Addressing Occupational Ergonomics Issues in Indonesian Forestry: Laborers, Operators, or Equivalent Workers

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Abstract

This study addresses occupational ergonomics issues in Indonesian forestry (work conditions, workers’ characteristics, occupational safety, occupational health, and job satisfaction) to acquire a comprehensive perspective in understanding the actual problems facing the operations. Direct observation, interview, questionnaires, and secondary data analyses were carried out to acquire all of the required information. A total of 191 frontline forestry workers (chainsaw operators, helpers, manual hauling workers, skidder/tractor operators, logging truck drivers, and nursery workers) participated in this study. The study shows that various techniques of forest operations (labor-intensive to semi-mechanized systems) have been applied in Indonesian plantation forests, both short and long-rotation, as well as in natural forest management. Most of the workers were non-permanent workers, who receive a low wage, work under a straight piecework system, have a high dependency on the forestry work to make a living, and exhibit poor comprehension of the concept of hazard control. The fatality rate was recorded as 1.3 deaths/10⁶ m³ log, but this may be even higher as this rate only represents data taken from formal forestry workers. An intense physical dimension of fatigue occurs among workers involved in forest operations, with the highest prevalence of musculoskeletal disorders in the upper back, lower back, neck, shoulders, and arms. This study reveals eight variables that influenced job satisfaction, i.e., wage, type of contract, accessibility, health services, living facilities, work equipment, training, and social facilities.

Keywords: forest operation, OSH, accidents, MSDs, CFSI, fatigue, job satisfaction

1. Introduction

Work in the forest brings significant pressures to forestry workers. These job stressors relate negatively to job performance (Arshadi and Damiri 2013) and are detrimental not only to the individual health and work productivity (Karasek and Theorell 1990) but also to occupational safety (Potočnik et al. 2009, Lindroos and Burström 2010, Tsioras et al. 2014). According to the reports, the accident rate in this industry has been significantly higher when compared with other sectors (Klun and Medved 2007, Shalini 2009, Albizu-Urionabarrenetxea et al. 2013).

Indonesian forest operations also face the same situation. Indonesian frontline forestry workers (especially laborers, operators, or equivalent workers) suffer from excessive physical workload (Yovi et al. 2005, 2006). The excessive workload threatens workers with severe musculoskeletal impairment (Bovens et al. 1991), causing disability, long-term downtime (Kahraman et al. 2016), and low work productivity (Yovi et al. 2006). The excessive physical workload can also lead to fatigue (Lerman et al. 2012), poor decision-making (Shappell and Wiegmann 2000), and poor behavioral motor performance (Neu et al. 2011), which leads to error and accidents (Reason 1990).

Indonesia also faces competence problems amongst forestry workers, which is evident in the knowledge aspects, i.e., general safety, safety management, chainsaw operation and maintenance, and safe tree felling (Yovi and Yamada 2015, Yovi et al. 2016). Given that »person« is one of three main areas where a hazard may develop (Makin and Winder 2008), a worker with a low level of competence has a high probability of
showing unsafe work behavior, which ultimately leads to increased occupational safety and health (OSH) risk.

In the context of Indonesian OSH policy, there is also an issue regarding OSH protection for forestry workers. The Indonesian government has ratified several ILO conventions related to OSH, productivity, and well-being. A technical safety regulation on felling and log transportation was issued in 1978 (Regulation of the Indonesian Republic of Ministry of Manpower, Transmigration and Cooperation Numbered PER.01/MEN/1978). The latest issues on OSH and workers’ well-being have been explicitly stated in the Indonesian mandatory sustainable forest management (SFM) policy (Regulation of the Directorate General of Sustainable Management of Production Forests Numbered P.14/PHPL/SET/4/2016) (Yovi and Nurrochmat 2018). However, OSH protection of forest operations has remained weak and stagnant (Yovi and Yamada 2015, Yovi et al. 2016, Yovi and Nurrochmat 2018).

