Australian Government
Australian Centre for
International Agricultural Research

ENHANCING KEY ELEMENTS OF THE VALUE CHAIN FOR PLANTATION GROWN WOOD IN LAO PDR

Improving value and quality of wood products for domestic and export markets

Detailed analysis of wood recovery rate in production of high value wood products

Benoit Belleville

April 2014

VALTIP2

Preface

The present document contains information concerning assessment procedure of activity 3.1 *Determine typical current recovery and productivity levels in Laos manufacturing facilities and identify and recommend improved efficiencies in-company and through co-operative cluster scenarios*.

Outputs and milestones for the mentionned activity incude:

- A detailed analysis of the current wood recovery rate in production of high value wood products
- A detailed analysis of the current productivity levels in Lao manufacturing facilities

The outputs of the present activity are extremely important to ACIAR project FST/2010/012. Based on obtained data, advices will be provided to Lao wood manufacturing companies to address constraints and inefficiencies in the processing stages and increase returns by enhancing competitiveness and capacity. The ultimate objective is not to compare or rank companies but rather to improve productivity on an individual basis by providing tailored solutions for each company.

Questions that the present research aims to answer include:

1. Which practices and value-added manufacturing technologies would increase the value recovery of small dimensions, inferior quality plantation wood and facilitate early improvements from dry feed stock to marketable products?
2. Which strategies could be applied to improve productivity and quality in wood processing and manufacturing?
3. What training programs would be most efficient in improving Lao wood processing and manufacturing?

Proposed schedule & general information

Companies who could be involved, if they agree, are:

1. Khamphai Sana Wood Furniture Company
2. Lao Furniture Industry Company (km 21)
3. Kongsa Furniture
4. Phengmoungkhoun Factory

The selected companies will be contacted to confirm their interest in participating in the activity and schedule a visitto collect data. A company visit should take one full day and **companies must be operating on the visiting day**.

Prior to the visits, a training will be provided to FoF researchers. Two additional days will be spent conducting recovery study in two different companies to demonstrate to FoF researchers how the recovery study assessment should be conducted. Following the first two visits, FoF researchers will be able to conduct the assessment on their own for the two remaining companies. At the end of the activity, data will be analysed, individual recovery rate determined and an action plan containing recommendations will be provided to each company. After implementation of the recommendations, recovery will be assessed again and compared with previous results to measure improvement.

May 21: Wood recovery training by Benoit Belleville at NUoL for FOF researchers

May 22: Visit and Wood recovery assessment for one (1) company (by FOF researchers, Barbara and Benoit)

May 23: Visit and Wood recovery assessment for one (1) company (by FOF researchers and Benoit)

May 26-30: Wood recovery assessment of two (2) additional companies (by FOF researchers)

Introduction

A recovery study is an important part of a continuous optimisation process (Fig. 1). Such kind of study helps determining how much wood is actually recovered and how much is actually wasted. A recovery study aims to provide all the required information to make appropriate decisions when it comes to optimising a manufacturing process. The main objective here is to improve manufacturing process by: 1) assessing the efficiency of every manufacturing steps; 2) ranking priorities and elements to focus on; 3) implementing recommendations; 4) reassessing the manufacturing process to confirm whether or not the recommendations helped improving the efficiency of the manufacturing process.

