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TECHNICAL REPORT

THE DEVELOPMENT OF *GONYSTYLUS* SPP. (RAMIN) TIMBER MONITORING SYSTEM USING RADIO FREQUENCY IDENTIFICATION (RFID) IN PENINSULAR MALAYSIA

ITTO-CITES PROJECT
MALAYSIA'S WORK PROGRAMME FOR 2008

Ensuring International Trade in CITES-listed timber Species is Consistent with their Sustainable Management and Conservation

IMPLEMENTING AGENCY

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PROJECT IDENTIFICATION

Title

The Development of *Gonystylus* spp. (Ramin) Timber Monitoring System Using Radio Frequency Identification (RFID) in Peninsular Malaysia.

Executing Agency

Ministry of Natural Resources and Environment Malaysia

Implementing Agency

Forestry Department Peninsular Malaysia

Host Government

Government of Malaysia

Starting Date

November 2008

Actual Duration

8 months (Extended to 24 months)

Actual Activity Costs

ITTO	=	103,200.00
GOM (In kind)	=	70,910.00
TOTAL	=	174,110.00

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EXECUTIVE SUMMARY

1.0   BACKGROUND INFORMATION ABOUT THE ACTIVITY

Ramin (*Gonystylus* spp.) is a tropical hardwood native to the fragile peat swamp forest and one of the most valuable timber species that are currently being utilized in Malaysia. There are wide spread of concern about the rate of these species are being harvested due to the increasing demand for timber from industries both domestic and global. Ramin is now listed under the Convention on International Trade in Endangered Species (CITES). In 2004, the Parties to CITES had agreed unanimously to upgrade Ramin to Appendix II as a result of the continued threats to the species.

As a highly sought after species, there are serious concerns that Ramin species are under threat from illegal logging and tax evasion that caused Malaysia government loss of forest revenues. In light of this, enhancing the Forestry Department of Peninsular Malaysia's (FDPM) capacity to control and monitor its Ramin forest is deemed of strategic importance to maintaining Malaysia's position as one of the main sustainable exporter of Ramin wood resources. The pilot activity embark on the use of Radio Frequency Identification (RFID) technology in the harvesting of peat swamp area particularly Ramin species with aims of deploying a Ramin Timber Monitoring System using RFID and with detection and notification for tracing non-compliances in Peninsular Malaysia.

The original activity schedule is set between October 2008 to June 2009. However due to unforeseen circumstances, FDPM has extended the activity schedule and the final completion date is set on October 2010. The report is intended to serve to generate enhanced discussions and exchange with regards to the institutional framework, specifications and deployment of a Ramin Timber Monitoring System using RFID for the whole Malaysian forest sector. The deployment was based on the Service Provider's CI World platform and endeavoured to demonstrate how the system could be used to promote sustainable utilization towards the conservation of Ramin in production forest of Malaysia.

2.0   ACTIVITY OVERVIEW

This section briefly describe the scope and objectives of the activity; the activity location; and the key participants in facilitating the deployment from a managerial, implementation and logistical point of view.

2.1   Activity Scope & Objectives

The goal of the activity, as defined by the Forestry Department of Peninsular Malaysia (FDPM), is to deploy and implementation of a Ramin Timber Monitoring System using Radio Frequency IDentification (RFID) technology. The objectives of the activity are to contribute significantly in ensuring the detection of non-compliance timber harvesting procedures. The activity is conducted in a selected logging license area in Pekan Forest Reserve, Pahang.

In order to create a framework for the activity, the high level aim of demonstrating the implementation of the Ramin Timber Monitoring System using RFID was translated into the following specific objectives, related to the technological, regulatory, corporate and human implications to the deployment of such a system:

i.   Demonstrate the ability of an off-the-shelf RFID Ramin Timber Monitoring platform to provide real time or near real time information on the management, production, monitoring and compliance of the forestry sector in Peninsular Malaysia and therefore to assist in tackling illegal logging;

ii.   Demonstrate the capabilities of a RFID Ramin Timber Monitoring system in replicating the Malaysian Forest Legal Standard and facilitating the monitoring, regulating and enforcement of the standard;

iii.   Evaluate the potential of a RFID Ramin Timber Monitoring system as a configurable multi-stakeholders data sharing platform providing independent third party online information sharing and auditing capabilities;

iv.   Evaluate the cost/benefit relationship as well as feasibility of using RFID tags to manage the Chain of Custody of wood from the inventory of standing trees to forest checking station located outside the concession;

v. Demonstrate the ease of use and practicality of such a system in a real forest environment especially in peat swamp forest; and

vi. Provide further recommendations with regards to specifications, design, training as well as institutional framework related to the deployment of such a system for Peninsular Malaysia.

2.2 Activity Location

The activity area is located in compartment 74A, Pekan Forest Reserve, Pahang with a total license area of 101.17 ha.
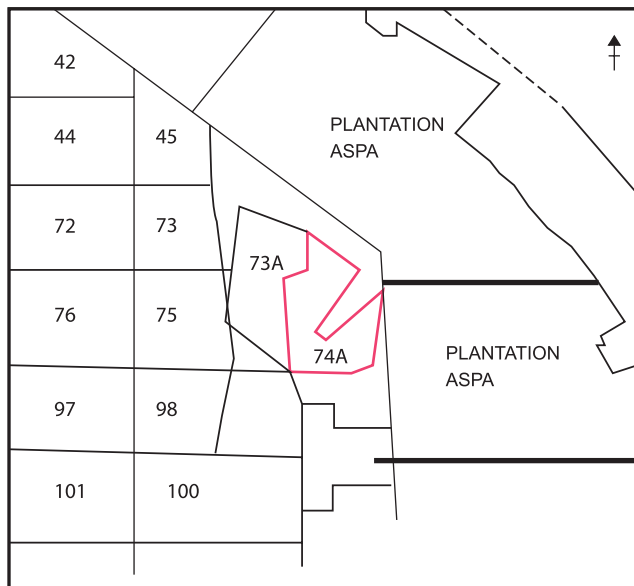
The exact details of the concession selected by FDPM for the pilot are described below.

CONCESSION DETAILS

Licence Holder   : Amanah Saham Pahang Berhad (ASPA)
License Number   : KT 018/2010 (KP)
Compartment   : 74A
Forest Reserve   : Pekan
Area   : 101.17 Ha
Licence Duration   : 23/07/10 to 22/07/11
Contractor   : Mohd Subky Bin Ahmad

Location of the Pekan, Pahang in Malaysia

2.3 Stakeholders, Roles and Responsibilities

The main stakeholders of the project and their respective role are summarily described below.

