

# WIRELESS TECHNOLOGY FOR INFORMATION COMMUNICATION IN LOGISTICS & TRANSPORTATION SYSTEMS FOCUSING ON THAI FRESH PRODUCE EXPORTED TO CHINA

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## ABSTRACT

*Thailand is one of the well-known fruit producers in the world. Also, the export value of fresh produce is one of the main factors that drive the national economy. This study focuses on the implication of wireless technology enabling the information communication regarding the temperature monitoring from exporter within logistics and transportation system of fresh produce shipment from Thailand to China. The current issue of transporting fresh produce is to ensure the quality of the products. In order to maintain good quality produce with the optimum temperature controlled during the shipping process, Temperature Tracking System Through Wireless Technology (TRAC) is a proposed model of this investigative research. With the TRAC, the integration of the temperature sensor and wireless technology can enhance the information communication through the wireless network.*

## INTRODUCTION

Thailand is one of the well-known fruit producers in the world. Due to the climate and geographical characteristics of Thailand, the unique taste of Thai fruits has set it apart from many competitors. Each year, the export value of fresh produce is one of the main factors that drives the national economy (Chomchalow et al., 2008).

According to the Department of Export Promotion of Thailand (DEP), the agricultural commodities export in 2008 was 625.76 millions US dollars (USD), and in 2009 the expected export value was between 644.53-657.04 million USD (DEP, 2009).

This study is focusing on the implication of wireless technology enabling the information communication within logistics and transportation system of fresh produce shipment from Thailand to China.

Since fresh fruit is a sensitive product, any factors such as moisture, temperature, harvesting and packaging can lead to a decline in quality. By integrating logistics and transportations with various wireless technologies, these factors can be controlled.

For this reason, product information from the source to the point of consumption will be transmitted to ensure the quality and freshness of Thai pro-

duces from Thailand. Furthermore, customer satisfaction can be guaranteed as a result of accurate transmission to all parties.

The Temperature Tracking System Through Wireless Technology (TRAC) will apply the Radio Frequency Identification Technology (RFID) tags, temperature sensors, Global Positioning System (GPS), and other technical advantages, including the temperature monitoring system and information flow procedure, etc. The system can semi real-time location and monitor the location and the temperature of fresh produce, to achieve quality.

## LITERATURE REVIEW

While Thailand is recognized as one of the world fruits producers of unique and great-tasting fruits, it has not been very successful in penetrating China. Due to the quality issue, many orders for Thai fruits have been canceled, especially Logan and Durian (DEP, 2009). This suggests that it is essential for increasing the value of the country's fruit exports.

According to the Department of Agriculture Extension, the damage from exporting fresh agricultural products from Thailand is approximately 25%. Because

most agriculture products like fruit and vegetable is fragile and hypersensitive, improper handling and care in transportation will damage the products.

By discovering the advantage of technologies, the results can be an option for potential improvement of existing logistics and transportation practices of agricultural product shipments to ensure the necessary quality standard.

### Longan

From January to August 2009, the export value of longan has been 77.40 million USD, and is the top five fruits that China imported from Thailand. These figures are so significant hence government and private agencies should be concerned.

Because of the high sugar content, longan fruit has a short shelf life. Under ambient temperature (25°C-31°C) harvested longan fruit rind turns brown within 3-4 days, and the aril turns rotten within a week and loses its commercial value (Wang, 2000).

Nevertheless, controlling temperature seems practical. Improbable cooling technique can led to chilling injury symptom that is also a factor that damages the quality of Thai longan. Chilling injury occurred on fruits stored at low temperature, indicated by water soaking or drying and darkening of the pericarp browning (Boonyakiat, 2002).

For the chilling method, at the optimal temperature, the longan life span can be extended. However, depth interviews have found that most Thai

gardeners and exporters do not refrigerate longan after harvesting and packing. According to Ketsa (2005), at 30°C, the life span for longan is only one or two days. Consequently, controlling temperature and time management is critical for transporting longan.

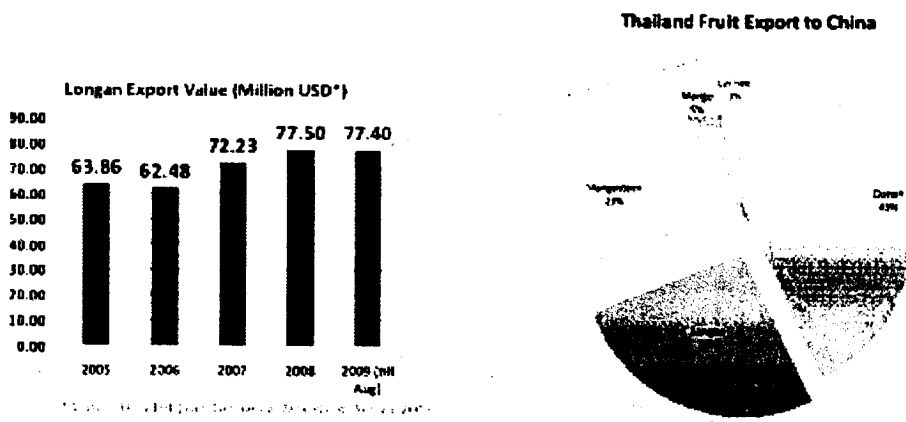
From the investigations, exporting longan is quite a challenge. In order to maintain a good quality longan, wireless technology can be implemented to solve the issues of shipping longan.

