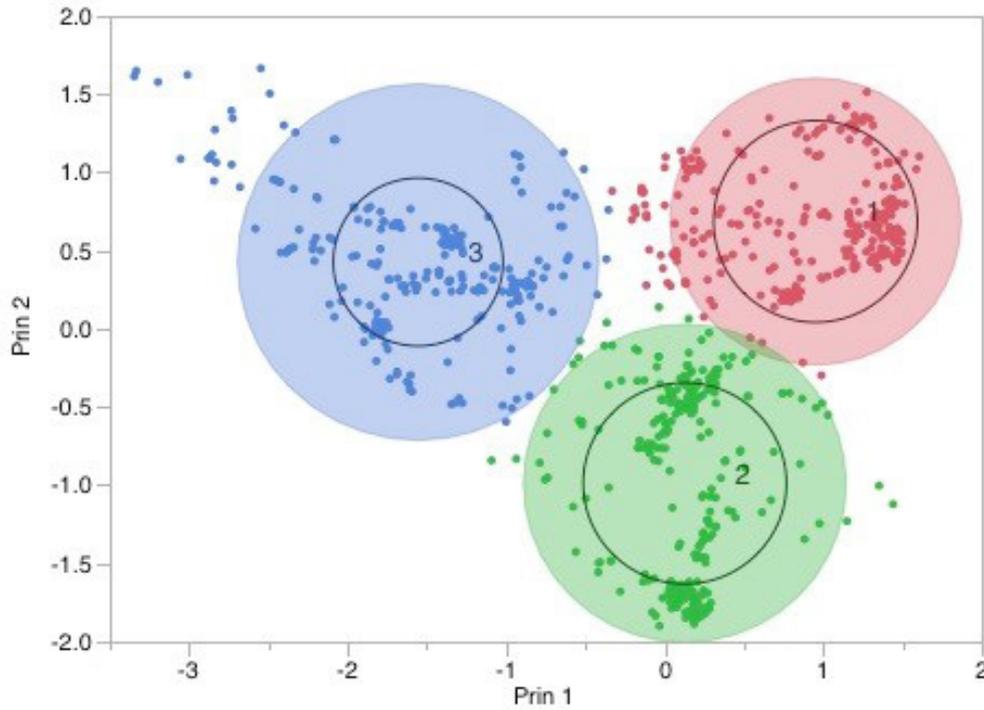


Figure 1. Data grouped in 3 clusters

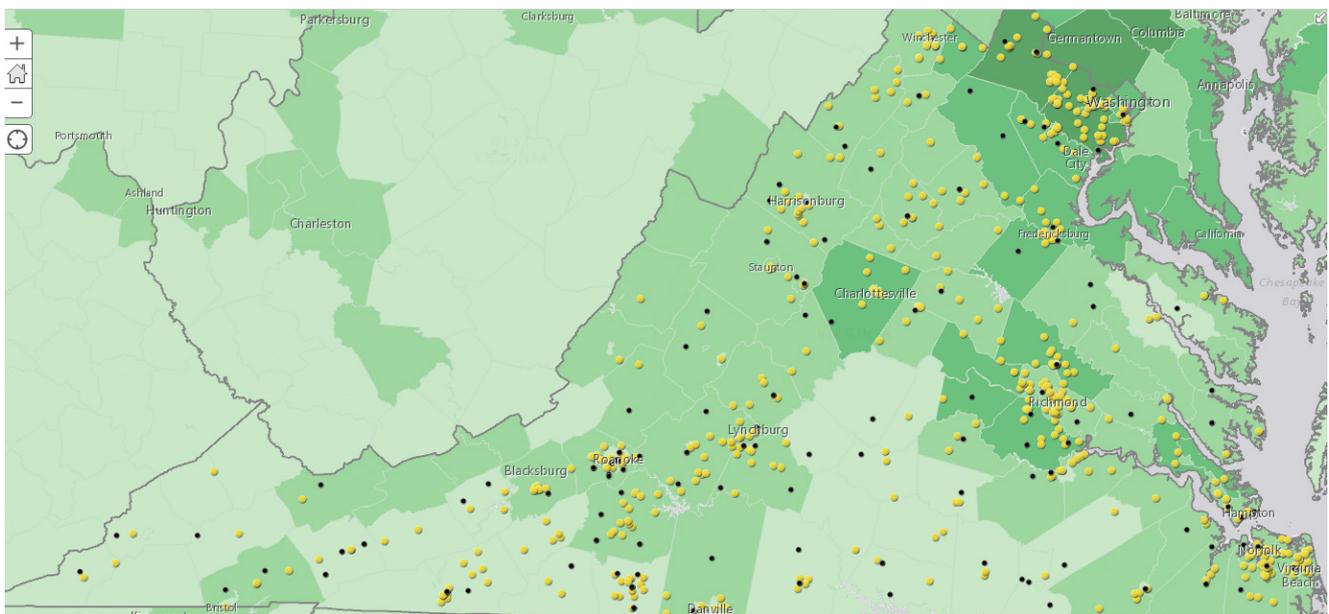


Figure 2. Primary and secondary industries distributed by average household income.

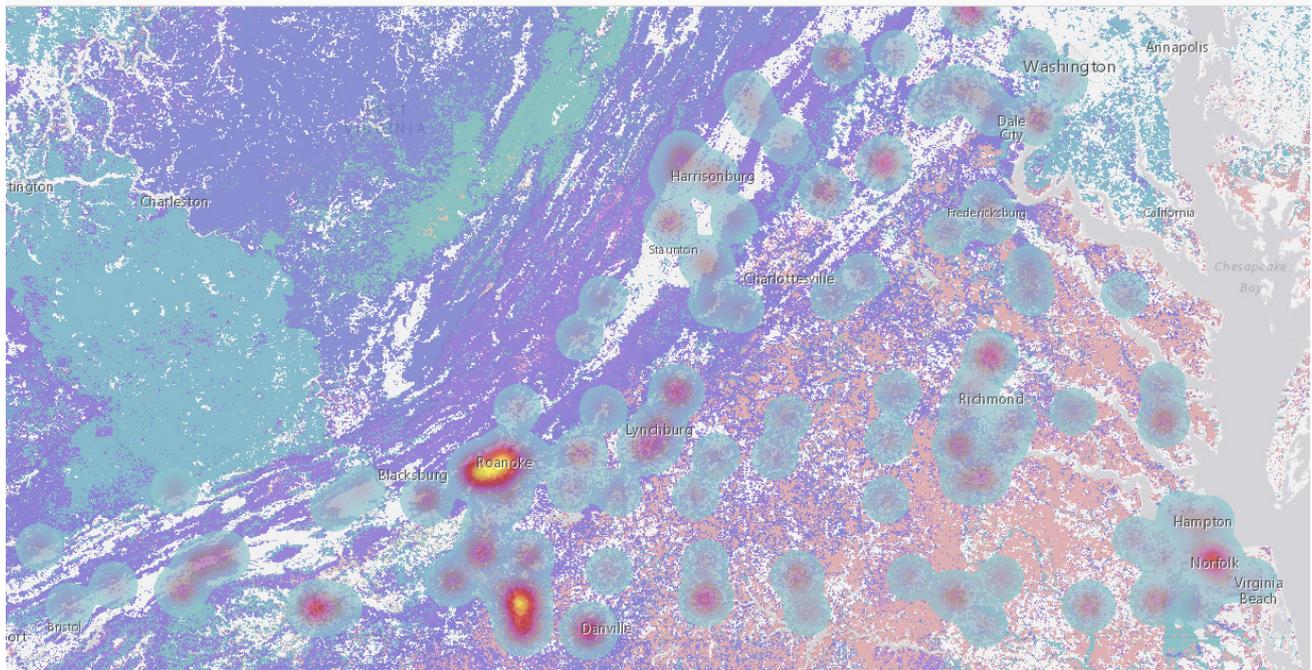


Figure 3. Primary industries distribution in Virginia based on type of forest coverage.

one to believe that primary wood products industries prefer to be closer to the supply than high income areas.

4.3 GIS strategies for marketing applications

Even though none of the industries in the database reported using GIS for marketing applications; the per-

formed cluster analysis indicates that there might be some strong space relationships in regards to the key elements in the marketing mix. For example, secondary wood products industries tend to cluster closer to potential customers and primary wood products industries tend to cluster near suppliers (see Figures 2 and 3). These two space relationships could be used to

Table 2. List of GIS marketing strategies by elements of the marketing mix (Hess, Rubin & West 2004, ESRI 2010, Moore & Pareek 2006 and interviews to GIS experts).