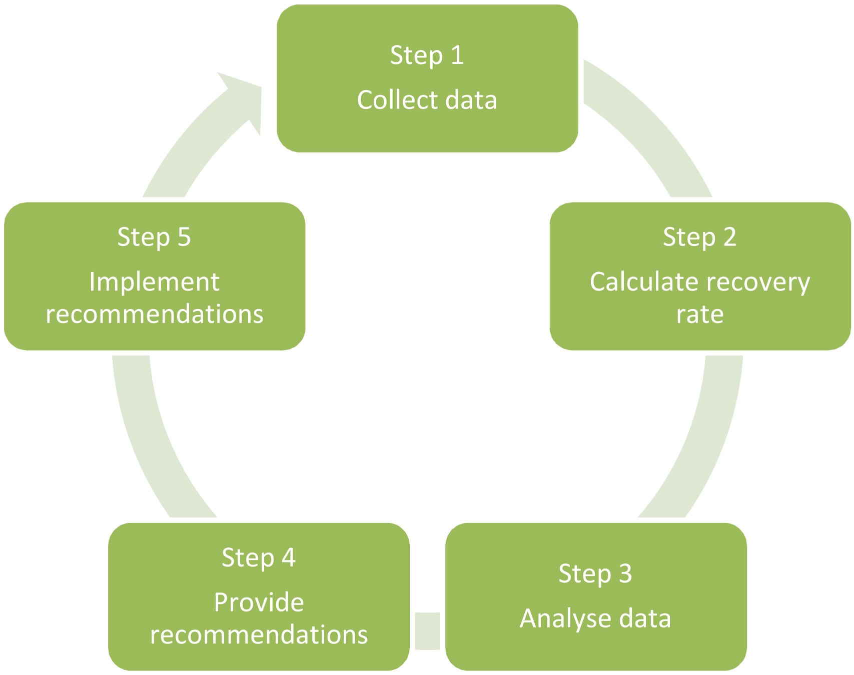

Figure 1. Recovery study steps as part of a continuous optimisation cycle

Methodology

Selecting companies

The first action consists in selecting companies within the industry clusters. The selection should be representative of the industry clusters and conducted on typical products manufactured by the clusters.

Collecting data

The recovery rate (%) is determined by collecting data on **input** and **output** (volume or weight) on each machining operation from the original dry sawn timber to the final wood component as it is going into the dimensions change:

$$Recovery\ rate\ (\%) = \frac{Output}{Input} \times 100$$

<u>Each and every machine or station within the manufacturing process will be assessed and provided with its own specific recovery rate</u>. For example, if processing step A of company XYZ is cross-cutting wood components by using a radial arm saw for the production of chair legs, then the objective is to calculate a recovery rate for the radial arm saw (not for the production of chair legs). In the end, recommendations will be provided on how to use the radial arm saw effectively and no matter what the desired component is.

The interest of assessing each machine/station is that it will help ranking and selecting machines or stations that require an immediate intervention. Focus should always be on machines or stations producing and/or wasting the biggest volume of wood.

Because of the many possibilities of shape and style for a specific furniture product and the fact that each company has its own order book, the recovery rate will be determined from individual furniture components production instead of a completed product approach. Even if the focus is not on the produced components, it must be identified when collecting data (Fig. 2) to allow comparison in the future. If all components of a specific product have been assessed during the day of assessment, then an overall recovery rate could be determined for this specific product but it is not the main objective here.

At this stage, we do not select or decide dimensions of input material. Our task will be to observe, take notes and measure input/output material. If we notice that a company or a machine operator might not be doing the right thing or doesn’t take the right decisions then we note it in our report (Step 1 from Figure 1). The notes will then be used to make recommendations so that the company can optimise its manufacturing process and eventually improve its wood recovery rate (Step 4 from Figure 1).

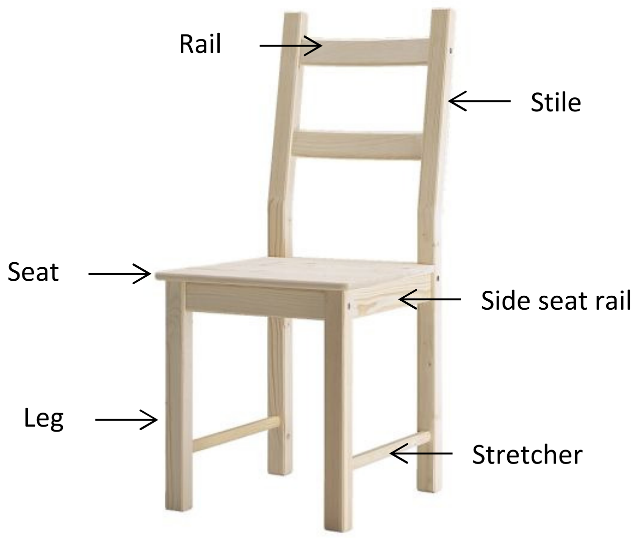

Figure 2. Chair components

The assessment procedure can be divided into six different steps: 1) Define the process line and the assignment; 2) Quantify all the input; 3) Quantify all the output; 4) Determine a recovery rate for each machine or station and analyse data; 5) Provide recommendations and implementation procedure; 6) Reassess the process line and compare with previous results (Fig. 4).

