Classification and Definitions of Business Logic for End-User-Initiative Development

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Abstract. The development of Web applications should be supported by business professionals themselves since Web applications must be modified frequently based on their needs. In our recent studies with the three-tier architecture of user interface, business logic and database, the construction of the graphical user interface and the simple database system is supported by using application framework and visual modeling technologies. As for the business logic, however, it is rather difficult to support it by the same way because there are various kinds of business logic. This paper describes the classification of the business logic of Web applications with case studies. These results indicate that the classification of business logic is dependent on how the business logic is expressed. Then, for end-user-initiative development, the business logic should be expressed from the view of the service providers or the support systems instead of the view of the clients. Finally it is confirmed that the template based on the UI-driven approach is useful for requirement specifications of business logic.

Keywords. End-user computing, Web application, business logic, requirements

Introduction

The number of Web applications which end-users have access to has been increasing. Most of these applications are developed by IT professionals. Thus, attempting to achieve automation is limited to particular tasks which calculate profit over the development cost. Furthermore, it is difficult to develop applications quickly. Primarily, Web applications should be supported by business professionals themselves since Web applications must be modified frequently based on users' needs. Therefore, end-user-initiative development has become important for the automation of end-users' fulfilling their own needs.

There are several approaches for end-user-initiative development. The UI-driven approach makes it possible to develop applications for the UI-centered front-end systems easily. It is strengthened by using domain-specific framework technologies. The model-driven approach makes it possible to develop applications for workflow-centered back-end systems easily. It is strengthened by using a visual modeling tool.

Terms for end-user computing (EUC) and papers on EUC often came out in the 1980's. Some papers described definitions and classifications of EUC [7], the

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management of EUC [3] and summary of the trends of end-user development without IT professionals' assistance [17]. End-user software engineering research for end-user programmers and domain experts appeared also [10, 13].

There are some other works related to EUC. In the programming field, the technologies for programming by example (PBE) [14] were studied. PBE implies that some operations are automated after a user's intention is inferred from examples of operations. Non-programming styles for various users including children and for various domains including games were proposed. In the database field, the example based database query languages [15] such as QBE (Query-By-Example) were studied. QBE implies that a DB query is executed by examples of concrete queries. User-friendly inquiry languages were proposed in comparison with SQL.

Our research target was different from these technologies and is for business professionals and business domains. The user's intention is definitely defined as requirement specifications without inference as business professionals with domain expertise develop software which executes their own jobs.

Therefore, this paper pays attention to a Web application in which the user interface is a Web browser because most users are familiar with how to use the Internet. Furthermore, the three-tier architecture is supposed, which has been popular recently [2]. Generally, there are three approaches corresponding to the user interface (UI), business logic (BL) and database (DB). In our studies, application frameworks and visual modeling tools based on components were developed for EUC. Then, the construction of the graphical user interface and the simple database system was supported by using application framework and visual modeling technologies. [6, 12]

As for the business logic, however, it is rather difficult to support it by the same way because there are various kinds of business logic. Therefore, the classification of the business logic for the end-user-initiative development of Web applications is tried based on two steps. At the first step, case studies that business logic for a sample program is classified into five categories at the requirement level are tried. These results indicate that the classification of business logic is dependent on how the business logic is expressed. Then, for end-user-initiative development, the business logic should be expressed from the view of the service providers or the support systems instead of the view of the clients. Finally it is confirmed that the template based on the UI-driven approach is useful for requirement specifications of business logic.

This paper presents basic approaches for Web application development in Section 1, an example of Web applications for case studies in Section 2, the classification of the business logic at requirement definition level in Section 3 and the requirement specifications for flexible business logic definition in Section 4.