In a broad spectrum, ergonomics plays a key role in moving towards sustainable forest operations (Marchi et al. 2018). In this context, ergonomics information, in the form of research evidence, will serve as an essential reference or an enlightenment factor that should help policymakers, as well as decision-makers, to understand the existing problems (Kemm 2006) and to formulate suitable public policy that will affect a large number of people (Orton et al. 2011). Unfortunately, comprehensive reports related to the characteristics of workers, the OSH status (fatigue, musculoskeletal disorder/MSDs, occupational accidents), and job satisfaction of forestry workers in Indonesia are not available. Therefore, this study aimed to investigate work conditions, workers’ characteristics (including wage, payment system, consumption patterns, and perception of occupational accidents and hazard control), and OSH. Job satisfaction was also discussed in this study as it corresponds positively to the commitment to safety management policies (Gyekye 2005).

2. Methods

In total, as many as 191 frontline forestry workers (laborers, operators, or equivalent workers) participated in this study (Table 1). Data was collected in 2016–2017. The data were taken from forest management units representing three common types of forest management units in Indonesia, i.e., natural forest management (5 forest management units), industrial plantation forest management (short-rotation, 1 forest management unit), and plantation forest under right-to-use management (hak pengelolaan; long-rotation plantation forest, 5 forest management units). A total of 130 questions were given to each respondent, asking for general information and financial conditions (wage, payment system, and consumption patterns), exploring the respondents’ perception of accidents and job satisfaction, and investigating the status of occupational health (fatigue and MSDs).

The following statistical tests were used: Pearson product-moment correlation coefficient (for normally distributed data, ratio scale), Spearman’s rank-order correlation coefficient (for not normally distributed data, ratio scale), and Somers’ Delta (Somers’ D) test (for not normally distributed data, ordinal scale or bi-

### Table 1 Distribution of respondents (2016–2017)

<table>
<thead>
<tr>
<th>Profession</th>
<th>Personal data</th>
<th>Accidents data</th>
<th>CFS ∗</th>
<th>SNO ∗*</th>
<th>Job satisfactions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General data</td>
<td>Financial data</td>
<td>5</td>
<td>19</td>
<td>52</td>
</tr>
<tr>
<td>Chainsaw operator</td>
<td>52</td>
<td>49</td>
<td>5</td>
<td>19</td>
<td>52</td>
</tr>
<tr>
<td>Forest inventory worker</td>
<td>9</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Helper</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Logging truck driver</td>
<td>19</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Manual hauling worker</td>
<td>60</td>
<td>53</td>
<td>5</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Nursery worker</td>
<td>33</td>
<td>17</td>
<td>7</td>
<td>29</td>
<td>33</td>
</tr>
<tr>
<td>Skidder/tractor operator</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>TOTAL</td>
<td>191</td>
<td>130</td>
<td>51</td>
<td>114</td>
<td>191</td>
</tr>
</tbody>
</table>

* Cumulative Fatigue Symptoms Index
* Standardized Nordic Questionnaire
The Pearson correlation coefficient and Spearman’s correlation test present a good estimation of the actual degree of association (Göktaş and İşçi 2011), while Somers’ D test has been widely used to measure strength and direction association between variables distinguished into dependent and independent variables (Newson 2001).

2.1 Work Conditions, Workers’ Characteristics, and Perception of Occupational Accidents

Considering that the targeted respondents were at laborer, operator, or equivalent level, most of whom were not willing to read lengthy questionnaires, data and information related to work specifics, workplace characteristics, and workers’ characteristics were obtained through direct observation, face-to-face semi-structured interviews, or short questionnaires, which were then verified by using gray literature either in the form of documentation or the forest management unit official reports. The perception of the forestry workers on work accidents and hazard control strategy in their workplace was captured by interviewing forestry workers who had experienced occupational accidents or near misses (near hits).

2.2 Occupational Accidents

The number of accidents and fatalities were recalculated from the raw data obtained from the Indonesian Public Agency for Social Security (Badan Penyelenggara Jaminan Sosial; BPJS).

2.3 Occupational Health Disturbances

2.3.1 Fatigue

Fatigue was measured by using the Cumulative Fatigue Symptom Index (CFSI, Kosugo et al. 1992). The CFSI is a self-reporting questionnaire (dichotomous, “yes” or “no” answer) covering three dimensions of fatigue (physical, mental, and social), which are further classified into eight subgroups (74 questions) (Table 2). The associations among the variables were tested by using the Somers’ D test. In this study, an Indonesian version of the CFSI questionnaire was constructed based on the English version of CFSI (see: Yoshimura and Acar 2004).

