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- PNG Forest Products (PNGFP)
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- Pryde Furniture
- 3A Composites
- WR Carpenter PNG (WRC)
- Austral Plywood
- Centor
- Mr Kwila

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Acronyms and initialisms used in the report:

Australia	- A
Australian Bureau of Agricultural and Resource Economics and Sciences	- ABARES
Australian Centre for International Agriculture Research	- ACIAR
Building Code of Australia	- BCA
Business Coalition for Women	- BCFW
Centralised Processing Unit	- CPU
Chain of Custody	- CoC
Cross Laminated Timber	- CLT
Queensland Department of Agriculture and Fisheries	- DAF
East New Britain	- ENB
Engineered Wood Products	- EWP
Engineered Wood Products Association Australasia	- EWPAA
Fire Retardant	- FR
Food and Agriculture Organisation of the United Nations	- FAO
Free on Board	- FOB
Intellectual Property	- IP
International Tropical Timber Organization	- ITTO
Jack Norton Timber Protection	- JNTP

Koppers Performance Chemicals	- KPC
Lae Builders and Contractors	- LBC
Laminated Strand Lumber	- LSL
Laminated Veneer Lumber	- LVL
Monitoring and Evaluation	- M&E
Multi-laminar wood	- MLW
Orientated Strand Board	- OSB
Partner Country	- PC
Papua New Guinea	- PNG
Pacific Islands Projects	- PIP
Phenol Formaldehyde	- PF
Phenol Resorcinol Formaldehyde	- PRF
PNG Forest Authority	- PNGFA
PNG Forest Products	- PNGFP
PNG Forest Research Institute	- PNGFRI
PNG University of Technology	- PNG UniTech
PNG Forest Industry Association	- PNGFIA
Polyvinyl Acetate	- PVA
Project Steering Committee	- PSC
Public-Private Partnership	- PPP
Quality Assurance	- QA
Research and Development	- R&D
Rimbunan Hijau	- RH
Salisbury Research Facility	- SRF
Strength, Weakness, Opportunity and Threat	- SWOT
Timber and Forestry Training College	- TFTC
Vacuum/pressure Impregnation Treatment	- VPI
Vacuum/vacuum treatment	- VOI
Women in Forestry and Timber Network	- WFTN
Workplace Health and Safety	- WH&S
WR Carpenter PNG	- WRC

2 Executive summary

Currently, the Papua New Guinea (PNG) forestry industry is predominantly a log export orientated industry with around 80% of the log production being sent offshore. For some time, the PNG government has indicated its strong policy preference for much greater conversion and value adding of these logs within PNG in order to achieve desirable economic, community and social benefits. Engineered wood products (EWPs) offer a significant opportunity for increasing downstream processing and value adding in PNG. EWPs are manufactured composites that provide consistent and reliable building products with improved structural characteristics and allow more efficient use of forest resources. Examples of EWPs include plywood, laminated veneer lumber (LVL), cross laminated timber (CLT), glued-laminated beams (glulam) and multi-laminar wood (MLW). Although a comparatively mature industry in Australia, the development of new EWPs and advancement of manufacturing techniques provides substantial opportunity to significantly enhance the value add to the country's timber sector.

This project represented a new approach to an ACIAR funded forest industry research project. The project team worked more directly with private sector businesses, in both PNG and Australia, to optimise manufacturing processes and develop EWPs, as well as improve the capacity, skills and knowledge within the industry. The project also featured a focus on the development of Public Private Partnerships (PPP) in PNG and industry clusters.

The project built on the momentum from previous ACIAR research efforts through provision of research, expert technical support and training in the development of more sophisticated wood conversion techniques and prototype wood product design and development. Partners and collaborators included both private and public sector representatives from processors and manufacturers, wood preservation and adhesive suppliers, government institutions and industry associations from Australia and PNG.

Many significant technical outputs were produced by the project, including:

- EWP prototypes and processes developed that have substantial commercial potential – including lightweight balsa cored solid doors, lightweight construction panels, Group 1 fire retardant (FR) rated hoop pine plywood, gluing systems for aluminium overlaid plywood rolling stock for railway carriage floors, finger-jointing connections for PNG hardwood and innovations in I beams manufactured from hoop pine.
- Advanced gluing systems for PNG timbers that have already been adopted by at least one industry partner in PNG.
- Demonstrated the potential opportunities for using PNG sawmill waste and offcuts as energy generating briquettes and school furniture.
- Comprehensive new technical knowledge and literature developed, including manuals, technical reports, factsheets and a database detailing PNG and Australian species with various wood product utilisation options.

A detailed market analysis study was also conducted, which highlighted many opportunities and challenges for the development of wood products from PNG. In particular, the investigation recommended:

- The establishment of a multi-user Central Processing Unit (CPU) or hub, located within close proximity to the Timber and Forestry Training College (TFTC) in Lae.
- An increased focus on the development of rotary peeled veneer and plywood production for local markets.
- Development of the pre-fabricated component, housing and other small buildings markets.

- Enhancing the development of international markets for PNG's wood products through the establishment of a market development and access pilot program.
- Improving log transport infrastructure into the CPU, whether by road or by sea.
- Establishing a co-marketing program for domestic applications, focused on treated wood products.

However, financial and regulatory barriers were identified in relation to exporting from PNG that make regular exports unreliable and less competitive in the global market.

The structure of this project trialled a new approach for ACIAR Research and Development (R&D) projects in developing countries, with much stronger emphasis on working directly with the private sector. Whilst various public institutions were engaged throughout the project, their contributions were not as dominant compared to previous projects delivered through ACIAR. This methodology proved successful with the project able to accelerate product, process and industry development when compared to previous projects. With commercial implementation anticipated in several areas, it would be expected that ensuing economic and social benefits will be realised as a direct result of the project.

It was not possible to form innovation/business or industry clusters as was originally proposed due to industry resistance concerned with intellectual property (IP) sharing, differences in forestry and logging chain of custodies, different scales of operation and business models, and also an unwillingness of companies to work with others at this time. Therefore, research clusters were established as a compromise, instead of traditional business clusters.

During the course of the project, it became increasingly obvious that neither the private nor public sector involved in the timber industry in PNG saw immediate value in pursuing potentially beneficial partnership arrangements. Some of the reasons identified for the lack in interest in a PPP approach in the PNG timber sector were:

- Lack of support from the PNG Forest Authority (PNGFA) due to inadequate resources within the organisation being available to support the project.
- Lack of PNG Government clarity on/and commitment to policies for PPPs in PNG.
- Lack of PNG Government clarity on/and commitment to downstream processing policies in PNG.
- Challenging business and investment environment in PNG and the high risks perceived in further investment in forestry.
- A dominant enterprise exists in the PNG timber sector and this poses a risk to smaller investors wishing to develop downstream processing businesses.
- Concerns (mainly by potential investors) with the appropriateness of PNG harvesting practices, legality of wood supplies and chain of custody (CoC).

The project produced very high quality outputs in the gender equity and social inclusion domain, generating new networking, information and awareness, which will assist in greater gender equity and social inclusion within the forest industry of PNG and Australia.

The project faced many challenges that have provided useful insights into recommendations for future work. Specific recommendations include:

- Many of the PNG companies are not in a position to immediately adopt advanced processing and manufacturing of EWPs, which was a focus of many project activities. A more progressive approach building on the optimisation of current processes may have assisted industry partner's preparation to move towards more advanced solutions.
- Several unforeseen challenges emerged as a result of a relatively untested ACIAR project delivery model (i.e. close interaction directly with the private sector),

particularly concerning commercial confidentiality and IP sharing. For future projects, it will be important to clarify policies regarding the direct engagement of private sector stakeholders.

- Successful progress and outcomes of project activities were expedited when face-to-face contact occurred with project partners in PNG. Options to facilitate more in-person interaction in future projects should be identified and evaluated. A potential option could be the appointment of a full-time, in-country project manager (national or expat) reporting directly to the project leader.
- Detailed economic tasks proposed in this project proved challenging due to the hesitance of project partners to share sensitive information. A future project in this R&D area would benefit from a dedicated economic analysis component that is more compatible with the business environment of PNG, to better support commercial decision making by industry partners.
- The formation of a specialised technical centre in PNG would enhance capability in wood product and process development.
- Further work needs to be undertaken to test and commercialise the new EWP prototypes developed by the project.

3 Background

Papua New Guinea has a forest area of over 29 million hectares, covering nearly two thirds of the country. Harvesting from these forests and subsequent processing activities generate significant social and economic benefits for landowners, communities and local economies. Many of the social and economic benefits accrue in rural areas through local employment, contributing to social services and augmenting infrastructure.

Traditionally, the PNG forest industry has been a major log exporter to markets in Japan, Korea and China, with a smaller proportion logs being supplied to value-adding enterprises operating in the country.

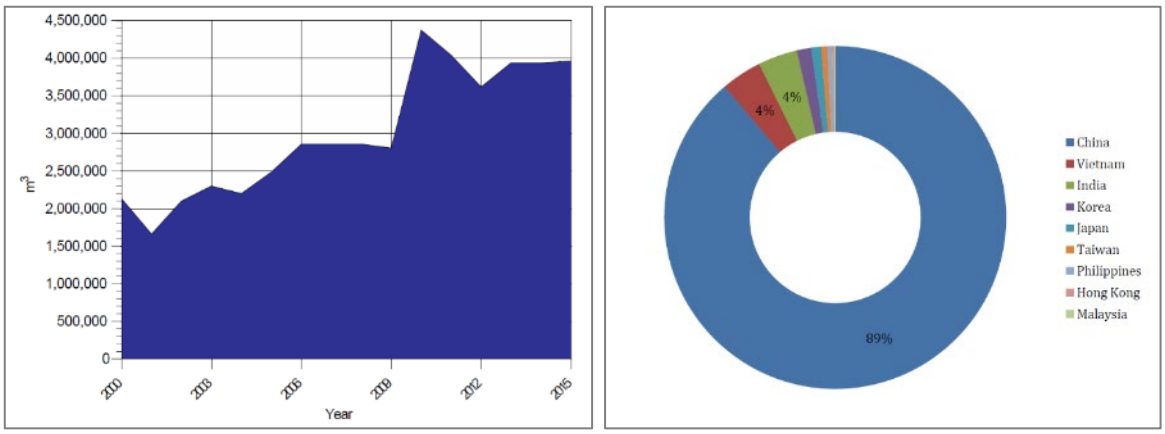

Figure 1: PNG hardwood log exports, total volume (left) and by country (right). (Source: Industry Edge, 2018).

More recently, new government policies are being developed that encourage local resource processing and production in order to create more value in-country enabling the associated socio-economic benefits to be realised. For example, in the PNG Development Strategic Plan 2010-2030, forestry has been targeted to increase the level of domestic processing of annual log harvest from 20% to 80% by 2030, thereby building a sector that is sustainable and highly profitable. To achieve this goal, the government has developed the National Strategies for Downstream Processing of Forest Products in PNG (2014 draft) with the objective to promote industrial development in the forestry sector thus complementing the 1991 National Forest Policy. The strategy reinforces the policy directive of the government of maximising local wood processing and value adding operations, and phasing out log exports within existing logging and timber contracts. These initiatives also link to overarching government policies such as PNG Vision 2050, Medium Term Development Plan 2010-2015 and 2009 National Forestry Development Guidelines. In June 2019, this policy direction was further reinforced by the newly appointed Forestry Minister Solan Mirisim, who was quoted as saying:

> *"Raw log exports mainly to China, will decline drastically as the government makes a major shift to downstream processing by next year. From 2014 to 2018, the log export volumes increased to more than 3.5 million cubic metres and the free on board (FOB) values reached more than K1 billion."*

> *"The current scenario is that much of the log harvest goes out in raw form for export markets, mainly to China. However it is the intention of the government to reverse this trend where it wants to see a major shift into downstream processing in the country,"*

"I intend to fulfill this major shift from major log exports to increase downstream processing to promote increased employment for our citizens."

EWPs offer a significant opportunity for increasing downstream processing and value adding in both PNG and Australia. EWPs are manufactured composites that provide consistent and reliable building products with improved structural characteristics and allow the most efficient use of forest resources. Examples of EWPs include plywood, LVL, CLT, glulam, laminated strand lumber (LSL), MLW and oriented strand board (OSB). PNG's forests produce a wide range of commercial wood species, including many that have high natural durability, with a corresponding wide range of properties and attributes. The successful development of EWPs requires extensive technical understanding of wood material science, wood mechanics and glue adhesion.

Within Australia, the significant drivers for further EWP development are:

- recognised capability to increase product opportunities from lower quality wood resources;
- new trends in the housing and building industry - with the latest construction practices focused on prefabrication and also an increasing shift from detached housing to multi-residential and high rise buildings. EWPs are generally more suited to these types of buildings and are often more competitive against steel and concrete compared to conventional sawn products;
- supply existing markets more profitably as well as expand market share; and
- increase the opportunity to maximise product recoveries and value of forest resources, more predictable performance, faster production and a greater range of available product dimensions.

Figure 2: Examples of Engineered Wood Products (Source: https://www.cbi.eu).

Through consultation with processors and product manufacturers in PNG and Australia during the initial development of the project, the R&D priorities to maximise the value of forest resources by developing EWPs were identified as:

- improving wood drying systems and treatment efficacy;
- selecting the best adhesive systems;
- matching species performance to products/markets;
- matching species characteristics to product performance expectations;

- optimising EWP product design and specifications.

By taking account of the inherent properties of different timber species, product designs can be optimised to ensure superior service life in tropical conditions and meet consumer expectations and confidence in the EWP's strength, durability and performance under different conditions. Industry stakeholders suggested that the current major impediment to market penetration and expansion is inadequate knowledge regarding the wood properties of different timber species and their suitability for various products. The industry partners who expressed interest in participating in the project each had some existing capacity for producing EWPs and were highly motivated to develop products and pursue new market opportunities.

The Australian Government has also identified partnerships with the private sector as an important way to achieve its development objectives and maximise the overall impact of its development investments. Partnering with the private sector is recognised as an efficient mechanism to access ideas, promote innovation and utilise different business models in search of solutions to development impediments. For businesses, partnerships with aid funded projects may: provide access to information on market conditions in developing country markets; enable better understanding of efforts underway by donors and governments to improve enabling environments; and mitigate risks related to poor enabling environments in some countries. Partnerships may also enhance the impact of business programs to educate employees or improve the health of communities in which they work.

As developing countries are an integral part of global supply chains, larger companies in particular are paying increasing attention to managing supply chain risks and creating shared value for the communities in which they operate and the consumers who buy their products. Partnerships between donors and the private sector are most likely to begin by being non-financial in nature, in some cases progressing to a financial partnership. PPPs might be an effective strategy to enhance private sector investment in value-adding wood processing enterprises in PNG.

For the reasons outlined above, this project adopted a new approach compared to previous ACIAR Forestry projects in PNG with a strong focus on working directly with the private sector and reduced reliance on public institution involvement. There was also a stronger emphasis on exploring the potential of innovative EWPs rather than traditional solid wood products.

4 Objectives

The aim of this project was to engage directly with the private sector to accelerate the development of novel EWPs in PNG and Australia. The project objectives were divided into three main themes as described below.

4.1 Objective 1: Develop and evaluate the use of industry clusters to accelerate the development of EWPs.

Activities

1.1 Form industry clusters comprising private sector companies willing to improve processes, products and to develop and grow new markets in PNG and Australia.

1.2 Analysis of available inputs, knowledge gaps and potential outputs for cluster companies.

1.3 Undertake a Training Needs Analysis.

1.4 Develop new products and markets using idea generation tools and techniques.

1.5 Prepare action plans and include iterative continuous improvement processes.

1.6 Assess current involvement of women and explore options for increasing the project benefits to women in PNG.

4.2 Objective 2: To develop EWPs appropriate to the timber resources and potential markets.

Activities

2.1 Wood quality and processing research and development.

- 2.1.1 Species/mixes X products matrix
- 2.1.2 Improve processing systems
- 2.1.3 Improve wood adhesive systems
- 2.1.4 Improve preservation systems

2.2 Undertake Market Analysis concerning EWPs in PNG and Australia.

2.3 Develop and test prototypes for targeted EWPs.

2.4 Develop quality manuals, product specifications and information sheets.

4.3 Objective 3: To understand how PPPs can operate to promote expansion of value adding wood processing in PNG.

Activities

3.1 Review the current situation for business development in the wood processing industry in PNG, in particular focusing on the EWP sector.

3.2 Review case studies- PPPs, industry clusters and co-operatives.

3.3 Review financial schemes, investment incentives and make policy recommendations.

3.4 Provide advice regarding a potential PPP model for the PNG forest industry.

5 Methodology

5.1 Project organisation and location

The project was led by the Queensland Department of Agriculture and Fisheries (DAF). The leader of the project was Dr Henri Bailleres and the PNG Project Country Coordinator was Dr. Ruth Turia, PNG Forest Authority.

The principal PNG companies involved in the project were RH, PNGFP, LBC, Pryde Furniture, 3A Composites and WRC.

The principal Australian companies involved in the project were Austral Plywood, Mr Kwila, Koppers Performance Chemicals (KPC), Lonza and Centor.

The principal non-private sector partners in PNG were as follows: PNGFA, PNG Forest Research Institute (PNGFRI), PNG Forest Industry Association (PNGFIA), TFTC, PNG University of Technology (PNG Unitech).

The principal non-private sector partner in Australia was the Engineered Wood Product Association of Australasia (EWPAA).

The project team included:

- Dr Henri Bailleres, Mr Tony Dakin, Mr Bill Leggate, Mr Gary Hopewell, Mr Rod Vella, Dr Adam Redman, Dr Susan House, Miss Lesley Francis, Mr Harrison Brooke, Mr Adam Faircloth, Miss Rhianna Robinson – DAF; other staff from the DAF Salisbury Research Facility (SRF);
- Dr. Ruth Turia – PNGFA;
- Dr. Martin Golman, Frank Asok, Benjamin Vali (until April 2017) – PNGFRI;
- Ms Julieth Jiap - EWPAA
- Jon Marlow – ProAnd Associates – work on Objective 3 - PPP
- Simon Rollinson – Pacific Island Projects (PIP) – Communication & Dissemination
- Dr. Russell Haines – Griffith University (until April 2017) – Monitoring and Evaluation (M&E)
- Simon Dorries – Responsible Wood (from May 2017) – M&E
- Joanne Roberts – SEE4D – M&E
- Charles Tsiritsi, Vagi Lovo, Moira Spairong – TFTC;
- Bob Tate – PNGFIA
- Various industry participants - PNGFP, RH, Pryde Furniture, LBC – Philco Joinery, Furniture Exports, Mr Kwila, WRC, 3A Composites, Centor, Austral Plywood, Lonza, KPC.

