UNIVERSITI PUTRA MALAYSIA

PERFORMANCE COST INDEX IN EVALUATING OIL PALM STEM AS ALTERNATIVE FIBRE MATERIAL IN CHAIN OF CUSTODY CERTIFICATION OF PLYWOOD MILLS IN MALAYSIA

AIDA ADNAN

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By

AIDA ADNAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Chairman: **Professor Paridah Md. Tahir, PhD**
Faculty: **Institute of Tropical Forestry and Forest Products**

The major concern in chain of custody (COC) certification is the cost of implementation and maintenance. Thus, the main aim of this study is to assess the above said costs and factors that motivate the Malaysian certified plywood mills. First stage of the study was the identification of motivational factors. Second was evaluations of COC cost components where, certified plywood mills in Malaysia were surveyed through personal interview. The independent variables were measured using Likert-like scale. The third stage was an application of performance cost index (PCI). Mann-Whitney, percentage data analysis and regression with an econometric analysis were used to analyse data on motivational factors. Data collected on cost components was analysed using simple mean and one-way ANOVA. Pearson's correlation analysis was used to explore the relationship between grades of plywood product and PCI, as well as PCI and plywood price. Whilst, linear regression analysis was used to predict the new plywood product price. Result of the study shows that seven cost components were identified in COC certification; 1) cost of procuring certified raw material (MYR1.24/m^3 to MYR2.44/m^3); 2) consultancy (plus training) MYR0.41/m^3 to MYR0.47/m^3); 3) auditing fees (MYR0.99/m^3 to MYR1.59/m^3); 4) documentation (MYR0.04/m^3 to MYR0.27/m^3); 5) marketing or promotional (MYR0.35/m^3 to MYR0.49/m^3); 6) continuous training (MYR0.00/m^3 to MYR0.21/m^3) and 7) cost for hiring additional staff or reward given (MYR0.00/m^3 to MYR0.06/m^3). 41% of the certification cost was due to certified raw material which is statistically significant at $P \leq 0.05$. Thus, as an alternative, Oil Palm Stem (OPS) was introduced. The study proposed a "Performance Cost Index (PCI)" to be used as a guiding tool in consuming OPS as raw material. PCI has shown as a good predictor for plywood grade ($R^2 = 0.50$) and price ($R^2 = 0.70$). In term of performance value over cost (PCI), OPS give better PCI results than using MLHW (1.57). Plywood produced using 100% OPS through improved production method shows the best result (1.82) followed by OPS mixed plywood (1.76) produced through conventional method. Every change in PCI will result in a marginal change on average of 555.91 unit of plywood cost.

Abstrak tesis yang dikemukan kepada Senat Universiti Putra Malaysia bagi memenuhi keperluan untuk ijazah Doktor Falsafah

INDEKS PRESTASI KOS BAGI MENILAI POTENSI BATANG KELAPA SAWIT SABAGAI SUMBER FIBER ALTERNATIF DI DALAM PENSIJILAN KILANG PAPAN LAPIS DI MALAYSIA