### Durian

Durian is a famous Thai fruit that generates foreign currency for Thailand every year. Durian is another major export of tropical fruits from Thailand. According to the OAE, the export value of durian in 2008 is 104.54 million USD and for 2009 the export figure from January to August is 115.97 million USD.

Durian is similar to Logan in that the temperature control for post harvest is also critical. According to Booncherm (1991), at 4°C-5°C (normal temperature for household refrigerator) could be stored for 5 weeks. However, at 12°C or lower the durian will show chilling injury. Symptoms include black discoloration of durian surface and failure to ripen as indicated by loss of ability to convert starch to sugars.

Kaderz (2010) states that at 13°C-15°C the storage potential is 3-5 weeks for mature unripe duri-



Source: Office of Agricultural Economics

Figure 1: the export value of longan from 2005 - 2009

ans and 7-14 days for ripe durians. Thus, controlling temperature and time management is critical for Durian.

### Prognostic Logistics

Prognostic logistics applies real time information in order to enable an accurate prediction on the future state of a system. Prognostic logistics continuously gathers information about the system, and uses this information to perform predictions of possible situations and disturbances; providing a larger time window for the organization to react, and allocating the resources where needed.

The accuracy of the prognostic logistics network relies on the quality of the data captured. The quality depends on the system used to do such a task.

Auto-ID technologies offer different tools that can be used to design the prognostic logistics data capture system. The technology used for the data

acquisition in prognostic logistics, needs to be accurate and automatic. The capture of data in prognostic logistics needs to be done without or nearly without human intervention.

RFID makes it a suitable technology to use as a data capture system and communication system in the prognostic logistics networks. This technology can be combined with sensors and other wireless systems, in order to make it a more powerful tool for capturing and transmitting specific data.

Almost 10% of all perishable goods are wasted before purchase (Roberti, 2005). A concept called quality oriented tracking and tracing is being developed to follow the total amount of time it takes for perishable goods to move from one point to another. At the same time, environmental data is collected (temperature and humidity) to determine what goods were exposed to the toughest conditions for longer time. With this information, replenishment strategies can be scheduled for specific products; first replen-

**Table 1: The Pros and Cons of Auto-ID Technologies**

Auto-Id Technology in Prognostic Logistics	Pros	Cons
Bar Code	<ul style="list-style-type: none"> <li>• Widely use</li> <li>• Low prices</li> </ul>	<ul style="list-style-type: none"> <li>• The bar code must be in the line of sight of the reader</li> <li>• Reads only one code at a time</li> <li>• Requires human intervention</li> </ul>
	<ul style="list-style-type: none"> <li>• It can store more information</li> <li>• It can be easily compromised or damage</li> </ul>	
2D Bar Code	<ul style="list-style-type: none"> <li>• One way communication</li> <li>• Tags are getting cheaper</li> <li>• Standards are being created</li> <li>• Provides real time information flow and constant monitoring</li> <li>• Data acquisition without human intervention</li> <li>• High storage capability</li> <li>• Multiple tags can be read at once</li> <li>• Promotes the creation of intelligent products (Zaharudin et. al., 2002)</li> <li>• Possible sensor integration</li> </ul>	<ul style="list-style-type: none"> <li>• Seldom cases provide real time information</li> <li>• Security issues</li> <li>• Costs need to go even lower</li> <li>• Readability problems with metals and liquids</li> </ul>
RFID		

Source: De Le Cruz, et. al. (2007)

ished with the products exposed the longest to hard conditions.

### **Cold Chain**

Cold chain is a supply chain system which ensures that the core requirements of maintaining low-temperature environment for the purpose of maintaining perishable goods quality, so it has higher requirements than the general logistics system at room temperature. Time requirements of perishable goods need a higher level of organization and coordination with every link of the cold chain. And the operation of cold-chain logistics and energy costs are always associated (Yan et al., 2009).