This project and the University of Melbourne led ACIAR Project FST/2012/092 (*Enhancing value added wood processing in PNG*) were overseen by the same project steering committee (PSC). The PSC comprised representatives from each partner organisation (who had a management role in the organisation). The role of the PSC was to ensure that the work in both projects was closely coordinated and also to ensure that project objectives and activities were satisfactorily completed on time and within the budget. The PSC meetings were held approximately twice per year for the duration of the project.

5.2 Research methods

Research and testing activities were conducted at the DAF SRF or within company facilities in both PNG and Australia.

The methodology applied in each of the project activities is summarised below.

5.2.1 Objective 1: Develop and evaluate the use of industry clusters to accelerate the development of EWPs.

In line with the design of project, the initial stage of the project was to be focused on the formation of industry clusters in PNG and Australia. The aim of the industry clusters were to ensure accelerated product and market development. However, in the very early stages of the project the traditional business or industry cluster approach met with strong resistance from industry partners and was determined to be infeasible. Reasons for this industry resistance included: a non-willingness of companies to work collaboratively with others; different business models, scale and type of operations; concerns over IP sharing; and different CoC set-ups. As a compromise, activities were grouped around companies with similar R&D themes. Research clusters were formed in lieu of the originally proposed approach.

From the outset, particular emphasis was placed on involving women from participating companies in the research clusters. These women, representing their companies, were encouraged to take part directly in the activities listed below.

Activity 1.1 Form industry clusters comprising companies willing to improve processes, products and to develop and grow new markets.

Given the identified challenges preventing industry clusters from being established, research clusters were formed as an alternative. The project team engaged directly with business owners and managers in both PNG and Australia and identified key stakeholders to build a project innovation team. These people worked collaboratively with other team members to develop best practice protocols customised for their own company.

Research clusters were established in both PNG and Australia and the participating companies in each cluster were chosen based on the following criteria:

- representative of the available timber resources – species, log qualities;
- representative of the different scales of operations;
- capability to develop and produce EWPs; and
- willingness to participate in the project and share information with other stakeholders.

During the formation of the research clusters, agreements were established with each participating company to provide an agreed understanding of the expectations and contributions of each party; how the collaboration would operate; and how the outputs from the collaborative research and development funded by ACIAR would be utilised and communicated with other interested parties.

Those companies involved in the industry clusters contributed timber resources, equipment, staff time, ideas, contacts, industry know-how, market knowledge and commercial awareness.

Activity 1.2 Analysis of available inputs, knowledge gaps and possible outputs for cluster companies.

Each cluster company from both PNG and Australia was surveyed to determine current, short, and long-term potential manufacturing capacity. Processes, materials, goals and technical skills were assessed by conducting SWOT analyses to clarify the company's current position, and what is required to achieve a desired future state. The analyses identified opportunities for intercompany collaborations for mutual benefit and feasibility of PPP involvement. The analysis also included an assessment of constraints to EWP production within each company.

A knowledge gaps analysis was undertaken that detailed existing skills, qualifications and experience within participating companies.

Activity 1.3 Training Needs Analysis

A Training Needs Analysis was undertaken to provide an understanding of existing skills, qualifications and experience within participating companies from both PNG and Australia. This facilitated the identification of areas where training was necessary to build capacity and deliver planned project outputs and impacts.

Activity 1.4 Develop new products and markets using idea generation tools and techniques.

The key driver for the EWP development focus of the project is that it enables more to be produced with less. Specifically, a greater volume of, and better performing, products can be manufactured using a smaller amount of high quality feedstock resources. With this in mind, contemporary ideation techniques for new products were implemented with each company. A key component of this activity was to document the prospects and options for markets for new EWPs identified through a workshopping process.

Activity 1.5 Prepare action plans and include iterative continuous improvement processes.

The research team worked with companies in both PNG and Australia to identify inefficiencies, production bottlenecks and other barriers to progress due to existing processes and then developed solutions and improvement opportunities to build confidence and resilience in-company. The final task for Activity 1.5 was the development of action plans for the 'best bet' array of products and the design of an appropriate iterative process.

Activity 1.6 Assess current involvement of women and explore options for increasing the project benefits to women.

Various qualitative approaches were implemented to investigate gender balance and the roles undertaken by women in the timber industry in PNG and Australia, and to identify strategies for increasing their involvement.

Initially, a review was conducted to assess the current gender balance in the timber industries of PNG and Australia. This included an analysis of available reports and statistics, along with an informal survey of companies participating in the project to provide further understanding of gender ratios, positions, ages, income, training, skills and qualifications. Particular constraints and opportunities were identified. Two workshops were held in PNG that were designed to help establish strategies for enhancing the role of women in the timber industry and to increase the project benefits for women. The project also investigated the potential for women's network groups to promote the involvement of women.

5.2.2 Objective 2: To develop EWPs appropriate to the timber resources and potential markets.

This project objective focused on the technical aspects of EWP development including design, testing and evaluation. Researchers from PNG and Australia combined with participants from the research clusters to undertake the required R&D tasks. Special attention was directed towards involving women in the research activities outlined below.

Activity 2.1 Wood quality and processing R&D

This work was conducted in both PNG and Australia except where noted. Trials were designed, conducted and reported to determine the most effective systems.

2.1.1 A matrix database combining the properties of PNG and Australian timbers currently in use or available to processors correlated to product requirement and performance expectations was developed. A profile for each product listing the most suitable species was produced.

2.1.2 Improve processing systems. This involved a review of current knowledge on processing and drying; development of improved processing practices matched to available infrastructure and to meet the strict requirements of EWPs; and the development of a Quality Assurance (QA) protocol for the processing, storage and handling of EWPs.

2.1.3 Improve wood adhesive systems. This involved a review of current knowledge on gluing properties and recommended adhesive systems for each relevant PNG and Queensland species; investigating most effective adhesive systems for species/EWP products; and the development of a manufacturing and QA protocol for the adhesive systems.

2.1.4 Improve preservation systems. This involved a review of current knowledge on treatment properties and recommended wood preservation systems for each relevant PNG and Queensland species, EWP and end-use or hazard category; conducting research trials on preservatives; development of a QA protocol for the preservation practices; and investigating fire-retardant treatments for hoop pine.

Activity 2.2 Undertake Market Analysis concerning EWPs in PNG and Australia

Market analysis experts, Industry Edge, were engaged to consult directly with the companies involved to gather market intelligence and identify target markets, and to provide recommendations for 'best bet' products for domestic and export destinations.

Specific tasks in the market analysis included:

- Review of published information (e.g. industry journals, websites, reports, statistics) relevant to both PNG and Australia. The latest market reports and data were sourced.
- Accessing data from other relevant sources such as the Food and Agriculture Organisation of the United Nations (FAO), International Tropical Timber Organization (ITTO), IBIS World, BIS Shrapnel, Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), and other government resources.
- Where possible, direct contact with potential buyers of EWPs, and visits to industry expositions were completed to gather further market intelligence.
- Close interaction with companies involved in the project and discussions regarding market factors, prices, trends, constraints and opportunities.

Activity 2.3 Develop and test prototypes for a range of EWPs.

Based on the results of activities described above, a range of new products for both PNG and Australia were designed and tested in collaboration with partner companies, and in accordance with relevant standards.

Activity 2.4 Develop product specifications and information sheets.

For both PNG and Australia, technical information and promotional materials were produced to support marketing and extension efforts.

5.2.3 Objective 3: To understand how PPPs can operate to promote expansion of value adding wood processing in PNG.

This project component examined the role that PPPs can play in promoting the expansion of value adding in the PNG wood processing sector. A PPP expert (ProAnd Associates) was appointed to coordinate the activities outlined below. It was proposed that a PNGFA researcher would train and work alongside the PPP expert so that capability remained in PNG to extend the benefits further following completion of the project. However, PNGFA were unable to assign a staff member to work on this activity.

Activity 3.1 Review the current situation for business development in the wood processing industry in PNG, in particular focusing on the EWP sector.

The PPP expert visited selected companies and agencies to gather industry information pertinent to developing a model for PPP in the timber processing and manufacturing sector in PNG.

Activity 3.2 Review case studies on PPPs, industry clusters and co-operatives.

There were many examples of PPPs across a range of industries. A report was prepared based on a review of the literature on PPPs, industry clusters and commercial co-operatives. The findings of the review were described to highlight what has worked and what has failed based on the history of PPPs and related development structures. The literature review documented issues and approaches to establishing PPPs to guide the work in PNG.

Activity 3.3 Review financial schemes, investment incentives and make policy recommendations.

During in-country research visits in PNG, the PPP expert consulted with finance institutions and government departments to provide a report summarising loans, schemes, incentives that are available or lacking for local processors and manufacturers.

A report and policy brief, identifying constraints and policy options to support enhanced production of EWPs in PNG was prepared.

Activity 3.4 Make recommendations regarding a potential PPP model suitable for the PNG forest industry.

This activity aimed to establish possible approaches and guiding principles to implementing PPPs suitable for application in the PNG forest industries. This was based on the findings of Activities 3.1, 3.2 and 3.3. The report details risks, assumptions and recommendations for how a PPP might be applied in PNG and what conditions would be necessary to increase the chances of success.

5.3 Monitoring and Evaluation

This project represented a new approach to R&D collaboration, the intention being that Australian and PNG members of the project team would work more directly with private sector businesses. Given the novelty of the approach, a dedicated M&E Program was developed. The specific purposes of the M&E program were to:

- Permit project management to adapt rapidly to changing circumstances, problems and opportunities;
- Ensure that the project was on schedule, that all partners were fulfilling their specified roles, that activities were being completed as planned, and that scheduled outputs were being delivered;
- Ensure that cross-cutting targets, e.g. with respect to gender equity and capacity building, were being met; and
- Monitor and analyse impacts, and promote opportunities for impact.

A draft M&E plan was developed at the project commencement and presented to partners and stakeholders for consultation at the project inception workshops in both PNG and Australia. The workshop were held to analyse the project's impact pathway and identify stakeholder assumptions, users of M&E, indicators and appropriate data collection methods. The plan was then finalised. The M&E plan was relevant to both the PNG and Australian components of the project and was an early output from the project. M&E was integrated closely with project management throughout the project in order to optimise prospects for success.

An M&E specialist, SEE4D, was engaged to assist with the development and execution of the M&E plan for the project.

6 Achievements against activities and outputs/milestones

6.1 Objective 1: Develop and evaluate the use of industry clusters to accelerate the development of EWPs.

No.	Activity	Outputs/ Milestones	Completion Date	Comments
1.1	Form industry clusters comprising companies willing to improve processes, products and to develop and grow new markets.	Industry clusters established in both PNG and Australia. (A, PC)	April 2016	Site visits were conducted prior to the Inception Workshop and the potential for development of clusters was assessed and discussed with stakeholders. The outcomes are summarised in the report Activity1.1a_Clusters. It was not possible to form conventional business clusters because of challenges concerning IP sharing; CoC; competition; willingness to collaborate; differences in scale and nature of commercial activities. Therefore clusters based on R&D themes were formed as a suitable alternative.
	Negotiate agreements with participating companies	Agreements	June 2016	Agreements were prepared in consultation with all participants and compiled in the report 1.1b_compilation_agreementsTORs.
1.2	Analysis of available inputs, knowledge gaps and possible outputs for industry cluster companies.	Reports for both PNG and Australia describing current capacities, knowledge gaps, equipment, materials and the range of EWPs possibilities available based on these findings. (A, PC)	July 2016	Site visits and interviews were conducted with all partners and a follow-up survey was sent out in an attempt to fill in any gaps in the data. Results from this activity are covered in the report - Activity 1.2_Assessments. Some companies were unable or unwilling to provide all data.
1.3	Training Needs Analysis	Reports for both PNG and Australia describing current skills, experience and qualifications of relevant personnel and identifying specific areas where more training is required. (A, PC)	October 2017	The training needs information was collected and details are included in report Activity1.3_Training Needs.
	Register of Training Conducted	Register of Training Conducted	July 2019	The register of the training conducted is included in report Activity1.3_Training Register.

1.4	Develop new products and markets using idea generation tools and techniques.	Workshops in PNG and Australia training in use of ideation tools; follow-up workshop. (A, PC)	Various	Direct individual sessions were provided initially in lieu of a workshop and then later follow-up sessions were held with partners. Novel ideas were proposed for optimizing processes on-site and also for new product development. These are described in various technical reports, mainly under Objective 2.
	Document the prospects and options for markets for new EWPs identified through workshop process.	Report for cluster partners	July 2017 and April 2018	The outcomes of this activity are described in the PNG trip report July 2017 and the joint comprehensive PNG market analysis report D.2.2._Market_Analysis_Report_-_ACIAR_PNG_-_Industry_Edge.
1.5	Prepare action plans and include iterative continuous improvement processes.	Reports for PNG and Australia with detailed action plans per product and company. (A, PC)	Various	Action plans were reported as part of the terms of reference documentation developed with each partner. Continuous improvement was an ongoing activity throughout the project.
	Evaluation of the effectiveness and lessons from the industry cluster approach in PNG and Australia	Evaluation report	April 2016 and June 2019	The initially planned cluster approach was modified in accordance with the partners' recommendation for small R&D clusters where they work with the researchers on their own projects based on agreed Terms of Reference. This item is addressed through two reports: Activity1.1a_Clusters and Final-report-Objective 3 – 200619.
1.6	Assess the current status of women within the timber industries of PNG and Australia.	Report on the current role and status of women (A, PC)	February 2017	A report was prepared and submitted as Activity_1.6_Gender_final.
	Dialogue with cluster groups to identify options and strategies for increasing the involvement of women in the PNG and Australian timber industries from the project outputs.	Reports with strategies for increasing benefits to women (A, PC)	August 2017	SEE4D engaged with PNGFA, DAF & EWPAA to link companies with Business Coalition for Women (BCFW) who have specialist expertise in implementing policies better suited to company operations. Workshops were conducted in August 2017 and April 2018 with BCFW presenting to the partners. A report has been submitted as 1.6.2_GenderWorkshopandPlan.
	Evaluate outcomes and benefits for women in cluster companies as a result of project activities.	Evaluation report	December 2018	An evaluation report has been submitted as Activity 1.6 Gender Evaluation Report.

PC = partner country, A = Australia

6.2 Objective 2: To develop EWPs appropriate to the timber resources and potential markets.

No.	Activity	Outputs/ Milestones	Completion Date	Comments
2.1	Wood Quality and Processing R&D: a range of tasks to provide essential background information, determine new information to fill knowledge gaps, develop processes, products, quality systems and technical marketing literature.			
	2.1.1 Prepare matrix spreadsheet: cross-referencing products with suitable species, noting conditions for use e.g. minimum durability rating, strength grouping, required moisture content and product grade quality thresholds.	1. Spreadsheet: (A, PC)	November 2016 and June 2018	A database cross referencing species with wood products was produced and user notes also provided as Activity_2.1.1_Master_DAF_EWPtimbers_Pt1. and Activity_2.1.1_Matching timbers to products_Part2_Notes_final. The spreadsheet database was further expanded, including the addition of wood structure micrographs, and presented as a Microsoft Access database: EWP_woods_V2.
	2.1.2 Improve processing and drying systems in both PNG and Australia	1.Report on survey of industry partners in both PNG and Australia regarding current knowledge, issues and status of processing and drying systems(A, PC)	February 2017 and December 2016	This activity was reported in Activities_2.1_Aus companies and Technical-Report-EngineeredWoodProduct-2.
		2. Report on optimum processing and drying systems, implementation of Lean Manufacturing and continuous improvement protocols. (A, PC)	October 2017 and various	This activity focused on drying in response to needs identified by the companies. A report was submitted - Drying of wood in Papua New Guinea – survey and recommendations. Supplementary research activities were conducted and the following reports submitted: 2.3.1.1_Volumator_Faircloth_studentreport; RH Balsa Characterisation Report; 180709 Balsa Squeezing update.
		3.QA Manual for the processing of EWPs and storage and handling of EWPs in tropical and sub-tropical conditions (A, PC)	June 2018 and July 2019	A best-practice manual for wood drying in Papua New Guinea was produced as a project output. A manual was produced and submitted as Good Practice Manual EWP Storage.
	2.1.3 Improve wood adhesive systems	1. Report on current knowledge on adhesive properties and systems for relevant PNG and Queensland species (A, PC).	February 2017 and December 2016	This activity was reported by; Activities_2.1_Aus companies.pdf and Technical-report-EngineeredWoodProduct-2.

		2.Technical report- Recommended adhesive system description per product category and species. (A, PC)	May 2018 and January 2019	This activity was finalised through the submission of reports: 2.1.3.2 adhesion and adhesive selection; LBC final report; 2.3.1.2_Abel Moke_MLW.
		3. Report on results of trials and recommended design for continuous press system. (PC)	March 2019	This activity was removed due to partners' revised priorities. The substitute project was assessment of gluing on post and pre-treated timber. Addressed through Research_report_for_gluing_and_treating_of_hoop_pine.
		4. QA manual for adhesion. (A, PC)	May 2019	A QA manual for adhesion was produced and submitted as 2.1.3.4 QA adhesion.
	2.1.4 Improve treatment systems	1. Report on current knowledge of treatment properties and recommended wood preservation systems for species, EWP and end-use category survey result. (A, PC)	February 2017 and December 2016	This activity was finalised through the submission of reports: Activities_2.1_Aus companies; and Technical-report-EngineeredWoodProduct-2.
		2.Technical report- on pest protection prescriptions for timber treatment per application and species requirements. (A, PC)	May 2018	This activity was addressed in the report: 2.1.4.2 Pest protection prescriptions.
		3.QA manual for recommended preservation practices. (A, PC)	June 2019	A QA manual was produced and submitted as: PNG Best Practice Preservation Manual.
		4. Technical report on fire retardant treatments for hoop pine (A, PC)	February 2019	This activity was addressed through the report: Final Report - Fire retardancy.
2.2	Undertake market analysis concerning EWPs from PNG and Australia.	Report on best bet market options supported by cluster companies(A, PC)	April 2018	A comprehensive market analysis study was completed and reported as: D.2.2._Market_Analysis_Report_-_ACIAR_PNG_-_Industry_Edge.
	Evaluate the potential economic benefits associated with actual and prospective markets for EWPs from PNG and Australia arising from project's activities.	Economic benefits report (A, PC)	n/a	This activity was cancelled due to commercial confidentiality constraints with partner companies – companies were unwilling to share adequate detail to enable a useful economic analysis.

