Study on Real-time Transaction Tracing Management System Based on an Extended Finite State Machine

Ming-Yuhe Chang, Ph.D., Department of Multimedia and Entertainment Science
Southern Taiwan University Technology, Taiwan
Li-Gun Chung, Graduate Student., Department of Information and Communication
Southern Taiwan University Technology, Taiwan

ABSTRACT

In the process of lending or returning public property, the borrower may not be the same person who is the actual user at a particular time as far as the lending facility is concerned. The borrowing relationship becomes more complicated through the multi-level borrowing activity of the lending facility. This could lead to unrealistic information that could influence the management of resources. The lack of the abilities to conduct real-time tracing management and control the process of public property lending reduces the effective utilization rate of the resources and leads to resources safety and idle time problems. In this way, we can reach the goal of efficient use of resources by reducing administrative costs and decreasing the burden involved in the management of lending or returning public property. The paper aims to establish a simple Web-type real-time borrow (transaction) tracing management system. It will provide a three-stage management mode characterized by validity and instinct. The proposed system also allows administrative staff and users to promptly monitor new trends or information about resources. Thanks to the Extended Finite State Machine, we can achieve an improved and effective utilization rate of resources through real-time resources information and automatic staged resources management.

Keywords: Data Warehousing, Real-time Tracing Management, Multi-party Management.

INTRODUCTION

Most enterprises currently face tougher challenges and more serious business environments in the increasingly competitive global market. With the advent of the knowledge economics era, all enterprises have begun to pay more attention to information management and usage [1,2] in order to improve the service efficiency and availability of facilities. In view of these, many managerial technologies have emerged from the requirements that arose. Among these, logistics management and warehousing management are considered the more important branches.

With the current financial crisis, some enterprises and non-governmental organizations have reduced the unit cost by decreasing their respective external expenditures and contributions. Our country has formed a huge OEM (Original Equipment Manufacture) industry with well-known advanced technology for production and management as well as excellent supply chain. However, not all kinds of technologies can be carried out in other fields, especially in the non-profitable organizations. At present, in the internal management of public elementary and secondary schools, the movable property resources are managed by paper work, except for the management of the fixed assets, such as a meeting room that can be lent through the Network.
As previously mentioned, the borrowing property resources of schools and universities are currently being managed and recorded through paper work. This has the following important disadvantages:

- it consumes huge human resources resulting from repeatedly collating records using a large number of manpower;
- it makes for difficult tracing management, because the borrower may not be the same person who is the actual user at a particular time as far as the lending facility is concerned (the borrowing relationship thus becomes more complicated after the multi-level borrowing activity of the lending facility); and
- it leads to less effective utilization rate of resources, because if we are incapable of making real-time tracing management and control in the process of public property lending, the effective utilization rate of resources will be reduced; likewise, there will be problems on safeness of resources and idle time. At the same time, this will lead to damaged public facilities resulting from the lack of timely maintenance.

Therefore, this paper proposes a real-time transaction tracing management system on the basis of the Extended Finite State Machine in order to solve the abovementioned problems.

The purpose of this paper is to establish a simple Web-type real-time borrowing (transaction) tracing management system. It will provide a three-stage management mode characterized by validity and instinct. The proposed system also allows the administrative staff and users to promptly monitor new trends or information about resources. Through the Extended Finite State Machine, we aim to improve the effective utilization rate of resources by real-time resources information and automatic staged resources management.

Various industries are currently engaged in efforts to reduce and maintain the existing scale under the same performance. Thus, we must deal with lending/borrowing relationships to ensure that both parties will have a clearer understanding of the situation. The objectives of this study are as follows:

A. to establish a simple tracing management mode in order to make condition clearer.
B. to devise a simple Standard Operation Process (SOP) by means of EFSM and bring it into current resources management mode to improve old tracing facilities methods that waste time in the process of identifying useful information from too much data.

RELATED LITERATURE

Periodic Real-Time Tracing Management

Periodic real-time tracing management is approached from the perspectives of the administrative staff and the borrower in accordance with the characteristics of data warehousing [1,2]. The study aims to identify the process according to managerial rules and then divide it to several stages, that is, three warning stages indicated by red, yellow, and green lamps. This is different from [2] the chain-tracing method in that our system can make a correct real-time action in complicated conditions and scenarios.