2.3.1 Forestry Department Peninsular Malaysia (FDPM)

As the initiator of the activity, the FDPM was the main driver of the whole activity. Its collaboration was instrumental in leading and assisting with activities coordinated with the Pahang State Forestry Department and concession holder as well as in providing direct support and advice with regards to the specifications of the pilot activity.

It also actively contributing by providing manpower to perform various activities in the field that required in the activity and collaborating with the IT processes of testing and running the system from tree inventory to the forest checking station.

FDPM's active participation in defining the configuration of the system platform, facilitating a progressive deployment of the activity as well as in providing logistical and lodging support was the central most important success factor to the activity, and that in all aspects, its contribution exceeded all expectations.

2.3.2   Pahang State Forestry Department (PSFD)

PSFD is the collaboration partner from a state level where the activity concession site is located. It also actively contributed to the activity by assisting with the survey process undertaken to better define the specifications of the system with regards to the applicable legal standard.

2.3.3   Mohd Subky Bin Ahmad

As the concession holder for logging licence KT 018/2010 (KP), Amanah Saham Pahang Bhd appointed Mohd Subky bin Ahmad as a contractor to perform the logging and transportation activities.

The main activities of the contractor typically involve access road clearing & maintenance, bridge building, log yard management, felling and cross-cutting of the trees, transportation of the logs to a temporary log yard and onwards to a main log-yard and finally, delivery of the logs to mills. As such, securing the cooperation of contractor was also pivotal in insuring the smooth implementation of the pilot activity.

3.0   ACTIVITY CONTEXT

FDPM plans to deploy a RFID Ramin Timber Monitoring system in order to assess and evaluate the effectiveness of the RFID technology in Ramin tracking and monitoring such as capture log movement and log production as well as in mitigating the challenge to a successful outcome that form the basis of new coding system for FDPM's tree marking exercise in logging operation. The current RFID system that include data synchronization, field data collection using handheld, monitoring of log transportation, document management and security and law enforcement is supplied by Solution Provider CI World™ platform.

CI World™, a commercial software platform that enables fully auditable asset tracking, resource mapping and Chain of Custody (CoC) control for extended supply chains in the timber industry.

As a result of implementing the CI World™ using RFID technology as its operational Ramin monitoring information system, the state forestry department and industry participants would be able to:

- Monitor all Ramin timber across the entire supply chain;
- Maintain accurate Ramin inventory and production information;
- Improve its forest management and planning capabilities through the provision and automation of comprehensive information; dan
- Optimize revenue collection.

Solution Provider will configure the RFID Ramin Timber Monitoring system for the pilot deployment and operate it for the duration of the pilot on behalf of FDPM – with relevant stakeholders being accorded to access to the data and report as is appropriate. On conclusion of the pilot activity, a decision will be made following the evaluation of CI WorldTM as to whether to incorporate the results of the activity into a region-wide system for FDPM and Peninsular Malaysia.

4.0   ACTIVITY DESIGN AND SPECIFICATION

To facilitate the implementation of the activity and deployment of RFID monitoring system, a technical activity team comprises representatives from FDPM (Forest Management Division) and Solution Provider is formed to oversee the activity initiation, specification study, schedule management and processing as well as to solve technical matters pertaining to the activity.

4.1   Activity Initiation

The initial tasks of the Technical Activity Team are as following:

- Department, District Forest Office and contractor;
- Ensure participation of all stakeholders during the activity implementation;
- Gather feedback and input during business requirement definition;
- Process chain of custody/user rules/reports definition ;
- User role and responsibilities confirmation; and
- Conduct system testing and user training in the field.

4.2   Activity Specification

In order to design a RFID Ramin Timber Monitoring System, one of the first few requirements is to look at the Malaysian Criteria and Indicator (MC&I), chain of custody scheme as well as at its translation into actual processes and procedures related to enforcement and monitoring. Therefore below are some elements of these legal standard, concentrating on the main aspects that were integrated in the RFID Ramin Timber Monitoring pilot activity.

4.2.1   Activity Scope & Operational Overview

The logical chain of custody developed for the Ramin RFID activity includes 5 physical control points, as listed and illustrated below:

1.   Forest Inventory;
2.   Tree Felling;
3.   Temporary Log Yard;
4.   Main Log Yard; and
5.   Forest Checking Station.

RFID Ramin Timber Monitoring System Control Points

4.2.1.1   Forest Inventory

The operational process that forms the first link in the custody chain is the forest inventory. Before the forest inventory, the area will undergo boundary demarcation. This process will divide the cutting area into rectangular bars called blocks, which are further divided into square boxes along the vertical access. Once this process is complete the inventory can begin.

The inventory teams will apply an RIFD tag to each Ramin's tree and use handheld computer devices in the forest to record details of each tagged tree, thereby creating a profile for each tree within the system. It is this profile that is then compared with the subsequent data recorded against the timber as it passed along the supply chain enabling the system to alert if the profile is not consistent.

4.2.1.2 Tree Felling

Once the logging license issued, harvesting will begin. The concessionaire initiates the felling operation as per the forest harvesting plan. A tree feller cuts down trees designated for removal and data is again captured using the handheld computer, this time about the felled tree. At this point another RFID tag is affixed to the long log and it is excavated from the forest to the log yard area for cross-cutting activities.

4.2.1.3 Temporary Log Yard

At the temporary log yard area it is where the long log is divided into shortened cross-cut logs. Here the long log tag is scanned while additional tags are affixed to the cross-cut logs and scanned. The key objective is therefore capturing the parent/child relationship between the primary RFID tag of the long log and the secondary tags of the resulting logs.

4.2.1.4 Main Log Yard

Once the logs have been cross cut, the tags are scanned again and data relating to the timber including species, length, diameter, RFID tag number and quality of log are entered again using the handheld computer.

4.2.1.5   Forest Checking Station

Upon leaving the forest, it is a legal requirement that a lorry stops at the assignned forest checking station in order to declare the logs being removed from the concession. The objective is to assess the forestry tax (based on log volume and species) to be levied. In the RFID monitoring system, all the details of the logs carried by the truck as well as truck information is entered into the handheld and provided there are no discrepancies, the truck driver is issued a Removal Pass and the truck is allowed to continue its journey to the mills.

4.2.1.6   Truck Authentication using Security Code

Here the CI Mobile software running on the handheld computer will provide additional security to the removal pass by creating an electronic signature and outputting a system code that can be verified at any point along the transports route. Should the truck be subject to further stops and inspections, the enforcement officer can use the system code carried with the removal pass to verify the loads legitimacy.