Generic Strategy	Specific strategy	Examples
Product	Match products attributes to characteristics of customer groups	College students tend to prefer contemporary furniture vs traditional solid furniture
	Match the product to ethnic population distributed geographically	Understand needs and taste of specific ethnic groups on wood species
	Product design decisions	Packaging design for ready-to-assemble (RTA) furniture
	Consumers match with the product characteristics	Understanding why consumers preferred solid to laminated flooring in specific locations.
Place	Products routing	Design of distribution routes to minimize transportation costs of lumber deliveries
	Determine location of distribution channels	Retail stores, distribution centers, warehouse locations of wood composite products
	Determine customer buying habits by location	Understand better shopping behavior of rural vs urban customers
	Integration of internal and external data for an accurate and efficient promotion strategy	Location data needs to be effectively integrated with targeted campaigns
Promotion	Target promotional campaigns	Location of specific customers such as hotels, office, and other institutional furniture consumers
	Verifying the effectiveness of promotional campaigns by location	Analyzing and comparing data from similar customers in different locations
Price	Understand better needs and behaviors of customers by location	Design of promotional campaigns based on behavior of customers by location
	Pricing estimation and modification based on location	Pricing for urban vs rural settings may vary
	Maximization of return of investment based on specific locations	Identify what locations generate the best return of investment for specific marketing campaigns

develop location-based supplier relation collaborations (for primary industries) and specific pricing strategies based on niche markets for secondary industries.

In order to identify other potential applications and strategies for the application of GIS in the developing of the elements of the marketing mix (product, place, price, and promotion); the results from the clustering section were complemented with data from secondary sources and interviews of three GIS experts. See Table 2. The perception of the GIS industry experts is that most companies (in any industry sector) focus on utilizing GIS for logistic applications but have found little use of GIS for marketing purposes. The GIS experts also indicated that capital investments in GIS have a very good return on investment (ROI) and that there is a general positive perception of GIS applications and its advantages. In addition, the interviewed experts pointed out that companies in general lack information and procedures to implement GIS in marketing applications but the opportunity to incorporate GIS in the marketing process is there.

5.0 Conclusions

Information systems are a critical component to support the strategic process of business organizations, including wood products industries. Previous research indicated that there is access to a large number of datasets that could be used to support the decision making process such as strategic marketing. It was also found from the literature that little has been done to study the marketing process as a holistic and strategic approach in the wood products industry. Rather, the majority of marketing research on the wood products industry has been focused on specific aspects of the marketing mix. This research was conducted in response to the lack of examples of integrating information technologies with the marketing mix's elements

It was found that secondary wood products industries in Virginia are not aware of the potential of using new information technologies for marketing applications. Specifically, secondary wood products companies in Virginia are aware of GIS but do not use it in their marketing strategic processes. A GIS database was developed using primary and secondary wood products industry data in Virginia. Cluster analysis was conducted on the dataset and several interesting spatial relationships were revealed that are a good fit for marketing applications. Interviews with GIS experts in combination with the

cluster analysis were used to define specific strategies based on the elements of the marketing mix. The GIS data was implemented in ESRI ArcGIS maps allowing flexibility and easy manipulation of the dataset to uncover other potential relationships.

A total of 14 different strategies for using GIS in the development of the marketing mix's elements were determined using the results of the cluster analysis and the opinions of the consulted GIS experts. As presented in the results section, the opportunity to apply GIS in marketing applications is very promising but it would require some level of creativity by the interested parties. This could be an issue for the majority of wood products industries as investment in marketing efforts are minimal and the industry is considered a slow-technology adopter.

The cluster analysis revealed that primary and secondary industries in Virginia tend to cluster along certain economic regions and that location plays indeed an important role in the strategic process of wood products industries but it is rarely explored. For example, primary wood industries are grouped closer to forested areas (proximity to raw material) whereas secondary wood products industries are clustered closer to the end customers. A primary wood products company that processes logs into lumber for example, would like to know the distance between his processing facilities and the location of the raw material (suppliers). For the same reason, knowing the location of customers could help the lumber producer to develop effective delivery routes to impact cost and delivery times.

