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Short communications

From theory to practice: RFID in Thai forestry businesses

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INTRODUCTION

The forestry industry generally ignored automatic identification (Auto-ID) until available technology such as embedding tags into timber could be implemented. Auto-ID can bring value by tracking timber through logging operations, transportation and in monitoring deliveries, among other uses. Even though auto-ID has become a powerful technology facilitating the identification of products in a timber tracking system, in Thailand simpler methods such as hammer branding still dominate. Each teak log is stamped with two different hammers: a log id and the forest plantation logo. The log data are then manually entered into a computer. Hammer branding is quick and easy to apply; however, it offers low security and reliability, as it is very easy for human error to be introduced. This problem has resulted in the demand for studies on the implementation of new identification technologies. There is room for improvement in terms of efficiency, user acceptance, cost, and tag quality.

Radio Frequency Identification in a nutshell

Radio-Frequency Identification (RFID) is a wireless communication technology that is used to uniquely identify tagged objects or people (Hunt *et al.*, 2007). RFID uses radio waves to read and capture information stored on a tag attached to an object.

An RFID system is made up of two parts: 1) a tag or transponder; and 2) a reader or interrogator. RFID tags are embedded with a transmitter and a receiver. The RFID components on the tags have two parts: 1) a microchip that stores and processes information; and 2) an antenna to receive and transmit a signal. The tag contains the specific serial number for one specific object. To read the information encoded on a tag, a two-way radio transmitter-receiver, called an interrogator or reader, emits a signal to the tag via an antenna. The tag responds with the information written in its memory bank. The interrogator will then transmit the resultant reading to an RFID computer program (Figure 1).

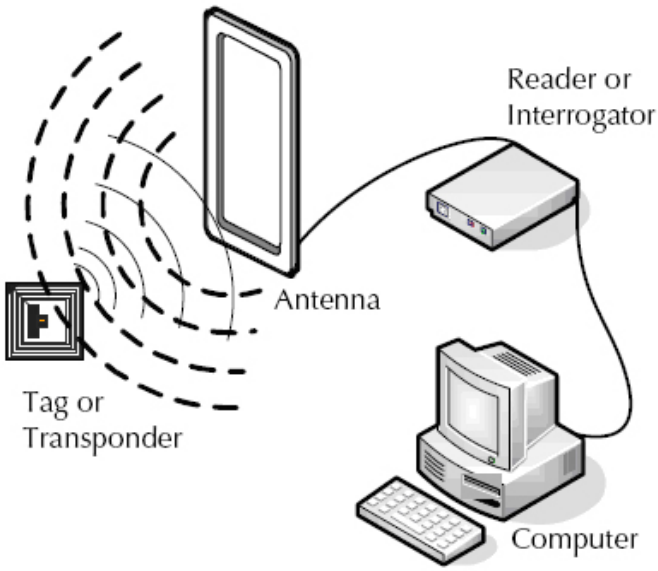

Figure 1 How an RFID system works.
(Source: www.epc-rfid.info)

There are two types of RFID tags: 1) passive; and 2) active. Passive RFID tags contain an integrated circuit that has a basic radio transceiver and a small amount of nonvolatile memory. They are powered by the current that the reader's signal induces via their antennas. The received energy is just enough to power the tag to transmit its data once, and the signal is relatively weak. In an active RFID system, the tag has its own power supply and radio transceiver, and transmits a signal in response to a received message from a reader. Active systems can transmit over a much longer range than passive systems, and are less error-prone (Igoe, 2012).

Advantages of RFID over barcode

RFID and barcoding are different technologies and have different applications, which sometimes overlap. In many circumstances, RFID offers advantages over traditional barcodes. The big difference is that barcodes are line-of-sight technology. RFID doesn't require line of sight. RFID tags can be read as long as they are within the range of a reader. Table 1 shows a comparison of the two technologies.

Table 1 Comparison of RFID and barcode (Hunt *et al.,* 2007).

	RFID	Barcode
Data transmission	Electromagnetic	Optical
Memory/Data size	Up to 128 kbytes	Up to 100 bytes
Read rate	High throughput. Multiple (>100) tags can be read simultaneously.	Very low throughput. Tags can only be read manually, one at a time.
Reading range	Centimeters to meters (system dependent)	Up to several meters (line-of-sight)
Position to scan	Non-line-of-sight possible	Line-of-sight mandatory
Human capital	Virtually none. Once up and running, the system is completely automated.	Large requirements. Laborers must scan each tag.
Read/write capability	More than just reading. Ability to read, write, modify, and update.	Read only. Ability to read items and nothing else.
Durability	High. Much better protected, and can even be internally attached, so it can be read in very harsh environments.	Low. Easily damaged or removed; cannot be read if dirty or greasy.
Environmental susceptibility	Low	Dirt
Access security	High. Difficult to replicate. Data can be encrypted, password protected, or include a "kill" feature to remove data permanently, so information stored is much more secure.	Low. Much easier to reproduce or counterfeit.
Price	More expensive	Least expensive

Applications of RFID in forestry businesses

Auto-ID has become a popular solution for tracing various kinds of products including those in the wood industry. Tracking technologies vary from simple methods to high technology and include: conventional painting and chisel labels, hammer branding, attached plastic or paper tags, barcodes, magnetic stripe cards, smart cards, chemical and genetic fingerprinting, and RFID (Dykstra *et al*., 2002). The most popular identification technologies that are applied in the forest industry are the barcode and RFID; for example in Finland, Sweden, the United States, and South Africa (Hogg, 2012; Hogg and Scheepers, 2012; ITTO, 2012; Timpe, 2005; Timpe *et al*., 2012).