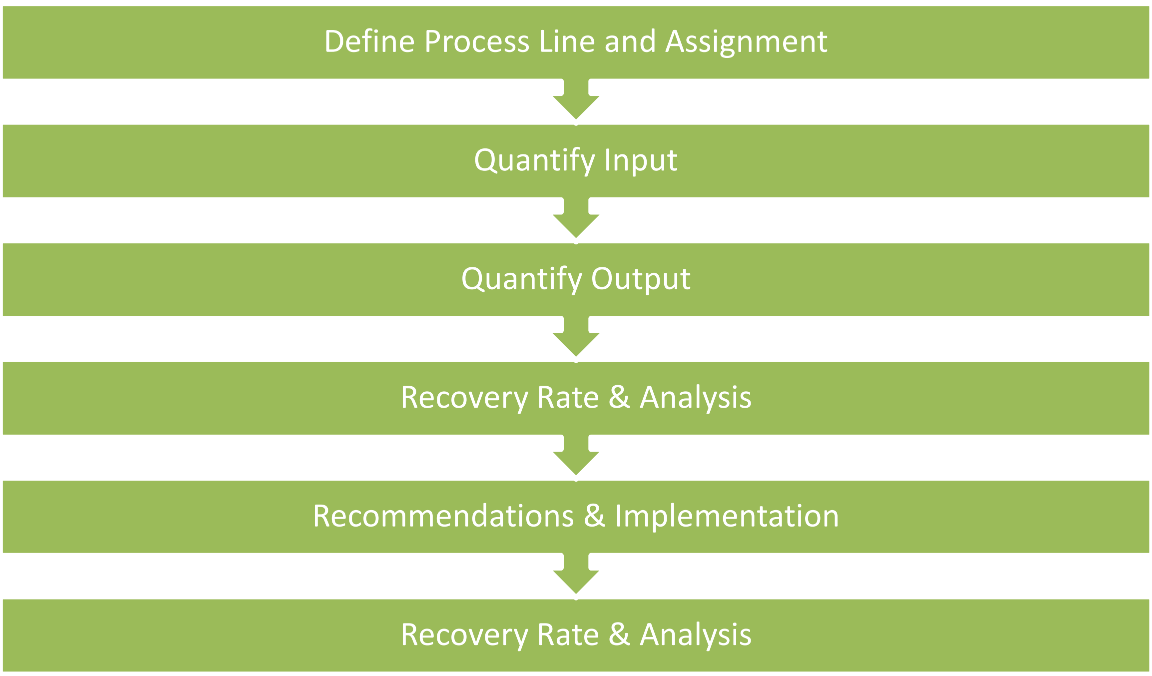

Figure 3. Assessment procedure for a recovery study.

Step 1 - Define the process line and assignment

This action consists in listing all operational machines or stations within the company premises and defining the assignment (i.e. the item or component to be produced). The first part can be presented as a sketch a flow diagram (Fig. 4).

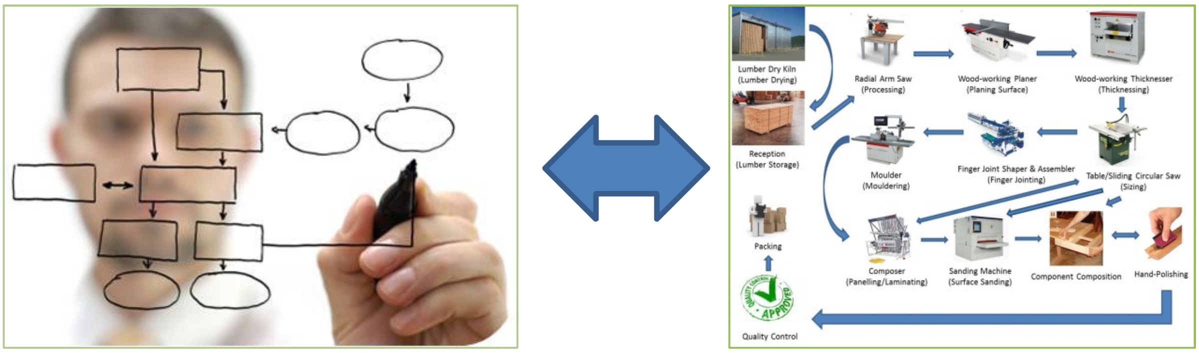

Figure 4. Examples of sketch flow diagram.

Defining the assignment consists in identifying the processing step (see Table 1) and the component produced if it’s possible (*e.g.* legs for chair) for each machine or station. This includes information about the number of components required and dimensionality, prioritization information (length vs. width), details on cutting bill and cutting pattern, and information on machines (Fig. 5) including condition and maintenance. **It is important to remember that the more information we collect here, the easier it will be to make recommendations at the end**.