6.0 References

- Anderson, R. C., Fell, D., Smith, R. L., Hansen, E. N., & Gomon, S. (2005). Current consumer behavior research in forest products. *Forest Products Journal*, 55(1), 21-27.
- American Marketing Association (AMA). (2016). *Definition of Marketing*. Retrieved from <https://www.ama.org/AboutAMA/Pages/Definition-of-Marketing.aspx>
- Armstrong, G. & Kotler, P. (2005). *Marketing: an introduction* (7th ed.). Upper Saddle River, New Jersey: Pearson; Prentice Hall.
- Atif, A., Richards, D., & Bilgin, A. (2012). Estimating non-response bias in a web-based survey of technology acceptance: a case study of unit guide information systems. Proceedings from 23rd Australasian Conference on Information Systems. Geelong, Australia. Retrieved from <https://dro.deakin.edu.au/eserv/DU:30049121/atif-estimatingnon-2012.pdf>
- Austin, B., Gordon, A., Kennedy, G., Sonnevill, K., Blossom, J., and Blood E. 2013. Spatial Distribution of Cosmetic-Procedure Businesses in Two U.S. Cities: A Pilot Mapping and Validation Study. *Int. J. Environ. Res. Public Health*, 10(12), 6832-6862

- Badea, R., Bagu, C., Badea, A & Moises, C. (2009). Customer Profiling Using GIS. Proceedings of 19th International DAAAM Symposium. Vienna, Austria.
- Bartels, Robert (1988). *The history of marketing thought* (3rd ed.). Columbus, OH: Publishing Horizons.
- Bowe, S. A., Smith, R. L., & LaBissoniere, M. D. (2005). Understanding the United States S4S hardwood board market. *Forest Products Journal*, 55(2), 21-27.
- Bumgardner, M. S., Bush, R. J., & West, C. D. (2000). Beyond yield improvement: Selected marketing aspects of character-marked furniture. *Forest Products Journal*, 50(9), 51-58.
- Clarke, I. & Flaherty, T. (2005). *Advances in electronic marketing*. Hershey, PA: Idea Group Publishing.
- Cohen, D. & Smith, P. (1991). Global marketing strategies for forest product industries. *Canadian Journal of Forest Research*, 22(1), 124-131.
- Dasmohapatra, S. (2009). Future marketing drivers for the forest product industry. *BioResources*, 4(4), 1263-1266.
- Dillman, D. A. (2000). *Mail and internet surveys: the tailored design method*. New York, New York: John Wiley.
- De Hoop, C., Kleit, S., Chang, S., Gazo, R. & Buchar, M. (1997). Survey and mapping of wood residue users and producers in Louisiana. *Forest Products Journal*, 47(3), 31-37.
- Demers, M. (2009). *Fundamentals of Geographic Information Systems*. (4th edition) Hoboken, NJ: John Wiley & Sons, Inc.
- ESRI. (2010). *GIS for marketing; where strategy meets opportunity*. Retrieved from <http://www.esri.com/library/brochures/pdfs/gis-for-marketing.pdf>
- Everitt, B. (2011). *Cluster analysis*. Chichester, West Sussex, U.K: Wiley.
- Forbes, C. L., Sinclair, S. A., Bush, R. J., & Araman, P. A. (1994). Influence of product and supplier attributes on hardwood lumber purchase decisions in the furniture industry. *Forest Products Journal*, 44(2), 51-56.
- Fowler, F. Jr. (2002). *Survey research methods*. (3rd ed.). Thousand Oaks, CA: SAGE Publication.
- Gazo, R., & Quesada, H. J. (2005). A review of competitive strategies of furniture manufacturers. *Forest Products Journal*, 55(10), 4-12.
- Grillo, N., Tokarczyk, J. & Hansen, E. (2008). Green advertising developments in the U.S. forest sector: a follow-up. *Forest Products Journal*, 58(5), 40-46.
- Hess, R., Rubin, R. & West, L. (2004). Geographic information systems as a marketing information system technology. *Decision Support Systems*, 38(2), 197-212.
- Hoffman D. K, Czinkota M, R., Dickson P. R, Dunne P., & Griffin A. (2005). *Marketing principles & best practices* (3rd ed.). Nashville, TN: South-Western College Publishing Group.
- Howe, J. & Bratkovick, S. (2005). A planning guide for small and medium size wood products companies (2nd ed.). Newtown Square, PA: United States Department of Agriculture.
- Iju, P. A., & Bush, R. J. (1993). Export barriers and incentives in the eastern hardwood lumber industry. *Forest Products Journal*, 43(3), 45-48.