The officer enters the code, the removal pass ID and/or scan the log RFID into CI Mobile and the software will immediately pass the load as legitimate or reject it as suspect. This functionality is available in "off-line" mode and will significantly improve Removal Pass security regardless of whether or not the handheld is synchronised with the server. This would enable FDPM to establish a secure chain of custody by having a reliable monitoring of log transportation and verification of origin.

4.2.2 Process Control Management

In terms of process control, a number of "rules" can be defined in the CI WorldTM Process Control Module using software based algorithms. Any calculation, comparison and logical operation based on the data can be easily configured into the system and performed either systematically or upon request by a system user.

In the case of the RFID Ramin Timber Monitoring System, two rules were defined to illustrate the concept:

i.   Duplicate RFID entry for log label

ii.   Log number and size inconsistency

In these case, all the alarms generated by the system were issued and tracked. Note however that some thresholds could also have been defined in order to release the alarms only if a certain number of similar problems were identified over a pre-defined period of time.

4.2.3 Reporting and Document Management

One of the main features of the system is the capabilities and flexibilities to configure the system perform analysis and provide real-time reporting based on the different datasets stored in server.

The possible modes of reporting include:

i.   Configuration of an HTML based online report for easy access to information.

ii.   Automatic generation of daily, weekly, or monthly reports as PDF documents that can be printed; stored or e-mailed as required. Such documents can also be made available online to stakeholders.

iii.   Generation of reports based on variable parameters such as start-date, end-date, geographical area, company, tree species, etc.

In the present activity, all reports are produced as PDF documents. It is accessible via an online environment and stored as digitized paper documentation in a repository for review and validation by all key stakeholders involved in the activity. The various reports generated are described in the table below:

CONTROL POINT	REPORT	CONTENT
Forest Inventory	Ramin Inventory Report	The information of all the Ramin trees in *Compartment 74*, including RFID tag number, tree species, diameter, estimated logs produce, quality, block and box location.
Tree Felling	Ramin Felling Report	The information of the standing tree RFID label and Fallen Tree RFID label.
Temporary Log Yard	Log Production Report	The information of the number of logs being cross-cut by listing of Standing Tree RFID label, RFID labels of the logs, estimated and actual number of logs produced.
Main Log Yard	Log Yard Control Book Report	Lists all the logs reaching the main log-yard. Information listed include the date, concession area, tree species, log RFID tag number, log length and diameter as well as estimated and actual number of logs
Forest Checking Station	Removal Pass Report	The information is all about log species, log RFID tag number, log length, diameter and volume, defects information, royalty rate, and checking station details.

4.3 Handheld Computer

The activity will make use of handheld computers to read RFID tag and capture field data relating to the timber Chain of Custody for Ramin wood. The handheld computer that has been specified for the activity is the Psion Workabout Pro. The handheld unit is rugged; field tested under difficult conditions, and with Wi-Fi connection capability which is practically useful in data synchronization as well as already widely used in the industries.

The system can be interfaced with different type of handheld units and the FDPM could decide to offer a few standard models as potential options to users of the RFID Ramin Timber Monitoring System. A key requirement would however be to define high level minimum specifications to be met, including for example:

- Support of Windows Mobile operating system
- Support of specific RFID frequency and format
- Potential support of features such as internal camera, GPS, etc

The WorkAbout Pro Handheld Computer

Field Operator with WorkAbout Pro

4.4   RFID Tag and Application Tools

The RFID tags used in the activity are Signumat UHF type designed specifically for timber use. The tags are glass fibre reinforced with abrasion resistant labelling. They are affixed using a purpose designed hammer and contain an integrated curved prong that enables them to attach to the cut surface of a log without the need for nails or staples. The hammer contains an integral ball joint to ensure even striking and first time tag application. When attaching to the standing tree the tags will be applied with nails.

Fixing Hammer

Tag Dispenser Magazine
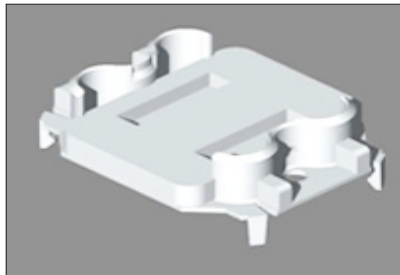
Signumat RFID Tag (Rear)

Signumat RFID Tag (Front)

The main characteristics of the Signumat tags are as follows:

- Device type : Class 1 Gen 2 passive UHF RFID transponder; 96bit
- Air interface protocol : EPC Global Class1 Gen2 ISO 18000-6C
- Operational frequency : 865-869 Mhz
- Reading distance : 0.7-2m depending on type of wood and humidity
- Power supply : DC 5V, regulated
- Dimensions : 43 x 38 mm
- Housing material : Polycarbonate

Note that any type of RFID tags can be supported by the system provided that an appropriate reader is also used. In that regards, it would be highly recommended to initiate a study in order to define the design of tags suited to the Malaysian climate as well as to the processes required to fulfil the legal standard. Specifications defined include:

- Frequency band of operation
- Form factor (i.e. shape, dimensions, material, colour, etc)
- Labelling (i.e. potential outside marking to identify the tags and possibly the user)
- Security features (i.e. encryption)
- Numbering scheme.

5.0 ACTIVITY IMPLEMENTATION

The primarily output of the activity would be the deployment and evaluation of RFID technology based solutions as a means to overcoming challenges to timber tree tagging and timber legality compliance of state law and federal law. Hence it is essential the RFID Ramin Timber monitoring system act as a check-and-balance system to control the Ramin harvesting from logging area in terms of species, size and collectable taxes; as well as to enhance the enforcement procedures and activities as forest officers are able to ensure the Ramin timber is from legal source of origin.

Amid the fact that the adoption of RFID based technology timber monitoring system is still new to the Malaysia forestry sector, and the potential challenge to the foresters to quickly adapt and operate the system. A series of training/ capacity building and demonstration sessions in the field have been carried out by the Solution Provider prior the start of the activity for the officers of FDPM, State Forestry Department, District Forestry Office and the contractor, making sure the participants are well equipped with the skill and required knowledge to carry out the jobs effectively.

The RFID Ramin Timber Monitoring System and RFID handheld application were made available and online to the operational team in October 2009. In this section, its describe how the system was used in the field at the time of the activity.

5.1 Tree Inventory Control Point

The first process required in the activity was to perform a forest inventory in order to tag the Ramin trees to be tracked through the supply chain with RFID tags. The implementation of the Ramin inventory was performed by a team of authorized contractor themselves after being guided and trained by the technical activity team from FDPM.

The process essentially consisted of using the handheld to capture the tree information as well as to read the associated RFID tag number, and to affix the RFID tag to the tree using the special designed hammer and tag magazine.