Table 1. Processing steps and recovery rate calculation.

Processing step	Measurement	Recovery	Remarks
Dry sawn timber 	Measure length, width and thickness (*L*, *W*, and *T*) of 30 samples of dry sawn timber input and calculate volume (V_0).		
Cross-cutting 	Measure *L* of cross-cutted sawn timber produced and offcuts from the 30 dry sawn timbers. Calculate volume (*Vc*).	$R_c = \frac{V_c}{V_0} \times 100$	R_c = Recovery at cross-cutting stage
Edging/Rip sawing 	Measure *W* of 30 samples before (input) and after (output) edging/rip sawing. Calculate input and output volume (V_{ie} & V_{oe})	$R_e = \frac{V_{oe}}{V_{ie}} \times 100$	R_e = Recovery at edging stage
Planing 	Measure *T* of 30 samples before (input) and after planing (output or blanks). Calculate volume (V_{pi} and V_b)	$R_p = \frac{V_b}{V_{pi}} \times 100$	R_p = Recovery at planing stage
Shaping 	Measure *L*, *W*, and *T* of 30 samples or weight samples before (input) and after (output or component) shaping. Calculate volume (V_{si} and V_c)	$R_{sh} = \frac{V_c}{V_{si}} \times 100$	R_s = Recovery at shaping stage
Sanding 	Measure *L*, *W*, and *T* of 30 samples before (input) and after (output or smooth component) sanding. Calculate volume (V_i and V_{sc})	$R_{sa} = \frac{V_{sc}}{V_i} \times 100$	R_{sa} = Recovery at sanding stage
Overall recovery rate[1]		$R_c \times R_e \times R_p \times R_{sh} \times R_{sa}$	

[1] See example at the end of the document.

Machine: GMC 330 mm (13”) Planer thicknesser
Feeding speed: 8800 mm/min
Connected to a vacuum system: Yes
Number of cutting blades: 2
Cutting capacity (max chip thickness): 3 mm
Sharpening frequency: Daily (sharpening on site)
Blade material: High speed steel
Revolutions per minute: 3600

Figure 5: Example of machine specifications (information can be obtained from operator’s manual or operator and by taking photos) (Source: www.gasweld.com.au).

Step 2 – Quantify Input

The second action consists in quantifying input (cubic volume or weight). Information required here includes:

- ✓ Number of items/timbers;
- ✓ Grade and value ($/m^3);
- ✓ Dimensions (Measures: 1 x Length; 3 x Width; 3 x Thickness, Fig. 6);
- ✓ Presence of natural characteristics
- ✓ Relevant comments.

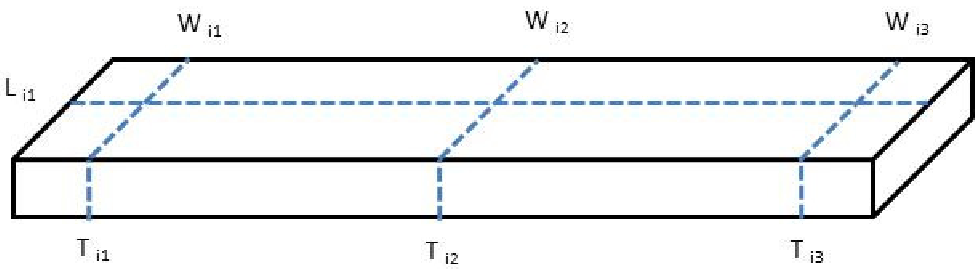

Figure 6. Method for measuring input. Length (L_{i1}), width ($W_{i\ 1\ to\ 3}$) and thickness ($T_{i\ 1\ to\ 3}$).

The preferred measuring tool for this study is a digital vernier caliper (Fig. 7) unless dimensions exceed the maximum measuring range of the vernier caliper. For such scenario, a measuring tape can be used instead.

