Finger Joint Timber Products for Effective Utilization of Natural Resources: An Analysis of Physical Properties, Economics Factors and Consumers' Perception

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Abstract
Finger joint (FJ) is sustainable, eco-friendly and economically valuable concept for furniture industry. It ensures the sustainable utilization of small wood cut pieces which removed as waste. Wood pieces are jointed together using glued box comb finger joint cut. It is a new concept for Sri Lankan Therefore, it is necessary to analyze the physical properties, economic parameters and customer satisfaction to ensure the sustainable utilization of timber through FJ production. This study attempted to compare the physical properties such as strength, appearance and economic variables such as prices, cost of production and profit and, customers' perception on FJ products. Comparison of FJ product (Model: STC B-FJ 0019) with the similar size normal timber products (Model: STC B- 132) was done to achieve the objective of the study. Strength reduction for FJ products was significantly high. Strength also varied with timber species. Timber cost for FJ product was low because of small cut pieces but finishing material, labour, machinery & factory overheads costs were higher than common furniture. Therefore, FJ furniture significantly increased the profitability of FJ than common furniture. Customers' awareness on FJ products was much lower but satisfaction about FJ was very high. When purchasing FJ products, customers gave more priority for price and attractiveness. The uniqueness of and high demand for FJ products can increase market price of FJ products and income of producers. Therefore, FJ product can be promoted to ensure sustainable utilization of timber.

Keywords: Finger joint, Strength, Price and attractiveness
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Introduction

Timber is one of the most valuable and renewable resources in the earth. It is used for varied requirements. Timber is one of the most valuable and versatile raw material used by man and plays a vital role in the economic development of the country. It is easily worked with tools and machines and has a very high strength. Despite its strength, it is so elastic and can be used to make it into complex shapes. Wood is resistant to mild chemicals and does not corrode (Keating and Eleanor 1982). However, until recent, there was no considerable attention has made to ensure the sustainable management and use of timber and forest as a natural resource. There are about 300 timber species in Sri Lanka. Among those species, about 30 timber species are readily available in local market (Hatharasinghe *at el.*, 2014). Sri Lanka import about 20 timber species from other countries. Prices of local as well as imported timber are increasing gradually during the recent past (Sandika, 2015). On this back ground, the higher prices of timber provide incentives for illegal logging from natural forests (Jeevika and Gunatilake, 2006). Therefore, it is required to ensure the sustainable utilization of timber to reduce the deforestation. Finger Jointed timber is an alternative methods which can be used to ensure the effective utilization of timber as natural resource. FJ is a new concept for Sri Lankan furniture industry and is one of the most sustainable, eco-friendly and economically valuable concept. It ensures the sustainable utilization of small wood cut pieces which removed as waste. Wood pieces are jointed together using glued box comb finger joint cut. FJ timber is becoming popular and desirable product in the timber industry. Further, finger jointing results in much higher quality and stronger pieces and components, while dramatically reducing waste in the timber industry where the cost of timber materials is rapidly increasing.

Even though the Sri Lankan State Timber Cooperation (SLSTC) is already used finger jointed timber to make furniture and other timber products, FJ timber production is not popular in Sri Lanka. Research findings on FJ are lack in Sri Lanka. On this scenario, specific objectives of the study were to assess the physical properties (quality and strength) of FJ products as compared to normal timber, to analyze economics factors and consumer preference about FJ products as compared to normal timber products.

Materials and methods

The study consisted of three phases' viz., laboratory test, and field study with consumers and economic analysis. Laboratory test was focused to analyze the physical properties based on the strength properties. For the strength properties, Modulus of Rupture (MOR), Modulus of Elasticity (MOE) and Maximum Force were measured.