2.3	Develop and test prototypes for three engineered wood products including custom wood-based components (structural and non-structural) and standard manufactured products (panels and beams)	1.Prototype packages- for each product: detailed design drawings, modelling results, scale model, prototype fabrication and test results. (A, PC)	Various	Activity 2.3 is addressed through numerous reports that are detailed in a separate table in Section 10.2. Additionally, demonstration samples of each prototype product were produced and displayed in various fora. Samples were supplied to PNGFA for further demonstration opportunities.
		2. Demonstration samples of each prototype product for use in industry forums and trade shows. (A, PC)		
	Analysis of the nature and production potential for prototype EWPs developed with two industry clusters (KPI)	3. Report for each cluster of achievements and recommendations for enhanced production		
2.4	Develop quality manuals for product manufacturing and specifications and information sheets to support marketing campaigns.	Quality assurance manuals for a range of engineered wood products- structured description in simple language describing each step of the process including quality check methods. (A, PC)	Various	Quality manuals were addressed through the activities and outputs of 2.1 to 2.3.
		Technical product brochures listing mechanical and related properties, conditions for correct storage, handling, packaging, installation and use. (A, PC)	June 2019 and July 2019	Due to the developed EWPs not yet being produced at a commercial stage, this activity was modified to include: Document and report on the achievements, lessons and the follow up actions required to facilitate successful production and marketing of EWPs – addressed through outputs of 2.3 and Final-report-Objective 3–200619. Produce material to promote the potential of EWPs for both small-medium and larger scale enterprise to support future industry development – addressed by RWD8425 IWBP Flyer Aust, RWD8425 IWBP Flyer PNG, RWD8425 IWBP Video Aust and RWD8425 IWBP Video PNG.

PC = partner country, A = Australia

6.3 Objective 3: To understand how public private partnerships can operate to promote expansion of value adding wood processing in PNG.

No.	Activity	Outputs/ Milestones	Completion Date	Comments
3.1	Review the current situation for business development in the wood processing industry in PNG, in particular focusing on the EWP sector. This will include the following components: 3.1.1 Collect information on public and private sector stakeholders relevant to the PNG wood processing industry. (PC) 3.1.2 Consult with industry to determine their needs in terms of an enabling environment (PC) 3.1.3 Who is addressing these needs currently and what programs are already underway? (PC) 3.1.4 Clarify the PNG Government's potential role in creating an enabling environment for EWP sector development including regulation, incentives, taxation (PC)	Report on the current business environment for the wood processing industry in PNG. (PC)	May 2016	This activity was completed and a report submitted: Activity3.1_PPP_current_situation.
		Report and policy brief for creating a more enabling environment for EWP sector development. (PC)	June 2019	This activity was addressed through the report: Final-report-Objective 3–200619.
3.2	Review case studies on PPPs, industry clusters and co-operatives. (PC)	Report on PPPs and similar arrangements including success stories and failures. (PC)	August 2016	This activity was finalised through submission of the report: Activity3.2_case_studies.

3.3	Review financial schemes, investment incentives and make policy recommendations. (PC)	Report 1. Recommendations for industry on available finance options to assist with capital expenditure and investment. (PC)	May 2017	This activity was completed as report: Obj3.3.1_FinancingCapitalInvestment.
		Report 2. Policy Brief and Recommendations to PNG government policy makers summarising incentive and other options (eg taxation, regulation) for consideration to promote private sector investment in modern wood processing technologies. (PC)	June 2019	This activity was addressed in the report: Final-report-Objective 3 – 200619.
3.4	Provide advice regarding a PPP model suitable for the PNG forest industry. This report will establish possible approaches and guiding principles. (PC)	Report describing recommendations for PPP structures in PNG for the wood processing industry. (PC)	May 2017 and June 2019	This activity was addressed through reports: Obj3.4_Interim Report-PPP and Final-report-Objective 3 – 200619.
		Policy Workshop	June 2019	This activity was addressed through report: Final-report-Objective 3 – 200619.
		Report of project achievements and lessons regarding PPPs	June 2019	This activity was addressed through report: Final-report-Objective 3 – 200619.

PC = partner country, A = Australia

7 Key results and discussion

7.1 Objective 1: Develop and evaluate the use of industry clusters to accelerate the development of EWPs.

Activity 1.1 Form industry clusters comprising companies willing to improve processes, products and to develop and grow new markets.

In the first six months of the project it became obvious that traditional innovation, business or industry clusters were not feasible. Reasons for this included; the non-willingness of companies to work collaboratively with others; different business models, scale and type of operations; concern over IP sharing; and different forestry and logging CoC set-ups. For that reason, activities were grouped around companies with similar R&D themes and research clusters were formed in both PNG and Australia.

During the formation of the research clusters, agreements were prepared with each participating company to provide an agreed understanding of the expectations and contributions of each party, how the collaboration would operate, and how the outputs from the collaborative research and development funded by ACIAR would be utilised and communicated with other interested parties.

Those companies involved in the research clusters contributed timber resources, equipment, staff time, ideas, contacts, industry know-how, market knowledge and commercial awareness.

Research Clusters were:

Within PNG:

i. Cluster 1, Plantation Pine Sector
   - PNGFP
   - DAF
   - EWPAA
   - PNG UniTech (via student projects)

ii. Cluster 2, Native Hardwood Sector
   - RH
   - Pryde Furniture
   - LBC
   - DAF
   - EWPAA
   - PNG UniTech (via student projects)
   - PNGFRI
   - TFTC (via student projects)

iii. Cluster 3, Balsa Sector
   - 3A Compsites
   - WRC
   - DAF
   - EWPAA

Within Australia:

iv. Cluster 1, Plantation Pine Sector
   - Austral Plywoods
   - DAF

- EWPAA

v. Cluster 2, MLW Cluster
  - Centor Pty Ltd
  - DAF
  - EWPAA

Activity 1.2 Analysis of available inputs, knowledge gaps and possible outputs for cluster companies.

Reports were generated detailing the results from a survey process, informal discussions, site visits, extracts from company technical literature and website information. This information included data and information on the following criteria for each company: year established, log and wood volumes processed, type of input wood resources, processing and manufacturing capabilities, product recovery, residue usage, products, markets, R&D needs, strengths, weaknesses, opportunities, threats, number of staff, qualification of staff. An example of the assessment conducted on each industry partner is contained as Appendix 1 to this report.

Figure 3: Site visit to WR Carpenter PNG Balsa, September 2016.

Activity 1.3 Training Needs Analysis

Most companies did not identify any critical training needs. The only two companies to nominate training needs were LBC (training in gluing and glue-laminated beam production) and Austral Plywoods (Workplace Health and Safety (WH&S) and leadership training). However, DAF and EWPAA identified training needs for all companies which included: wood treatment, drying, gluing and EWP production and matching species to products via the DAF database.

The training that was delivered in the project is discussed in other later sections of the report and was also detailed in a Training Register (refer to list of publications in section 11.2).

Activity 1.4 Develop new products and markets using idea generation tools and techniques.

Due to the reluctance of companies to work collaboratively with perceived competitors, a workshop process was untenable. Instead, idea generation techniques were implemented individually between each company and DAF. During these sessions, each company identified priority R&D areas, possible product prototypes and market opportunities to investigate. These are outlined in more detail below.

Figure 4: Identifying short lengths as a priority (left) and discussing product opportunities (right) at RH Port Moresby, February 2017.

Activity 1.5 Prepare action plans and include iterative continuous improvement processes.

The research team worked with companies in both PNG and Australia on problem solving for existing processes, identifying inefficiencies and developing solutions and improvements to build confidence and resilience in-company.

Direct individual sessions were provided initially and then later follow-up sessions were held with partners but there was a lack of enthusiasm from participants to contribute new ideas. Instead, this activity leaned more towards trouble shootings for improvements in their organization rather than putting forward new ideas. For each company, a terms of reference was developed which detailed the scope of works that the project team would work on in collaboration with them. These activities are outlined in more detail below.

Activity 1.6 Assess current involvement of women and explore options for increasing the project benefits to women.

Companies based in PNG described the advantages of a diverse workforce and preference for women in certain roles, but also highlighted current constraints that affect gender decisions when employing staff. Pressure for women to stay at home for domestic and carer duties, among other reasons, prevents many women from establishing a career path and limits opportunities to reach management roles. For the Australian companies, women were regarded as having superior colour coordination abilities and excellent processing skills, though physical strength can limit some activities to male employees.

The gender report highlighted the advantages of female employees for roles in the timber sector, especially in activities such as quality grading. Most companies surveyed described female workers as more reliable and better at maintaining equipment. These desirable employee attributes auger well for female opportunities except where local laws and cultural issues prevent their engagement.

The current gender ratio in PNG as determined from the survey of seven companies was 66:34 in favour of male employees. This contrasts with Australian information which indicated a ratio of 84:16 in favour of males, based on data for five companies. Not all project partners from Australia participated in the survey. However, data was obtained for four representative Australian companies not involved in the ACIAR project but in the targeted industry sector.

More women than men were employed in clerical and administration roles in both countries, and women held more sales positions than men in PNG.

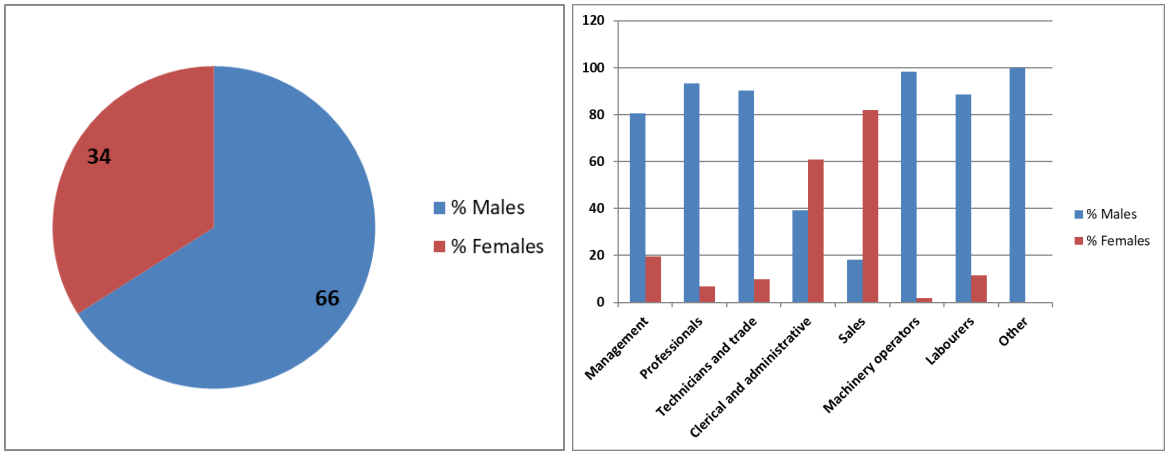

Figure 5: Relative proportions of male and female workers in PNG in total (left) and by role type (right).

Two workshops were held in PNG specifically focusing on this issue. The workshops were designed to help establish strategies for enhancing the role of women in the timber industry and to increase the project benefits for women. The project also investigated the potential for women's network groups to promote the involvement of women.

The project team endeavoured to encourage all partners to develop gender policies and improve awareness of the benefits of a diverse workforce. PNG companies were encouraged to join the BCFW and Australian companies were encouraged to investigate the opportunity to join the Women in Forestry and Timber Network (WFTN) and participate in White Ribbon Day. These options may provide models for similar educational and support activities and networking.

Figure 6: Gender equity and social inclusion workshop in Lae, August 2017.

7.2 Objective 2: To develop EWPs appropriate to the timber resources and potential markets.

Activity 2.1 Wood quality and processing R&D.

2.1.1 Species/mixes X products matrix

PNG and Australia have a wide range of sub-tropical and tropical hardwoods and softwoods from their vast reserves of natural forest resource and plantations, which are suitable for EWPs. Within this spectrum, it is possible to find every colour, grain, density and strength combination possible in the timber world. However, not all timbers are suitable for processes such as rotary peeling, slicing or drying and some woods are not amenable to gluing or preservative treatment using currently available technologies. For these reasons, it is important that processors and manufacturers make considered decisions when selecting which species will be used for which products to avoid wasted resources (time, money, materials) and to ensure that their products are fit-for-purpose for the duration of their intended design life.

A database was prepared in Microsoft Access and lists the majority of PNG commercial timbers for which key properties relevant to EWPs are known in the literature. The species used by the Australian project partners are also listed which include several commercial timbers imported from the northern hemisphere. In addition, the primary Queensland-grown timbers available to southeast Queensland processors, manufacturers and end-users are listed, bringing the total number of timbers in the database to 240.

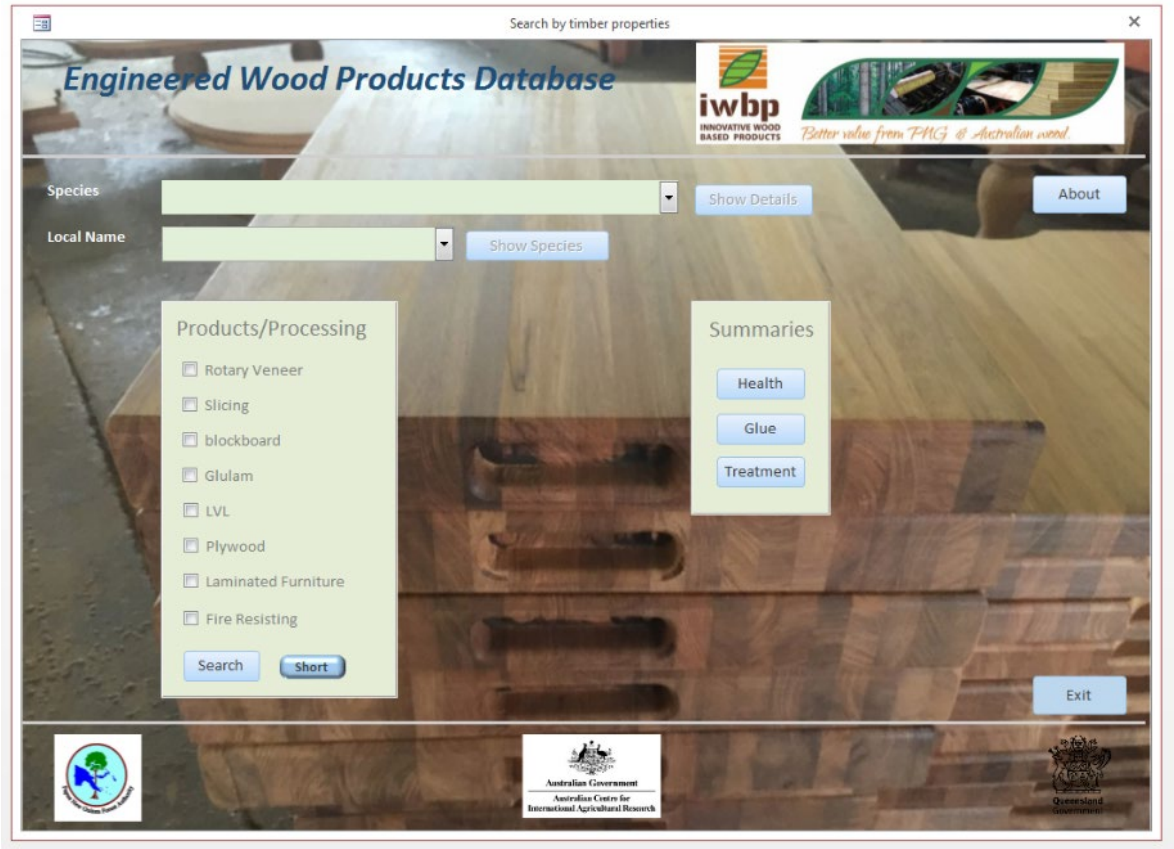

Figure 7: Screenshot from the matching species with products database.

2.1.2 Improve processing systems

Various levels of technology and capability existed in the PNG and Australian timber processing industries prior to commencement of the project ranging from rudimentary to world class. Anecdotally, this capability range was reflected across the project partner companies. To formalise this understanding a survey was conducted, and subsequent report produced, of industry partners in both PNG and Australia regarding current knowledge, issues and status of processing and drying systems. The findings of this survey underpinned the design of project activities related to the improving of processing systems.

Based on company needs identified by the processing survey, timber drying was considered a high priority. A detailed drying survey was conducted at four PNG operations processing native hardwoods and balsa. The outcomes of this survey and resulting recommendations for improved product quality and efficiency of operations were presented to project partners as a formal report, which is also readily accessible on the project website. Several basic improvements with the potential to make enormous impact were identified and detailed in the report, as follows:

- Kiln stack composition – single species, single thickness, end alignment, sticker alignment;
- Drying schedules, monitoring and control;
- Kiln operation optimisation – e.g. baffling; and
- Equipment maintenance.

These recommendations, and further information, were also verbally conveyed to project partners during various subsequent site visits.

Figure 8: Use of baffles to improve kiln air flow (from Drying in PNG – Survey and recommendations).

In addition to the specific recommendations made following the drying survey, a best-practice manual for wood drying in PNG was produced and distributed to project partners. The manual is also readily available to the broader industry via the project website. Innovative drying research was also conducted by DAF at the SRF in Brisbane as part of the project. Green balsa is characterised by its extremely high moisture content (can exceed 200%). The high cost of removing this moisture can be a major impediment to the economically viable use of balsa in EWPs. The project investigated a novel approach using compression to rapidly expel moisture from green balsa boards. Whilst success in removing

water from the wood was attained, further work is required to assess the impact on the structural integrity of the squeezed product.