The RFID handheld application data capturing screen (picture on right) provides the field to enter data required in the activity specification such as Block No., Box No., RFID tag number for standing tree, Species field, diameter of the standing tree, estimated of logs produce, quality of log, tree type which is mandatory for harvested tree. There is remarks field as well to allow the contractor filling the necessary info if required.

Over a period of four months from November 2009 to Feb 2010, a total of 832 Ramin trees were inventoried for Compartment 74A. The high number of Ramin trees recorded in the area had exceeded the forecast by FDPM and Pahang State Forestry Department. The early estimation of Ramin species found in the 101 ha area would be in the range of 300 to 400 trees only. There were no issues in applying the handheld RFID application and the contractor managed to efficiently tag the Ramin trees using new tools and collect the data without much assistance.

Noted that below is the report of Ramin inventory generated by the Solution Provider after the data entered in RFID handheld application is synchronized and sent to the central server system wirelessly. The report contained Block No., Box No., RFID No., Diameter (of Ramin), Estimated of log produce, Quality, Type of Tree. The report replicate the existing tree inventory report format but with additional columns of the login user and time stamp. By observing the system, FDPM has able to monitor the inventories activities on the ground especially keeping track the progress of the contractor in completing their job within the stipulated schedule and compartment area.

Ramin Tree Inventory Report

| No. Blok	No. Petak	No. Siri Tad RFID	Diameter (cm)	Anggaran Bil Tual Balak	Anggaran Isipadu (m3)	Kualiti Pokok	Jenis	ID Pengguna
15	14	N3E26948M7XC	71	3	3.86	1	Pokok Tebangan	Ramin 3
16	1	XH18YFNOE158	62	3	2.94	1	Pokok Tebangan	Ramin 3
16	1	8P9YCLO5N2JP	68	3	3.54	1	Pokok Tebangan	Ramin 3
16	2	6H3JYJYW6038	60	3	2.76	1	Pokok Tebangan	Ramin 3
16	2	4PDKY4426A57	68	3	3.54	1	Pokok Tebangan	Ramin 3
16	2	33WCYOJA2915	66	3	3.34	1	Pokok Tebangan	Ramin 3
16	2	7RNPYK9K1JE7	58	3	2.58	1	Pokok Tebangan	Ramin 3

5.2   Tree Felling Control Point

After given few training and demo sessions the chainsaw operators have managed to carry out the job as asked i.e. scanning the RFID tags at the stump and affixing the RFID tag on the felled tree using the hammer.

The RFID handheld data capturing screen for tree felling (picture below) includes RFID number of the standing tree (left at the stump and the RFID number of the felled tree). That creates the first parent/child relationship in the system for the standing tree and the log produced. This process is vital especially for linking up the standing (stump) tree with the first log produced (felled tree), and subsequently the shorten logs at the cross cut area.

A few comments are in order with regards to the felling control points:

- After months in the peat swamp forest, under very adverse weather and conditions, all the RFID tags attached at inventory were still readable except two RFID tags were reported had to be taken off from the tree. After reading then only re-attached on the stump.
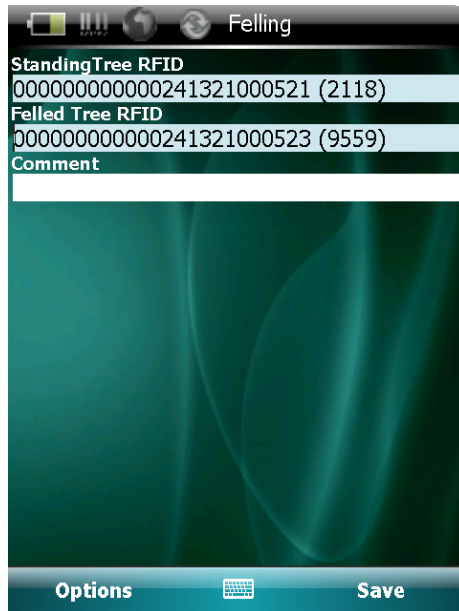
- To replicate the existing process by tagging the felled tree in where it is harvested is not so suitable in peat swamp forest. The RFID tag is very prone to missing and damaged while skidding out by excavator through the waterlogged environment which is full of thick mud, broken branches and roots on the ground. Hence the approach has to be altered. After scan the stump RFID tag and the tag for felled tree, the chainsaw operator mark and pair this RFID tag with the felled tree and keep it. The chainsaw operator only did the actual tagging on felled tree later in the closest road side. That is no doubt that a detailed analysis of the form best suited to RFID tags for forestry and peat swamp applications would resolve such issues.

- From the Tree Felling report, the system can show whether the felling is outside the working block and provides the platform to trace back the first fallen log to the standing tree.

Ramin Tree Felling Report

Block Number	Box Number	Standing Tree RFID	Felled Tree RFID	User Name
37	8	A5W749KMCXRO	OX1MO9CF4PMK	Ramin 10
39	4	EXCA7ELJWAWF	82NHA7L3AC38	Ramin 7
39	4	1C2M7K3M34J10	3731JH8L2EAY	Ramin 7
39	5	2YFKW16CH6C3	C6N91EHXAYPE	Ramin 10
39	5	WF6PW2K9608C	XCP75J8EYWFO	Ramin 7
39	6	8YOAR99735ML	056C4EOCH26E	Ramin 7
39	6	L51JWRMN38JY	9FYY4NFRL37Y	Ramin 7

5.3   Temporary Log Yard Control Point

Upon reaching the log-yard, the trees were cross cut into smaller logs for onwards transportation. At the main log yard, the job to affix and read the RFID tag is done by a team of clerical staff from contractor's office. The chainsaw operator only responsible to cross cut the log. Again the new approach of using RFID handheld application has not posed too much difficulty to the staff as they have carried out the data collection smoothly.

Logs are shortened at cross cut control point
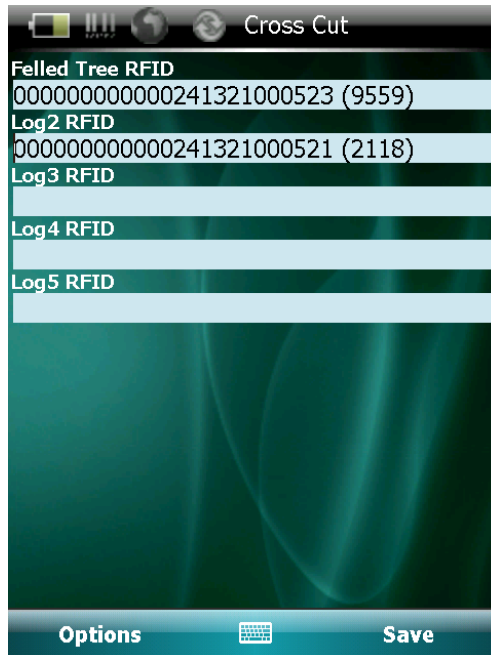
Cross cut handheld data capturing screen

In the RFID handheld screen shot above, it shows how the system is designed to capture the RFID number in linking up the felled tree which automatically becomes the first log produced, and the subsequent cross cut logs.