1. Basic Approaches for Web Application Development

Our approach to Web application development is shown in Figure 1. The business model at the business level is proposed by those end-users who are business professionals and domain experts. Then, at the service level, the domain model is constructed and the required services are specified. At the software level, the domain model is implemented by using components. In this approach, the granularity gap between components and the domain model is bridged by business objects [4, 8], patterns [1, 11] and application frameworks [9]. The semantic gap between the domain model and end-users is bridged by domain-specific technologies [16].
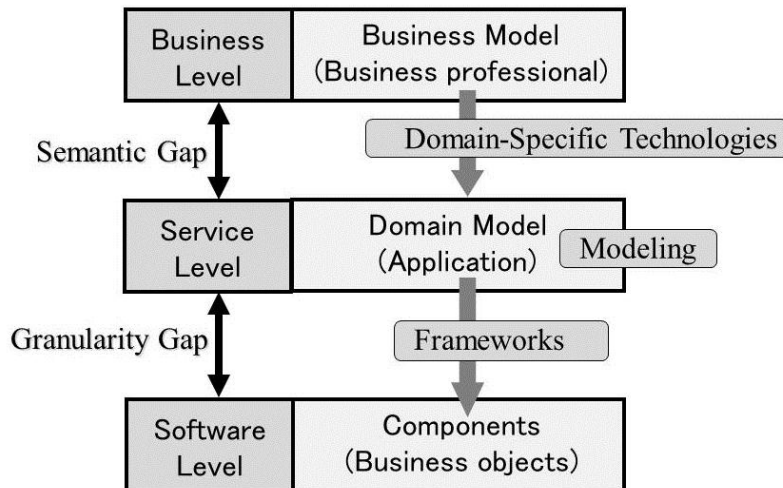
Figure 1. Technologies for end-user computing

The approaches to end-user-initiative Web application development methodologies based on the three-tier architecture are classified into the three categories of UI-driven, model-driven and data-driven processes by first focusing on any one of the UI (user interface), the model (business logic) or DB. The first two approaches are suitable for EUC, although the third approach seemed to be difficult for end-users.

Recently, a UI-driven approach has emerged as Web applications are increasing. In this approach, it seems to be easier for the end-user to define the UI in comparison with definitions of the model or the DB. In our UI-driven approach [5], the forms are defined first and the framework is used. The business logic depending on the application is defined by the form definitions. The other business logic is embedded into the framework. However, this framework does not support the back-end system with the workflow and DB.

The one solution for workflow-centered back-end systems is the model-driven approach. In our model-driven approach, end-users can get application software by visual modeling which defines forms and form-to-form transformation. A Web application model which is defined by end-users is transformed finally into Java codes of the Web application.

One of main problems for end-user-initiative development is how to describe business logic. In our past studies, some scripting languages and rules were tried. However, in these methods, end-users are required to learn some programming concepts. Therefore, tile programming was adopted for the visual modeling tool. The system prepares some tile templates for instruction statements. End-users construct the business logic by combining these templates. However, it may be difficult to prepare a sufficient set of tile templates. Further studies are needed for reinforcements of the modeling for easy description of business logic. Therefore, in this paper, business logic is analyzed with case studies.

2. An Example of Web Applications for Case Studies

2.1. Reuse Promotion Services

For the analysis of business logic, a reuse support system is selected by the following reason. This is because it is expected that information technology (IT) contributes to saving resources and environmental preservation for a sustainable society. For this purpose, application software is required, and then funds are needed for its development by IT professionals. However, the preparation of funds is difficult unless a profit is calculated over the development cost. The end-user-initiative development of application software is indispensable for the solution of this dilemma.

For example, let's consider a charity shop or a thrift store which sells limited goods to limited customers in a local area. The number of goods and the number of customers will increase if business professionals develop the application for the web site in which customers can register goods to be reused or search the list of registered goods for their own use easily.

For our further studies, the reuse support system for a charity shop or a thrift store is considered as a typical Web application for end-user-initiative development because it is supposed that there are a lot of variations.

2.2. Survey on Reuse Promotion Services

First, actual support systems for the promotion of reusing second-hand items were surveyed by searching the Internet. As a result, the following facts were confirmed:

- Many local governments support reuse promotion activities for ecological movements. Most of them use the Internet for announcements of the activities, but do not use it for practical operations. Instead practical operations are executed at the counters.
- An Internet site in practical operation for reuse could not be found.
- There are a lot of regulations for reuse promotion services and the regulations are strongly dependent on each local government's policy.