Several key pieces of work were completed as part of this activity relating to areas of timber and EWP processing other than drying. A good practice manual for handling and storage of EWPs was developed for use by project partners and is readily available to the broader industry from the project website. A low cost, high accuracy log volume measurement system using image processing techniques was developed and prototyped for Austral Plywoods in Brisbane. This technology is currently being considered for implementation and would provide real time, highly accurate production volume measurements resulting in more reliable log pricing calculations. Further, testing and analysis was conducted to characterise the mechanical properties of timber products for two project partners: sawn balsa for RH and finger-jointed plantation softwood glue-laminated beam feedstock for PNGFP. The characterisation work provides key information for these project partners as they consider the adoption of new product opportunities.

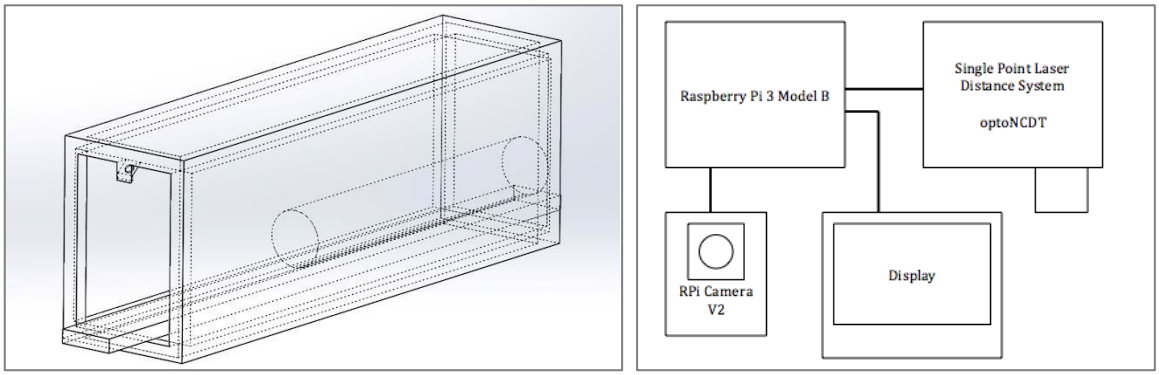

Figure 9: 3D sketch (left) and electronics schematic (right) of Log Volume Estimator.

2.1.3 Improve wood adhesive systems

As was the case with wood processing systems, various levels of technology and capability existed in the PNG and Australian industries at the project's commencement relevant to timber adhesion. Whilst Australian gluing operations were considered relatively advanced, PNG operations were seen to be quite basic with a strong propensity towards using sub-optimal systems. A survey was conducted, and subsequent report produced, of industry partners in both PNG and Australia regarding current knowledge, issues and status of adhesion systems. The findings of this survey underpinned all project activities related to the improving of adhesion systems.

Two technical documents were produced and made available to all project partners, as well as being available to the broader industry via the project website. A guide to adhesives and adhesive selection was developed to aid in the understanding of different adhesive types, along with recommending the most appropriate adhesive for use with different timber species and for different EWP types. A best practice manual for wood adhesion in PNG was also produced to provide recommendations and guidelines to help ensure successful adhesive use and EWP production.

A specific research activity was conducted in conjunction with LBC where a new generation polyurethane adhesive was successfully tested for compatibility with the existing kwila door and benchtop manufacturing lines. Subsequently, epoxy was replaced with the new generation, and much higher performing, adhesive at the commercial operation. Significant improvements in finished product quality, reduced adhesive wastage and operational productivity have consequently been realised by LBC.

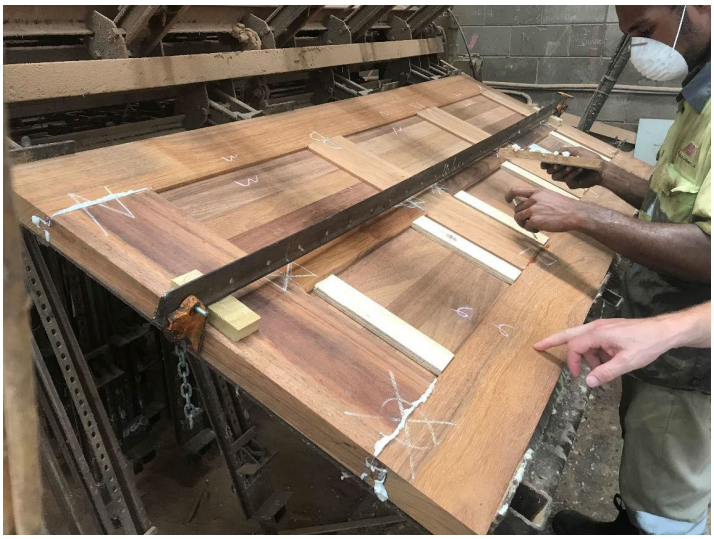

Figure 10: Door fabrication at LBC using new single component polyurethane adhesive.

Similarly, a specific adhesion research activity was undertaken with Austral Plywoods in Brisbane. Aluminium overlaid plywood for passenger train floors has traditionally been costly and difficult to manufacture. Additionally, due to high profile and costly adhesive failures in Australian made product, the plywood industry has lost market share to imported product. Research conducted in the project has been successful in identifying improved adhesive systems and the necessary manufacturing protocols, which are compatible with “normal” plywood manufacturing equipment, and produce durable and reliable glue bonds. According to industry experts, this work has real potential to restore the competitiveness of Australian (and PNG) manufacturers in this high value market with an estimated value of approximately $200K per year.

The project also supported further timber adhesion studies, more fundamental and academic in nature, by PNG based researchers. Abel Moke, a Civil Engineering student at PNG UniTech in Lae, completed a literature based study on MLW blanks using different density of timber and variable species in the block. Moira Spairong, a Trade Instructor at TFTC in Lae, was sponsored by the project to conduct a practical investigation on the comparative performance of different adhesives and the interaction of adhesives and preservatives in hoop pine glulam, at the SRF in Brisbane. These studies provided a significant increase to in-country adhesion knowledge and expertise in PNG.

Figure 11: Example products from mixed species MLW.

2.1.4 Improve preservation systems

Similar to other timber production processes, various levels of technology and capability existed in the PNG and Australian industries prior to commencement of the project relevant to timber preservation. A survey was conducted, and subsequent report produced, of industry partners in both PNG and Australia regarding current knowledge, issues and status of preservation systems. The findings of this survey underpinned all project activities related to the improving of preservation systems. The project addressed improving preservation systems through packaging and disseminating existing knowledge, delivering training workshops and undertaking new research.

Two key technical documents were produced and provided for the reference of all project partners, as well as being available to the broader industry via the project website. An extensive pest protection prescriptions guide was developed which details applicable biological hazards (insects and decay), the susceptibility of various timber species to these hazards, available preservatives and application techniques for different products, and the appropriate standards that govern preservation in PNG and Australia. A best practice manual for wood preservation in PNG was also produced which elaborates on the topics covered in the pest protection prescriptions guide as well as including detailed recommendations and guidelines to help ensure safe and successful preservative application and final product quality.

Figure 12: Timber attacking insects identified in the Pest Prescriptions and Best Practice manuals.

At the recommendation of the Executive Director of the PNGFIA, two wood preservation workshops were conducted in PNG as part of the project. A leading preservation expert presented a training course to eight industry managers and government decision makers in Port Moresby covering topics including:

- Wood – its origin and properties;
- Causes of timber degrade;
- Timber treatment chemicals, processes, application, efficiency and design life; and
- Treated timber specifications, standards, regulation, best practice and markets.

A second, more detailed, timber treatment plant operator course was provided in Bulolo. There were nineteen attendees from industry, educational institutions and government authorities. In addition to the subject matter presented at the management orientated course, the following topics were also included:

- Wood – its origin and properties;
- The causes of timber degrade;
- Timber protection chemicals;
- Timber treatment processes;
- Treated timber specifications;
- Preparing timber for treatment;
- Treatment solution controlling;
- Treatment control documents;
- Checking the treated product; and
- Safety in the treatment plant.

Positive and complimentary feedback was received from all, demonstrating the value gained by all participants.

Figure 13: Timber preservation workshop in Bulolo, March 2019.

A specific research activity was undertaken in conjunction with Austral Plywoods, KPC and Lonza, in Brisbane. Work was conducted to trial the development of Group 1 fire retardant (FR) rated hoop pine plywood. Testing of prototype material produced as part of the project confirmed that this was successfully achieved for the first time by an Australian plywood. This has the potential to be the most significant innovation in plywood since the introduction of LVL in 1986. According to an industry expert this project outcome has a high certainty of commercialisation and in economic terms could completely repay the ACIAR investment in the total project in less than 12 months. If successfully commercialised, this product could completely open and remove all restrictions in the commercial panelling market to Australian/PNG plywood.

The project also supported a more fundamental wood preservation study led by Moira Spairong (Trade Instructor at TFTC). Ms Spairong was sponsored by the project to conduct a practical investigation on the interaction of adhesives and preservatives in hoop pine glulam, at the SRF in Brisbane. This study assisted in increasing preservation and adhesion knowledge and experience in PNG.

Activity 2.2 Undertake Market Analysis concerning EWPs in PNG and Australia

A comprehensive market study was undertaken by Industry Edge. The key criteria assessed were; demand drivers for PNG wood, domestic consumption, international demand for

wood, EWPs, EWP market development in Australia, opportunities, constraints and recommendations.

Papua New Guinea's domestic market for wood products is small by international measures, but appears to be significantly larger than the formal consumption data suggests. Demand for residential dwellings, and also for other small buildings is growing, providing nascent opportunities for increased utilisation of wood products, including EWPs.

Enhancing the value adding of PNG's wood processing sector, including the expansion of EWP manufacture is very challenging. Globally, competitive value adding requires manufacturing that is at a scale beyond that which is likely to be feasible for PNG, now and into the future, without substantial assistance such as that provided through this ACIAR project.

Manufacturing at scale typically requires a large, consistent and stable supply of wood resources, a range of infrastructure pre-requisites, and large and proximate end markets. These deliver cost-competitiveness that is a necessity for any sustainable manufacturing.

EWPs are a specific group of products that have performance properties that make them useful in engineering applications. They must be manufactured in stable and controlled environments, typically with a mid to high level of automation and at least reasonable technological sophistication.

In the absence of scale, infrastructure support, end-product cost competitiveness and significant and expensive export market access and development activities, PNG's wood products that directly compete in the international commodity markets are potentially best directed towards domestic markets.

Where export markets can be developed for wood products, they are likely to continue to be in niches and related to unique species and appearance characteristics.

In addition, there are significant financial and regulatory barriers to exporting from PNG that make regular exports unreliable and less competitive than for many other nations in the region. Perceived sovereign risks on supply and access to wood resources, as well as other regulatory matters, are a significant impediment to attracting manufacturing investment of a scale required to be competitive for many export markets.

The main current export markets are for hardwood logs and to a much lesser extent, sawn hardwood, with China the major recipient of both. There is also plywood export to other Asian markets.

Despite the challenges of manufacturing in PNG, there are smaller and niche markets of existing and potentially greater value for PNG's wood products, especially associated with 'appearance' products. The market assessment identified the best opportunity for adding and extracting value from PNG's wood products is in the integrated supply of affordable, pre or semi prefabricated residential dwellings to meet PNG's growing demand for more, and improved, housing.

Figure 14: Existing kwila products manufactured and exported by LBC (Source: http://www.mrkwila.com).

Industry Edge considered that the following items could reasonably be pursued to seek added value to PNG's wood products, both domestically and internationally:

- Establishment of a multi-user CPU or hub, located within close proximity to the TFTC in Lae;
- Increasing the focus on development of rotary peeled veneer and plywood production for local markets;
- Developing the dwelling component and pre-fabricated housing and other small buildings market;
- Enhancing the development of international markets for PNG's wood products through the establishment of a market development and access pilot program;
- Improving log transport infrastructure into the CPU, whether by road or by sea;
- Establishing a co-marketing program for domestic applications, focused on treated wood products; and
- Map and develop the required skills and capabilities for operation of each development activity and conduct training and skills development through the TFTC.

Activity 2.3 Develop and test prototypes for targeted EWPs

A total of ten EWP prototypes were designed, manufactured and tested in collaboration with project partner companies. Prototype ideas were developed in conjunction with the partners and typically stemmed from an identified issue, commercial need or market opportunity within their existing operations. The typical drivers for new product ideas were waste reduction and value adding.

The EWP prototypes developed included structural, appearance, furniture and energy generation products. Native hardwoods, plantation softwoods, balsa and aluminium were included in the prototypes in-line with the project partner's business. A detailed technical report outlining product manufacturing protocols and results of performance testing was issued to the project partner for each product developed. The new products are at various stages of commercial evaluation and implementation.

A summary of the prototypes developed for each project partner is as follows:

Rimbunan Hijau (PNG)

The key driver for EWP prototypes developed in conjunction with RH was waste reduction. Opportunities were identified using two current by-products; short length hardwood offcuts and sawmill residues (sawdust and planer shavings).

Finger-jointed structural hardwood

Short length PNG hardwood was shipped from RH's Sarco timber yard in Port Moresby to SRF. The jointing method used consisted of 10 mm long fingers secured with a resorcinol formaldehyde adhesive. The finger length achievable was limited by the accessibility of tooling that suited the equipment available at the commencement of the study. While a visually acceptable joint was produced with 10 mm fingers, testing showed that it did not meet the strength or durability requirements of Australian Standard AS 5068. Further assessment of the failure modes exhibited by the test specimens indicated that both the low strength and durability could potentially be attributed to the use of a joint length not optimised to structural applications and the relatively high density of the timber.

Preparations to conduct an assessment of longer finger joints had commenced. DAF purchased newly available finger joint cutters that would allow the machining of 20 mm long

joints using the existing SRF machinery. Unfortunately, timber was not able to shipped to Brisbane by RH in time to permit the completion of this work before finalisation of the project. In lieu of PNG hardwoods, preliminary tests were conducted on samples produced using Australian spotted gum, which has a comparable wood density to the PNG timbers being investigated. Initial results are encouraging and justify continued investigations.

Figure 15: Finger-jointed hardwood sample manufacture (left), finished sample (centre) and testing (right).

School furniture from hardwood offcuts

A cohort of industrial design students from QUT Creative Industries School of Design were engaged to work on a practical design project using short length PNG hardwood shipped from RH's Sarco timber yard. The objective of the student's project was to produce designs and samples of children's school furniture for PNG from this currently under-utilised resource. The students were given specific criteria to work with to ensure compatibility with PNG manufacturing capability – e.g. specific sizes of timber, non-complicated tooling, rudimentary carpentry skills and limited budget. Through this process the students enhanced their capability in industrial design, budgeting, project management, innovation and manufacture. A range of prototype furniture was manufactured by groups of four students. A workshop was held where all pieces were displayed and presented to key project collaborator, RH. Miss Olive Kiu, the marketing manager of RH, judged the pieces for suitability, quality and appearance. The prototypes have been returned to RH as demonstration pieces to aid in potential commercialisation. The Port Moresby Rotary Club, a key provider of furniture to schools in PNG, has expressed interest in purchasing and distributing the furniture in the future.

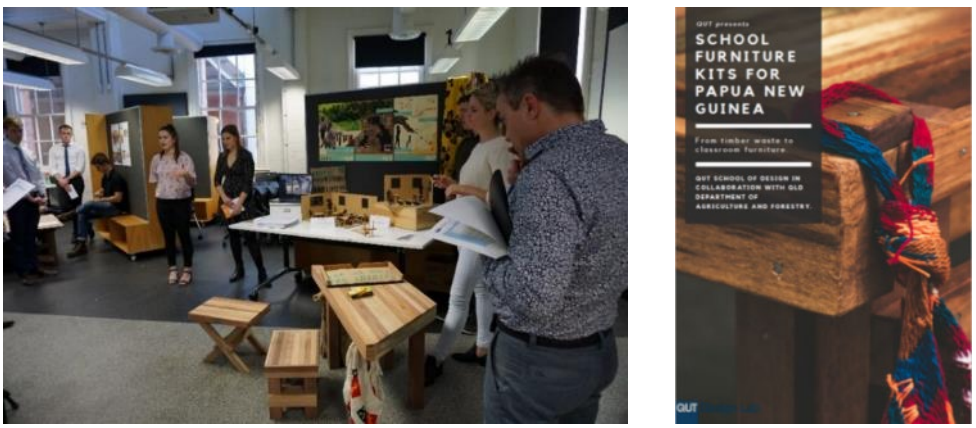

Figure 16: School furniture prototype workshop (left) and QUT publication (right).

Supply of short length hardwood for prefabricated housing

In addition to the prototypes developed using short length hardwood offcuts, another opportunity was pursued with Omni Limited, a Port Moresby based building and construction company. The DAF team provided technical assistance in the development of a pre-fabricated modular timber housing system. Recognising that RH was looking for opportunities to better utilise its excessive volumes of under-utilised short length hardwood, DAF facilitated a relationship between RH and Omni Limited that has resulted in an on-going commercial supply arrangement of this by-product into the highly valuable pre-fabricated housing market.

Figure 17: Pre-fabricated modular housing prototype at Omni Limited in Port Moresby.

Briquettes for energy production from sawmill residues

During discussions with the project team, RH suggested that it would like to investigate the possibility of producing energy from this by-product, both for its own use and potentially for wider community benefit. The compaction of these residues into briquettes was identified as one potential option to facilitate this. Sawmill residues were supplied by RH in Port Moresby and briquettes produced using a RUF Briquetting System Type – RUF 5,5/2400/60x60 at Austral Plywoods, Brisbane.

Briquettes of inherent integrity and robustness were successfully produced. Appropriate testing was conducted based on advice provided by industry experts, HRL Technology Group. Properties regarding moisture, energy, ash and impurity contents were tested and reported. Specific advice regarding the calibre of the test results, or suitability of the briquettes for energy production was not provided as the typical approach would be to design an energy system based on the properties of the available fuel material.

Figure 18: Compacted briquettes (left) made from sawmill residues (right).