Note that by now one can visual the 'back-to-stump' traceability from the system. The report below, which is the Cross Cut (Log Production) Report generated from the RFID Ramin Timber Monitoring system covers:

- The system lists the tree numbers as well as the associated logs produced from the mother tree, giving the RFID tag number for each log.
- The system provides a quick comparison between the original estimated number of logs and the actual production from each tree. An alarm or alert could be configured should the mismatch between the estimation and actual number of logs.

Cross Cut (Log Production) Report

No. Siri Tag RFID	Tual Balak 1	Tual Balak 2	Tual Balak 3	Tual Balak 4	Tual Balak 5	Anggaran Bil Tual Balak	Bil Tual Balak Sebenar	ID Pengguna
33RRYOJA4LY2	6YN1567JA4N7	KM1CPKKW82JJ	9WFPJF7268C5	A1J8JLMAY3KY		2	4	Ramin 10
8PFXCL05J5J1	F9M9L03CR2CK	6J6YJC6KJM1J	A5W649KML1R3	RY4P452LKHHK	5MCNP10X046N	3	5	Ramin 10
9MAMCC2F8C44	L374LEAHFHXW	3WO3PA23W2F7	2N8053M85CN2	RPKKPO9HHPC0		2	4	Ramin 10
9MAMCC2F8C44	L374LEAHFHXW	3WO3PA23W2F7	2N8053M85CN2	RPKKPO9HHPC0	EHLM6MH5W8EA	2	5	Ramin 10
7RN2YK9KK9EY	J6YWLK56C4N5	Y98RLCR26PMO	W6H26XYJ9CFH			2	3	Ramin 10

5.4 Main Log Yard Control Point

At the main log yard, the main challenge faced was quite similar to the one encountered under the normal process, meaning the difficulty to read certain RFID tags due to the accumulation of sap at the end of the tree. The data capturing operation otherwise proved quite simple and efficient for the clerical clerks.

Scanning RFID tag at main log yard
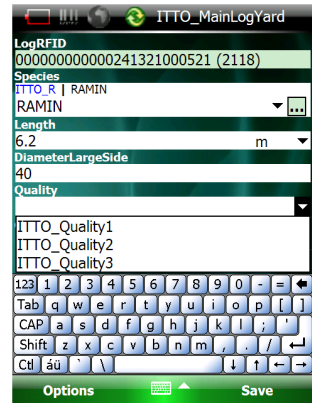
Main log yard handheld data capturing screenlog yard

At the main log yard, the clerk scales the logs before scanning each logs RFID tag and entering data in a parent/child capture mode. The data are species name, the length of the log in meter (m), the diameter of log in centimetre (cm) and quality of log. The results of the data will be populated in a 'Control Book' where the forest district office can use it to verify the difference between the actual number of logs produced compared to the estimated logs to produce during the inventory stage, as well as the total logs volume achieved in cubic meter (m3) after the scaling done by contractor. In the report partially sampled below and automatically generated by RFID Ramin system, configured to track all the logs arriving at the main log-yard. This report could be produced on a daily, weekly or monthly basis as required.

Control Book Report at Main Log Yard

No. Siri Tag RFID	Diameter cm	Anggaran Bil Tual Balak	Kualiti	Tual Balak 1 No. Siri Tag RFID	Diameter cm	Panjang m	m3	Tual Balak 2 No. Siri Tag RFID	Diameter cm	Panjang m	m3	Tual Balak 3 No. Siri Tag RFID	Diameter cm	Panjang m	m3	Tual Balak 4 No. Siri Tag RFID	Diameter cm	Panjang m	m3	Tual Balak 5 No. Siri Tag RFID	Diameter cm	Panjang m	m3	Jumlah Bil Tual Balak	Jumlah m3
2YFKW16 CH6C3	70	3	1	C6NQ1EHXA YPE	25	20.00	0.98	JM538P92E J3W	24	20.00	0.91	5WMJ8MN A1J2H	21	20.00	0.69	M1YKKW7 KA6MK	20	24.00	0.75	X	X	X	X	4	3.33
3W7HPA2 34FC1	71	3	1	M1YXKW7KJ L12	21	20.00	0.69	9WFLJF72 RWY5	19	20.00	0.57	A1JHJLMA 18J7	17	20.00	0.45	6J87JC8K 740P	15	20.00	0.48	X	X	X	X	4	2.17
1HAC8X2 H28EN	52	3	1	78Y0JPW930 9Y	18	20.00	0.51	3W0YPA23 EPFM	18	20.00	0.40	0HR8P4PP 1CJH	12	24.00	0.39	X	X	X	X	X	X	X	X	3	1.30
1HAC8X2 H28EN	53	3	1	78Y0JPW930 9Y	18	20.00	0.51	3W0YPA23 EPFM	18	20.00	0.40	0HR8P4PP 1CJH	12	24.00	0.39	X	X	X	X	X	X	X	X	3	1.30

Jumlah Bil Pokok: 9
Jumlah Anggaran Bil Balak: 23
Jumlah Bil Tual Balak: 35
Jumlah Isipadu m3: 12.32

5.5 Forest Checking Station Control Point

At the forest checking station, all the information about the log load carried by the truck as well as truck information is recorded by the checking station officer after being physically checked. The load is typically inspected and all logs are measured and entered into RFID handheld application.

Once the data is uploaded in the RFID Ramin Timber Monitoring System, the data collected is checked and reconciled against the "Control Book" which updated for logs taken out of the concession in the system. Similar, an alarm could be configured and pick up by the system should the mismatch between the total volume of logs became too important.

Based on current procedure, at the checking station, provided there are no discrepancies, the truck driver is issued a Removal Pass by the officer after inspection. Since the Pekan forest checking station is under the 3G bandwidth coverage, by using a wireless mobile broadband and connecting with the PC via docking station, the RFID handheld system can synchronize and send the data directly to the central database system. The officer can log into the Ramin Timber Monitoring system to produce and print the Removal Pass physically at the checking station. The system has showed its capability in expediting the issuance of removal pass on the spot. However the removal pass ready for this activity is in the A4 size paper format only and not the pre-formatted removal pass form.