Active Information Tracing Control

In the conditions of [8,9,10], facilities are traced one by one whether in inducting with RFID or recording with GPS. However, in our study, we aim to trace facilities by personnel because doing so makes it easier to control such facilities. We then trace the personnel through e-mails and other messages as these comprise a more popular communication medium at present. The records left from these two methods can be used to clearly identify responsibilities in the future.
The study works out a three-stage control system as indicated by red, yellow, and green lamps. The three parties, that is, the borrower, the undertaker, and the Facilities Commission, can achieve a clear idea about the nature of their respective conditions and responsibilities. This system allows for real-time tracing and real-time management of resources with active information reminders, universal management interfaces, and simple user-friendly operation.

**RESEARCH METHODS**

**Mode Improvement**

In the past, management modes, such as logistics and warehousing management used in enterprises, were specialized in their own fields without overlapping. Our study aims to simplify the management mode with a common concept. The tracing methods most people use are convenient in terms of clarifying the responsibilities involved.

![Flowchart of Automatic warning tracing management](image)

**Figure 1: Automatic warning tracing management flow**
1. Application for lending: the nominal keeper is the one who is responsible for keeping proper ty prior to lending.
2. Lending registration: the borrower becomes responsible for keeping the property upon lending.
3. The warning tracing system will start to work automatically upon lending; it has the advantages of easy proof, clear responsibility, simple operation, and lower administrative costs, there by reducing the administrative burden required.
4. Reminding borrower by green lamp: the day prior to lending, the warning tracing system will automatically send a warning letter with a green lamp to remind the borrower and authorizing agent.
5. Returning registration: the property and its auxiliary are returned by the borrower; the undertaker issues the returning document, while the nominal keeper signs to confirm the return. The nominal keeper becomes responsible for keeping the property.
6. Yellow warning: if the property is not returned, the system will automatically send information to the borrower, the authorizing agent, the undertaker, and the Facilities Commission.
7. Check lending: within three days from receiving the yellow warning letter, the Facilities Commission will dispatch personnel to check the lending with the undertaker.
8. Release procedure of yellow warning: the department head should release the yellow warning within five days from receiving the yellow warning letter after confirming that no loss took place.
9. Red Warning: if the yellow warning is not released, it means the property is lost. Thus, the system will automatically send a red warning letter to the borrower, the department head, and the Facilities Commission on the sixth day after due date.
10. Issue lost notice imminently: the department head will hold a meeting for tracking the lost property within three days after sending the red warning.
11. Meeting for tracking the lost property: this is done in order to confirm the status of the lost property and obtain a solution to find it.
12. Find/make up:
   Find: should confirm the scope of damage. Make up: should compensate with the same level or higher property. The abovementioned solution must be confirmed by the General Services offices of the school and should then be recoded.
13. Review after property loss event appeared: this is carried out to 1) assess the reason for this loss event, and 2) to propose effective measures for improvement.

**Definition of Extended Finite State Machine model (EFSM)**

According to the system processing plan, our proposed system is transformed to EFSM Synoptic View, as shown in Figure 2 above. At the beginning of the warning tracing management, it will turn to the green state on the eve of the due date. If any property is returned while the green lamp is on, it will go back to the beginning state to wait; otherwise, it will turn to the yellow state at the first day of deadline. If there is a property returned during this time, it will go back to the beginning or finally turn to a red state, indicating that a warning must be released after finding or making up for the lost property six days after the due date.
The abovementioned procedure indicates the EFSM survey in accordance with our flow chart. We marked out three warning states that are indicated by green, yellow, and red. We likewise adopted different management rules in the different states; we must then introduce the management rules into EFSM to form Figure 3.

We set four kinds of states in Figure 3, which are respectively presented by S0, S1, S2, and S3. S0 refers to the initial stage from the beginning to the eve of due date. S1, S2, and S3 are the warning stages presented by green, yellow, and red. T0 to T11 are the actions we set, as shown in Table 1:

**Table 1: Introduction of all steps in Fig. 3**

<table>
<thead>
<tr>
<th>T0</th>
<th>Check the deadline, green warning will be set if there is one day left.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Check if there is a one-day overdue, shift from green to yellow.</td>
</tr>
<tr>
<td>T2</td>
<td>Check if there is a five-day overdue, shift from green to yellow.</td>
</tr>
</tbody>
</table>
Check if it is in the green warning condition. It must be displayed in the green block if it is in the green condition.

Send an e-mail to remind the borrower that the property is due to be returned the following day.

Check if it is in the red warning condition. It must be displayed in the red block if it is in the green condition.

The system will reset and go back to the beginning state if the lending is returned or renewed.

Send an e-mail to remind the borrower that the property is due to be returned as soon as possible.

Check if it is in the yellow warning condition. It must be displayed in the yellow block if it is in the green condition.

The system will reset and go back to the beginning state if the lending is found or compensated.