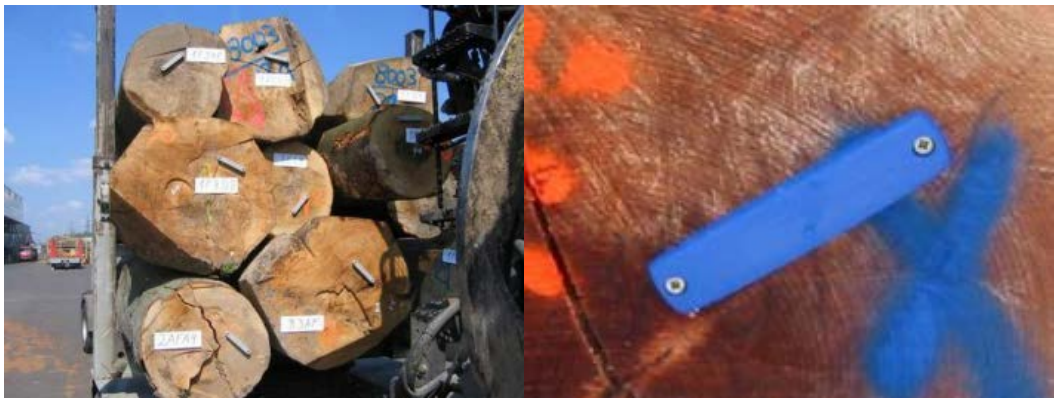

Figure 2 Examples of RFID tags in forestry applications.
(Source: Hogg and Scheepers, 2012; Häkli *et al*., 2010)

Comparisons of different identification technologies and technology reviews have been carried out globally (Dykstra *et al*., 2002; ITTO, 2012; Hogg, 2012). In Africa (Liberia and Guyana), every harvestable tree and any timber are required to carry a barcode throughout the supply chain from the forest to the point of utilization (Carey and Schrader, 2012). There has been a substantial increase in the number of applications and implementations of RFID. RFID has been tested for the control and optimization of timber logistics (Korten and Kaul, 2008). Another study involved the traceability of timber throughout the whole supply chain and investigating improved RFID tag tolerance to extremely cold weather (Häkli *et al*., 2010). The application of RFID in the wood supply chain has been examined with regard to whether the investment cost is acceptable (Timpe, 2005). The most recent study was a survival test of RFID UHF tags in timber harvesting operations, where Picchi *et al.* (2015) found extracting operations may play a major role in damaging or removing the tags from tree. However the embedded tags still provided good reliability in traceability systems.

Radio Frequency Identification notably can help to support sustainable forest management, in providing visibility in the timber supply chain and the technology can also help to identify all trees and then track an individual tree from the forest to the sawmill with every stop in between processed, tracked, and controlled. This can help to reduce waste, let workers know exactly how many trees they need to harvest and from what area, and assure the sawmills they are getting exactly the type and quantity of needed trees at any given time. RFID is also efficient in logistics management and can help to reduce human error in the forestry process.

Feasibility to apply RFID in Thai forestry businesses

Kaakkurivaara (2015) investigated the possibility of applying a barcode or an RFID system in the Thai timber industry and

identification of the most favorable technology for traceability. Three approaches were examined: 1) a conventional method (hammer branding); 2) a barcode; and 3) an RFID. Each method was compared on the basis of three key measurements: efficiency, user acceptance, and cost. The results revealed that RFID was the most preferable identification method in terms of efficiency and user acceptance. However, the cost of the RFID tag should be reduced to THB 15 or less, and tag improvement is required with regard to durability, moisture resistance, and the ability to be embedded into the wood.

Figure 3 Feasibility testing of RFID and barcoding in Thai forestry operations: (A) hammer branding; (B) barcoding; and (C) RFID.

Key message

RFID is the most promising method for marking logs; however, further development of this technology is needed, particularly with regard to the investment cost, with the RFID cost per tag expected to decrease in the future. The normal RFID tags that are currently available on the market may not be suitable for forestry work. Moisture and dirt are key barriers to using this technology in the forest and the rugged working conditions require the specific development of an RFID tag that is resistant to moisture and more robust. This should lead further research to focus on the examination of a suitable tag design for the forest industry. Durability under different circumstances and the survival rate of RFID tags should be tested throughout all logging operations felling, extraction, and transportation.

The entire supply chain flow needs to be connected into one system. This will provide system transparency, improve supply chain management, and provide a complete inventory. The whole supply chain is recommended to apply the same timber tracking system in the near future in order to facilitate and create a national standard for the timber tracking system.

Together with IT and networking that are developing rapidly nowadays, a tablet

computer in conjunction with a cloud service system has high potential in the near future in the forestry sector, as it moves toward a paperless system. Moreover, with the introduction of the Internet of Things (IoTs), the ability to track and communicate with products will greatly increase. RFID tags will hold more information about an object, and will be able to communicate that information to an inventory system. RFID tags will be built into objects, which will then be able to send information on temperature, moisture, and nutrient for example. The ability to integrate RFID with large data receiving systems from IoTs can play an important role as a tool to support decision making and aid forest managers in making the right decision at the right moment, in order to maximize benefit.

Lastly, the relevant related regulations, particularly the Thai Forest Plantation Act, need to be updated to allow for alternative methods and be open minded to allow for further development.

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