Let's give some cases of big cities in Japan. In Kawasaki city where our faculty exists, two kinds of ecological supports were found. One is the reuse promotion event that a citizen can get free and available goods which the city office collects as garbage. The other is an open-air market that a citizen can sell unnecessary goods to other citizens. Both are face-to-face dealings, although the announcement is performed via the Internet. Furthermore, there are some rules and regulations. In the reuse promotion event, a receiver must be more than seventeen years old and can propose less than three items at one event. In the open-air market, only citizens can participate in the event and goods to be sold are limited to unnecessary ones in their houses.

In some wards of the Metropolis of Tokyo, similar events are supported. In Osaka city, the office holds open-air markets in several wards but does not support a daily reuse promotion service.

This survey on the present status of reuse promotion service confirmed some facts. First, most reuse promotion services use the Internet for announcements but do not use it for actual dealing of second-hand items. If the Internet is used, the number of donors and donees can increase and the effectiveness of the reuse promotion service can be drastically improved. Secondly, almost all the reuse promotion services are provided

under detailed rules and regulations. Since these rules and regulations are dependent on the policy of each office, the general application system for reuse promotion services must be customizable.

2.3. Analysis of Business Logic with Case Studies

The analysis of business logic is indispensable to support that end-users describe the various business logic. It is desirable that business logic descriptions are mapped into implementation. Therefore, first, a lot of business logic gathered by the survey on the Internet is classified into several categories.

This paper adopts the following five types of business rules in [18] since it seems general and reasonable for the case studies:

(1) Fact: "*Facts* are simply statements that are true about the business. Often facts describe associations or relationships between important business terms. Facts are also called *invariants* – immutable truths about data entities and their attributes."

(2) Constraints: "*Constraints* restrict the actions that the system or its users may perform. Some words and phrases that suggest someone is describing a constraint business rule are *must*, *must not*, *may not* and *only*."

(3) Action Enablers: "A rule that triggers some activity under specific conditions is an *action enabler*. A person could perform the activity in a manual process. Alternatively, the rule might lead to specifying some software functionality that makes an application exhibit the correct behavior when the specified conditions are true. "

(4) Inferences: "Sometimes called *inferred knowledge*, an *inference* is a rule that establishes some new knowledge based on the truth of certain conditions. An inference creates a new fact from other facts or from computations. Inferences are often written in the "if/then" pattern also found in action-enabling business rules, but the "then" clause of an inference implies a fact or a piece of information, not an action to be taken."

(5) Computations: "Computers compute so one class of business rules defines *computations* that are performed using specific mathematical formulas or algorithms."

This paper supposes that the business logic implies the business rules. The business logic may actually include the business rule. According to the Google search on May 22, 2012, the results are 4,280,000 on "business logic", 931,000 on "business rule" and 3,410,000 on "business knowledge".

3. Classification of Business Logic at Requirement Definition Level

3.1. Five Categories

In this section, a set of business rules which are gathered by the survey on reuse promotion services mentioned in 2.2 are classified into the five categories. In this classification, there are some problems. For example, many rules are represented from the view of clients of the services. For the software requirement specifications (SRS), however, business rules are represented from the view of the service providers or the support system.

The following abbreviations are used for five categories:
FA: Fact
CR: Constraint
AE: Action Enabler
IN: Inference
CP: Computation

3.2. Identification and Qualification of Donors and Donees

In almost all services which are found by the aforementioned survey on the Internet, qualification of donors and donees is limited by the age and the resident area or the workplace. The following three examples are extracted separately from some reuse promotion service sites:

(A-1) "Citizens which are residents of the city or work in the city and are more than 17 years old can be registered."

(A-2) "Dealers cannot be registered."

(A-3) "The identification is required."

Is the first rule classified into either CR or AE? If the expression of (A-1) is changed to the following expression of (A-11) without semantic modification, this rule seems to be CR because the action for registration is restricted:

(A-11) "A citizen may be registered only if he or she is a resident of the city or works in the city and is more than 17 years old."

On the other hand, if changed to the following expression of (A-12), it seems to be AE because this rule triggers the activity of registration under specific conditions:

(A-12) "If a citizen is a resident of the city or works in the city and is more than 17 years old, then register him or her."