Oleh

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Pengerusi: **Professor Paridah Md. Tahir, PhD**
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Kebimbangan utama dalam pensijilan kayu (COC) adalah kos pelaksanaan dan penyelenggaraan. Oleh itu, kajian ini dijalankan bertujuan menilai kos tersebut dan faktor motivasi kilang papan lapis bersijil di Malaysia. Tahap pertama kajian adalah mengenalpasti faktor motivasi. Kedua adalah penilaian komponen kos COC di mana, survei ke atas kilang papan lapis bersijil dijalankan melalui temubual peribadi. Pembolehubah bebas diukur menggunakan skala Likert. Peringkat ketiga adalah penerapan indeks kos prestasi (PCI). Mann-Whitney, analisa data peratusan dan regresi dengan analisa ekonomi digunakan terhadap data berkaitan faktor motivasi. Data komponen kos yang dikumpul, dianalisa menggunakan ANOVA satu arah. Analisa korelasi Pearson digunakan untuk menerokai hubungan antara gred produk papan lapis dan PCI, serta harga PCI dan papan lapis. Manakala, analisa regresi linier digunakan untuk meramal harga produk papan lapis baru. Terdapat tujuh komponen kos dikenalpasti dalam pensijilan COC; 1) kos mendapatkan bahan mentah yang disijil (MYR1.24 / m^3 hingga MYR2.44 / m^3); 2) perundingan (termasuk pelatihan) MYR0.41 / m^3 ke MYR0.47 / m^3); 3) yuran audit (MYR0.99 / m^3 ke MYR1.59 / m^3); 4) dokumentasi (MYR0.04 / m^3 ke MYR0.27 / m^3); 5) pemasaran atau promosi (MYR0.35 / m^3 ke MYR0.49 / m^3); 6) latihan berterusan (MYR0.00 / m^3 ke MYR0.21 / m^3) dan 7) kos untuk kakitangan tambahan atau ganjaran (MYR0.00 / m^3 ke MYR0.06 / m^3). 41% daripada kos pensijilan adalah bagi mendapatkan bahan mentah yang disijilkan dimana secara statistiknya signifikan pada $P \leq 0.05$. Oleh itu, sebagai alternatif, batang kelapa sawit (OPS) diperkenalkan. Kajian ini mencadangkan "Indeks kos Prestasi (PCI)" digunakan sebagai alat panduan dalam menggunakan OPS sebagai bahan mentah. PCI telah dibuktikan sebagai peramal yang baik untuk gred papan lapis ($R^2 = 0.50$) dan harga ($R^2 = 0.70$). Dari segi nilai prestasi ke atas kos (PCI), OPS memberikan hasil PCI yang lebih baik berbanding menggunakan MLHW (1.57). Papan lapis yang dihasilkan menggunakan 100% OPS melalui kaedah pengeluaran yang ditambah baik menunjukkan hasil terbaik (1.82) diikuti oleh papan lapis campuran OPS (1.76) yang dihasilkan melalui kaedah konvensional. Setiap perubahan dalam PCI akan menyebabkan perubahan marginal purata sebanyak 555.91 unit kos papan lapis.

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I certify that a Thesis Examination Committee has met on 30 May 2018 to conduct the final examination of Aida binti Adnan on her thesis entitled "Performance Cost Index in Evaluating Oil Palm Stem as Alternative Fibre Material in Chain of Custody Certification of Plywood Mills in Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This is to confirm that:

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- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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LIST OF ABBREVIATIONS

COC	Chain of custody
FAO	Forest and Agriculture Organisation
FSC	Forest Stewardship Council
ITTO	International Tropical Timber Organisation
MC&I	Malaysian Criteria and Indicators
MPOB	Malaysian Palm Oil Board
MTCC	Malaysian Timber Certification Council
MTCS	Malaysian Timber Certification Scheme
NTCC	National Timber Certification Council
OPS	Oil Palm Stem
PCI	Performance Cost Index
PEFC	Programme for the Endorsement of Forest Certification
RAP/COC	Requirements and Assessment Procedures for Chain of Custody Certification
RCOC	Requirements for Chain of Custody Certification

CHAPTER 1

INTRODUCTION

1.1 Timber Certification in Malaysia

Timber certification has become an important and growing phenomenon in forestry sector all over the world. It is generally regarded as a yardstick for companies to show commitment towards the efforts of implementing good forest management. Since the 1990s, sustainable forest management has been regarded as an instrument for forest certification (Stevens et al., 1998). Timber or forest certification is divided into two categories; Forest Management (FM) certification and Chain of Custody (COC) certification. Forest Management certification applies to forest owners or managers and their forest management system. While COC certification is for ensuring the tracking system is in place at the manufacturing company where timber origins can be traced and confirmed. Forest management certification addresses the quality of forest management practice rather than the quality of forest products. It is market driven, aiming at improving forest management through market-based incentives as well as improving market access and share for the products from such forest management activities (Bass, 2004).

As a timber producing country where plywood is one of the major exports earning of timber industry, both Malaysia and the plywood industries are not exempted from the growing concern for timber certification. However, there are other underlying issues beneath all these certification efforts and concerns, such as the motivation factors and cost of certification which remain partially or totally unresolved to date.