PNG Forest Products (PNG)

The primary drivers for EWP prototypes developed in conjunction with PNGFP were value adding and the desire to become a “one stop shop” for all timber construction components. Opportunities were proposed by PNGFP and ratified through discussions with the project team.

Three prototypes were produced and assessed as part of the project:

Engineered timber I-beams

Following theoretical performance modelling conducted by the project team, prototype engineered timber I-beams were manufactured by PNGFP in Bulolo. The beams were produced in two sizes and consisted of finger-jointed H4 treated araucaria LVL flanges and a H4 treated araucaria plywood web. The prototypes were shipped to SRF in Brisbane for structural testing and assessment. Structural test results did not achieve the anticipated and modelled performance. Upon further inspection, shortcomings in the manufacture process were identified by the project team and communicated to PNGFP. Adjustment of the performance model to account for these deficiencies validated the model.

A second iteration of prototype beams were manufactured taking into account the results and recommendations of the initial assessment. Production was consolidated to a single beam size using the same feedstock materials. When tested at SRF, despite significant improvement in performance from the first iteration beams, the prototypes again did not achieve the anticipated and modelled structural performance. Closer inspection conducted by DAF and PNGFP representatives again identified deficiencies in the production process as the cause of low test results. PNGFP are committed to commercialising the engineered timber I-beam product and are confident that the manufacturing issues can be resolved. It is intended that final product testing and development will be completed under the company’s volition following the conclusion of the project.

Along with physical prototypes, a spreadsheet for calculating the span-ability of the timber I-beams as floor joists under different construction scenarios was developed as part of the project. This important specification tool has been provided to the project partner to aid in further product development and optimisation, and for use as a technical sales and marketing resource.

Figure 19: Engineered timber I-beam sample (left), and testing (right).

Engineered lightweight panels

Prototype engineered lightweight panels were manufactured by PNGFP in Bulolo for potential use as a floor or wall panel in domestic construction. The panels consisted of plywood faces separated by a plywood web, formed into a sinusoidal type waveform by curving standard plywood sheets parallel to their length. The faces were secured to the web at the crest of each wave using PRF adhesive. Both faces of the panel were orientated such that the face grain of the plywood ran parallel to waveform of the web.

Assessment of the panels performance was undertaken by the project team at SRF in Brisbane. Structural capacity testing, appropriate for the intended uses of the panel, was conducted including bending stiffness and strength, compression strength (parallel to the corrugations) and shear strength (separation of faces from web). A basic structural performance model was developed by the project team to aid in further design improvements. Further inspection of the tested prototypes and additional informal tests conducted enabled the provision of several recommendations to PNGFP to improve panel performance. Further development of the engineered lightweight panel will be considered by the project partner once commercialisation of the I-beam product is complete.

Figure 20: PNGFP engineered lightweight panel prototypes.

Glue-laminated beam feedstock

A research and testing plan was developed by the project team and PNGFP to assess the suitability of finger jointing their plantation grown softwood framing for use as feedstock in glue-laminated beam manufacture. Prototype material was produced using existing machinery in Bulolo and shipped to Brisbane for testing. The following feedstock types were assessed:

- Untreated finger-jointed radiata pine;
- H4 treated finger-jointed radiata pine;
- Untreated finger-jointed hoop pine;
- H4 treated finger-jointed hoop pine;
- Untreated finger-jointed klinki pine; and
- H4 treated finger-jointed klinki pine.

Structural capacity testing for all relevant properties was conducted at SRF and the EWPAA Laboratory in Brisbane. The appropriate statistical analysis of test results in accordance with Australian Standards was applied and the ensuing characteristic properties provided to PNGFP to allow the material to be considered further for glue-laminated beam

manufacture. The test results also provided important information regarding the impact of preservation treatment and timber species on structural performance.

East New Britain Balsa Companies (PNG)

Coco-wood veneer and laminated balsa solid core door

The driver for investigating new EWPs for balsa producers in East New Britain (ENB) is a combination of waste reduction and value adding. Due to exceedingly high product quality standards, large quantities of balsa is discarded, despite its potential usefulness in other applications. Developing alternate uses for these downgraded materials represents huge environmental and economic potential for balsa producers. Although not a core focus of this project, another potential waste product requiring repurposing in PNG is senile coconut stems. This is particularly relevant given the prevalence of coconut plantations being replaced with balsa in ENB. Work in previous ACIAR projects in the South Pacific has proven the viability of producing veneer from senile coconut stems.

Based on a product idea by the project team, a solid core timber door using downgraded balsa as its infill, and coco veneer produced from senile coconut stems, was successfully fabricated, proving the technical viability of producing unique, innovative and potentially high value products from waste materials. Along with a full size demonstration door, currently installed at SRF, small-scale samples were produced and presented to project partners and industry experts. The prototypes were exceptionally well received and prompted the identification of several other opportunities including tabletops, and “structural insulated panels” if structural plywood skins were included.

Figure 21: Laminated balsa core door manufacture (left), final installation (centre) and internal detail (right).

Austral Plywoods (Australia)

Austral Plywoods in Brisbane produce a range of structural and appearance grade plywood products using hoop pine. Consequently, product development activities conducted with Austral are also applicable to PNG softwood plywood producers. Two specific value added plywood products were researched and prototyped in conjunction with this partner.

Aluminium overlaid plywood panel

Aluminium overlaid plywood has previously been manufactured in Australia. However, this product has been notoriously difficult to reliably manufacture and very costly to produce. There have also been some high profile and costly adhesive failures in Australian made aluminium overlaid plywood leading to lost market share to imported product in the passenger train floor market. In this project, a range of new generation adhesives were evaluated to assess their suitability for bonding aluminium to plywood and their compatibility with standard plywood manufacturing equipment. The project has been successful in identifying an improved adhesive system (Jowat EPI Jowacoll 102.49), which meets all performance and utility requirements. Owing to this work, a direct relationship has been established between Austral Plywoods and Jowat Adhesives to finalise product development and commercialisation. According to industry experts, this work has real potential to restore the competitiveness of Australian (and PNG) manufacturers in this high value market with an estimated value of approximately $200K per year.

Figure 22: Aluminium overlaid plywood bond quality testing.

Group 1 FR rated hoop pine plywood

Group 1 fire retardancy for hoop pine plywood was identified by Austral as being of high importance to the company as they had been carrying out research related to this for a number of years with little success. Austral indicated that attainment of this fire rating in accordance with the Building Code of Australia (BCA) would open up a major market for the company Australia wide. The main application that is intended for the Group 1 FR rated plywood is wall and ceiling linings.

Three FR manufacturing companies were involved with the study, two of which are global companies in timber treatment and FR technologies. Both of these companies requested that company names and product names were not to be disclosed in the technical report and as such these companies are listed as Company A and Company B. Company A supplied three treatment solutions identified as CA-1, CA-2 and CA-3. Company B supplied only one solution which was identified as CB-1. The third company provided an intumescent

coating for consideration in the trials however once Austral investigated the product further the decision was made that it would not be an economically viable alternative for their application.

The study investigated two possible methods of product treatment to achieve Group 1 fire rating – 1) on plywood (post-manufacture) and 2) on veneers (pre-manufacture). The first part of the study employed the use of current commercial treatment methods to achieve a group 1 fire rating on pre-constructed 9mm, 7- ply Hoop pine panels. These were:

- Full cell vacuum/pressure impregnation treatment (VPI);
- Full cell vacuum/vacuum treatment (VOI); and
- Dip treatment in cold solution.

Company A elected to try all three of the treatment protocols while Company B opted to only proceed with the dipping treatment.

Part 2 of the study investigated the pre-treatment of individual 1.4mm hoop pine veneers by using a cold dipping process prior to panel manufacture. Three different adhesives were trialled to overcome the historical issues of successfully adhering FR treated veneers. These included a phenol formaldehyde (PF) resin, this being the standard adhesive currently used for plywood manufacture, a high moisture resistance D4 rated PVA adhesive and an emulsion polymer isocyanate (EPI). All samples were conditioned to 12% after manufacture and submitted for fire testing to the requirements of AS3837:1998 - Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter.

The results showed that a VPI treatment of pre-constructed 9mm panels to a minimum retention of 52Kg/m3 (active ingredients) is sufficient to achieve a group 1 fire rating when treated with solution CA-3. Solutions CA-1 and CA-2 failed to achieve Group 1 rating with VPI treatment, giving consistent Group 3 results to the maximum retentions trialled of 60kg/m3 (active ingredients). Both VOI treatment and dip treatments of plywood all achieved Group 3 rating, failing to achieve the targeted Group 1 rating for any of the retentions trialled for all solutions from both supplying companies.

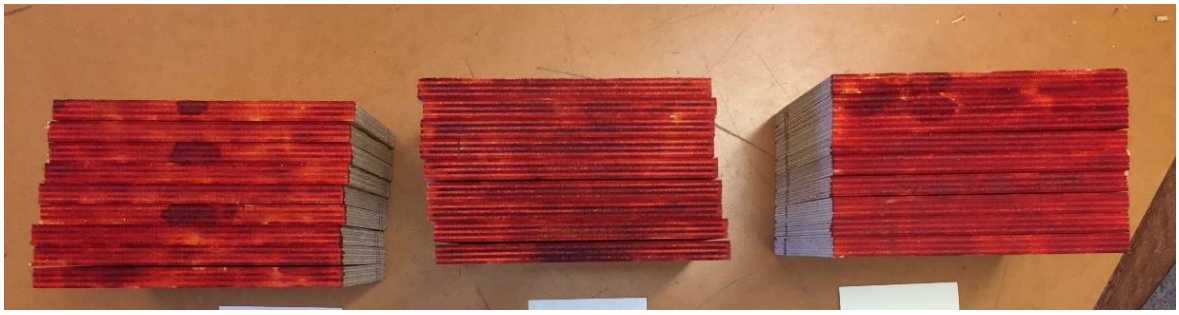

Figure 23: FR treated plywood with chemical test indicating retardant penetration.

Dipping treatments of 1.4mm hoop pine veneers were conducted in line with Company A and Company B recommendations and then allowed to dry. All veneers for manufacture of panels using the PVA and EPI adhesives were conditioned to 12% moisture content. The veneers used for the PF adhesive were conditioned to 8% moisture content. Once all veneers had equilibrated at the target moisture content, replicate panels were manufactured. Adhesives were applied and pressed to their respective manufacturer's recommendations and then allowed 7 days to ensure full cure. Samples were tested to B-bond requirements as per AS/NZS 2098.2: 2012 - Methods of test for veneer and plywood: Bond quality of plywood (chisel test). The only samples that passed the requirements of the standard were veneers that were single-dip treated with treatment solution CB-1 and

adhered with EPI. These were submitted for fire testing to determine Group rating, however, none of these met the targeted requirement of Group 1 with all samples achieving a maximum of Group 3 fire rating.

Discussions are now ongoing with Austral and Company A to further the research initiated in this project and to validate results at an industrial scale.

Centor (Australia)

MLW for high-end door mouldings

Centor is a high-end timber door manufacturer with a target market of the top 7% of income earners. Traditionally, mouldings produced from solid hardwood sections have been used in door construction. As these traditional hardwoods become more difficult and expensive to source, an opportunity may exist for EWPs in this market. Research work was undertaken in conjunction with Centor to explore this possibility.

Native PNG hardwood veneers were shipped to SRF in Brisbane. Advice from Centor indicated that visual similarity between EWP prototypes and traditional solid hardwood mouldings was of paramount importance. The colour of all veneers was measured using colorimetric techniques and an interior design student from Griffith University was engaged to apply colour theory and psychology to veneer arrangement in the manufacture of a range of sample MLW designs for presentation to Centor. After a series of iterations and consultations, a MLW prototype that met Centor's requirements was finalised and the fabrication of a full sized door planned. Adequate volumes of the MLW prototype product were produced by DAF, however, due to more immediate business development demands, Centor were unable to manufacture the MLW door within the project timeframe.

Figure 24: MLW samples presented to Centor as potential door mouldings.

Activity 2.4 Develop quality manuals, product specifications and information sheets

An extensive range of materials was produced throughout the project to support the development, production and marketing of EWPs in PNG and Australia. These materials include technical documents, promotional brochures and videos, and product samples. Whilst some resources are authored to a specific project partner or industry segment, the content is generally equally applicable to both countries. Following is a summary of the materials produced.

EWP prototype technical reports

A detailed technical report outlining product manufacture methodology and results of performance testing was issued to the project partner for each product developed. Electronic copies of each report are also held by DAF and ACIAR. Many of these reports are commercial in confidence and their wider availability to project partners and the industry is currently being clarified.

Figure 25: Extracts from a EWP technical research report.

Span tables for engineered timber I-beams

In addition to the detailed technical report produced for all prototypes, a spreadsheet tool for calculating the span-ability of the timber I-beams as floor joists under different construction scenarios was developed as part of the project. This spreadsheet has been provided to the project partner to aid in further product development and optimisation, and for use as a technical sales and marketing resource.

Table 1 - I-Beam Joists - 40kg/m²

Loadings: Permanent Loading, G: self weight + 40kg/m²

Joist Spacing (mm)		300	400	450	500	600
Joist Code	Self Weight (kg/m)	Max. Floor Joist Span (mm) Single Span				
J30050	3.0	4000	4000	4000	4000	4000
J30065	3.6	4200	4200	4200	4200	4200

Figure 26: Example span table for engineered timber I-beams.

Best-practice manuals

Best-practice manuals were developed for a number of key areas within the EWP production process. The manuals are designed to promote appropriate and repeatable concepts and procedures to ensure high quality, efficient and safe EWP production. Best-practice manuals were developed for:

- Wood drying;
- Wood adhesion;
- Wood preservation; and
- Handling and storage of EWPs.

The best-practice manuals were distributed to project partners, typically in hard copy format during site visits, and are also readily available to the broader industry via the project website.

Figure 27: Best practice manuals for PNG range.

Technical guides for EWP processing

In addition to the best-practice manuals, several technical guides were developed for a number of key areas within the EWP production process. The guides are designed to be informative and aid in decision making when considering the development of a new EWP product or process. Technical guides were developed for:

- Wood drying – Drying survey and recommendations;
- Wood adhesion – Adhesive selection guide; and

- Wood preservation - pest protection prescriptions guide.

The technical guides were distributed to project partners, typically in hard copy format during site visits, and are also readily available to the broader industry via the project website.

Figure 28: Extracts from a EWP processing technical guide.

EWP Project Fact Sheets

A large number of technical reports produced throughout the project have been distilled into fact sheets of approximately two pages. Key information has been extracted from the reports and presented in a concise and easy to read manner. This presentation makes the fact sheets ideal for physical distribution.

The majority of the best-practice manuals and technical guides have been converted to fact sheets. In addition, technical reports on the following topics have been adapted:

- EWPs for PNG;
- PNG timber trade; and
- Women in the PNG timber industry.

The fact sheets are readily available to the broader industry via the project website.

Figure 29: PNG Timber Trade factsheet.

General EWP industry promotional materials

General marketing material for the promotion of the EWP industry was produced as a part of the project. The material highlights the abilities, benefits and potential of the industry, along with the work of the project, with the intent of promoting understanding, interest, involvement and ultimately investment in EWP manufacture. A short promotional video and brochure has been developed for both PNG and Australia.

The materials are openly available on the project website with the intent that they could be distributed electronically, shared on social media, included in presentations, shown at industry events or in industry publications, and displayed at project partners facilities. Printed brochures are held by DAF and can be distributed as required or requested.

Figure 30: Extract from EWP industry promotions brochure.

EWP prototype product samples

For all EWP prototypes developed as part of the project additional product samples were held for future promotional purposes. Prototype samples have been provided to the appropriate project partner with addition samples held by DAF at SRF in display or archive. For some products, additional samples could potentially be manufactured and distributed if required.

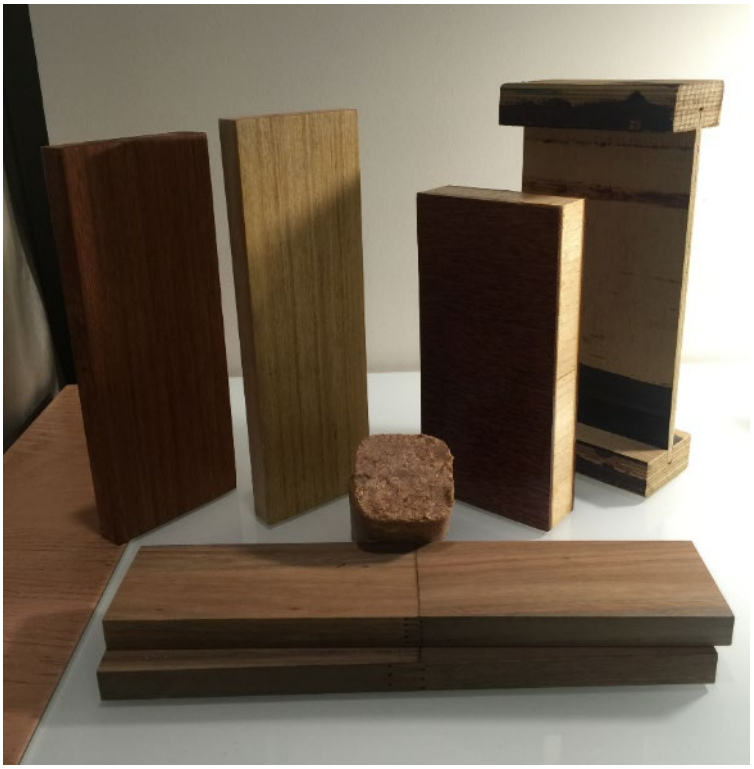

Figure 31: A selection of the EWP prototype samples produced by the project.

7.3 Objective 3: To understand how PPPs can operate to promote expansion of value adding wood processing in PNG.

Four formal reports were produced as components of the project. These included:

Activity 3.1 Review the current situation for business development in the wood processing industry in PNG, in particular focusing on the EWP sector

- Report on the Current Business Environment for the Wood Processing Industry in Papua New Guinea (PNG) – May 2016.

Activity 3.2 Review case studies on PPPs, industry clusters and co-operatives.

- Report covering global review of PPP case studies in relation to the wood processing industry in Papua New Guinea (PNG) – August 2016.