Send a message by mobile phone to let the related personnel know about the status of the loaned property and give a notice regarding a meeting.

Green Warning EFSM

![Diagram of Green Warning EFSM](image)

Figure 4: Green Warning EFSM

Table 2: Introduction of all steps in the green warning EFSM

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0</td>
<td>Starting state</td>
</tr>
<tr>
<td>S1</td>
<td>Green lamp indicates the status of the notification messages being sent</td>
</tr>
<tr>
<td>T0</td>
<td>To meet the green starting standard (three days before the deadline)</td>
</tr>
<tr>
<td>T1</td>
<td>To obtain borrower information and send a notice via e-mail regarding an overdue property</td>
</tr>
</tbody>
</table>

Table 3: Introduction of the green warning

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>getTime_less()</td>
<td>Predetermined return date minus current date</td>
</tr>
<tr>
<td>return_date</td>
<td>Return date</td>
</tr>
<tr>
<td>state</td>
<td>Warning state at present</td>
</tr>
<tr>
<td>port.MsgT()</td>
<td>Subprogram to sending e-mail</td>
</tr>
<tr>
<td>Msg.user_information.0</td>
<td>The information of receiving party in the green condition</td>
</tr>
</tbody>
</table>

When the starting position S0 meets the T0 condition, that is, the valid date (getTime_less()) is less than 3 (it meets the standard of entering into green warning) and the return date has a null value (it means...
that the property has not yet been returned), warning state is set to green and it enters into the S1 state. Afterwards, T1 will check actively if the warning state of this record is set to green. If it is set to green, the borrower information will be obtained using function (Msg.user_information.0) and then remind the borrower by sending a notice that the return date is coming and that the property is expected to be returned in due time.

Yellow Warning EFSM

![Yellow Warning EFSM Diagram]

**Figure 5: Yellow warning EFSM**

(T0)
To S0
From S1
When Condition getTime_less <= -2 and getTime_less >= -5 and return_date is null
Begin state="Yellow" End

(T1) To S2
From S2
When Condition state="Yellow"
Begin output port.MsgT(Msg.user_information.1) End

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0</td>
<td>Starting State</td>
</tr>
<tr>
<td>S1</td>
<td>Green lamp indicates the status of the notification messages being sent</td>
</tr>
<tr>
<td>T0</td>
<td>Meet starting condition of yellow lamp (over two days overdue and within five days)</td>
</tr>
<tr>
<td>T1</td>
<td>Obtain borrower information and send a notice that it is overdue and must be returned as soon as possible</td>
</tr>
</tbody>
</table>

**Table 4: Introduction of all steps in the yellow warning EFSM**

**Table 5: Introduction of Green Warning EFSM**

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>getTime_less()</td>
<td>Predetermined return date minus current date.</td>
</tr>
<tr>
<td>return_date</td>
<td>Return date</td>
</tr>
<tr>
<td>state</td>
<td>Warning state at present</td>
</tr>
<tr>
<td>http.MsgT()</td>
<td>Subprogram to send message</td>
</tr>
<tr>
<td>Msg.user_information.2</td>
<td>The information of receiving party in the red condition.</td>
</tr>
</tbody>
</table>

Beginning with starting state S0, when it meets T0 condition, that is, valid date (getTime_less()) is over two days overdue but less than five days (it meets the standard of entering into the yellow warning) and return date is null value (it means facility is not returned yet), warning state is set to yellow and it enters into the S1 state. After turning into S1, T1 will check initially if the warning state of this record is set to yellow. If it is set to yellow, then the information or data about the borrower, the undertaker, and the Facilities Commission will be obtained using function (Msg.user_information.1) and then remind the borrower, the authorizing agent, the undertaker, and the Facilities Commission by sending a notice letter (port.MsgT()) that the return date is coming and that the property is expected to be returned on time. In
the meantime, the authorizer, the undertaker, and the Facilities Commission must trace the property and urge the borrower to return it.