1.2 Certification of Plywood Mills

Certification of wood-based panel industry in Malaysia has started with plywood companies as early as 1999 under the Forest Stewardship Council (FSC) and the Malaysian Timber Certification Council (MTCC) schemes. Export statistics of certified products produced by Malaysian Timber Certification Council (MTCC) in 2013 reported that plywood was the second highest contributor to the total export of Malaysia Timber Certification Scheme/Programme for the Endorsement of Forest Certification (MTCS/PEFC) certified products. In term of volume, plywood constituted 29% (47,276 m^3) out of 164,612 m^3 of certified products exported by Malaysia after sawn timber (60% or 97,995 m^3) and other products including paper, mouldings and finger jointed (11%) (MTCC, 2013).

At the end of 2014, the total MTCS/PEFC certified product exported was 168,094 m^3. Although there was a slight decrease in the total volume of plywood exported, it remained the second largest (26%) of certified product exported after sawn timber (65%) in 2014 (MTCC, 2015). In 2015, the export of certified timber products had increased by 18% to 198.992 m^3. But, export of certified plywood in 2015, showed

further decreasing trend to also 18% that forced plywood to be on the third place of certified products exported after mouldings and sawn timber (MTCC, 2016). As for the volume of Forest Stewardship Council (FSC) certified plywood exported by Malaysia, unfortunately, the statistics is not available. Due to a growing demand for certified wood products in the market and the significant economic contribution of plywood industry, there is a need to investigate the motivation factors, challenges and cost components of certification of the certified plywood mills. The information obtained could be valuable to a decision-making process as well as to policy makers in encouraging more plywood mills to embark into certification.

1.3 Statement of Problems

Timber and forest certification phenomenon started in Malaysia in 1999. However, after about 17 years of implementation, only 29 (23%) out of a total of 125 active plywood mills in Malaysia are certified (MIDA, 2014). This situation has raised several questions with regards to timber certification, including if the existing certified plywood mills opted for certification because of market pressure or because they were truly concerned about forest conservation.

It was reported that adoption of certification offers better opportunities for increased credibility and competitiveness in market place such as price premium and access to new markets (Hansen, 1998). According to Kollert and Lagan (2007), a few studies have claimed that consumers in the European and US markets are willing to pay between 2% to 30% more for certified tropical timber. Similarly, Mannan (2002) and Kollert (2003) reported that premium prices were offered for certified logs by a margin of USD51/m³ which is equivalent to 44% of price increase compared to non-certified logs. A comparative price analysis study conducted from 2000 to 2004 on certified logs produced by the Sabah Forestry Department revealed that certified logs did achieve a higher price premium by 2% to 56% depending on the species group. For instance, high quality logs for the export market would fetch a premium price amounting from 27% to 56% higher than the normal price. However, light hardwood logs which were mainly for veneer production gained between 2% to 30% lesser premium (Kollert and Lagan, 2007).

As for certified products, the average increase in the price of certified plywood is about USD$25/m³ (, personal communication with Mike Chong, 2007). However, the question remains; *Does the higher price truly give certified product a "premium price" status and access to new market in comparison to non-certified product? Or the price was actually just enough to cover the cost for the implementation and maintenance of the certification system? What about the cost components of plywood certification?* As highlighted by Baharudin and Simula (1994), the biggest challenge in establishing a causal link to a market premium is the lack of systematic and accurate information on the additional costs of certification. Hence, it is very crucial to establish a cost structure in certified plywood mills in order to assess whether or not cost has significant influence in the motivational factors behind the willingness to participate in the certification programme.

Chain of custody certification is often seen as a significant challenge and cause for cost increment, especially by operations that involved hundreds of wood raw material suppliers as well as continuous processing like plywood mills. The direct cost (i.e. certification or auditing fees) of COC certification is typically around USD3,000 to USD5,000. But little is known about the indirect costs incurred which include cost of promotional activities and in some companies cost for hiring additional manpower if any, for implementing and maintaining the COC system (Hansen and Bratkovich, 2007).