Figure 7. Digital vernier caliper

Step 3 – Quantify Output

The next action consists in quantifying output (cubic volume or weight) and providing information on the produced part dimensions depending on the processing step (see Measurement in Table 1):

- ✓ Dimensions or weight of output (Measures: 1 x Length and/or 3 x Width and/or 3 x Thickness, Fig. 8 to 10);
- ✓ Is the output acceptable or not so that we can we use actually use it? Sometimes, the output just can't be used (e.g. chipped grain making the surface unacceptable for appearance products, output breaks during process, etc.);
- ✓ Offcut(s) dimensions (Measures: 1 measure for Length and/or 3 measures for Width and/or 3 measures for Thickness);
- ✓ Calculate average length, width and thickness and the standard deviation for output(s) and offcut(s) to determine the processing step variation within each sample and between samples;
- ✓ Identify other forms of residue (e.g. shaving, sawdust, etc.) and estimate proportion and volume based on measures obtained for output and offcut. Specify if the residue is contaminated (mixed with another residue, grease, etc.).

A minimum of 30 samples/components should be measured for each processing step if possible. Component dimensions which will be measured are the length, the wide and the thickness. Calculating the recovery rate for irregular shaped components can be done by weighing the components before and after the manufacturing process to calculate loss of material.

Measurements for output(s) and offcut(s) are function of the processing steps. This means that we only measure the dimension(s) that is affected during a specific processing step. For example, we will only measure thickness of output(s) after a planing step because this step only affects thickness and has no effect on width or length. The width and length of a blank after planing are supposed to remain the same before (input) and after (output). Same principle applies for a cross-cutting step where we only measure length (1 measure per sample) or for an edging processing step where we only measure width (3 measures per sample). The only exception here would be if a processing step affects two or three planes. In this case, all affected planes would need to be measured.

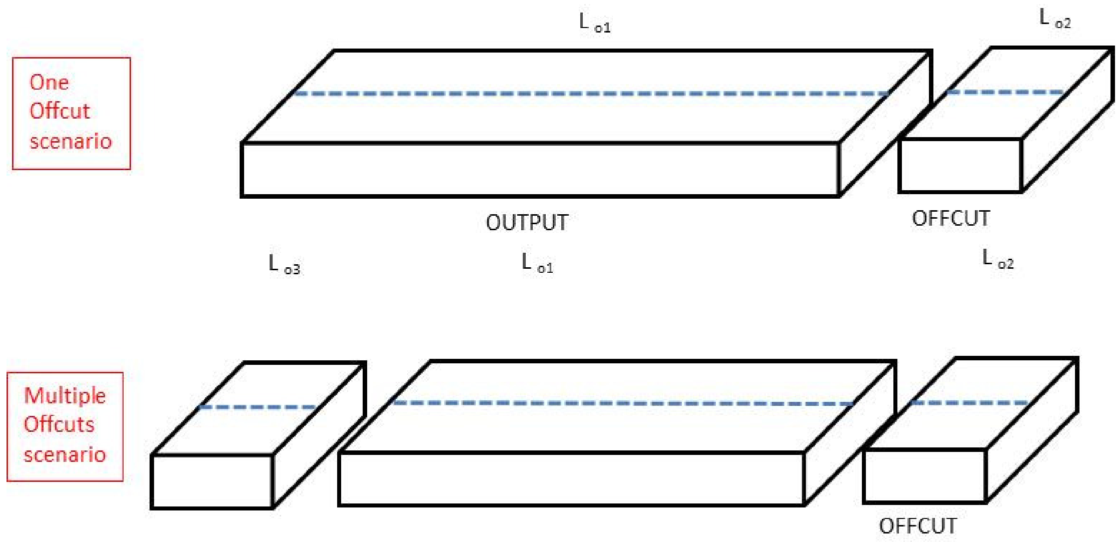

Figure 8. Measuring method for a cross-cutting processing step. Measure length of output (L_{o1}) and offcut(s) ($L_{o2, 3, 4...}$) to quantify output volume.

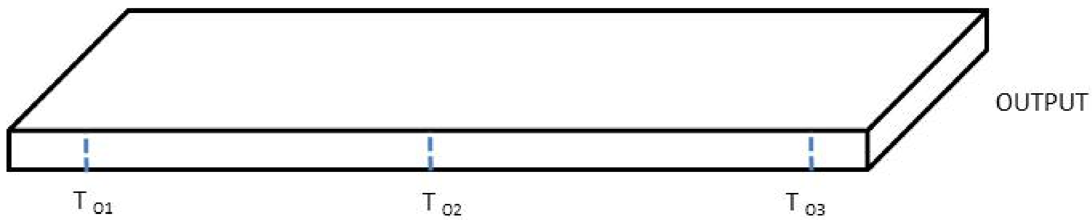

Figure 9. Measuring method for a planing processing step. Measure thickness of output ($T_{o1\text{-}o3}$) to quantify output volume.