2.3.2 Musculoskeletal Disorders

A body map based on the Standardized Nordic Questionnaire (SNQ, Kuorinka et al. 1987) was used to examine occupational health in terms of MSDs. Respondents were asked to mark the map to indicate their musculoskeletal pain experiences.

2.4 Job Satisfaction

In this section, the analysis was directed to verify the impacts of wage, type of contract, accessibility, health services, living facilities, work equipment, training, and social facilities on job satisfaction. A questionnaire, consisting of nine (short but clear) questions (closed-ended questions with a five-point scale format-ordinal modified from Likert scale) was developed. Perception of general satisfaction, wage,

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**Table 2** Description of questions in the Cumulative Fatigue Symptom Index* (CFSI, Kosugo et al. 1992)

<table>
<thead>
<tr>
<th>Type of fatigue</th>
<th>Number of questions</th>
<th>Aspects of symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>General fatigue</td>
<td>10</td>
<td>Carelessness, feeling weak, dizzy, tiring eyes, backache, tired legs, and bad sleep quality</td>
</tr>
<tr>
<td>Chronic fatigue</td>
<td>8</td>
<td>Too sleepy, feeling tired all the times, lacking energy, and not recover from the previous fatigue</td>
</tr>
<tr>
<td>Physical disorders</td>
<td>7</td>
<td>Loss of appetite, difficulty in falling asleep, problem with the digestive system, diarrhea, and heavy head</td>
</tr>
<tr>
<td>Depressive feeling</td>
<td>9</td>
<td>Feeling gloomy, hate their self, enjoy nothing, no fun in their life, and tend to be a loner</td>
</tr>
<tr>
<td>Feeling of anxiety</td>
<td>11</td>
<td>Feeling of worry, uneasy, restless, poor concentration, and feeling inferior.</td>
</tr>
<tr>
<td>Decrease in vitality</td>
<td>9</td>
<td>Impatience, laziness, low ability to give full attention to work, troublesome, loss of vitality ( languish), and dull mind</td>
</tr>
<tr>
<td>Irritability</td>
<td>7</td>
<td>Sensitive to get angry, tense, irritated for no reason, and feeling to beat someone up</td>
</tr>
<tr>
<td>Unwillingness to work</td>
<td>13</td>
<td>Dissatisfaction with their work, monotonous feeling, and bad relationship with boss or colleagues</td>
</tr>
</tbody>
</table>

* Adopted from English version of CFSI (Yoshimura and Acar 2004)
and type of contract (permanent, temporary) was described as »very dissatisfied, dissatisfied, neither, satisfied, or very satisfied«, while perception of work facilities (tools and equipment), living facilities (housing, sanitation), health services, training facilities, and social facilities (sport facilities, prayer room) was described as »very poor, below average, average, above average, or excellent«. Questions about accessibility were stated as »very poor, poor, acceptable, good, or very good«.

3. Results

3.1 Nature of Work Conditions, Workers’ Characteristics, and Perception of Accidents

3.1.1 Nature of Work Conditions

The business license for timber utilization in the natural forest has been granted to 19.3 million ha out of 68.8 million ha of Indonesian total forest production area; the annual timber production in 2016 was 5.4 million m$^3$ (MoEF 2017). Indonesia applies selective cutting; thus, only commercial tree species with ≥40 cm in diameter (for permanent production forest) or ≥50 cm in diameter (for limited production forest) are allowed to be harvested in this forest. Felling is carried out using a chainsaw, and the conventional method (simple notch and back-cut technique) is common. Various forest machines are used for skidding, loading/unloading, and log transportation (Table 3).

Indonesia has also developed plantation forests. This intensively managed forest plantation is the leading forest industry in Indonesia. MoEF (2017) has granted a business license for timber utilization in the form of a plantation forest to a total of 10.8 million ha area. This industrial plantation forest is mostly located in Sumatra, Kalimantan, and Papua islands (fast-growing species: e.g., acacia, eucalyptus). Annual timber production from this plantation forest was 32 million m$^3$ in 2016 (MoEF 2017). Similar to harvesting
in natural forests, timber harvesting in these short-rotation plantation forests is carried out in the form of semi-mechanized forest harvesting (Table 3).