Previous studies conducted were mostly focused on the perspective of the demand side regarding the consumers' willingness to pay a premium for certified products (Ozanne and Vlosky, 1997; Stevens et al., 1998; Vlosky and Ozanne, 1997). These studies were mainly conducted on consumers, manufacturers and business owners' through questionnaire surveys. To the best of the author's knowledge, there is none or very limited published data or reports available on the motivation factors and costs components in the Malaysian certified wood manufacturing operations, particularly in plywood production.

Based on the author's personal communication with some of the plywood mills, high cost of wood raw material from certified forest appears to be one of the key factors influencing the sustainability of certified plywood. Although at present, there are about 4.7 million hectares of PEFC certified forest in Malaysia (MTCC, 2016), such high raw material cost cannot be avoided as there is limited availability of certified raw material which causes the price to escalate.

The production and supply of logs in Peninsular Malaysia is determined by the annual allowable cut which is subjected to the National Forest Policy (NFP). This is based on Malaysia's commitment towards Sustainable Forest Management (SFM). As a result of the implementation of NFP and SFM, the production of logs from natural forest has declined from 23.1 million m^3 in 2000 to 20.7 million m^3 in 2008 (MTIB, 2017). Whilst in 2015, Sabah Forestry Department (SFD) has also recorded a decline in log production of 13.7% or 2.87 m^3 from 3.33 m^3 in 2014 (SFD, 2017). Similarly, Sarawak's timber company, Rimbunan Hijau group, had reported a 17% drop in log production during the first six months of 2016, a decline of 87,472 m^3 from 528,172 m^3 in the first half of 2015. This is in view of the stringent timber certification rules and sustainable forest management policy imposed on the timber licensees by the state authorities (The Star, 2016). Hence, the industry would have to adjust their operations to the limited supply of timber resources (MTIB, 2017).

1.3.1 Non-Wood Fibre Material for Plywood Production

In view of the conditions and policy mentioned earlier, in order to ease the dependence on certified timbers, the wood-based panel manufacturers are therefore suggested to start looking for non-wood materials as an alternative to their timber supply. Both certification schemes, the FSC and MTCS/PEFC, consider non-wood fibre materials such as bamboo, kenaf, jute, hemp, coconut trunk and oil palm stem as "Non-forest

base material" (FSC Standard for Chain of Custody Certification, 2011) or "Neutral Material" (PEFC Chain of Custody of Forest Based Products-Requirements, 2013). In other words, the use of non-wood fibre materials in a mixture with certified wood for the production of certified product allows the final products to be claimed or labelled as "FSC Pure" or "100% PEFC Certified". Oil palm stem or oil palm trunk is one of the most abundant raw material in Malaysia.

Oil palm (*Elaeis guineensis*) stem (OPS) is the most potential raw material particularly for plywood manufacture which is abundant and widely available in Malaysia. Oil palm trees were grown initially for palm oil production. The productive period is from 20 to 30 years before the oil production decrease and the trees have to be replanted. It is reported that Malaysia is producing about 22 million m^3 of oil palm biomass yearly, which include stems, fronds and empty fruit bunches (Anon, 2006). By 2020, the total biomass produced is expected to increase when the total planted area reaches 5 million hectares. Based on 100,000 hectares of replanting activity each year, the annual availability of OPS is estimated to be about 14 million logs (Anis, 2006) which in controlled conditions can be converted into 5 million m^3 of plywood. In contrast to log price, the OPS fetch much lower price of between MYR8 to MYR18 per stem (Wan Asma, 2010). Currently the price of OPS has increased to about MYR38 to MYR45 per stem in the northern part of Malaysia (personal communication with Central Kedah Plywood, 2016) and between MYR30 to MYR35 per stem in the southern region (personal communication with Plus Intervest, 2016).

Various studies have been conducted to determine the performance of OPS as part or alternative material for plywood production. Modification of plywood production processes could produce OPS plywood with superior mechanical strength in both dry and wet conditions with values of 2.433 MPa and 1.626 MPa, respectively (Loh et al., 2010). Nevertheless, the fact that these "non-wood fibre" are fairly new and unverified in terms of commercialisation potentials have made such effort dawdling.