MOR, (sometimes referred as bending strength), is a measure of a specimen's strength before rupture. It is used to determine a wood species' overall strength; unlike the modulus of elasticity, which measures the wood's deflection, but not its ultimate strength. It can be used to determine a wood species' overall strength. The modulus of elasticity (MOE) measures a wood's stiffness, and is a good overall indicator of its strength *Jack (Artocarpus heterophyllus), Kumbuk, (Terminalia arjuna)Teak (Tectona grandis), Mahogany (Swietenia macrophylla), Grandis (Eucalyptus grandis)*and *Pinus (Pinus roxburghii)*timber were used to evaluate the physical properties. Further, three point bending test was done for each sample by using universal testing machine. MOE and MOR values were calculated using collected data. About 12 samples for each variety of both finger joint and normal wood was used. The sample size was 30cm x 2cm x 2cm.

For the economic analysis of FJ production, unit production cost, (material cost, labour cost, and machinery cost and factory overheads) and unit price were considered for product of STC B-FJ 0019. Economic analysis was done as a comparison of same design, size and material used with normal timber products (STC B- 132) Consumer preference about FJ products was done using a customer survey, based on the awareness about FJ and satisfaction level about FJ products. Awareness about finger joint and satisfaction level about finger joint products were measured by employing five point scale with the weight of +2 = "strongly agree" -2= "strongly disagree". To collect the data from the respondents, formal discussion based upon the interview schedule was used. Target population was fifty (50) individuals who visited to the show rooms of State Timber Cooperation.

Results and discussion

Results of the study illustrates that strength of FJ products was significantly low compared to normal timber products. Further, strength of FJ varied with timber species. *Eucalyptus grandis* and Pinus showed the highest strength while Teak showed the lowest strength. Strength reduction of different timber species of FJ were 82.3%, 78.3%, 62.3%, 61.7%, 60.9% and 60.4% for Teak, Pinus, Jack, Mahogany, Grandis and Kumbuk, respectively. MOE describes tensile elasticity or the tendency of an object to deform along an axis when opposing forces are applied along that axis. It is defined as the ratio of tensile stress to tensile strain. It is often referred simply as the elastic modulus. Elasticity reduction of Jack and Kumbuk were low (7%) compared to Teak, Mahogany, Grandis, Pinus (50%). Modulus of Rupture (MOR) is a measure of strength before rupture. Result of the study illustrated that there was a significant overall strength reduction of FJ. The teak shows the lower strength properties than others because Teak is hard timber variety having fine texture and dusty surface appearance. The wood texture and surface appearance cause low strength for the FJ because it negatively affect to absorption of gums. Jack, Kumbuk and Mahogani showed medium strength while Grandis and Pinus showed high strength. Therefore, Grandis and Pinus were the best varieties for FJ production because light wood can absorb gum well at the compression that may help to increase strength.

On the other hand, results of the study proved that strength on vertical and horizontal FJ cut were not that of significant difference but vertical cut was slightly higher.

Table 1: Cost and price of FJ

Item	FJ Product STC B-FJ 0019 (Rs)	Normal Product STC B-132(Rs)
Material cost	13,22	13,15
Labor cost	5978	3469
Machinery cost	919	731
Factory overheads	677	539
Total Production Cost	20,802	17,894
Cost Difference	2,908	
Market Price	Rs.34,000	Rs.29,900
Price Difference	4,100	

Timber cost for FJ products was low because the process uses small timber cut pieces to make FJ.

Whereas finishing material, labour, machinery and factory overheads costs were higher than common furniture. Unit production cost for FJ was Rs.171.91 compared to cost of normal furniture 147.88. FJ furniture showed a higher price most of the time. Therefore, profitability of FJ furniture was significantly higher than common furniture ($p = 0.00$). The uniqueness and high demand help to increase the market price and to gain more income for FJ producers.

Though the customers' awareness on FJ products was much low, perception was very high. It means that consumers who were aware about FJ showed high satisfaction about the FJ products. Further, when purchasing FJ products, customers gave high priority for price and attractiveness. Customers satisfied about price and attractiveness of FJ furniture nevertheless they did not satisfy about strength, durability and availability.

Conclusion

Profitability of FJ furniture was significantly higher than common furniture. Customers 'satisfaction on FJ furniture was also very high. The uniqueness and high demand help to increase the market price and to gain more income for FJ producers. On this context FJ product can be promoted to ensure sustainable utilization of timber. Further, this subject is open for further researchers.

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