On Java Island, a state-owned forest company has intensively managed 1.8 million ha of plantation forest (dominated by long-rotation species, e.g., teak, Indonesian rosewood, mahogany). In this forest, the intensive labor system has become the backbone of the forest operations for decades (Fig. 1).

3.1.2 Workers’ Characteristics

The age of forestry workers involved in this study averaged 39 years of age (±10 years). Approximately 53% of workers were older than the average. Work experience averaged 12 years (±9 years), and the number of dependent family members averaged 4 persons (±1 person). About 89% of workers had lower than high school education. Out of 130 respondents, who answered the financial-related questions (Table 1), 49% stated that forestry work was the only source of income, while the rest (51% of respondents) had alternative financial support (which, on average, accounted for 20% of the total household income). Financial data showed that 49%, 45%, and 5% of respondents spent as much as 27–49%, 50–74%, and >75% of total income on food, respectively (average spending pattern was 53%; Fig. 2). The lower-income households had a higher food spending rate than the relatively higher-income households (Spearman’s correlation test, \( r_{s}=-0.579, \ p=0 \)).

Despite their poor financial condition, smoking behavior was found in 69% of respondents (from the entire survey). With an average of 12 cigarettes per day, the expenditure for cigarettes can reach USD 27 per month, which is 17% of a household’s monthly total income.

3.1.3 Workers’ Perception of Work Accidents and Hazard Control

The majority of respondents agreed that accidents are »shocking«, »sad«, but quite »common«. As stated by worker A, a manual hauling worker: »... accidents are events caused by work activities that are essentially undesirable. One of my friends has been in an accident and suffered serious injury and is in miserable condition. Of course, I do not want that to happen to me. However, it is a »normal« occurrence if you work in this industry...« Similar to other manual hauling respondents, he wore personal protective equipment (PPE) improperly while at work (Table 4). The other 21% of respondents also stated a similar opinion and showed the same work behavior.

A statement of worker B, a logging truck driver, represents another general description of the workers’ perception of an accident: »... as long as we work carefully, we can avoid accidents...« The statement be-
comes very interesting because some of them did not maintain a safe driving distance. In regard to manual hauling workers, we found that they prefer to carry 60 kg of logs using no manual lifting devices. The workers said that the use of such lifting devices would consume more working time and result in decreased wages.

Further, worker C, a chainsaw operator who wears no safety shoes, safety trousers, eye protection, and ear protection during work stated as follows: "... Cutting work is hard and dangerous work, and accidents are unwanted. In my opinion, I will be able to prevent work accidents if I wear PPE properly....« This statement represents the perception of 86% of respondents.

Table 4 Overview of occupational accidents: accident type, personal protective equipment (PPE) used, and respondents’ opinion about hazard control strategy

<table>
<thead>
<tr>
<th>Workers</th>
<th>Type of accidents</th>
<th>Cause of accidents</th>
<th>PPE used during accidents</th>
<th>Respondents’ opinion on hazard control strategy*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chainsaw operators</td>
<td>Slipped while cutting, almost hit by a tree, bee stung, and hit by a machete while cleaning bush shrubs</td>
<td>Careless, slippery road</td>
<td>Rubber boots, helmet, gloves</td>
<td>Wearing PPE, being alert to the work environment, being careful, preparing an evacuation route</td>
</tr>
<tr>
<td>Helpers</td>
<td>Chainsaw is struck by a fallen tree, hit by a tree</td>
<td>Careless</td>
<td>Rubber boots, glove</td>
<td>Being alert to the work environment, being careful</td>
</tr>
<tr>
<td>Logging truck drivers</td>
<td>Crashed into another car, rolled over</td>
<td>Slippery road, careless</td>
<td>Safety shoes</td>
<td>Wearing PPE, being careful, obeying traffic signs, praying before start work</td>
</tr>
<tr>
<td>Manual hauling workers</td>
<td>Slipped, hands or feet wedged in logs, crashed by logs</td>
<td>Slippery log, careless</td>
<td>Helmet</td>
<td>Wearing PPE</td>
</tr>
<tr>
<td>Nursery workers</td>
<td>Falling off the motorbike</td>
<td>Slippery road, careless</td>
<td>Helmet, rubber boots</td>
<td>Wearing PPE</td>
</tr>
<tr>
<td>Skidder/tractor operators</td>
<td>Tractor overturned because failure on the brake system</td>
<td>Slippery road</td>
<td>Safety shoes</td>
<td>Wearing PPE, not to work when tired</td>
</tr>
</tbody>
</table>