Unless there is a method available to evaluate the true potential of OPS, this raw material cannot be considered as potential replacement of wood for it requires a special treatment in order to produce comparable quality of plywood as that from Mix Light Harwood (MLHW). In this study, the costs structure of certified plywood mills was established and the important cost factors influencing the mills decision in certification activities were identified. The study also chose OPS to represent non-wood material for the calculation of Property Cost Index (PCI). The use of OPS as an alternative raw material in plywood manufacture was analysed based on its processing methods and properties of the plywood produced. The results of this study were used to develop a Property Cost Index (PCI) for evaluating the true potential of OPS as an alternative fibre material by considering both the manufacturing method and the plywood properties in relation to cost.

1.3.2 Establishment of Performance cost index (PCI)

As mentioned earlier, OPS is used as a non-wood model for this purpose. However, the use of OPS as a potential material for plywood production, has created further challenges that may occur in term of performance cost, production system modification and manufacturing costs unlike the MLHW, OPS veneer requires pre-treatment prior to pressing (Paridah, 2010). Cost is the main criteria for any new investment. There are 4 possible scenarios when OPS is used as raw material in plywood production;

Scenario-1	High investment cost with no effect on plywood performance
Senario-2	High investment cost with improved plywood performance
Senario-3	Low investment cost with no effect on plywood performance
Senario-4	Low investment cost with improved plywood performance

In this study, cost-performance factor was identified as having a vital role in deciding whether or not a new investment can be considered. According to D'souza and Williams (2000) cost-performance is the performance of product as a function of costs for direct labour, direct materials and allocated overhead, as well as the non-manufacturing costs. The study attempted to establish a PCI to prove that product properties over cost performance of the final product is important in evaluating the true advantage of an investment.

Performance Cost Index represents the performance factor for every 1 (one) MYR spent to produce the product. For instance, it could be a measuring tool for exploring the possibility of using a new material and/or using new production method. So far, the performance index has not been practised in wood industry but it is well accepted by other fields including the engineering and environmental sectors through concept selection, new product development and decision-making process. In order for a company to compete in the marketplace, cost and performance have become qualifying dimensions (Drury, 2000). Performance refers to quality or internal quality where the concept captures the ability of manufacturing firm to produce products conforming to their designed quality at an economical production cost (Crosby, 1996).

1.4 Objectives of Study

In evaluating the willingness of plywood manufacturers to embark on certification programme, a survey was conducted to identify the motivational factors and cost components involved. The aim of the study was to identify key factors in motivating plywood industry towards certification and to develop a tool to assess the significance of the key factor.

1.4.1 Objectives

The specific objectives of the study were to:

1. Evaluate and identify the motivational factors and challenges faced by certified plywood mills in practicing certification,
2. Evaluate cost components and identify major cost factors in practising certification by certified plywood mills,
3. Application of Performance Cost Index (PCI) as a measurement tool to evaluate the significance of the major factors.

The first and second objectives are described and achieved in Chapters 3 and 4, respectively; whilst the third and fourth objectives are addressed in Chapter 5.

1.5 Research Questions

Seven research questions were formed with regards to the above objectives. They were:

1. What are the motivational factors and issues of concern by certified plywood mills in practising COC certification?
2. What are the cost components contributed to the implementation and maintenance of COC certification by certified plywood mill?
3. What is the major cost factor in practising COC certification?
4. What measures to be taken to address the major cost factor?
5. Is there any tool in measuring the effectiveness of decision made by the plywood manufacturers?
6. Can such tool be established, how and what production components are to be considered?

1.6 Research Hypotheses

1.6.1 Generic Hypothesis

1. There is no difference in the motivational factors and issues of concern among plywood mill operators.
2. There is no difference in the cost components of plywood mill operations.
3. There is no difference in the property value of plywood product(s) produced from non-wood fibre material.
4. There is no difference in the production method for producing plywood.

1.6.2 Specific Hypothesis

1. There is no difference in the motivational factors and issues of concern among certified plywood mills.
2. There is no difference in the production cost and cost components of certified plywood mill operations.

3. There is no difference in the properties values of plywood product made from OPS.
4. There is no difference in the production method for producing plywood made from OPS.