Checking station officers reading RFID tags

Checking station handheld data capturing screen

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Removal Pass Report

PAS BAGI PEMINDAHAN HASIL HUTAN
Seksyen 70(2)

No. PAS PEMINDAHAN
Pas Ini membenarkan Encik/Syarikat
No. K.P.P.N
Yang beralamat di:
Memindah melalui Balai Pemeriksa Jabatan Hutan di:
hasil hutan yang deperihalkan dibawah ini yang telah diambil dibawah Lesen / Lesen Kecil / Permit
Penggunaan No:
Dan Dipunyai oleh:

Jenis Hasil	Bilangan Atau Kuantiti			Meter Padu					Royalti
				Isipadu	Potongan Bagi Rongga dll		Isipadu Bersih (m3)		
					Garispurat Min	Isipadu			
Jumlah									
SES				RM	10.00	x			
JUMLAH BESAR									

No. Lori :   Waktu :

Destinasi: Tarikh:
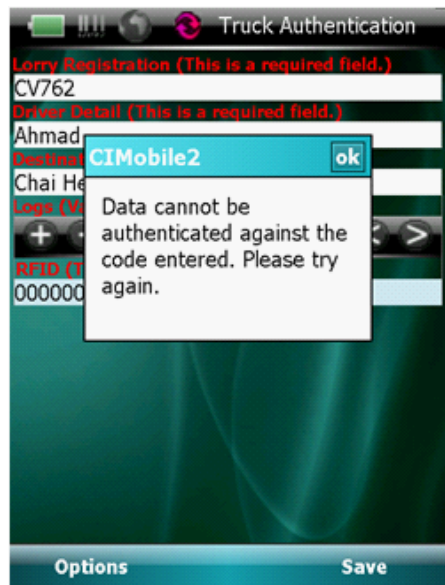
Had Muatan

No. Tukul Besi Hasil

_____
Pegawai Hutan Berkuasa

The RFID Ramin Timber Monitoring System has developed additional secure key for the security of removal pass and truck inspection. It is a set of unique authentication code associated to removal pass and RFID numbers that can be verified at any point along the transports route. At the time a truck driver is issued a removal pass, the RFID handheld application generates the authentication code that is then written on the removal pass.

To evaluate the security code, trucks leaving check point are checked, an enforcement officer enters the authentication code carried with the removal pass into a handheld to verify the loads legitimacy. The officer enters the code, the removal pass's ID and scan the log RFID into handheld. If all these data match each other and the system immediately pass the load as legitimate or reject it as suspect if wrong code is entered or different RFID detected. This functionality is available in "off-line" mode and has significantly improved removal pass security and that preventing the counterfeiting of removal pass as well.
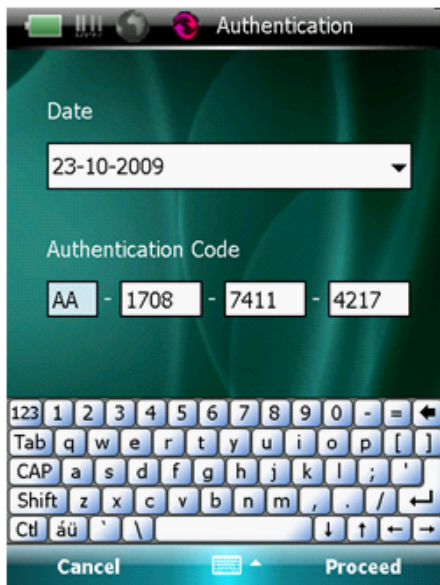
Authentication code verification screen shot (1)	**Authentication code verification screen shot (2)**

6.0 RFID RAMIN TIMBER MONITORING SYSTEM INTERFACE

This section is about an overview of the online interface of the RFID Ramin Timber Monitoring system, focussing on how to navigate the various modules of the system. The RFID Ramin Timber Monitoring system can be accessed at the URL provided below by using the following User ID and Password:

URL Address	:	https://pilot.helveta.com:8333/ciview/login.jsp
Web User ID	:	XXXX
Password	:	XXXXXXXXXXXX

RFID Ramin Timber Monitoring System Screenshot

Login screen to RFID Ramin Timber Monitoring System

Note that the above user ID and password are both case sensitive. If is not successful login either because of wrong username of password up to 5 attempts, the system will automatic lock and has to reset its account as part of the security of the online system.

The table below provides an overview of the main menu funcons located in the Menu Bar at the top of the screen.

Funcon Icon	Name	Descripon
	Language	Allows the user to select the interface language
	Home	Brings the user back to the main interface page
	Asset Browser	Brings the user back to the "Asset Browser"
	Explorer View	Provides access to document loaded on the system
	Select Role	Grants the user access to the system as per various "roles" configured on the system
	Preferences	Allows the user to customize the interface as well as change the access password
	Workflow Forms	Brings the user to online data entry forms configured
	Help	Help menu (not yet configured)
	Logout	Logout opon

6.1   RFID Ramin System Main Interface

Once logged onto the system, the first page displayed allows the user to select a role in, thus illustrang the "configurable access" whereby different users can be made to have access to a different cross secon of the data, as well as of the online system. At any given me, a user can change the role he is operang under (if accessible to his level of security clearance) by clicking the icon on the top-right menu banner. For the purpose of demonstrang the feature of the system, the "JPSM Supervisor" role is selected at this stage.

RFID Ramin Timber Monitoring System Screenshot

Role setting in RFID Ramin Timber Monitoring System

The "Home Page" of RFID Ramin Timber Monitoring System for the specific role selected is illustrated on page below. It is a dash board view where the user can just click and access the report directly from various control points defined across the supply chain. It is a very flexible platform and the report generated for the activity are Ramin inventory report, Ramin felling report, Ramin cross-cut report, control book report and removal pass report. Supposed the tree inventory and tree tagging using RFID covers all the harvesting trees in the compartment but due to the time constraint and change of decision from FDPM, only Ramin tree is inventorized and therefore there is no data available for inventory report covering other species.