This rule is a typical one which may be classified into two categories. (A-1) and (A-11) are represented from the view of clients of the services. On the other hand, (A-12) is represented from the view of the service providers or the software requirement specifications (SRS) for the support system.

The second rule, (A-2), must be classified into CR. The third rule, (A-3) may be classified into CR or AE according to the following expressions of (A-31) or (A-32) which are changed from (A-3) without semantic modification respectively:

(A-31) "A citizen must show the identification for registration."

(A-32) "If a citizen requests registration, then check the identification."

In the remainder of this paper, (X-mn) represents a change in wording of (X-m) as described in this section.

3.3. Registration of Items to be Reused

There are many rules for registration of items to be reused. Three examples extracted from some reuse promotion service sites are given as follows:

(B-1) "Items to be registered for reuse are limited to ones which have been used in domestic life"

(B-2) "Large pieces of furniture or expensive jewels which are not suitable for exhibition may be registered but must be kept at home."

(B-3) "A part of bulky refuse which is gathered such as furniture etc. is repaired and is exhibited for reuse."

The first rule may be classified into FA, CR or AE according to the following expressions respectively:

(B-11) "Every item to be registered for reuse has been used in domestic life."

(B-12) "An item may be registered for reuse only if it has been used in domestic life."

(B-13) "If an item has been used in domestic life, then register it."

Actually, (B-1), (B-11) and (B-12) may be represented from the view of clients of the services. On the other hand, (B-13) is represented from the view of the service providers or the software requirement specifications (SRS) for the support system. Furthermore, if the reuse promotion services are limited to Web site services, this rule will be changed as follows:

(B-14) "The system must require before the registration that the donor declares the item has been used in domestic life."

The second rule, (B-2), may be classified into FA, CR or AE also according to the following expressions respectively:

(B-21) "Every large piece of furniture or every expensive jewel which is not suitable for exhibition may be registered but must be kept at home."

(B-22) "Large pieces of furniture or expensive jewels which are not suitable for exhibition must be kept at home after registration."

(B-23) "If large pieces of furniture or expensive jewels are not suitable for exhibition, then register them in the keeping at home."

Actually, (B-2), (B-21) and (B-22) may be represented from the view of clients of the services. On the other hand, (B-23) is represented from the view of the service providers. However, if the reuse promotion services are limited to Web site services, this rule is not necessary because it is considered that every item will be kept at home.

The third rule, (B-3), may be classified into FA because the items which the local government gathers and repairs bulky refuse will be registered unconditionally.

3.4. List of Items not to be Registered

There are some rules for items not to be registered. A typical example of such rules is given as follows:

(C-1) "The following items cannot be registered."

Some examples of such items are given as follows:

(c1) A broken item

(c2) An expensive item which price is higher than 40 dollars

(c3) Living things such as plants and animals

(c4) An item with difficulty for quality assurance on safety

(c5) A dangerous item which requires the special management

(c6) Food and drink

(c7) An item which is prohibited by the low

(c8) A religious thing

(c9) An item which a manager considers wrong

This rule may be classified into FA, CR or AE also according to the following expressions respectively:

(C-11) "Any item including in the list is not be registered."

(C-12) "Any item including in the list must not be registered."

(C-13) "If an item is included in the list, then refuse the registration."

Actually, (C-1), (C-11) and (C-12) may be represented from the view of clients of the services. On the other hand, (C-13) is represented from the view of the service providers or the software requirement specifications (SRS) for the support system. However, if the reuse promotion services are limited to Web site services and every item will be kept at home, this rule is changed as follows:

(C-14) "The system must require before the registration that the donor declares the item is not included in the list."

Furthermore, the following rule may be added:

(C-15) "The registered item data is checked manually by a manager before the exhibition."

3.5. Registration Procedure

There are some rules for registration procedure of items to be reused. Some examples are given as follows:

(D-1) "A donor is required to show the identification for registration."

(D-2) "A donor can exhibit up to five items."

(D-3) "The registration fee for each item is two dollars."