1.7 Significance of the Research

It is hoped that this research will provide information to the general public, parties of interest such as researchers and economists and specifically the management of plywood companies regarding the costs involved in the implementation and maintenance of COC certification. Findings on motivation factors and issues of concern by plywood mill operators could become a guide for policy makers and governing bodies in promoting and encouraging more companies to become certified. Results from the second phase of the study are expected to provide information regarding the costs involved in producing certified product using non-wood fibre material in particular oil palm stem (OPS) as an alternative material to overcome the problem of limited supply of certified raw material. At a broader level, the results of the research would highlight the kind of supports that relevant institutions such as government and financing institutions as well as private sector could provide to generally encourage more companies, specifically plywood companies to go for certification and promote the use of OPS as an alternative raw material.

1.8 Limitation of the Research

This research depended mainly on the figures supplied by the companies surveyed where in certain situation involved figures that are more than five years old. Figures such as raw material or product price at the time of research being conducted may differ from the current price. This research also involved disclosures of what many companies considered as confidential information, making it challenging to obtain the data or figures. With regard to this, the companies were assured of the confidentiality of the information provided whereby only the mean values will be reported without disclosing the name, data and information of each individual company. When needed a disclosure agreement was signed with the company.

From the MTCS/PEFC and FSC certified list, only companies with a valid certificate and a minimum of one-year certification as of January 2008 were selected for the study. Since most companies are located in Sabah and Sarawak, and personal interview had been chosen as the data collection method. A research grant was secured to conduct this study in light of the significant costs of travel. The findings of this research may not applicable to all certified wood-based companies in Malaysia since the study was only focused on plywood manufacturing companies.

1.9 Overview

This thesis is presented in a manner where Chapter 1 describes the study and its objectives, followed by Chapter 2 which covers a comprehensive literature review on

timber certification and its cost, motivational factors and Performance Cost Index (PCI), where concept selection was used as the basis in developing the PCI. Chapter 3 discusses the details on motivational survey conducted on certified plywood mills in Malaysia. As a continuation from Chapter 3; Chapter 4 evaluates the certification cost components borne by the certified plywood mills where the main component of certification costs was identified. Chapter 5 proposes using OPS as an alternative fibre material to overcome the problem of limited supply and high cost of certified raw material. In addition, Chapter 5 also proposes a performance measurement tool based on concept selection method that is widely used in other sectors, particularly engineering. The PCI is expected to be used as a guidance in decision making process for new investment; Be it new raw material or new production method.

1.10 Definitions

The terms used in this research are defined conceptually and operationally. The following are the terms used in this research.

1.10.1 Average Cost

This study investigates the economic context of manufacturing where the "cost" involved is referred to as "cost when raw materials are transformed into finished goods on a large-scale basis". These include costs to operate at some particular output (Total Cost), cost that stays the same regardless of quantity produced (Fixed Cost), cost that varies following quantity produced (Variable Cost) and cost per unit item or product (Average Cost).

1.10.2 Direct and Indirect Cost

In this research, the fixed cost for producing non-certified and certified product is assumed to be the same, whilst direct and indirect costs are categorised as variable costs. Direct cost for certification includes cost for conducting training, additional staff, consultant fees, certified raw material cost, transportation cost and certification body fees. Indirect cost includes cost for promotional, marketing, website establishment, label printing for use on certified product, documentation and all relevant activities for the purpose of promoting certification.

1.10.3 Sales Volume and Value

Sales volume is measured based on the quantity of product sold in cubic meters (m^3). Whereas sales value refers to the volume of product sold in cubic meters measured in Ringgit Malaysia (MYR).

1.10.4 Neutral or Non-Wood Fibre Material

In certification, neutral or non-wood fibre material refers materials such as kenaf, jut and oil palm stems where the use of such materials in the production of certified product will not affect the calculation of wood content in certified product.

1.10.5 Performance Cost Index (PCI)

In the context of this study, Performance Cost Index is a performance measurement tool, established and used for evaluating cost and properties (or quality) of plywood produced, using a selected or proposed raw material associated with a particular or specific production method.

1.10.6 Motivation

Motivation refers to factors that led to certification decision and factors that motivate company to stay in the programme.

1.10.7 Concept Design

Concept design refers to development of a new product and an introduction of new production system or method that is applicable in the study.

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