RFID Ramin Timber Monitoring System Screenshot
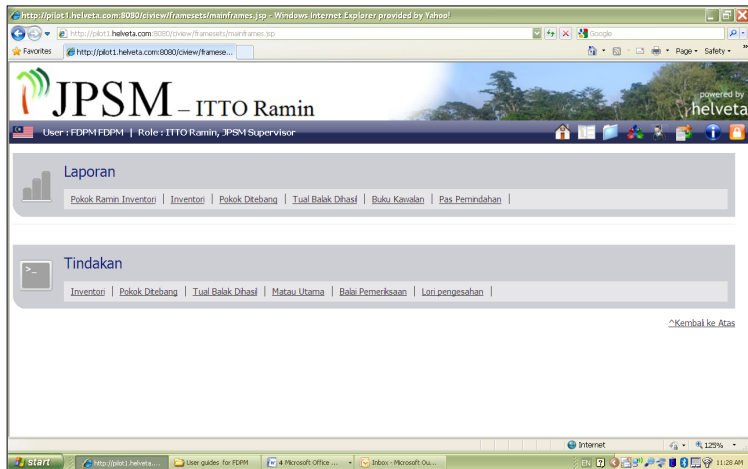
Dashboard view of RFID Ramin Timber Monitoring System

The '*Tindakan*' functionality actually is the action page for user to key in data from the online system. CI WorldTM powered RFID Ramin Timber Monitoring System supports online data entry besides field device data capture of information. The online data entry is an important feature that allows tailoring each system requirement to the needs of the user/operator. An example of an online inventory form is provided below.

RFID Ramin Timber Monitoring System Screenshot

Online data entry interface for inventory

6.2   RFID Ramin System Asset Browser View

User actually can access and view the system from the standard asset browser view. Under the asset browser view, the main page is divided into various panes representing functional areas of RFID Ramin Timber Monitoring System:

i.   The Asset Browser, located on the left, provides a list of all the chain of custody configured on the system. In a national deployment, the Asset Browser could contain an unlimited number of chains for the various supply chains i.e. from state level to district level monitoring. The asset browser information being fully configurable, chains could be added or deleted, grouped under geographical areas or depending on the legal standard applicable (Permanent Reserve Forests, Community Forest, etc.). Note that there are no limitations on the number of chains in the Asset Browser.

ii.   The Upper Central Pane is the main interface that allows accessing the representation of the Chain of Custody as well as the Alarm interface.

iii.   The Lower Central Pane is where reports are accessed.

iv.   Finally the Menu Bar in dark blue, provides quick access to the main modules and pre-programmed functionalities of the system.

By clicking Compartment 74A in the Asset Browser, specific chain of custody with its various control points is displayed.

Logical chain of custody for the RFID Ramin Timber Monitoring System Activity

6.3 Document Manager and Reports

To access the data entered in the database, various reports are configured and simply clicks the related control point form the dash board. Depending on the configuration of the report, a box might appear in order to select parameters that might have to be chosen to define the scope of the report (for example start date, end date, truck number, language, etc...). Once selected and displayed, the report can be simply saved, forwarded, printed or simply closed.

6.4 Process Control
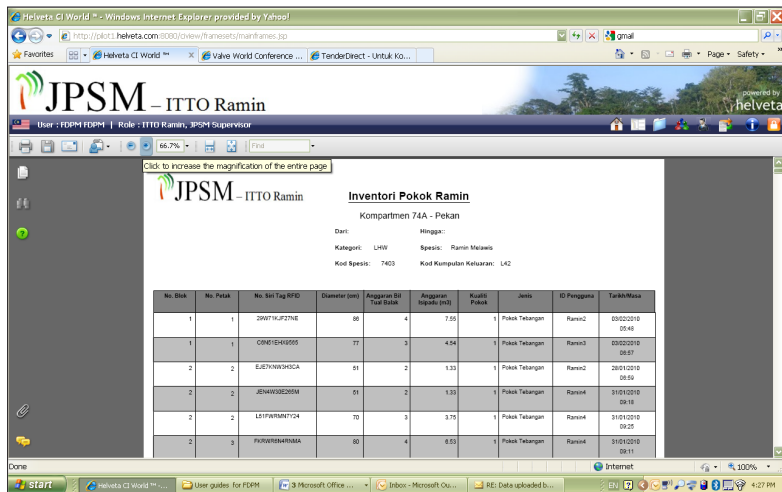
In the RFID Ramin system activity three simple alarms have been configured in order to demonstrate the capabilities of the system.

i.   Duplicate RFID tag:

This alarm generates a message at any time that a duplicate RFID tag is entered into the system. This allows to prevent "double entries" that could be simply due to a human error or to an attempt at corrupting data.

ii.   Change in species:

At any point where the species of a tree or a log is entered into the system, a simple cross check can be made to insure that the species captured matches the ones at all previous control points. Should there be a discrepancy, an alarm is generated and could provide the history of the tree/log in order to facilitate investigation.

iii.   Log number and size inconsistency in control book:

The logs diameter are measured and captured at the main log yard must consistently fill up the control book beginning with the biggest diameter follow by smaller and smallest diameter for the each subsequent log. An alarm could be generated if the log size arrangement is not in order and consistent as per requirement.

By clicking on a specific alarm, one can see the details of the faulty discrepancy picked up by the system and also use the platform to dispatch, escalate, further investigate and finally close the issue. Note that a record of the whole process is always kept in order for the system to be fully auditable.
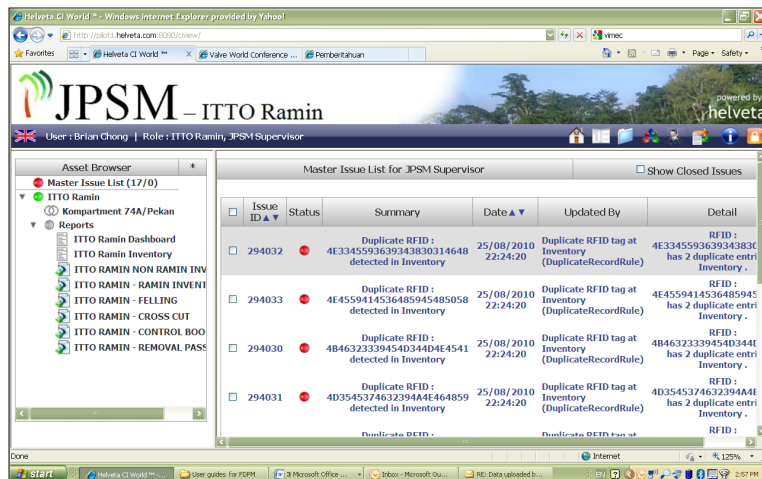
Alarms and their explanations being displayed on CI World

7.0   SYSTEM PERFORMANCE AND RECOMMENDATIONS

The RFID Ramin Timber Monitoring System activity was deployed to evaluate the potential use of a RFID technology enabled monitoring software system as a central tracking platform and in a prospective of being integrated into FDPM tree marking and forest revenue system setting. Below are few high level conclusions on the overall performance of the system.

7.1   Customization of RFID Monitoring System

One of the central attributes of RFID Ramin Timber Monitoring System must be its configurability and flexibility in order to be quickly deployed, customized in meeting varying requirements.