* Listed in sequent from the most effective to the least effective
who admit PPE is a critical instrument in avoiding accidents because PPE gives one a good ability to »control the hazards«.

3.2 Occupational Accidents

3.2.1 General Description

The 2008–2015 national data taken from BPJS show that forestry works (consisting of cutting, forest man-
agement, collecting forest products, making charcoal, and collecting resin) contribute to 984 accident cases annually resulting in 46.4 fatalities annually. Among different categories, felling and bucking contribute the most significant number of accident cases and fatalities annually (Fig. 3). The data also shows a decrease in the annual number of both accidents and fatalities in 2008–2015.

3.3 Status of Occupational Health

3.3.1 Fatigue

In general, the complaint rate of cumulative fatigue among manual hauling workers and chainsaw opera-
tors was more intense when compared to that of other workers (Fig. 4). Most workers mention the feeling of discomfort in the morning, suffering stiffness, and feeling sleepy throughout the day, indicating chronic fatigue, which is a physical dimension of fatigue (Kosugo et al. 1992). Other symptoms of the physical dimension of fatigue (general fatigue and physical disorders) were also detected. The Somers’ D test shows that the physical, mental, and social dimensions of fatigue reciprocally influence each other in a positive direction (see Table 5). This relationship indicates that the factors triggering fatigue in forestry work overlap in physical, mental, and social aspects.

3.3.2 Musculoskeletal Disorders

In line with the CFSI results, manual hauling workers have the most intense MSDs. MSDs were associated
with physical fatigue (Somers’ D test, $d=0.231$ for physical dimension of fatigue as dependent variable, $d=0.209$ for MSDs as dependent variable, $p<0.0005$). The MSDs were found in 18 body parts, with the most intense pain in the upper back, lower back, neck, shoulders, and arms (Fig. 5).

Detailed economics-loss data caused by fatigue and MSDs in the Indonesian forestry sector are not available; however, there is evidence that fatigue and MSDs inflict not only health problems that result in low quality of life, but are also significantly detrimental to economic well-being. In the United States, fatigue may cost as much as USD 9.1 billion annually (Reynold et al. 2004), while MSDs cost USD 2.6 billion (Bhattacharya 2014). In Columbia, Piedrahita (2006) estimated that the total loss due to MSDs in the country was USD 171.7 million (equal to 0.2% of the country’s 2005 GDP).

### 3.4 Job Satisfaction

The questionnaire was valid (Pearson Product Moment Correlation test shows the $p$-values of the Sig. 2-tailed for all nine questions <0.01) and reliable (Cronbach’s Alpha value=0.873). Data were not normally distributed, but monotonic relationships between general job satisfaction and the existing eight independent variables (wage, type of contract, work facility, living facility, health service, training facility, social facility, and accessibility) existed. The Somers’ D shows that job satisfaction was influenced by the eight variables (see Table 6).

### 4. Discussion

#### 4.1 Work Conditions, Workers’ Characteristics, and Perception of Occupational Accident

Besides the labor-intensive system (a combination of chainsaw+manual hauling for felling+skidding), the chainsaw+skidder (or equivalent machinery) combination is massively applied in Indonesia. Several studies...
have proven that the chainsaw+skidder combination poses a higher risk to safety and health (Potočnik et al. 2009, Potočnik and Poje 2017); thus, the combination of chainsaw+manual hauling potentially triggers a severe impact on the workers’ safety and health.