Activity 3.3 Review financial schemes, investment incentives and make policy recommendations.

- Report reviewing available finance options to assist with capital expenditure and investment in the wood processing industry in Papua New Guinea (PNG) – May 2017.

Activity 3.4 Make recommendations regarding a potential Public Private Partnership model suitable for the PNG forest industry.

- Preliminary report providing recommendations for PPP structures in PNG for the wood processing industry – May 2017.

Challenges

The above reports were generated in accordance with the project design; however, it was clear that the information, findings and conclusions were of peripheral interest to public or private sector organisations involved in the PNG timber sector.

As a result of the low interest in the development of policy to support timber based PPP's a number of concepts were investigated and discussed with various organisations with a view to establishing mutually beneficial investments involving both private and public sector enterprises. These concepts included:

- Power Generation Utilising Timber Sector Waste Biomass;
- Legality and Chain of Custody Development for Smallholder Supply of Timber Products;
- Utilisation of Spindle-Less Lathe Technology for Production of Veneer on Manus Island; and
- Establishing a CPU at TFTC to produce increased value added timber products.

These concepts were not able to be realised due to a variety of factors including:

- Reluctance to having the public sector involved in private business energy generation decisions;
- Lack of adequate legality and chain of custody infrastructure to ensure compliance of product sourced from smallholders;
- Inadequate recoverable resource under current resource extraction rules applying to Manus Island; and
- Lack of clear benefits accruing to disadvantaged communities.

During the progress of the project it became increasingly clear that for a variety of reasons neither the private nor public sector involved in the timber sector were interested in pursuing beneficial partnership arrangements.

As a result of limited interest in progressing policy development or partnership concepts, it was decided to redirect resources to other initiatives under the EWP Program. In May 2019, a project variation was completed that acknowledged that the original project design be modified to abandon outstanding milestones and to produce a final report that:

- Reviewed the failure of the PPP approach as included in the original project design;
- Reviewed the failure of the industry cluster approach as per the original project design;
- Analyse difficulties encountered in engaging and collaborating with the timber sector; and
- Makes recommendations for future project opportunities/approaches for timber industry development in PNG.

At the commencement of the project, it was confirmed that a draft downstream processing strategy had been developed and that laws had been passed to establish PPP arrangements in PNG. By the end of the project, the authorities required under the PPP legislation were yet to be established and none of the basic business environment strategies and policies had even been considered by the National Executive Council, let alone passed into laws or regulations. Such policies and standards are required in order to establish successful PPP arrangements based on an understanding of mutual benefit to the partners. The outstanding strategies, standards and systems include:

- Downstream processing strategies;
- Reforestation strategies;
- PNG timber legality standard;
- PNG timber legality verification system;
- PNG logging code of practice;
- PNG timber legality guidance template;
- Revised national forest plan;
- Revised PNG country specific guidelines to meet the Australian markets specifically; and
- Implementation of the multipurpose national forest inventory.

It is recommended that prior to commencing in future projects that encourage the establishment of PPP's, a more detailed review of the business environment be conducted to clearly establish factors that will impede progress.

Recommendations

As a result of Objective 3 findings regarding the establishment of PPP's in the timber sector in PNG, a number of recommendations were made including:

- **That the PNG Public sector move with as much haste as possible to implement comprehensive sector strategy encouraging downstream processing.**

  This will establish a format around which other programs can be developed to assist the enabling environment for the timber sector and results in increased private sector investment in downstream processing of timber in PNG.

- **That in future projects ACIAR consider engaging private sector programs (e.g. MDF, PHAMA) as partners in projects that are targeted at encouraging private sector investment.**

  The partners that are chosen need to have skills that can assist the private enterprises to understand raw material sourcing, operational controls and market opportunities and have access to financial resources that can be used to leverage investment activities. It is, however, most likely that these will only be applicable to projects that demonstrate economic benefits and/or employment growth for disadvantaged communities.

- **That the PNG Public sector in discussion with the private sector investigate the opportunity to implement an Export Enhancement Scheme that encourages the private sector to invest in downstream processing of timber in PNG.**

  Such a scheme to be based on import credit certificates issued in relation to the level of value addition performed in PNG. For forestry, the base activity would be log exports and value addition over exporting in log form. This incentive would be expected to be targeted at larger scale investments. Such a scheme would be more likely to attract investment than the complexity associated with PPP arrangements.

8 Impacts

8.1 Scientific impacts – now and in 5 years

8.1.1 Engineered wood products and process improvements

The outcomes of this project provided the scientific background for new and improved technologies across different EWP streams.

The project generated the knowledge and understanding of the characteristics and processes required to successfully utilise PNG and Australian species in EWPs enabling utilisation of these species in innovative products. New data was generated on the EWP processing and manufacturing characteristics of PNG and Australian species.

Research determined the best combination of species and adhesives matched to product requirements, ensuring the efficient use of these production resources.

The research resulted in knowledge of appropriate adhesive and preservative systems to produce a range of durable engineered wood products in PNG and Australia.

The information generated by this research opened opportunities to pursue new markets. The project team worked directly with the private sector to use the research results to develop reliable high performance products for projected markets. However, further research, development and extension needs to be undertaken to bring many of these EWP prototypes to commercial production.

Innovative EWPs such as those developed (as prototypes) in this project, keep the forest sector relevant and in demand, especially in the face of competition from alternative building materials, many of which cannot offer the equivalent sustainability benefits. There is a positive market outlook locally and worldwide for the building and construction sector generally and for wood-based products in particular. Short to medium term predictions forecast a strong demand for wood-based construction materials (IBIS World). Additionally, the scientific impacts of the project are aligned with the general PNG Government policies and preferences regarding increased in-country downstream processing and value adding.

Many of the scientific findings of the research studies are now widely available to the research community, the industry and the public in the form of ACIAR technical reports, best practice manuals and fact sheets. However, due to the design of this project, which focused on working directly with private sector companies, proprietary information specific to new EWPs developed as part of this project is currently held in commercial-in-confidence arrangements with certain partners. Discussions are currently being held with these companies to secure the information for future release to the public.

A number of project topics are also currently being considered for broader scientific publication e.g. adhesive/preservative interactions and compression of wood for moisture removal.

8.1.2 Public Private Partnership Program

The research data generated by the PPP component provided evidence on how and if a PPP could be managed in the PNG wood processing sector. Additionally, the research provides insights for the wider PPP community. It is anticipated that this activity will stimulate further studies and modelling activities across a range of industries and regions. The work undertaken on PPPs as part of this project is also being considered for publication as a journal paper.

8.2 Capacity impacts – now and in 5 years

Private wood processing companies in PNG and Australia achieved enhanced capacity through the improved skills and knowledge of trained operators, uptake of safe work practices, implementation of improved processes and improved efficiencies through the introduction of lean production principles (strategies for improved quality, inventory minimisation, waste minimisation and continuous improvement). Mill managers and staff were exposed to idea generation techniques, problem solving, scientific and technical research activities which provided the opportunity to gain knowledge and understanding of experimental methods, design, data interpretation and application of results. These organisations will retain the positive influence of working with a research team whose philosophy is based on continuous improvement and idea generation.

Figure 32: Rod Vella (DAF) providing adhesion advice to LBC staff.

The PNG wood processing industry will benefit long-term through the development of local expertise in adhesion, preservation, engineering, product design, project management and international communication. These skills will be invaluable throughout the careers of the researchers providing the basis for ongoing R&D capacity in wood products.

Project outcomes are also aligned to the core objectives of the PNGFA which include supporting economic growth and employment creation; increased down-stream processing of forest resources; and increased acquisition and dissemination of skills, knowledge and information in forest industries through education and training. The Forest Authority enables capacity building through informed policy decision-making that supports these activities.

Project outcomes are also aligned to the core values of the PNGFIA which recognises great value in: developing downstream timber processing; upgrading training to include more advanced technologies; increasing wood recovery, improving production management; and increasing wood waste utilisation. The Association supports capacity building through assessment of government policy matters and promotion of legal harvesting and processing activities.

A PNG national, Julieth Jiap, was appointed to work on the project in the area of EWP technical support and timber engineering. Julieth worked alongside experts in this field from Australia and was mentored by them. This will result in significant capacity enhancement within PNG for timber engineering and EWP process and product technical support. Julieth gained experience in wood science, structural timber engineering and project management; developed professional communication skills; delivered presentations; and represented DAF and the EWPAA at PSC meetings. Julieth undertook specialist training courses in

wood structure; wood and water relationships; wood adhesion science and technology; strand based composites manufacturing; practical wood adhesive technology and plywood manufacturing and testing. Julieth is now a permanent employee as a Building Services Engineer with Cardno, a major engineering company in PNG. As a consequence of her involvement in the project Julieth is also now also a member of the PNG Institute of Engineers and a student member of Engineers Australia.

Figure 33: Julieth Jiap preparing test samples (left) and at the school furniture presentation workshop (right).

Another PNG National, Moira Spairong from TFTC, was sponsored by the project to conduct an intensive study at the DAF SRF in Brisbane. During her time in Australia, Moira benefited from specialist training in wood preservation and adhesion; project planning; product and process testing; knowledge of relevant industry standards; data analysis and reporting. This experience was very valuable for both Moira and the PNG timber industry as it provides flow-on benefits for her on-going teaching in PNG, which will help in the capacity building of future employees in the PNG industry. An article on Moira's study experience at DAF was published in a recent Timber and Forestry E-newsletter with a photo of Moira on the front page.

Figure 34: Moira Spairong presenting results of her research at SRF (left) and featured on the cover of an Australian industry magazine (right).

Mr Abel Moke, a PNG national and final year civil engineering student at PNG UniTech, undertook a research study as part of the project. This study provided Mr Moke with a sound knowledge of wood material science and adhesion. Mr Moke successfully completed this project and graduated in April 2018.

The project also sponsored four PNG nationals from educational institutes to attend the wood preservation training workshop held in Bulolo. As an outcome of this course, these staff members gained new knowledge and skills in wood preservation, which will be of benefit to the broader PNG timber industry.

Apart from ongoing informal training provided during visits to companies by project staff, a formal training program with workshops was delivered in PNG. This included training in plywood manufacture, wood preservation and gender equity. 86 attendees were involved in these training workshops that will provide a significant long term benefit to PNG.

Figure 35: Participants at the preservation workshop (left) and gender equity workshop (right).

An Australian mechatronics engineering student, Mr Adam Faircloth worked on the project on a research topic concerning the development of a low cost, log volume measurement system using image processing techniques. The completion of a research project was a requirement for his Bachelor of Engineering course at Griffith University. Mr Faircloth gained new knowledge and skills, which eventually resulted in him being appointed to a Timber Technician position at the DAF SRF in the Forest Product Innovation team.

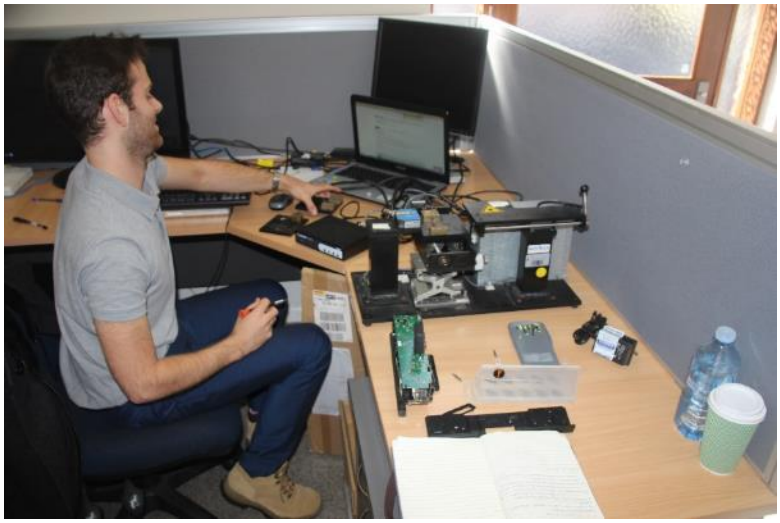

Figure 36: Adam Faircloth working on the log volume estimator prototype.

A third year student, Thomas Davies, enrolled in a dual degree in civil engineering and international relations at University of Queensland, obtained work experience directly with the project. Thomas was involved in various project technical tasks at DAF SRF such as sample preparation, adhesion assessments, EWP manufacture and performance testing.

A cohort of industrial design students from QUT Creative Industries School of Design worked on a practical design project as an assessment item for their course. This focused on the use of short length hardwood offcuts from RH to make children's school furniture for PNG. The students were given specific criteria to work with to ensure compatibility with PNG manufacturing capability– e.g. specific sizes of timber, non-complicated tooling, rudimentary carpentry skills and limited budget. Through this process, the students enhanced their capability in industrial design, budgeting, project management, innovation and manufacture.

Figure 37: QUT design students who participated in the school furniture design project.

An interior design student from Griffith University, Sara Vilugron, worked on this project to complete a research study as part of her degree. Sara worked with RH veneers to produce high value mouldings to substitute for solid timber traditionally used for high value doors by Australian partner, Centor. She employed colour matching, colour theory and psychology to produce a variety of designs for review by Centor.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

The project generated an array of economic impacts that are in the process of being realised. Some of these are very specific for certain products or processes, whereas others are more general in nature.

Group 1 FR Treated plywood:

According to a leading industry expert, the work undertaken on achieving Group 1 FR treated plywood has substantial commercial and economic potential. Testing of prototype material produced as part of this project achieved a Group 1 rating, which is the first time that this has been achieved in Australian plywood. This has the potential to be the most significant innovation in plywood since the introduction of LVL in 1986. The industry expert suggests that this project outcome has a high certainty of commercialisation and in

economic terms could completely repay the ACIAR investment in the total project in less than 12 months. If successfully commercialised, this product could completely open and remove all restrictions in the commercial panelling market to Australian/PNG plywood.

Figure 38: FR treatment – removing restrictions on plywood for commercial panelling (Source: http://www.australply.com.au).

Gluing systems for aluminium overlaid rolling stock for transportation (e.g. rail carriages, buses):

Due to the high profile and costly adhesive failures in Australian made aluminium overlaid plywood, the plywood industry has lost market share to imported products in the passenger train floor market. Additionally this product has been notoriously difficult and very costly to manufacture. However, the project has been successful in identifying improved adhesive systems that are compatible with “normal” plywood manufacturing equipment and produce durable and reliable glue bonds. According to industry experts, this work has real potential to restore the competitiveness of Australian (and PNG) manufacturers in this high value market with an estimated value of approximately $200K per year.

Lightweight balsa cored solid doors:

Prototypes of lightweight and aesthetically attractive solid core doors were manufactured using waste materials (downgraded balsa and senile coconut). The doors are both lightweight and strong. This product has significant potential in the boat building and transportable home markets where strength, durability and light-weight are critical. Even larger commercial potential is anticipated if the product were to be combined with structural plywood to produce “Structural Insulated Panels”.

Figure 39: Structural Insulated Panels – an opportunity for downgraded balsa? (Source: http://www.sip-energy.com).

Development of PNGFP's engineered lightweight panel and timber I-beams:

The successful commercialisation of PNGFP's engineered lightweight panel and timber I-beam could help to revolutionise logistics for pre-fabrication and general construction in PNG due to affordability and ease of handling. This would have immediate economic impact at various levels: increased sales and new markets for the manufacturer (including the potential for product licensing to offshore manufacturers) and cost savings in transport and construction. The project also developed span tables for the prototype timber I-beams in accordance with Australian timber design standards, making a significant contribution to the legally required technical product performance marketing literature.

Process improvements:

Project staff provided onsite assistance to companies through reviewing manufacturing operations and providing recommendations on process improvements. One PNG furniture company reported a 90% increase in productivity and a 50% decrease in glue waste when new generation wood gluing recommendations were implemented.

As part of a formal survey process, advice was provided by the project drying expert, that if implemented would significantly improve wood drying efficiency at several companies in PNG. Recommendations made and implemented by the same DAF drying expert at a wood processing operation of a similar scale in Laos, in another ACIAR project, resulted in a 50% decrease in fuel consumption and a 35% reduction in kiln drying time. This equated to a 30% increase in profitability. These improvements were achieved with a very low capital expense of around $350.

Longer-term economic benefits

Additional to potential economic benefits as mentioned above, other project outcomes could result in more general and longer-term economic benefits as described below.

Recent data published by the FAO indicated that PNG exports 3,000,000 m^3 of roundwood per annum, with an average value of $US212/$m^3$ (FAO 2012). During the same year PNG exported 5,000 m^3 of veneer sheets at an average rate of $US1,404/$m^3$ and 10,000 m^3 of wood-based panels at an average price of $US1,390/$m^3$. Table 1, below, highlights the value added by in-country processing.

Table 1: Papua New Guinea forest products- selected data for 2012 (FAO, Forest Products Yearbook 2012).

Product	Volume (m^3)	Unit value ($US)
Roundwood exports	3,000,000	212
Sawnwood exports	77,000	279
Wood-based panel exports	10,000	1,390
Veneer sheet exports	5,000	1,404

Based on these data, if outcomes from the project resulted in a diversion of 10% more roundwood into engineered wood products manufactured locally, this would increase the value added by approximately $US186,600,000 (in terms of total product revenues). This scenario uses a 10% diversion from roundwood exports into engineered wood products and an estimate for recovery of 60%:

- 10% x 3,000,000 = 300,000 m^3;
- 300,000 m^3 @ $212/$m^3$ = $US63,600,000 roundwood value;
- recovery for EWPs 60% of 300,000 m^3 = 180,000 m^3;
- 180,000 m^3 x $1,390/$m^3$ = $US250,200,000 engineered wood product value; and
- value added = $250,200,000 - 63,600,000 = $US186,600,000.

There is a multiplier effect from these impacts with improved financial status along the supply chain, including associated businesses in logistics/ haulage and processing (sawing plants and peeling operations), adding value in-country. The project outcomes will result in higher prices for market-oriented products and more efficient use of resources. It is anticipated that these benefits will be realised within five to ten years of the completion of R&D activities. An increase in local processing, especially manufacturing of EWPs will create value and improve profitability of local industries, benefiting the local population.