By being configured over the span of 4 weeks to match the FDPM harvesting processes as well as the removal pass procedure, the RFID system has demonstrated the value of an cost effective, off the shelf configurable application which can be deployed and kick-off rapidly.

The RFID monitoring system has proved its capability in transmitting and output data in real time, enabling the maximum visibility and detection of non-compliance timber harvesting procedures. The system has provided a fully documented Ramin inventory and documented evidence of timber moving from the peat swamp forest through the supply chain, therefore the legality of Ramin moving through the chain of custody.

Timber tracking and chain of custody monitoring management is, in theory a simple concept. But given the complexities of the processes involved at concessions, the difficult tropical environment in the peat swamp forest and the wide ranging background and skills of forest operators, trying to provide especially a RFID technologically adapted solutions in the forestry sector can be a challenge. The effectiveness of the system nevertheless delivered the following:

i.   Automated checking of Ramin timber for legality compliance by software based algorithms that are configured to reflect Malaysia Criteria and Indicator (MC&I), chain of custody scheme and revenue collection;

ii.   A RFID monitoring system that allows digitized paper documentation to be stored in a repository for review and validation by all stakeholders involved in the activity;

iii.   A RFID monitoring system that is sufficiently scalable and robust to handle the volume of RFID tree marking and related legality assurance data for FDPM and other relevant government agencies; and

iv.   A RFID monitoring system that accessible by a range of stakeholders that can be automate to verification of the underlying supply chain data alongside legality documentation.

7.2   RFID Tag Evaluation

As clearly demonstrated at the time of the activity, RFID technology can be used in a forest setting as tags to track the resources. However there are areas that might require more research:

i.   RFID Form

The signumat model of RFID tag used at the time of the activity performed their duties of tracking trees and logs. Some however did face difficult to read; the incidents are either caused by the moisture and dense wood absorbing the RFID signal or the hammer force used to affix the tag on logs. It was deemed that the hammering force was too excessive that cause the tag failed to response to a reader immediately. Normally after a long idle wait, the RFID tag would back to stable condition, and most of the tags were able to read. However during the operation, the data collection cannot stop and be interrupted. Hence it is suggested the RFID tag must have its serial number printed on the surface of tag itself. When the tag fails to read, the operator can manually enter the serial number of the tag in the handheld application and allow data reconciliation and matching back to the original RFID number in the database. In that sense, a more in-depth analysis of the form and specifications of the RFID tags would be beneficial in identifying models

ii.   RFID Process Handling

Another issue facing was during the process of skidding of logs from peat swamp forest to log yard area. The tag was prone to damage and lost. The prong of tag often could not penetrate deep enough to secure the tags in place. Additional nails had to be inserted to strengthen the tag. In spite of this, due to logs were skidded through the the muddy and waterlogged environment, most of the tags found lost or damaged until failed to response to a handheld reader at later stage. Therefore, while deploying a RFID tag marking system, the methodology of data collection must be modified to match the field process and forest environment.

This illustrates is one of the central conclusions of the activity, which is that the most important aspects when deploying a RFID Ramin Timber Monitoring System remains the detailed specifications of the system, often on a per chain of custody basis, in order to foresee all the potential situations. This is a crucial element that allows wider and quicker adoption by facilitating and optimizing processes throughout the supply chain and system implementation.

7.3   Objectives Analysis and Conclusions

Over and above the observations in the previous 2 sections, the following provides an analysis of the results and conclusions of the activity against other high level objectives.

i.   The system, as configured and customized, focused on the more complex aspects related to chain of custody management. The RFID system platform nonetheless demonstrated its ability to be easily configured to match and improve on existing paper-based processes, of facilitating the capture of information at key control points, therefore enhancing management capabilities from harvesting to transformation and revenue collection. The system efficiently replicated the processes of issuing Control Book and Removal Pass, thus ensuring effective monitoring and enforcement of compliance. Under the RFID monitoring system approach, the idea is to provide a strict control of the whole wood supply chain, therefore "fencing out" wood of illegal sources. If the system is extended by integrating all sectors of the wood industry and monitoring the associated wood flows, the RFID Ramin Timber Monitoring system can assists in tackling illegal logging by eliminating entry points for unlawful wood into the legitimate supply chain.

ii.   The various configurable modules built-into the RFID monitoring system platform, allow replicate and extend to any current processes and procedures used in managing, monitoring and enforcing the MC&I, chain of custody scheme. The system can provide tool to better share real-time information and documents between the district, state and central offices, as well as facilitate field inspections. Finally the system can also significantly impact the process of collecting fees, royalties, and levies by automating calculations, invoicing and payments.

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iii.   In order to be efficient, a RFID monitoring system must achieve wide acceptance within the forestry sector. Unless all actors in the forest supply chain agree to participate and actively use the system, its impact will remain limited. The best incentive for the industry to adopt a RFID Timber Monitoring System is to provide a flexible tool that can be adapted to corporate processes and therefore provide intrinsic benefits in terms of output optimization, Business to Business (B2B) processes facilitation, and management control.

iv.   A well and in-depth study of the most appropriate RFID form factor is crucial in the RFID tree marking and tracking processes. While the price of a RFID tag is a concern however it is estimated that pricing will quickly erode as the tag gets deployed in commercial applications and production volume increase.

v.   It is important that the sense of ownership and responsibilities of this RFID Ramin Timber Monitoring system is acquired by all stakeholders involved. The management of the data collection and monitoring is placed under the FDPM but it is equally vital for the state forestry and district forest offices share the responsibility to ensure the right skill and knowledge are equipped at the state and district level, as well as with the forest concession operators. These are the group of people is going to perform tree marking using RFID tag and using handheld to read and capture data in the field. Thus comprehensive training workshops and adequate user guides and manual have to be provided in order strengthen the beneficiaries' capacity to implement and use the RFID monitoring system for wood legality assurance.

Based on the results of the present activity, many follow-up activities could be considered to further deepen the experience of the FDPM and the various state forestry departments in managing and monitoring the forestry sector through an RFID timber monitoring system. Some programs could include:

i.   A larger scale activity to further develop the application such as writing data from handheld onto the RFID chips at certain control points, as well as field printing of removal pass either via a thermal printer or a PC connected printer at the checking station.

ii.   Extend the activity scope of coverage by including the transformation processes i.e. sawmill, plymill to further extend the traceability along the chain of custody

iii.   Analyzing the integration of RFID monitoring with FDPM current computer system as well as state revenue collection system to provide a wider range of monitoring,

iv.   RFID tag management that include the issue of unique identifiers in a controlled and auditable manner to the activity participants and for both assets (e.g. trees and logs) and documents (e.g. waybills, receipts, reports) in the form of encoded barcodes that can be validated in the field.

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