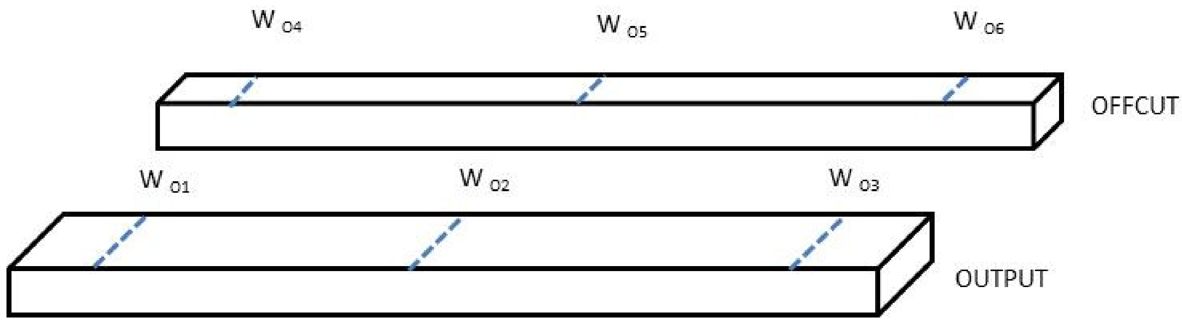

Figure 10. Measuring method for an edging or ripsawing processing step. Measure width of output ($W_{o1\text{-}o3}$) and offcut(s) ($W_{o4\text{-}o6}$) to quantify output volume.

Example on how to calculate overall recovery rate:

Initially, we have one dry sawn timber equivalent to 1 m^3 (or 100%) going through three manufacturing steps (A, B, and C).

After step A, we have an output and an offcut (80% and 20%, respectively). Recovery rate for step A is 80%. That 80% then goes to step B for further processing.

After step B, we have an output and an offcut (50% and 50%, respectively). Recovery rate for step B is 50%. That 50% then goes to step C for further processing.

After step C, we have an output and an offcut (50% and 50%, respectively). Recovery rate for step C is 50%.

So from the original dry sawn timber (100%), we have kept 80% of 1 m^3 after step A which means we have now 0.8 m^3. That 80% is then processed again during step B (recovery rate: 50%) which means that the output is now equivalent to 40% of the initial dry sawn timber or 0.4 m^3. After step C (recovery rate: 50%), that 40% is now 20% of the initial dry sawn timber or 0.2 m^3. In the end, we have kept 0.2 m^3 of the initial 1 m^3. The overall recovery rate here is 20% or 0.2 m^3 divided by 1.0 m^3 or 80%×50%×50%.

Step 4 to 6 – Analysis of results and recommendations

Following data collection and recovery rate calculation for all machines/processing steps/stations within selected industries premises, an analysis will be conducted and recommendations will be made. The recommendations will also be ranked based on the level of urgency and/or potential impact on the recovery rate. We might have to limit the number of recommendations to improve the effectiveness of the process. However, once a first series of recommendations will be implemented and a new recovery assessment is completed, other recommendations will be made as part of the continuous optimisation cycle (Fig. 1).

Recommendations must be tailored according to assessed manufacturing companies. A detailed plan for wood waste reduction and utilisation will also be provided as a milestone of activity 3.2 *Determine the most appropriate practices and equipment for furniture and joinery machining, bonding and finishing*.

Recommendations should:

- ✓ Provide practical comprehensive methods and/or approaches helping company owners and operators to improve their manufacturing process;
- ✓ Evaluate current and potential future scenarios related to wood waste;
- ✓ Provide a quantitative measure helping owners understanding financial opportunities of improving their manufacturing process;
- ✓ Recommend effective wood waste management practices and strategies;
- ✓ Increase industry sustainability standards and efficiency.

A complete report and a scientific publication providing a detailed analysis of the current wood recovery rate in production of high value wood products and productivity levels in Lao manufacturing facilities will also be prepared.

As stated in the preface, reports and publications will also try to answer questions such as:

1. Which practices and value-added manufacturing technologies would increase the value recovery of small dimensions, inferior quality plantation wood and facilitate early improvements from dry feed stock to marketable products?
2. Which strategies could be applied to improve productivity and quality in wood processing and manufacturing?
3. What training programs would be most efficient in improving Lao wood processing and manufacturing?