**Red Warning EFSM**

![Red Warning EFSM Diagram](image)

**Figure 6: Green warning EFSM**

(T0)
To S0
From S1
When Condition get Time_less <= -6 and return_date is null Begin
state="Red" End
(T1)
To S1
From S1 When Condition state= "Red" Begin output http.MsgT(Msg.user_information.2) End

| Table 6: Introduction of all steps in the red warning EFSM |
|--------------------|--------------------------------------------------|
| S0   | Starting state                                      |
| S1   | Red lamp indicates the status of the notification messages being sent |
| T0   | Meet Red Starting Standard (three days before due date). |
| T1   | Obtain borrower information and send message to notify those involved regarding the current condition, hold meeting as well |

<table>
<thead>
<tr>
<th>Table 7: Introduction of Green Warning</th>
</tr>
</thead>
<tbody>
<tr>
<td>getTime_less()</td>
</tr>
<tr>
<td>return_date</td>
</tr>
<tr>
<td>state</td>
</tr>
<tr>
<td>port.MsgT()</td>
</tr>
<tr>
<td>Msg.user_information.1</td>
</tr>
</tbody>
</table>

When the starting state S0 meets the T0 condition, that is, the valid date (getTime_less) is over six days (it meets the standard of entering into the yellow warning) and the return date has a null value (it means facility is not returned yet), the warning state (state) is set to red and it enters into the S1 state. After turning into the S1 state, T1 will check actively if the warning state of this record is set to red. If it is set to red, the information or data about the borrower, the authorizing agent, the department head, and the Facilities Commission will be obtained using function (Msg.user_information.2) and then remind the borrower, the authorizing agent, the department head, and the Facilities Commission by sending a notice (Port.Msg T) that the lending is overdue and that there is a lost property, after which the borrower shall be asked to return it or to explain the delay. If a property is reported as lost, the authorizing agent, the department head, and the Facilities Commission need to hold a meeting to trace the property and conceive of solutions to retrieve the lost property or make up for it.
SYSTEM APPLICATION

The Client/Server framework, here being used for the system constructed by the study, falls into two parts. The front part is a user interface for borrowing, and the back part is the management system. The software is created through the use of JSP (Java Server Page) language.

1. Hardware
   Server:
   CPU: Intel Core Duo T2200
   RAM: 4G MB
   HD: SATA 100GB 7200rpm
   CCD: portable laser bar code scanner

2. Software
   OS: MS Windows XP SP3
   Software of server: Resin 3.1 Java/PHP application server
   Data base: MS ACCESSS 2003
   Browser: above Microsoft IE7.0 or compatible program.

3. Interface introduction

   user interface

   ![Figure 7: Lending System – interface for choosing facilities](image)

   Every lending record in Fig. 7 starts with an opening menu. The types of facilities are used as options (field 1) to make for a more user-friendly interface. After making a choice as to the type of facilities, one can then find the related information (field 2). After marking the spot on the facility, one needs to make a choice of its quantity by clicking on “borrow” (field 3). Afterwards, one can continuously select different types. Finally, you can click “borrow” after checking, modifying, and deleting as seen in the menu below (field 4).
There is a table (field 1) listing the facilities selected by users in Figure 8, which is supplied for users to confirm. Users are then asked to fill in personal data (field 2), the course in which the related facilities will be used, and teacher’s data in order to facilitate tracing in the future. Finally, one could click “send” (field 3) to move to the next step.

There is a list (field 3) of items borrowed in Figure 9 to give the borrowers a clearer idea about the conditions. This list also serves to provide related information as evidence after the event. The borrower is then asked to print the list. There is a set of ID codes for the undertaker to deal with this phase promptly.

Interface for managerial personnel
In Fig. 10, the undertaker is able to select three managerial functions found on top (field 1). These include login, return and query, and to operate on the left frame (field 2). On the right, one can see the green warning field (field 4) on top, the yellow warning field (field 5) in the middle frame, and the red warning field (field 6) below. The related personal information can be arranged by a selected method, providing the names of items for the undertaker to check and assess.

![Bar Code Image]

Figure 11: One-dimensional bar code of code 128

Field 2 in Fig. 3.4 can be used by the undertaker to complete login, return, and query operations rapidly. In field 1 in Fig. 3.3, a one-dimensional bar code, formed with Code 128 and the application time, can be seen as an ID code for lending documents. With this system, it is now easy for the undertaker to complete the lending process and return the loaned properties by using a portable CCD, as shown in Fig. 3.5.

CONCLUSION

The study constructs a frame to facilitate more effective interaction among borrowers, undertakers, and members of the Facilities Commission by means of EFSM. With universal interfaces, both the borrower and the undertaker are able to manage the situation conveniently. This study designs and executes a three-stage system indicated by red, yellow, and green lamps which can clarify management responsibilities resulting from records left by every party’s action. Coupled with active tracing management, our proposed system is a simple tracking method that can facilitate the effective management of resources in real-time and send messages actively. Nevertheless, there is still room for improvement in this study in terms of whether or not the properties have been returned in time and if these have been properly used by the borrowers. We will develop and improve it with this concept and construct an appropriate system for this. With appropriate research, the proposed system will thus be expected to provide better service to users.

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