The research activities were designed to target measurable improvements in productivity and operational efficiency. They will also reduce reliance on imports and improve trade opportunities.

An economic impact of the project is likely to be eventually higher wages for skilled labour in the EWP manufacturing sector, as workers progress from low skilled manual labour positions within the workforce.

The types of economic impacts of the project for Australia are similar to those for PNG; increased development of EWPs will result in greater market share for wood products compared to alternative building materials such as steel, concrete and aluminium; higher recovery and more product options which will maximise the value of Australian forest resources; and flow on benefits or multiplier effects for associated industries along the supply chain such as the logistics, service and financial sectors.

8.3.2 Social impacts

The main social impacts generated by the project can be grouped around the following areas:

- Gender equity – An important focus of the project was on gender equity issues. Through the project work conducted, which included surveys, workshops and informal discussions with stakeholders, the project resulted in much greater awareness and education on gender inclusiveness as well as promotion of gender equity in the timber industries of PNG and Australia. Project staff also encouraged stakeholders to join various networks and associations promoting gender equity. These included the BCFW (PNG) and WFTN (Australia). Training and discussion on gender topics throughout the project were not restricted to women themselves but also the broader industry including managers/owners/industry associations. The project was also designed to maximise the involvement of women in all activities. For example, a female PNG national was contracted to fulfil a major technical and project management role in the project.

- Improved WH&S – from the outset of the project, improved WH&S at all wood processing sites was identified as a development priority. Staff and managers received guidance in achieving more productive and safer workplaces via formal training such as workshop, best practice manuals, and informally via site visits/discussions.

- Potential increased employment opportunities –the success of the project will eventually lead to increased log processing, EWP manufacture, and value adding within PNG with many flow-on social benefits resulting in increased employment and business opportunities.

Figure 40: Female sawmill machinery operator (Courtesy of PNGFP).

8.3.3 Environmental impacts

This project focused on developing EWPs. One of the main advantages of EWPs compared to traditional sawn boards is that the feedstock is utilised in the assembly process to maximise recovery of the harvested resource - doing more with less. EWPs are designed to produce homogenous components so that no single defect will reduce the potential of the component, whereas sawn board recovery is restricted by the limiting defect or combination of defects within a board. In veneer processing, final product recoveries of 60-70% can be achieved compared with 35% from traditional sawmilling operations. The impacts of this more efficient resource utilisation include: much greater recovery of usable wood; higher returns on material costs; and a corresponding reduction in waste. Therefore, by the development of new EWP's and improved manufacturing processes, the project has contributed to waste minimisation and hence more efficient utilisation of the forest resources.

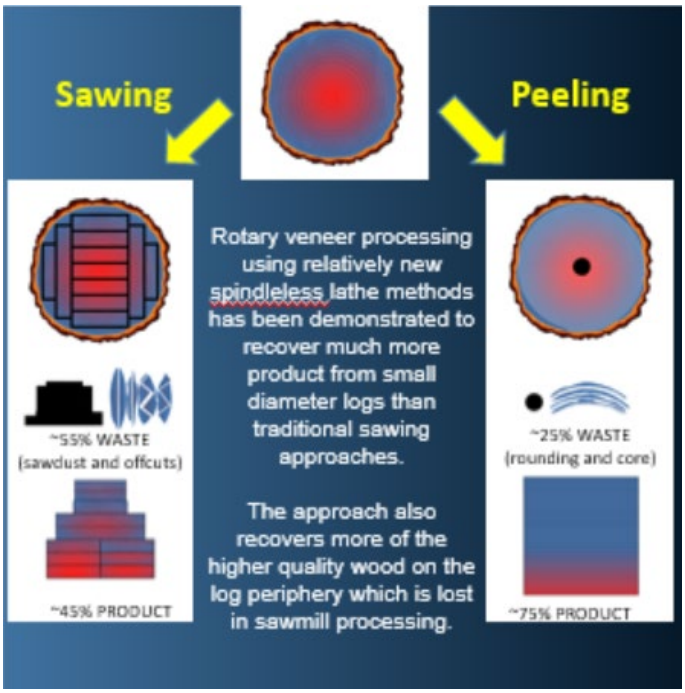

Figure 41: Indicative recoveries from sawing versus spindle-less lathe peeling (Note that recoveries are before drying and grading).

Additional to the waste minimisation benefits, the project demonstrated that some by-products of the EWP manufacturing process could also be used for alternative renewable energy sources (e.g. briquettes).

EWPs have more uniform and reliable structural performance compared to traditional solid wood products, which enables them to be competitive with less sustainable building material such as steel, concrete and plastic.

The project included a focus on manufacturing EWPs from plantation resources, which could provide sustainability benefits to the long-term management of native forests in PNG and Australia.

Environmental credentials for timber products are becoming increasingly important in many markets. Through working with the project team, industry collaborators gained an understanding of the benefits of administering quality systems into their production, which will enhance their opportunities for compliance with certification schemes allowing them to access markets requiring environmental certification and legal verification.

8.4 Communication and dissemination activities

8.4.1 Project communication and stakeholder engagement

Overall, the communication and engagement strategy implemented during the project has delivered the following key outcomes:

- **Internal collaboration** has enabled the development and dissemination of information products ranging from complete technical reports to technical manuals, guidelines, pamphlets, and news updates. Ongoing dialogue between the relevant team members was simplified by having two project communication & extension personnel; one in Australia (DAF) and one in PNG (PIP). The communication process was managed with reference to annual Communication Plans and bi-annual Communication Schedules.

- **Information products** have been developed for wood processors, component manufacturers, end users and the public sector; and incorporated into a Wood Processors Tool Kit that continues to be managed by PIP as a one-stop source of information for the wood processing sector.

- **Information networks** have been selected to share information products between project partners and stakeholders through the most appropriate communication platforms, and ensure sustainability of effort and uptake of outputs upon completion of the project. Seven bi-annual Communication Reports were produced to monitor user interactions on each of the adopted platforms.

- **Hands-on training** has been conducted to further develop the skills and knowledge of industry partners and key stakeholders in prioritised focus areas. This included on-site training with industry partners during the project research activities, as well as standalone formal seminars, courses and workshops for project stakeholders.

Figure 42: The Wood Processors Tool Kit's multi-media resources are freely available on the PIP website.

8.4.2 Communication and stakeholder engagement outcomes

Table 2, below, presents the progress made towards the project's ultimate (i.e. end-of-project) communication outcome: *Changes in access to knowledge and information and how that information is used.*

Table 2: Evidence of progress towards the project's ultimate communication outcome: *Changes in access to knowledge and information and how that information is used*

Objective 2:	
Desired Change	**Evidence**
New and refined knowledge for EWP development is generated with and transferred to targeted forest industry operations.	Project research activities conducted in collaboration with industry partners have led to the production of EWP development reports, manuals, guidelines, pamphlets and promotional videos. These resources are incorporated into the Wood Processors Tool Kit, and were circulated via e-news updates & alerts to stakeholders on the project mailing list (currently over 200 recipients): • A.1.1. Matching timbers to products spreadsheet and notes • A.2.2. Matching timbers to products database and notes • B.3.1. Kiln drying in PNG factsheet • B.3.1. Pest protection in PNG factsheet • B.3.2. Best practice drying manual for PNG • B.3.2. Best practice gluing manual for PNG • B.3.2. Best practice preservation manual for PNG • B.3.3. Drying survey and recommendations report • B.3.3. Pest protection prescriptions report • C.2.1. Project flyer and poster • D.1.1. Engineered wood product factsheet • D.1.2. Developing engineered wood products video • D.1.2. Constructing multi-laminar LVL video • D.2.1. PNG timber trade factsheet • D.2.2. Market analysis report for wood products from PNG The project also delivered a wood preservation seminar for managers and government decision/policy makers in Port Moresby, followed by a hands-on plant operator's course at PNGFP in Bulolo.
Where possible industry data and technical information is accessible through one well managed portal.	The Wood Processors Tool Kit provides a one-stop source of technical information for the wood processing sector. There are currently 143 files in 44 folders on the following topics[1]: • Wood species and properties (folder A); • Wood processing techniques (folder B); • Wood processing partnerships (folder C); and • Wood products and markets (folder D). The Wood Processors Tool Kit's multi-media resources are freely available from the following communication platforms that continue to be managed by PIP:

[1] *This includes resources developed by the sister ACIAR project: FST/2012/092 - Enhancing Value Added Wood Processing in Papua New Guinea, as well as additional resources supplied by project partners.*

	• Website / Resources / Wood Processors Tool Kit • Website / Completed Projects / Engineered Wood Products Project • YouTube / Videos for Wood Processors • Google Drive / Wood Processors Tool Kit The Wood Processors Tool Kit resources are also widely promoted from the following communication platforms that continue to be managed by PIP: • E-news updates and alerts • Facebook
Objective 3:	
Desired Change	**Evidence**
PNG Forest Industries have access to knowledge about initiating, building and participating in PPPs and stimulating investment.	Project research activities with the public and private sectors have led to the production of the following partnership building resources. These resources been incorporated into the Wood Processors Tool Kit, and circulated via e-news updates & alerts to stakeholders on the project mailing list (currently over 200 respondents): • **Engaging women in the timber industry folder:** ~ C.1.1. Women in timber industry factsheet ~ C.1.2. Gender ratios and status of women report ~ C.1.2. Gender equity and social inclusion workshop report • **Building productive partnerships folder** ~ C.3.1. PNG timber trade factsheet ~ C.3.2. Australian partner processing surveys report ~ C.3.2. Current business environment report ~ C.3.2. Review of public-private partnerships report The project also delivered two gender equity and social inclusion workshops for industry stakeholders in Lae and Port Moresby to share knowledge and discuss practices for enhancing the role of women in the timber industry and increasing project benefits for women.
Communication and Engagement:	
Industry clusters are creating, sharing and accessing information through transparent and appropriate modalities.	During the Wood Processors Survey in East New Britain Province, the Wood Processors Tool Kit contents and communication platforms were introduced to nine provincial wood processors (including the two industry partners collaborating with the project). Survey responses indicated that the PIP Website and shared folders (Google Drive or Dropbox) were the most popular platforms for accessing the Wood Processors Tool Kit resources. Both large enterprises (251+ staff) and small enterprises (11-50 staff) were interviewed.
PNG and Queensland forest owners (women and men) have access to information about possible products that can be derived from their forest resources.	The project assisted students at Queensland University of Technology to create prototypes for practical school furniture kits and, at the same time, find an economic solution for an industry partner's solid wood off-cuts at their rural processing plant. This activity led to the production of the following wood waste resources: • **Making the most of wood waste folder** ~ B.4.2. School furniture kits manual for PNG ~ B.4.2 From waste wood to classroom comfort video

	These resources accompany the 5 Wood Waste Factsheets developed by the sister ACIAR project: FST/2012/092 - *Enhancing Value Added Wood Processing in Papua New Guinea.*

9 Conclusions and recommendations

9.1 Conclusions

This project produced many significant technical outputs. These included:

- Several EWP prototypes and processes that have substantial commercial potential – lightweight balsa cored solid doors, Group 1 FR rated hoop pine plywood, gluing systems for aluminium overlaid rolling stock, systems for successfully finger-jointing PNG hardwood and innovations in I beams manufactured from hoop pine;

- Significant improvements in gluing systems for PNG timbers that have already been adopted by at least one industry partner in PNG;

- Demonstrated the potential beneficial opportunities for using PNG sawmill waste and offcuts as energy generating briquettes and school furniture;

- Generated considerable new technical literature in the form of manuals, technical reports, factsheets and a database matching PNG and Australian species with various wood products; and

- Significant increases to EWP R&D and production knowledge and skills in PNG, along with the introduction of techniques to help identify new opportunities.

A comprehensive market analysis study was conducted which suggested that the following items could reasonably be pursued to add value to PNG's wood products, both domestically and internationally:

- Establishment of a multi-user CPU or hub, located within close proximity to the TFTC in Lae;

- Increasing the focus on development of rotary peeled veneer and plywood production for local markets;

- Developing the pre-fabricated component, housing and other small buildings markets;

- Enhancing the development of international markets for PNG's wood products through the establishment of a market development and access pilot program;

- Improving log transport infrastructure into the CPU, whether by road or by sea;

- Establishing a co-marketing program for domestic applications, focused on treated wood products; and

- Map and develop the required skills and capabilities for each development activity and conduct training and skills development through the TFTC.

However, financial and regulatory barriers were identified relating to exporting products from PNG that could make regular exports unreliable and less competitive in the global market.

This project trialled a new approach to conducting an ACIAR R&D project in developing countries with a strong focus on working directly with the private sector and reduced emphasis on public institution collaboration. This methodology proved successful with the project able to accelerate product, process and industry development when to previous projects.

It was not possible to form innovation/business or industry clusters as was originally planned due to the challenges of IP sharing, differences in forestry and logging CoC, different scales of operation and business models, and an unwillingness of companies to work with others. Therefore, research clusters were established instead of business clusters.

During the course of the project, it became increasingly obvious that neither the private nor public sector involved in the timber industry in PNG saw immediate value in pursuing beneficial partnership arrangements. Some of the reasons identified for the failure of a PPP approach in the PNG timber sector were:

- Lack of support from the PNGFA due to limited resources within the organisation being available to support the project;
- Lack of PNG Government clarity on/and commitment to policies for PPPs in PNG;
- Lack of PNG Government clarity on/and commitment to downstream processing policies in PNG;
- Challenging business and investment environment in PNG and the high risks perceived in further investment in forestry;
- A dominant enterprise exists in the PNG timber sector and this poses a risk to smaller investors wishing to develop downstream processing businesses; and
- Concerns (mainly by potential investors) with appropriateness of PNG harvesting practices, legality of wood supplies and chain of custody.

The project also produced very high quality outputs in the gender equity and social inclusion domain, generating new networking, information and awareness, which assist in greater gender equity and social inclusion within the forest industry of PNG and Australia.

9.2 Recommendations

This project generated many useful outcomes and impacts as discussed throughout the report. However, many challenges were experienced during project delivery which have provided useful insights into recommendations for future work. Specific recommendations include:

- Successful progress and outcomes of project activities were expedited when face-to-face contact occurred with project partners in PNG. Options to facilitate more in-person interaction in future projects should be identified and evaluated to help ensure better engagement and communication between, and within, the project team and all stakeholders.
- Other ACIAR projects have shown benefit in having a full-time, in-country project manager (reporting directly to the project leader). This arrangement has been shown

to be very effective in ensuring accelerated delivery of project outputs and achievement of objectives. It is recommended that future projects in PNG consider having a similar arrangement in place.

- The current project has highlighted that many of the PNG industry partners were not in a position to immediately adopt advanced processing and manufacturing of EWPs. A more progressive approach, building on the optimisation of current processes (e.g. sawing, drying, gluing, handling and storage), may have assisted industry partners' preparation to move towards more advanced solutions.

- The current project highlighted the success of hands-on training and face-to-face interaction as opposed to training material delivered in a written format via guides and manuals. In future projects, greater emphasis should be placed on hands-on training compared to alternative methods.

- The project highlighted challenges that can emerge when ACIAR projects work so closely with the private sector, particularly concerning commercial confidentiality and IP sharing. It is important for ACIAR and project leaders to clarify the policy and approach regarding direct engagement of private sector stakeholders to ensure all project benefits can be realised.

- A future project in EWP R&D would benefit from greater emphasis on economic analysis. Economic analysis focusing on evaluating various processing and market opportunities for their impact on the PNG and Australian timber industries would guide R&D into themes with the greatest beneficial impact. The approach to economic analysis would need to be compatible with the business environment of the partner country.

- The project activities identified that there is currently minimal technical capability in PNG for R&D into manufacturing and testing of EWPs. It is recommended that a future project consider the enhancement of technical facilities to allow greater capability in local EWP R&D.

- The project produced many prototype products and processes that offer significant commercial potential. It is important that additional work be undertaken to develop and test these further, to increase the likelihood of commercial adoption.

- Further R&D would be expected to benefit considerably by the involvement of enterprising, innovative and dynamic PNG companies such as Omni Limited. Whilst Omni Ltd were not a formal partner in the current project, this company became known to the project in the later stages and with their unique capabilities and business philosophy, could be valuable in facilitating innovative timber research and use in future projects.

- The recruitment process for the project engineer was substantially more complicated and time consuming than expected. If a non-Australian is to be engaged by an Australian entity in the future, adequate resources need to be available to support the process.

- Specific technical recommendations:
    - Further development and testing of the prototypes developed during this project;
    - Further direct, on-site assistance with optimisation of basic wood processing and manufacturing practices at companies in PNG;
    - Specific R&D focus on improving wood adhesion technologies for PNG timbers;
    - Further development and enhancement of in-country technical knowledge and skills; and
    - Investigations into the potential conversion of some PNG forest resources via spindleless lathe peeling.