- Johnson, J. B. (2010). *Using GIS as a marketing decision support system to help Amari Studios locate new customers and effectively direct marketing and advertising efforts*. Retrieved from <http://www.gis.smumn.edu/GradProjects/JohnsonJB.pdf>
- Kotler, P. (1999). *How to create, win and dominate markets*. New York, NY: Free Press.
- Kumar, D. (2011). Monitoring forest cover changes using remote sensing and GIS: a global prospective. *Research Journal of Environmental Science*, 5(2), 105-123.
- Kvale, S., & Brinkmann, S. 2009. *Interviews: Learning the Craft of Qualitative Research Interviewing*. Los Angeles, CA: Sage Publications.
- Longley, P., & Graham, C. (1995). *GIS for business and service planning*. New York, NY: John Wiley & Son, Inc.
- Lyon, S. W., Quesada-Pineda, H., Smith, R. L., & Kline, D. E. (2013). Identifying market opportunities for Appalachian forest products companies in Central America. *Southern Journal of Applied Forestry*, 37(4), 202-207.
- McCarthy, E. J. (1964). *Basic Marketing*, IL: Richard D. Irwin.
- Miller, F. L. (2007). *GIS tutorial for marketing*. Redlands, CA: ESRI Press.
- Milligan, G. W. (1996) Clustering validation: results and implications for applied analyses, in *Clustering and Classification* (P. Arabie, L. J. Hubert, and G. De Soete, eds.) 341-375. World Scientific, Singapore.
- Moorman, C., & Rust, R. T. (1999). The Role of Marketing. *Journal of Marketing*, 63(4), 180-197.
- Moore, K. & Pareek, N. (2006). *The basics Marketing*. New York, NY: Routledge.
- Musyoka, S. M, Mutyaavyu, S. M., Kiema, J. B .K, Karanja, F. N., & Diriba, D. N. (2007). Market segmentation using geographic information systems (GIS). *Marketing Intelligence & Planning*, 25(6), 632-642.
- Nasirin, S., & Birks, D. (2003) DSS implementation in the UK retail organizations: a GIS perspective. *Information & Management*, 40(4), 325-336.
- Parhizkar, O & Smith, R. (2008). Application of GIS to estimate the availability of Virginia's biomass residues for bioenergy production. *Forest Products Journal*, 58(3), 71-76.
- Pick, J.B. (2005.) *Geographic information systems in business*. Toronto, Canada: Idea Group Publishing.
- Radut, C. (2009). The GIS and data solutions for advanced business analysis. *Economia, Seria Management*, 12(2):171-181
- SAS Institute (2014). *Cluster analysis. JMP statistical discovery from SAS*. Retrieved from http://www.jmp.com/support/help/Cluster_Analysis.shtml
- South Carolina Geographic Information Systems (SCGIS). (2008). *Marketing the value of GIS*. Retrieved from http://www.gis.sc.gov/resources_marketing.html
- Sciore, E. (2009). *Database design and implementation*. Hoboken, NJ: John Wiley & Sons.
- Smith, R. L., & Bush, R. J. (1994). Marketing practices in the timber bridge industry. *Forest Products Journal*, 44(11), 27-33.
- Smith, R. L., & Olah, D. F. (2000). *Marketing for wood products companies*. Blacksburg, VA Virginia Cooperative Extension.
- Thompson, S. (2010). Using GIS for Local Market Penetration, Winning Strategies IFA; International Franchise Association. Retrieve from <http://www.franchise.org/>
- Toivonen, R. (1999). Planning the use of information technology in marketing: the case of Finnish forest industries. *Forest Products Journal*, 49(10), 25-30.
- Toppen, F., & Wapenaar, H. (1994). *GIS in business: tools for marketing analysis*. The Hague: GIS Foundation.
- Trainor, K., Rapp, A., Beitelspacher, L.S., & Schillewaert, N. (2011). Integrating information technology and marketing: An examination of the drivers and outcomes of e-Marketing capability. *Industrial Marketing Management*, 40(1), 162-174.
- University of Southern California (USC). (2011). *The relationship between GIS and marketing*. Retrieved from <http://gis.usc.edu/msp-resources/the-relationship-between-gis-and-marketing/>
- Wu, P. Y., & Rathswohl, E. (2010) Visualizing Opportunities: GIS Skills for Retail Marketing. Proceedings from 2010 Information Systems Educators Conference. Nashville Tennessee, US. Retrieved from <http://proc.isecon.org/2010/pdf/1361.pdf>