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# Innovation in Information Management Using RFID Technology Throughout Product Life Cycle

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*Abstract* – **Using radio frequency identification (RFID) in the whole product life cycle is becoming increasingly important. Such innovation enables us to track products in production processes, automatically identify, record, transmit and search product information throughout its life cycle. Implementing RFID systems in the entire product life cycle model leads to the great improvement of decision support system (DSS), since it makes accurate, real-time, and complete product information easily available. Besides all, RFID-based Information Management Framework of product life cycle is introduced.**

*Keywords* – **Information management framework, Product life cycle, RFID.**

## I. INTRODUCTION

Using RFID technology in the whole product life cycle is becoming increasingly important. RFID is a technology that allows remote interrogation of parts using radio waves [1]. This has several advantages, since many tagged parts of a single product could be simultaneously identified in an automated manner.

The primary task of information management is to collect, exchange and analyze the product life cycle information.

With the high complexity of supply chain (SC), the need for accurate and detailed information is becoming essential. Therefore, three-dimensional model of the information needed for successful managing of SC operations is described.

Finally, RFID-based Information Management Framework of product life cycle is introduced.

The remainder of the paper is structured as follows: Section II comprises a brief description of the RFID technology. Section III is dealing with the product life cycle issue. Three-dimensional SC information model is described in Section IV, while the basic concepts of current product life cycle management systems are given in Section V. RFID-based Information Management Framework of product life cycle is introduced in Section VI. Finally, concluding remarks are given in Section VII.

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## II. RADIO FREQUENCY IDENTIFICATION BASICS

*Radio frequency identification* is an automatic, wireless identification technology capable of gathering data without human intervention and line of sight requirement. RFID increases efficiency and enables new fields of application by introducing the following abilities:

- To read multiple product identities simultaneously;
- To read identities from distance without having a line of sight;
- To provide the real time information service;
- Processing tags with rewritable and extendable memory features.

RFID systems use radio waves to capture data from tags. They have three *primary components* [2]:

- The tag or transponder;
- The reader; and
- The host computer.

*RFID tags* are the chips embedded in the product. They are made of a hard copper coil consisting of an integrated circuit (IC) attached to an antenna, then packaged into a housing device appropriate for the application. RFID tags are very rugged and come in several forms and sizes; e.g., some can be as small as a grain of rice. Data is stored in the IC and transmitted through the antenna to a reader. RFID tags can be "*passive*" (no battery) or "*active*" (self-powered by a battery). Passive tags are more popular, less expensive, with a virtually unlimited life span. They do not have their own power supply but use the radiated energy from RFID readers to transmit information.

*RFID reader* is radio frequency transmitter and receiver controlled by a microprocessor that communicates with the tags. In passive systems, readers transmit an energy field that "wakes up" the tag and provides the power for the tag to operate.

Next, great volume of data collected from tags is wirelessly passed to host computer for further processing.

## III. A DETAILLED VIEW ON PRODUCT LIFE CYCLE

The model of product life cycle is characterized by the three phases (see Fig. 1):

1. *Beginning-of-Life* (BOL) phase, including design and production;
2. *Middle-of-Life* (MOL) phase, including use and maintenance; and

3. *End-of-Life* (EOL) phase, characterized by various product-processing scenarios such as [3]:

- *Reuse* - any operation by which components of EOL products are used for the same purpose for which they were conceived;
- *Recycling* - the reprocessing in a production process of the waste materials for the original purpose or for other purposes;
- *Remanufacturing* - the process of disassembly of products during which time parts are cleaned, repaired or replaced and then reassembled to sound working condition; and
- *Disposal* - the process of getting rid of EOL products, such as landfill, incineration, etc.