Manufacturers conduct extensive research upfront to discover the optimal temperature range their products can endure throughout the supply chain to ensure food safety and product quality. Once these limits have been established, the responsibility for maintaining those temperatures throughout the cold supply chain falls on the shipper, the carrier and the retailer. (Terrerri, 2009)

Wawa Inc., a Pennsylvania-based convenience store chain, conducted a cold chain assessment to make sure its products are received at the highest optimum quality. At the receiving dock, employees prod the products with infrared or bimetallic thermometers to assure products are at the correct temperature. They also randomly test their most sensitive products using recording temperature monitors. (Doherty, 2009)

River Ranch Fresh Foods, managing produce harvesting in Salinas and King City, CA, uses PakSense labels to monitor and track time and temperature trends from harvest to arrival at the company's processing plant. The popularity of the PakSense solution relies on its small footprint, cost-effectiveness and its easy-to-use design requiring no extensive infrastructure, notes David Light, CEO of PakSense. Users snap the corner of the label to activate units that record five-minute average temperatures. A LED light signals an alert when temperatures go out of range, enabling immediate accept/reject decisions. Wireless units require just a push of a button to activate and readers can access data from 300 feet, downloading data into an MS Excel spreadsheet (Terrerri, 2009).

## **RESEARCH METHODOLOGY**

Research methodology contains data collection and gathering procedures, respondents, research instruments, and data analysis tool.

### **Research Method Used**

This paper is an investigative research using the qualitative analysis method. The purpose of this study is to propose the wireless technology to be used for enhancing the information communication for the fresh produce exported from Thailand to China.

### **Data Collection/Gathering procedures**

#### *Primary Data*

This researchers obtained the cooperation of the Thai exporters and cultivators from in the northern region and the eastern region of Thailand. Furthermore, the research activities were broad, ranging from process and methods of exporting Thai produce to China. The in-depth interview with the exporters was conducted to establish the definitiveness of the logistic routing of Thai produces from Thailand to China, the operating process of exporting Thai produce, and the current issues of product quality. The findings from the interview are then employed to determine the options of the wireless technology that can be used to aid and enhance the information communication capability to ensure the quality of fresh produce.

Additionally, the in-depth interview was conducted with the cultivators to gain the awareness of the fresh produce harvesting process such as the standard for fresh produce packing process, the quality control procedures including the sanitization process, and the current issues of fresh produce exporting.

A qualitative approach using comprehensive interview with 5 respondents was selected from 25 exporters (DEP active fruit exporters in 2008) in Chiang-Mai, and Chanthaburi area based on the willingness of information sharing. In addition, depth interviews were also conducted with 5 cultivators from Chiang-Mai, and Chanthaburi. These interviews are vital for understanding the beginning of exporting process from Thai cultivators to Chinese importers.

### Secondary Data

Journals, articles, textbooks, and reports have been used as the secondary data. Moreover, the reports from several government agencies have been referred as the support information for this research.

### RESEARCH FRAMEWORK

From the introductory investigations, exporting fresh produces is quite a challenge. In order to en-

sure the good quality of fresh produces, aligning technology can be implemented to solve the issues of shipping fresh produce in terms of quality monitoring.

Figure 2 illustrates the steps of TRAC whereby the black box receives temperature information, along with each unique identification number of temperature sensors. Then, the black box will receive the temperature information every 15 minutes and it will be transmitted wirelessly to the application servers. If the temperature range affects the quality of