Compared with the provincial or municipal minimum wage set by the Indonesian government (Government Regulation Numbered 78 of 2015 on Remuneration), total income of 76% of respondents slightly exceeds the minimum monthly wage. For reference, the minimum wage ranges from IDR 1,337,645 (equal to USD 100) for Yogyakarta up to IDR 3,100,000 (equivalent to USD 231) for Jakarta (average currency rate in 2017). However, since a worker should support 3–5 family members, the wage rate is not yet comparable to the decent living needs. This is indicated by the fact that the average spending rate for food consumption was 53%, which is even more than twice the typical low-income household spending pattern (Castner and Mabli 2010). The situation becomes complicated when the issue of health and lifestyle is taken into discussion. Wasting 16–17% of total monthly income on tobacco is a significant cost for low-income households. This rate is higher than the estimated tobacco cost in low-middle-income countries (Eriksen et al. 2012).

In addition to the high dependency on the forest to make a living, as much as 71% of respondents were non-permanent workers (working for a specific length of time or specific production target) and paid under a straight piecework system. The fact that the manual hauling workers perceived safety procedures as a time-consuming additional work that may reduce their work output should be seen as an indication that the current piece rate system provokes unsafe work behavior that threatens the workers’ safety (Johansson et al. 2010).

This study also shows that the lack of knowledge of the concept of hazard control potentially increases hazards (Makin and Winder 2008). In this study, most of the workers rely mainly on PPE to prevent accidents (see Table 4), whereas the hierarchy of hazard control has positioned PPE as the least effective action (NIOSH 2018). An obvious example can be seen in the case of the skidder/tractor accident caused by brake failure (see Table 4). Instead of preventive actions, e.g., carrying out regular maintenance, operators listed PPE as the primary strategy to avoid accidents. Another example is that manual hauling workers considered wearing PPE as effective in protecting their toes/hands from being pinned down by rolling logs. Based on the accident types, improving the working techniques (e.g., using lifting devices such as a portable winch or improving workers’ skill by conducting training) is the proper strategy to overcome this hazard. In the case of chainsaw operators, it is a fact that the legs are the most commonly injured body part (Bentley et al. 2002, Lilley et al. 2002); thus, it is not wrong to consider safety trousers as a strategy to avoid accidents. However, the operators failed to understand that safety trousers cannot provide 100% protection to the legs from chainsaw cut accidents, as there are many factors, e.g., cut angle, trousers’ material, chains type, and chain sharpness that influence the threshold of stopping speed in the protection mechanism (whether the chain stops or clogs, or if there is a cut-resistant mechanism) (Arteau et al. 1996). Therefore, using PPE as the first attempt at hazard control is inappropriate thinking because PPE alone cannot be relied upon to control hazard.
4.2 Status of Occupational Accidents

Chainsaw is the most common machine used for cutting (Table 3) and has been documented as the cause of most fatalities in Indonesia (Fig. 3). A similar tendency has also been revealed in other countries (Thelin 2002, Wilhelmson et al. 2005, Potocnik et al. 2009). In 2008–2015, the average annual fatality rate in forestry work accidents was 1.3 death/10^6 m^3 log, and the average annual round wood production was 35.4 million m^3 (MoF 2012, MoEF 2017). The death toll is lower than that of Austria and Switzerland (Klund and Medved 2007). However, it should be noted that 97% of the data shown in Fig. 3 were taken from formal forestry workers only, whereas the majority of front-line forestry workers (e.g., chainsaw operators, skidder/tractor operators, helpers, logging truck drivers, manual hauling workers, and nursery workers) are informal workers. This fact indicates that there is a high probability that the actual accident and fatality rate in forestry works is higher than the given figure.