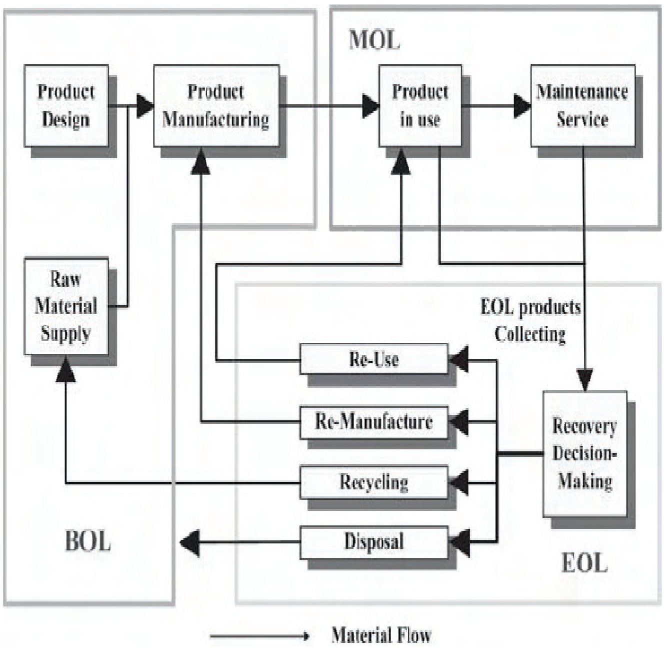


Fig. 1. The Model of product life cycle: SC point of view

Incomplete information on the product makes EOL decision-making process very complicated. Take hazardous materials as an example; there is no sufficient information about specifications and locations of such materials in the recycling processes.

## IV. Three-dimensional SC information model

The task of SC information management is to collect, exchange and analyze the life cycle information necessary to support decision making process and help in identifying and implementing features that will maximize economical effect and minimize environmental degradation. In fact, with the high complexity of SC, the need for accurate and detailed information is becoming increasingly essential.

Three-dimensional model of the information needed for successful managing of SC operations is shown in Fig. 2. Firstly, we can classify the information into three categories [4]:

1. Economical. It is crucial for measuring the profitability of SC activities;
2. Product & Production. It is vital for the efficiency of SC activities and is referring to product technical data (e.g., material content); and
3. Environmental. It is important for measuring the physical impacts (e.g., energy use, waste generated).

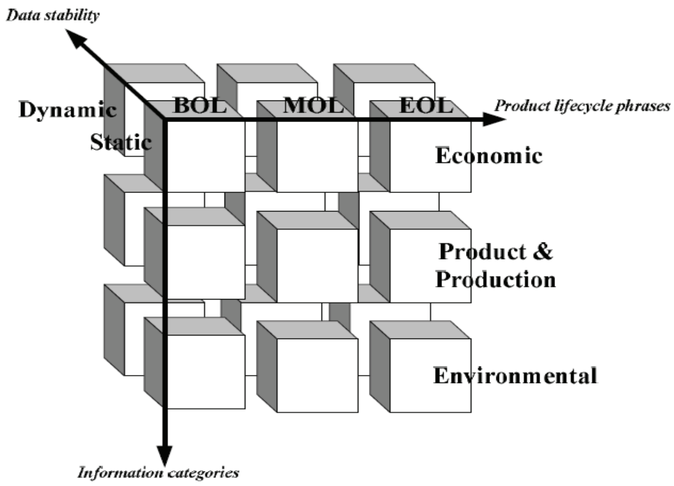


Fig. 2. 3D SC information model

Next, the information state can be classed into static (refers to the information that never changes) and dynamic (refers to the information that is always changing during life cycle). Finally, the information is distinguished into three phrases of product life cycle: BOL, MOL and EOL phase. BOL data is usually static and can be gathered from producers. MOL data is highly dynamic and keeps growing over time. It captures information during the product use and maintenance. The source of EOL data could be certified collectors, recycling facilities and/or eventual disposer.

### A. Information flow within the EOL phase

With the increasing pressure on producers to manage their product processing operations, the availability of information to improve processing decisions is becoming crucial [5]. In fact, a fundamental obstacle in making efficient decisions is the loss of information associated with the product after the point-of-sale.

