INTRODUCTION

The Malaysian timber industry has developed into a very significant socioeconomic sector, contributing 3.7% to the Growth Domestic Product (GDP) and 3.2% to the country’s total merchandise exports in 2010. Indeed, the furniture business from the wood-based industry continues to expand due to the high demand from the worldwide market, particularly in the Asian region. This is evident from the total export of wooden furniture amounting to RM 6.7 billion in 2014, and by the fact that Malaysia is positioned as the ninth biggest furniture exporter in the world (Malaysian-German Chamber of Commerce, 2014).

Oil palm trunk lumber (OPTL) has been recognised as one of the potential raw materials to substitute rubber wood in the furniture business. Likewise, the cost of oil palm trunks is low as they are readily available after the palms are felled at 25 to 30 years of age based on their economic life span (Abdul Khalil et al., 2010; Anis et al., 2011).

As indicated by Mokhtar et al. (2008), replanting activities cover more than 70 000 ha of oil palm estates every year, obliging the felling of around 9 million palms in Malaysia. A few studies have been conducted to examine and enhance the physical and mechanical properties of Oil Palm Trunk (OPT), for example, its strength (Abdul Hamid et al., 2005; Rokiah et al., 2009) for the generation of value-added products. Aside from these, several researchers (Ul Haq et al., 2010; Abdul Khalil et al., 2012; Abdullah et al., 2012) are similarly working to change this OPT biomass waste into an optional substitute wood lumber material. Such work results in positive effects, particularly in decreasing fossil fuel utilisation (by using biomass as an energy source) and also reducing the pressure of relying too much on tropical timber from the forests (Abdul Khalil et al., 2010).

In order to maintain competitiveness in the wood-based market, maximising the volume recovery from logs is the principal need to enhance the transformation effectiveness and intensity in lumber production (Rappold et al., 2007). Many aspects such as log diameter and sawing pattern can affect the resultant volume recovery, and this has been deliberated upon in past studies (Steele, 1984; Young et al., 2007; Lin et al., 2011).

However, there are just a couple of investigations on OPTL recovery because OPT is generally known to have unique properties which are different from other timber species, particularly in terms of moisture content (MC) and density properties. Those physical properties (MC and density) of lumber affect the criteria for selection of sawing pattern and volume recovery. Henceforth, this article provides data on OPTL recovery of Oil Palm Lumber Production.
volume recovery for every phase of production, and hopefully this can give a clear idea on how to apply ‘green’ sustainability practices in the oil palm biomass sector.

MATERIALS AND METHODS

Log samples of oil palm trunks (*Elaeis guineensis*) were harvested from 30-year-old palms (age for replanting) in a plantation in Kluang, Johor, Malaysia. To calculate the volume of each log before sawing, measurements of length, large-end, small-end and mid-diameter of each log were recorded. The live sawing pattern of the band saw (*Figure 1*) was used to cut the logs into lumber of 4 mm thickness. After sawing, the fresh lumber of each log was measured (length, width and thickness) and the volume (*V*) was determined using the formula below (Lin *et al.*, 2011):

\[
V = W \times L \times T
\]

where: \( V \) = volume of lumber recovered, \( W \) = width of lumber, \( L \) = length of lumber, and \( T \) = thickness of lumber.

**Drying stage**

After sawing, the lumber were stacked up to a height of 1.2 m using wood stickers inserted in a kiln-dryer (*Figure 2*). The stacked lumber were kiln-dried at a temperature following the schedule (*Table 1*) recommended by the Malaysian Timber Industry Board (2015). After the drying process, the lumbers were conditioned at room temperature for two days. The recovery of lumber (without defects) was then calculated.

Lumber recovery (LR), as a percentage, was determined by using the formula (Kukugho *et al.*, 2011) below:

\[
LR\% = \frac{\text{Volume of lumber recovered (m}^3\text{)} \times 100}{\text{Volume of log (m}^3\text{)}}
\]

**RESULT AND DISCUSSION**

Results indicate that the volume recovery of dried oil palm lumber was only 18.26% while the remaining 81.74% was considered as waste. The wastes which include lumber with defects, bark and sawdust can be used in other industries such as for the production of particle board, medium density fibreboard and other composites.

Complete drying time in this study was seven days, as the kiln-dry technique can reduce the drying period to 12 days (Balfas, 2006). The volume recovery within the drying period was just 28.49%, while the remaining 71.52% comprised defective lumber. These findings are in line with a study by Balfas (2006), who found that nearly 80% of defective oil palm lumber was produced after the drying process.

**TABLE 1. KILN DRYING SCHEDULE FOR OIL PALM LUMBER**

<table>
<thead>
<tr>
<th>MC (%) of the wettest timber in the air inlet side</th>
<th>Dry bulb temperature (°C)</th>
<th>Wet bulb temperature (°C)</th>
<th>Approximate relative humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>41</td>
<td>38</td>
<td>95</td>
</tr>
<tr>
<td>60</td>
<td>41</td>
<td>37</td>
<td>88</td>
</tr>
<tr>
<td>40</td>
<td>41</td>
<td>36</td>
<td>77</td>
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<td>35</td>
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<tr>
<td>25</td>
<td>52</td>
<td>38</td>
<td>44</td>
</tr>
<tr>
<td>20</td>
<td>60</td>
<td>41</td>
<td>33</td>
</tr>
<tr>
<td>15</td>
<td>66</td>
<td>45</td>
<td>33</td>
</tr>
</tbody>
</table>


**TABLE 2. RECOVERY RATE PER M³ OF OIL PALM LUMBER**

<table>
<thead>
<tr>
<th>Processing stage</th>
<th>Amount of wastage, % (based on volume)</th>
<th>Recovery rate, % (based on volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage yard (initial logs)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Sawing</td>
<td>35.87</td>
<td>64.13</td>
</tr>
<tr>
<td>Drying</td>
<td>71.52 (defects)</td>
<td>28.49</td>
</tr>
<tr>
<td>Total recovery from initial logs</td>
<td>81.74</td>
<td>18.26</td>
</tr>
</tbody>
</table>
The low volume of recovery resulted from the high temperature and low relative humidity during the drying process (Simpson, 1999). These conditions produced lumber with drying defects such as cupping, honeycombing and cracking as shown in Figure 3. A large portion of the deformed lumber came from the inner and upper parts of OPT, i.e. those parts having lower densities.

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REFERENCES