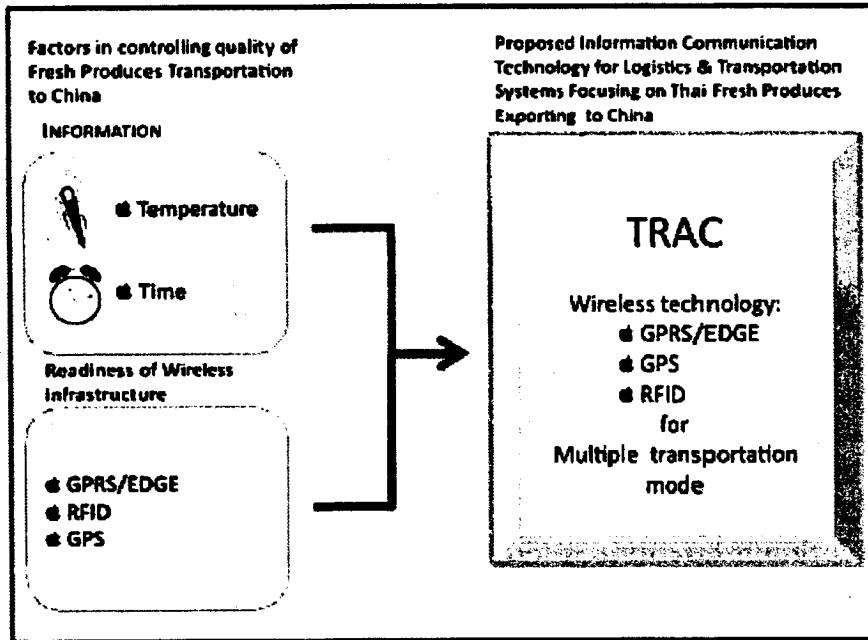


Figure 2: Conceptual Framework

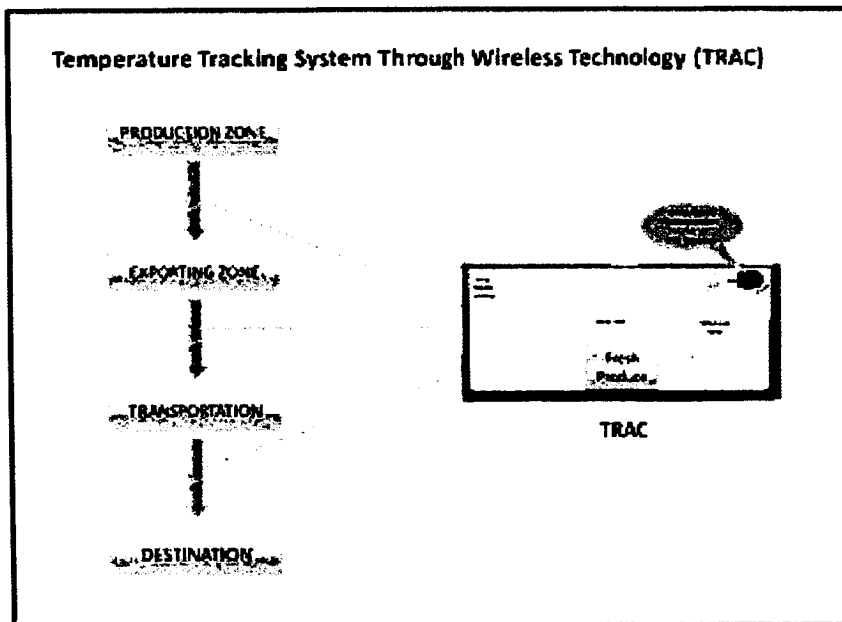


Figure 3: Temperature Tracking System Through Wireless Technology (TRAC)

the produces, the black box will use a wireless Internet connection to send each tag's identification number and temperature data with the date and time stamp to the back-end application server.

Once the fresh produce is loaded onto vehicles, the sensor configuration will be fixed for the preset temperature settings that are suited to maintain the good quality of the products. The black box will contain memory, and battery power, which allow it to monitor temperature every 15 minutes, and store those results throughout the voyage from Thailand to China.

At the destination, the monitoring system at that location receives the temperature history for each RFID tags and transmits that data to a monitoring server, which exploits a GPRS/EDGE connection to forward this information to the system. Information can be used to identify the product quality and remaining shelf life for longan that will then be sold by Chinese retailers.

## DATA ANALYSIS

This session contains 2 findings as follows: compiled data, and limitation of communication channels.

### Compiled Data

This investigative paper found 2 factors that affect the quality of fresh produces. The compiled data have been derived from TRAC, and illustrated in Table 2.

## Limitation of Communication Channel: Real Time VS Near Real Time

The TRAC will set the communication to send out only if the temperature information falls into the critical level for determination of the status, so that further precaution can be initiated. Moreover, during air and ocean transit, the communication channel for the TRAC may not be available. However, the temperature and other information will be periodically recorded into a memory in the black box. Upon arrival, if there is any recorded information, system will transmit the data to the monitor system as soon as the signal is available.

## CONCLUSION AND RECOMMENDATION

According to the investigation, the factors that have an effect on the quality of exported to China are temperature and time duration of shipping. With the deployment of TRAC, a single RFID tag can enhance the information communication through the wireless technology. The TRAC can provide a better way to transmit the temperature information, along with the wireless signal, and other information. This technology implementation is crucial for maintaining quality. Moreover, upon arrival the TRAC will notify the Chinese retailers of the remaining shelf life before the products expire, which can append to the value added for importing fruits from Thailand.

This paper proposed TRAC that enables exporter capability in ensuring the quality and fresh-

**Table 2: TRAC Towards Consideration Aspects/Issues**

Consideration Aspects	Issues	TRAC Solution
Temperature	<ul style="list-style-type: none"> <li>• Temperature control</li> <li>• Chilling damage</li> </ul>	RFID device will be placed into the box to track temperature for the fresh produces shipment. If there is any error, the TRAC will alert the monitor server
Time	<ul style="list-style-type: none"> <li>• Product shelf life</li> </ul>	RFID device will trace the time from post harvest to the destination. Upon arrival the customer will recognize the remaining shelf life of the product

ness of fresh produce exported to China so that customers could experience the freshness of Thai fruits as if it has been picked right from the orchard. Therefore, TRAC is recommended as an alternative for potential improvement of existing logistics and transportation practices of Thai produces exporters.

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