The information required for efficient product processing can be classified into the following six categories:

1. *Product* information. Examples of such information are product identification and product dismantling scheme. Product related information is *static* in nature (i.e., the information does not change over the product life cycle);
2. *Location* information, relates to the specific location of every part and its quantity;
3. *Utilization* information, relates to the use of the product over its entire life cycle (e.g., amount of usage). This information, which is *dynamic* in nature, is required to assess the quality of the product and its potential value. Automatic identification technology, like RFID, is making dynamic data

collection possible, where product identification is build into a product, giving it a unique "footprint";

4) *Legislative* information;

5) *Market* information. Finding markets for used products can be very difficult. Product processing critical objective is to receive the highest possible value for every potentially processed product. In order to achieve this objective, all participants in backward section of SC must have timely and accurate access to market information, concerning product demand, price and availability. E-marketing is helped to increase sales of used parts and introduced an important element of stability to the secondary part market. Maybe, the best example of successful E-marketing is American Recycling Association case [6]. Fifteen years ago, the American Automotive Recycling Association established an Internet based marketing system called "The International Database" which aims to increase the availability and use of recycled automotive parts. Today this database is the largest source of information about recycled vehicle parts in North America; and

6) *Process* information, generated within EOL processing activity. The two main categories of information generated "internally" are [7]: *storage* information (e.g., the availability, quality, stock currently held) and *sales* information.

## V. Contemporary Information Management Systems

In order to make effective processing decisions, it is critical to have access to information generated throughout the entire product life cycle. In this section, we will briefly describe the some approaches for managing product information throughout its life cycle, and their pros and cons.

Information Management Systems can be divided into three categories [8]:

- *Design/dismantle data sharing system*;
- *Life cycle data management system*; and
- *RFID-based approach* for managing product information.

*Design/dismantle data sharing systems* are designed to allow producers to share design and dismantle-related information with certified collecting facilities, dismantlers and recyclers. These systems are only able to capture and share the static information. Evidently, they are not capable of providing detailed product life cycle information. They have the following characteristics in common:

- Manufacturers provide design data and disassembly instructions to product processing facilities; and
- Every authorized SC actor is able to access part information through the Internet.

*Life cycle data management system* [9] is designed to store and share static and dynamic information. However, the major drawback of this approach is that it fails to capture the dynamic nature of the static information. This results in the inability of providing accurate information about the part status at the EOL phase. In general, this system displays the following characteristics:

- Enable unique identification of every part;
- Provide design data and disassembly instructions;
- Monitor and store important product parameters throughout its life cycle; and
- Product processing facilities are provided access to the information stored with the part and linked to the static information through the Internet.

A recent breakthrough in enabling affordable widespread global deployment of RFID is the emergence of approaches connecting a product tagged with an RFID to a network. The key features of a networked RFID approach for managing product life cycle information are [8]:

- Unique identification;
- Wireless communication between item and reader;
- Networked reader; and
- Common database access approach.

## VI. Innovation in Information Management using RFID Technology throughout Product Life Cycle

Implementing RFID systems in the entire product life cycle model (see Fig. 3) enables us to track products in production processes, automatically identify, record, transmit and search product information throughout its whole life cycle.

As showed in Fig. 3, the BOL material flow begins with linking *Raw material supplier* with *Product manufacturing department*. This is paralleled with RFID information flow comprised from design information sent from *Product design* to *Product manufacturing department*. Afterwards, the two combined flows are distributed to different *Customers* in *Product in use*, where the product reaches its MOL phase. Relevant product information is also processed and transmitted to an information management network named *Product Life Cycle Information Systems* (PLC IS). PLC IS contains *BOL Information Systems* (BOL IS), *MOL Information Systems* (MOL IS) and *EOL Information Systems* (EOL IS). It provides the immediate, automatic identification and sharing of item-level information in product life cycle management.