4.3 Status of Occupational Health

The CFSI and MSDs analysis confirmed that the practices of labor-intensive and semi-mechanized forest operations in Indonesia had caused a negative impact on the operators’ health. In half-day work, one group of hauling workers (usually consisting of four workers, labor-intensive system) should load approximately 4.5 m^3 of large logs onto a truck using only simple aid tools (e.g., pole, turning hook, or skidding tong, see Fig. 1). This fact implies that, on average, a worker is burdened with more than 1 ton of load per day. In terms of chainsaw operation, cutting a small diameter of trees scored 12 on ergonomics risk level (REBA score, which means »very high risk: immediate change is required«) (Yovi and Pradjawati 2015) and burdened the chainsaw operator with heavy physical workload (Yovi et al. 2006). Thus, the risk level is possibly higher for a larger diameter of trees (carried out in the natural forest), as larger diameters demand longer duration of awkward posture. Teak-stand clear-cutting, a part of a labor-intensive forest operation that still exists in Indonesia, is even harder. Teak is a high-value tree species so that the cut is made to be as low as possible to minimize logging waste. As a result, chainsaw operators should maintain an awkward posture (see Fig. 1) for a longer duration, which results in higher physical workload (Yovi et al. 2005) and hypothetically greater ergonomic risk level. As for logging truck drivers, they have to sit (in a forced and monotonous position) for an extended duration through uneven and bumpy forest roads. In an observation site, it was a 75 km driving distance with a driving speed (loaded) of 18–25 km/hr. Hence, the manual hauling workers, chainsaw operators, and truck drivers are burdened with excessive physical activity, which resulted in severe MSDs (Bovensi et al. 1991, Ohlendorf et al. 2017) and intense physical fatigue (Lerman et al. 2012).

4.4 Job Satisfaction

Forestry work leaves little room for error; on the other hand, the Indonesian forestry workers face complex problems. Therefore, supports are required. This study shows that improvement in health services, living facilities, working tools, training, and social facilities, together with the type of contract, wage, and accessibility, will boost the workers’ job satisfaction, which will lead to better safety protection, as workers with higher job satisfaction tend to be more committed to safety than dissatisfied workers (Probst and Brubaker 2001, Baring et al. 2003, Gyekeye 2005).

In terms of training facility improvement, regular-based designed training is recommended, as the designed training has been effective in reducing occupational accidents in forestry work (Potocnik et al. 2009). The recommended topics for the training are handling emergency conditions and safe work practices. In accordance with the training, open access to the OSH information is required. A safety education learning tool could be implemented for this purpose (Yovi and Yamada 2015, Yovi et al. 2016).

In addition to improving knowledge and skills, workers must also be equipped with tools fit for the job, e.g., equipping hauling workers with lifting aid tools to avoid excessive physical workloads. Furthermore, based on the current conditions, having a regular health examination or providing an emergency kit for every unit/workgroup is an example of recommended health facility improvement.

Eliminating a contract labor system in forestry works is not straightforward. Therefore, mutual benefit between the forestry business owner/manager and the workers reflected in the equality of bargaining power of rights and responsibilities and written in an employment agreement is compulsory (Yovi and Nurrochmat 2018).

Another strategy in improving the quality of workers’ life is by increasing wage/salary rate per output; the impact will likely be more effective if the current payment system adopts differential piecwork system, one which gives higher rewards to workers who observe good safety practices. This payment system revision is also a more effective and protective strategy in hazard control than wearing PPE (NIOSH 2018).
5. Conclusions

This paper presents the basic information describing actual occupational ergonomics-related problems in Indonesian forestry work. This study states that the "traditional" technology (labor-intensive and semi-mechanized harvesting) still plays a role as the backbone of forest operations in Indonesia. This technology level correlates with a high risk to occupational safety (high fatality rate) and health disturbances (fatigue in physical-mental-social dimensions and intense MSDs). In addition to having a high financial dependency on forest work, most of the workers are low-income and non-permanent and paid under a straight piecework system that provokes unsafe work behavior. Due to the lack of knowledge of the concept of hazard control, the situation becomes even more complicated. Improving the working techniques (equipping workers with proper devices), increasing wage rate per output (which is then followed by improving the payment system), and improving workers' knowledge (and skill) of safety and health protection should be considered as alternative exit strategies to overcome the problems. Improvement in these three aspects, together with improvements in health services, living facilities, and social facilities, as well as accommodating better mutual benefits between the workers and business owner/manager in employment contract, and ensuring better workplace accessibility, will increase the workers' job satisfaction, which, in turn, will increase occupational safety and health awareness among the forestry workers.

Acknowledgements

This work was supported by grant number 1417/IT3.11/PN/2017 from the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia to the first author as a part of a collaboration research program between the Japan Society for the Promotion of Science (Japan) and the Directorate General of Research, Technology, and Higher Education (Indonesia).

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