10 References

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10.2 List of publications produced by project

Technical Outputs – Objective 1

No.	Activity	Publication Title	File Name
1.1	Form industry clusters comprising companies willing to improve processes, products and to develop and grow new markets.	Leggate, W, Hopewell, G and Bailleres, H. 2016. *Interim report on the formation of industry clusters in PNG and Australia to accelerate the development of novel engineered wood products.*	Activity1.1a_Clusters.pdf
	Negotiate agreements with participating companies	Leggate, W et al. 2016. *A compilation of the terms of reference partner agreements.*	Activity1.1b_compilation_agreementsTORs.pdf
1.2	Analysis of available inputs, knowledge gaps and possible outputs for industry cluster companies.	Leggate, W, Hopewell, G and Vella, R. 2016. *Assessment of selected timber companies in Papua New Guinea and Australia.*	Activity1.2_Assessments.pdf
1.3	Training Needs Analysis	Hopewell, G et al. 2017. *Training needs analysis of collaborating companies.*	Activity1.3_Training needs.pdf
	Register of training conducted	Dakin, T. 2019. *Register of training conducted.*	Activity1.3_Training register.pdf
1.4	Document the prospects and options for markets for new EWPs identified through workshop process.	Redman, A, Vella, R and Jiap, J. 2017. *Notes taken during trip to PNG in July, 2017.*	170731 PNG TRIP REPORT July 2017.pdf
		Industry Edge. 2018. *Joint PNG Market Analysis Report.*	D.2.2._Market_Analysis_Report_-_ACIAR_PNG_-_Industry_Edge.pdf
1.5	Evaluation of the effectiveness and lessons from the industry cluster approach in PNG and Australia	Leggate, W, Hopewell, G and Bailleres, H. 2016. *Interim report on the formation of industry clusters in PNG and Australia to accelerate the development of novel engineered wood products.*	Activity1.1a_Clusters.pdf

		Marlow, J. 2019. *Review of the Public Private Partnership (PPP) Component of the Project to Develop Durable Engineered Wood Products in PNG.*	Final-report-Objective 3 – 200619.pdf
1.6	Assess the current status of women within the timber industries of PNG and Australia.	Hopewell, G and Leggate, W. 2017. *Gender ratios and the current status of women in some Papua New Guinean and Australian timber companies.*	Activity_1.6_Gender_final.pdf
	Dialogue with cluster groups to identify options and strategies for increasing the involvement of women in the PNG and Australian timber industries from the project outputs.	Roberts, J and Hopewell, G. 2017. *Gender equity and social inclusion - Workshop activities, outcomes and project plan for continued implementation of gender equity.*	1.6.2_GenderWorkshopandPlan.pdf
	Evaluate outcomes and benefits for women in cluster companies as a result of project activities.	Jiap, J. 2018. *Gender equity and social inclusion - Evaluation Report.*	Activity 1.6 Gender Evaluation Report.pdf

Technical Outputs – Objective 2

No.	Activity	Publication Title	File Name
2.1	2.1.1 Prepare matrix spreadsheet: cross-referencing products with suitable species, noting conditions for use e.g. minimum durability rating, strength grouping, required moisture content and product grade quality thresholds.	Hopewell, G et al. 2017. *Spreadsheet – Cross-referencing products with species.*	Activity_2.1.1_Master_DAF_EWPtimbers_Pt1.xlsx
		Hopewell G. 2016. *Matching timbers to engineered wood products – Part 2 – Notes on the data spreadsheet.*	Activity_2.1.1_Matching timbers to products_Part2_Notes_final.pdf
		Hopewell, G et al. 2018. *Database – Cross-referencing products with species.*	EWP_woods_V2.accdb
	2.1.2 Improve processing and drying systems in both PNG and Australia	Vella, R and Redman, A. 2017. *Australian partner processing and production surveys.*	Activities_2.1_Aus companies.pdf
		Golman, M, Vali, B and Asok, F. 2016. *Development of durable engineered wood products in PNG and Australia FST/2014/065 – Technical report 2: Milestones 7 – 9.*	Technical-report-EngineeredWoodProduct-2.pdf
		Redman, A. 2017. *Drying of wood in Papua New Guinea – survey and recommendations.*	2.1.2.2_Drying survey and recommendations report_V4.pdf
		Faircloth, A. 2017. *Log volume estimator.*	2.3.1.1_Volumator_Faircloth_studentreport.pdf
		Dakin, T. 2018. *Characteristic Mechanical Properties of Rimbunan Hijau (RH) Balsa.*	RH Balsa Characterisation Report.pdf
		Fitzgerald, C. 2018. *Progress Report - De-watering of Balsa waste by Mechanical Squeezing.*	180709 Balsa Squeezing update.pdf
		Redman, A and Jiap, J. 2018. *A best-practice manual for wood drying in Papua New Guinea.*	PNG Best Practice Drying Manual.pdf

		Dorries, S. 2019. *Good Practice Manual for Handling and Storage of Engineered Wood Products.*	Good Practice Manual EWP Storage.pdf
	2.1.3 Improve wood adhesive systems	Vella, R and Redman, A. 2017. *Australian partner processing and production surveys.*	Activities_2.1_Aus companies.pdf
		Golman, M, Vali, B and Asok, F. 2016. *Development of durable engineered wood products in PNG and Australia FST/2014/065 – Technical report 2: Milestones 7 – 9.*	Technical-report-EngineeredWoodProduct-2.pdf
		Vella, R. 2018. *A guide to adhesives and adhesive selections.*	2.1.3.2 adhesion and adhesive selection.pdf
		Vella, R. 2019. *A comparative study of three single component polyurethane adhesives in the manufacture of non-structural Kwila engineered wood products.*	LBC final report.pdf
		Moke, A. 2017. *Multi Laminar Wood blanks using different density of timber and variable species in the block.*	2.3.1.2_Abel Moke_MLW.pdf
		Spairong, M. 2019. *How will gluing before and after pressure treatment of hoop pine (Araucaria cunninghamii) panels affect pressure permeability and integrity of Epoxy, Phenol Resorcinol Formaldehyde and Single Component Polyurethane adhesives?*	Research_report_for_gluing_and_treating_of_hoop_pine.pdf
		Vella, R. 2019. *A best practice manual for wood adhesion in Papua New Guinea.*	2.1.3.4 QA adhesion.pdf
	2.1.4 Improve treatment systems	Vella, R and Redman, A. 2017. *Australian partner processing and production surveys.*	Activities_2.1_Aus companies.pdf

		Golman, M, Vali, B and Asok, F. 2016. *Development of durable engineered wood products in PNG and Australia FST/2014/065 – Technical report 2: Milestones 7 – 9.*	Technical-report-EngineeredWoodProduct-2.pdf
		Francis, L and Hopewell, G. 2018. *Pest protection prescriptions.*	2.1.4.2 Pest protection prescriptions.pdf
		Norton, J, Francis, L and Dakin, T. 2019. *A best-practice manual for wood preservation in Papua New Guinea.*	PNG Best Practice Preservation Manual.pdf
		Vella, R. 2019. *Achieving a Group 1 fire rating in hoop pine plywood.*	final report - fire retardancy.pdf
2.2	Undertake market analysis concerning EWPs fromPNG and Australia.	Industry Edge. 2018. *Joint PNG Market Analysis Report.*	D.2.2._Market_Analysis_Report_-_ACIAR_PNG_-_Industry_Edge.pdf
2.3	Develop and test prototypes for three engineered wood products including custom wood-based components (structural and non-structural) and standard manufactured products (panels and beams)	Dakin, T. 2019. *Finger jointing of short length PNG hardwood offcuts to produce structural products.*	RH Finger Joint Report.pdf
		Queensland University of Technology. 2018. *School Furniture Kit – Queensland University of Technology (QUT) - Prototype Package*.	2.3.1 RH_QUT School Furniture Kit Prototype package.pdf
		Hunjas, V. 2018. *School Furniture Kits for PNG.*	QUT School Furniture Kits for PNG from Timber Waste to classroom furniture.pdf
		Dakin, T. 2019. *Briquettes for energy production from sawmill residues.*	RH Briquette Report.pdf
		Dakin, T and Jiap, J. 2018. *Development of Timber I-Beams for PNG Forest Products.*	PNGFP I-Beam Report.pdf

		Dakin, T and Jiap, J. 2018. *PNGFP I-Beam Performance Model and Span Tables.*	PNGFP I-Beam Span Tables.xlsx
		Dakin, T. 2018. *Mechanical Property testing of Lightweight Panels manufactured by PNG Forest Products.*	PNGFP Lightweight Panel Test Report.pdf
		McLaughlin, A. 2019. *Assessment of Characteristic Properties of Finger Jointed Timber Manufactured by PNG Forest Products.*	2019-07 PNGFP FJT Characteristic Properties.pdf
		Dakin, T. 2019. *Coco-wood veneer and laminated balsa solid core door.*	Coco Balsa Door Report.pdf
		Vella, R. 2019. *Determination of a suitable adhesive to adhere aluminium sheeting to hoop pine plywood.*	Austral aluminium final report.pdf
		Vella, R. 2019. *Achieving a Group 1 fire rating in hoop pine plywood.*	final report - fire retardancy.pdf
		Vella, R. 2019. *Development of a multilaminar door moulding from locally sourced timbers.*	Centor final report.pdf
		Vilugron, S and Robinson, R. 2017. *Centor Design Process.*	2.3.1 Centor MLW moulding- Rev2.pdf
		Vilugron, S and Robinson, R. 2017. *PNG Prototype Design Process.*	2.3.1 RH Veneer Prototype Design Process - Rev1.pdf
2.4	Document and report on the achievements, lessons and the follow up actions required to facilitate successful production and marketing of EWPs.	Marlow, J. 2019. *Review of the Public Private Partnership (PPP) Component of the Project to Develop Durable Engineered Wood Products in PNG.*	Final-report-Objective 3 – 200619.pdf

	Produce material to promote the potential of EWPs for both small-medium and larger scale enterprise to support future industry development.	2019. *Engineered Wood Products Promotional Brochure – Australia.*	RWD8425 IWBP Flyer Aust r6.pdf
		2019. *Engineered Wood Products Promotional Brochure – PNG.*	RWD8425 IWBP Flyer PNG r7.pdf
		2019. *Engineered Wood Products Promotional Video – Australia.*	RWD8425 Aust.mp4
		2019. *Engineered Wood Products Promotional Video – PNG.*	RWD8425 PNG.mp4

Technical Outputs – Objective 3

No.	Activity	Publication Title	File Name
3.1	Review the current situation for business development in the wood processing industry in PNG, in particular focusing on the EWP sector.	Marlow, J. 2016. *Report on the current business environment for the wood processing industry in Papua New Guinea (PNG).*	Activity3.1_PPP_current_situation.pdf
		Marlow, J. 2019. *Review of the Public Private Partnership (PPP) Component of the Project to Develop Durable Engineered Wood Products in PNG.*	Final-report-Objective 3 – 200619.pdf
3.2	Review case studies on PPPs, industry clusters and co-operatives. (PC)	Marlow, J. 2016. *Review of Public-Private Partnership case studies in relation to the wood processing industry in Papua New Guinea (PNG).*	Activity3.2_case_studies.pdf
3.3	Review financial schemes, investment incentives and make policy recommendations. (PC)	Marlow, J. 2017. *Available Finance Options to Assist with Capital Expenditure and Investment in the Wood Processing Industry in Papua New Guinea (PNG).*	Obj3.3.1_FinancingCapitalInvestment.pdf
		Marlow, J. 2019. *Review of the Public Private Partnership (PPP) Component of the Project to Develop Durable Engineered Wood Products in PNG.*	Final-report-Objective 3 – 200619.pdf
3.4	Provide advice regarding a PPP model suitable for the PNG forest industry. This report will establish possible approaches and guiding principles. (PC)	Marlow, J. 2017. *INTERIM – Report – Recommendations for PPP structures in PNG for the wood processing industry.*	Obj3.4_Interim Report-PPP.pdf
		Marlow, J. 2019. *Review of the Public Private Partnership (PPP) Component of the Project to Develop Durable Engineered Wood Products in PNG.*	Final-report-Objective 3 – 200619.pdf

Other Technical Outputs – Training Reports

Topic	Publication Title	File Name
Plywood Manufacture	Dorries, S. 2017. *Report on Plywood Manufacturing Technology Training – ACIAR Project FST/2014/065.*	Report on Plywood Manufacturing Training -ACIAR Project FST_2014_065.pdf
Timber Preservation	Norton, J. 2019. *Wood preservation and durability courses PNG.*	Report on Preservation Training - ACIAR PNG March 2019.pdf
Project Engineer	Leggate, W. 2016. *Position Description – Timber Engineer.*	161012 ACIAR_engineer_PD.pdf

Additional Communications Materials – Technical Factsheets

Publication Title	File Name
Engineered Wood Products Fact Sheet - An overview of engineered wood product types and their applications	IWBP_Fact_Sheet_-_EWPs_high_res.pdf
Women in the timber industry	IWBP_Fact_Sheet_-_Women_in_Timber__Industry.pdf
Papua New Guinea timber trade – A snapshot	D.2.1_PNG_Timber_Trade_Snapshot.pdf
Kiln Drying – Critical steps for success	B.3.1_Kiln_Drying_Factsheet.pdf
Protecting timber from insect pests - PNG	B.3.1_Pest_Protection_Factsheet.pdf

Additional Communications Materials – Project Newsletters

Publication Title	File Name
IWBP News Update #1 – June 2016	IWBP_UPDATE_1.pdf
IWBP News Update #2 – December 2016	IWBP_News_Update_2.pdf
IWBP News Update #3 – May 2017	IWBP_News_Update_3.pdf
IWBP News Update #4 – August 2017	IWBP_News_Update_4.pdf
IWBP News Update #5 –December 2017	IWBP_News_Update_5.pdf
IWBP News Update #1-2018 – April 2018	iwbp_news_update_1-2018.pdf
IWBP News Update #2-2018 – October 2018	IWBP_News_Update_2-2018.pdf

Project Operational Reports – ACIAR Annual Reports

Year	Publication Title	File Name
2016	Hopewell, G and Bailleres, H. 2016. *Annual Report – Development of durable engineered wood products in PNG and Australia.*	FST2014065_AnnualReport.pdf
2016 - 2017	Hopewell, G et al. 2017. *Annual Report – Development of durable engineered wood products in PNG and Australia.*	FST2014065_Annual_Report_July2017.pdf
2017 - 2018	Jiap, J et al. 2018. *Annual Report – Development of durable engineered wood products in PNG and Australia.*	FST2014065_Annual_Report_July 2018 HB.pdf

Project Operational Reports – Monitoring and Evaluation

Year	Publication Title	File Name
Plan	Haines, R and Roberts, J. 2016. *Monitoring and Evaluation Plan.*	Activity4_MandE_plan.pdf
2016	Haines, R. 2017. *Project FST-2014-065 Monitoring and Evaluation Report, September 2016.*	Haines M&E report Feb 17.pdf
2016 - 2017	Dorries, S. 2017. *Monitoring and Evaluation Report – Project FST/2014/065 – For the period September 2016 to June 2017.*	Monitoring and Evaluation Report 2017-Project FST2014-065 September 2016 to June 2017.pdf
2017 - 2018	Dorries, S. 2019. *Monitoring and Evaluation Report – Project FST/2014/065 – For the period July 2017 to December 2018.*	Monitoring and Evaluation Report FST 2014-065 Final Feb 19.pdf
2019	Dorries, S. 2019. *Monitoring and Evaluation Report – Project FST/2014/065 – For the period January 2019 to June 2019.*	Monitoring and Evaluation Report 2017-Project FST2014-065 January 2019 to June 2019.pdf

Project Operational Reports – Communications

Date	Publication Title	File Name
July 2016	Rollinson, S. 2016. *Newsletter / Website Report.*	Wood Processors Communication Report #1.pdf
January 2017	Rollinson, S. 2017. *Newsletter / Website Report.*	Wood Processors Communication Report #2.pdf
June 2017	Rollinson, S. 2017. *Wood Processors Communication Report #3.*	Wood Processors Communication Report #3.pdf
January 2018	Rollinson, S. 2018. *Wood Processors Communication Report #4.*	Wood Processors Communication Report #4.pdf
July 2018	Rollinson, S. 2018. *Communication Report #5.*	Wood Processors Communication Report #5.pdf
June 2019	Rollinson, S. 2019. *Communication Report #7.*	Wood Processors Communication Report #7.pdf

11 Appendixes

11.1 Appendix 1: Example Industry Partner Assessment

iwbep
INNOVATIVE WOOD BASED PRODUCTS

Assessment of Austral Plywoods Pty Ltd: Processing, Products and Markets

A. General Information

1. Infrastructure overview: size of the processing and manufacturing sections.
2. Raw material used:
   - Timber used in the production:
     - Species
     - Plantation (ages, qualities eg pruned)
     - Volume used (per month or per year)
     - Quality issues of species
   - Raw material – Types of Wood based materials (eg. logs, veneer, particleboard, MDF)
   - Other materials.

B. Wood Products Manufactured in the Company

1. Type of products.
2. How many different products and different dimensions, designs are currently produced.
3. Is there seasonality in products and designs, dimensions etc
4. Current Markets (domestic, export) and destinations.
5. Future Markets ? – best options? Why?
6. What untapped potential do you see for EWPs?
7. Who designs the products (e.g. the owner, manager, client, designer).

C. Processing

1. **Processing Machinery:**
   - Describe peeling, drying and treatment operations
   - Types of equipment in the factory (including the age, country).

1

2. **Production layout and production flow.**
   - Is the factory well organized with a strategy for wood storage, with segregation into wood off-cuts, usable wood materials and waste?

3. **Production Efficiency**
   - Veneer recovery rate from logs in the production process.
   - Amount of wood waste, its uses (if any), storage of wood waste.
   - The use of lower quality and small dimension logs.

4. **Gluing Methods and Procedures**
   - Types of glues used for various products.
   - Are different glues used for different products?
   - What clamping/pressing system is used for gluing?
   - Is moisture content checked before gluing?
   - Are there problems of glue delamination or open joints?
   - Are there any other procedural problems with gluing

5. **Sanding**
   - What equipment is used for sanding and finishing products?
   - What grit papers are used? Are they differentiated for various product finishes?

D. Quality Control Procedures in the Manufacturing Process

1. What standards or specifications used for the products (e.g. required by a client)?
2. Is any quality control used in the manufacture of the product components and the assessment of the final product? If so, describe the quality control procedures.
3. Is there scope for improving the quality of the products? What would be the major recommendations for improvements?

E. Other Matters related to Manufacturing Process and Products

1. Training:
   - Does the company train the workers in-house or employs workers already trained?

- Are some workers sent to Training Centres to improve their skill?
- What training courses are needed (e.g. drying, machining, gluing, production management, etc).
- What training system would be most appropriate for companies (e.g. short courses, evening courses, in-house training etc)?
- Current skills and qualifications of staff.
- What training courses would be most beneficial

2. Does the company have any plans for improvements? Provide details. Planned capital improvements and timeframes.
3. What help the company would like from the ACIAR project.

General comments by the company on priorities for the EWP industry development in Qld.

F. Role of Women

1. Roles occupied by women; training, skills and qualifications of women
2. Options and strategies for increasing the role of women
3. Impediments (e.g. family commitments, cultural issues) to roles or hours available to work
4. Advantages of female or male employees (patience, reliability, sobriety, quick uptake of skills and knowledge)
5. Disadvantages of employing females or males (time off to care for children or perform domestic duties)

G. SWOT Analysis

1. Strengths
2. Weaknesses
3. Opportunities
4. Threats