The information flow consist all crucial product information during the whole product life cycle, i.e.:

- Design information;
- Production information;
- Usage information (e.g. data collected from sensors and recorded in RFID tags);
- Maintenance information; and
- EOL instructions and eventually processing record.

Implementing RFID systems in the entire product life cycle model leads to the innovation of decision support, since it makes accurate, real-time, and complete product information available throughout the whole product life cycle. For example, the information needed in EOL phase can be retrieved from the PLC IS according to the unique ID stored in the RFID tag.

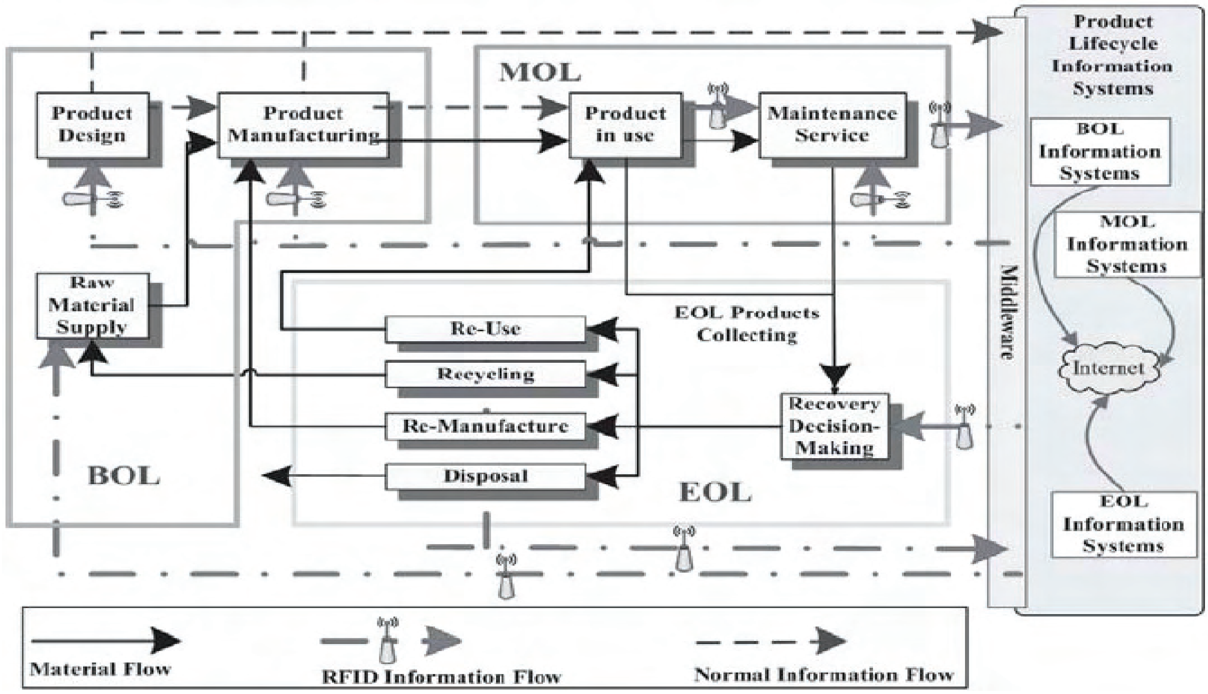


Fig. 3. RFID-based Information Management Framework in product life cycle

## VII. Conclusion

In this paper, we give an insight into how advanced identification technology, such as RFID, could provide the information necessary to improve the quality of decisions made during product processing activities.

It is concluded that RFID is securing the ability to extract product information in a timely manner. In addition, RFID brings following twofold benefits: *processes improvement*, that upgrading the efficiency and cost effectiveness of SC operations; and *decision improvement*, that leads to higher profit.

From the long-term point of view, the "full" RFID scenario, i.e., implementing RFID in the entire product life cycle should become a reality. The realization of such a concept would enable the complete transparency of one product, the state of its containing parts and would provide direct access to stored information.

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