The first and second rules seem to be classified into CR and the third rule seems to be classified into FA as the similar examples are described in [18]. On the other hand, the expressions of the second and third rules may be changed into the expressions of the AE category respectively as follows:

(D-21) "If a donor registers an item, then confirm that the donor has not already registered more than four items."

(D-31) "If a donor registers some items, then collect two dollars for each item."

3.6. Attributes of Registration Items

There are some variations of attributes for categories of items. Some examples are given as follows:

(E-1) "The photographs can be attached to the registered item."

(E-2) "The number of the attached photographs is up to three."

(E-3) "The photograph including images of some people cannot be attached to the registered item."

(E-4) "There are free items and nonfree items."

(E-5) "The upper limit of the price for each item is 60 dollars."

The first rule seems to be classified into FA and the second and third rules seem to be classified into CR as the similar examples are described in [18]. On the other hand, the expressions of the second and third rules may be changed into the expressions of the AE category respectively as follows:

(E-21) "If some photographs are attached to the registered item, then confirm that the number of photographs is less than four."

(E-31) "If some photographs are attached to the registered item, then confirm that each photograph do not include images of some people."

The fourth rule is classified into FA. The fifth rule seems to be classified into FA also. However, the expression of this rule may be changed into the expressions of the CR or AE category respectively as follows:

(E-51) "The donor may prices up to 60 dollars for the item."

(E-52) "If an item is priced, then confirm that the price is not more than 60 dollars."

3.7. Decision of a Donee

There are some rules of decision of a donee of an item. Some examples are given as follows:

(F-1) "The information for contact with the donor of an item is notified an applicant who negotiates by himself or herself with the donor."

(F-2) "If the number of applicants is over the number of items, donees are selected by lot."

(F-3) "A citizen can apply up to two items at an event for a lottery."

(F-4) "If a failure or an accident on the item is happened, the donee and the donor should deal with the trouble each other."

The first rule seems to be classified into FA and the second and third rules seem to be classified into CR and the fourth rule is classified into AE. However, the expressions of the first, second and third rules may be changed into the expressions of the AE category respectively as follows:

(F-11) "If a citizen applies for an item, then notify the applicant of the information for contact with the donor of the item as the applicant negotiates by himself or herself with the donor."

(F-21) "If the number of applicants is over the number of items, then select donees by lot."

(F-31) "If a citizen applies for an item at an event for a lottery, then confirm that the applicant has not applied for more than two other items."

3.8. Deletion of Registered Items

There are some rules for deletion of the registered items. Some examples are given as follows:

(G-1) "The registered items which remain in the list after five weeks are returned."

(G-2) "The term on exhibition is three months after the registration of the item."

These rules seem to be classified into FA. However, they may be changed into the expressions of the AE or IN categories. For example, (G-1) may be changed into the expressions of the AE or IN categories respectively as follows:

(G-11) "If the items remain in the list after five weeks, then return the items to the donors."

(G-12) "If the items have not been sold within five weeks, then they are the items to be returned."

3.9. Results of case Studies

In this section, a set of business rules which were gathered by the survey on reuse promotion services on the Internet were classified into the five categories of { FA(Fact), CR(Constraint), AE(Acton Enabler), IN(Inference), CP(Computation) } although there were no examples for CP. In this classification, there are some problems. For example, many rules are represented from the view of clients of the services. For the software requirement specifications (SRS), however, rules are represented from the view of the service providers or the support system.

These case studies confirmed that the classified category of each rule varies by the

expression of the rule which depends on the view of a client or the system. A lot of examples were given for this result.

4. Requirement Specifications for Flexible Business Logic Definition

4.1. Template for Definitions of Business Logic

The reuse support system for a charity shop or a thrift store is considered as one of typical Web applications which need end-user-initiative development by using domain-specific framework and visual modeling. These domain-specific technologies require customization of business logic because it is supposed that there are a lot of variations in business logic.

As a result of the previous case studies, in this section, the business logic is defined from the view of the service providers or the support system. Furthermore, it is supposed that a Web application have the typical three-tier architecture of user interfaces (UI), business logic (BL) and database (DB) as shown in the upper part of Figure 2.
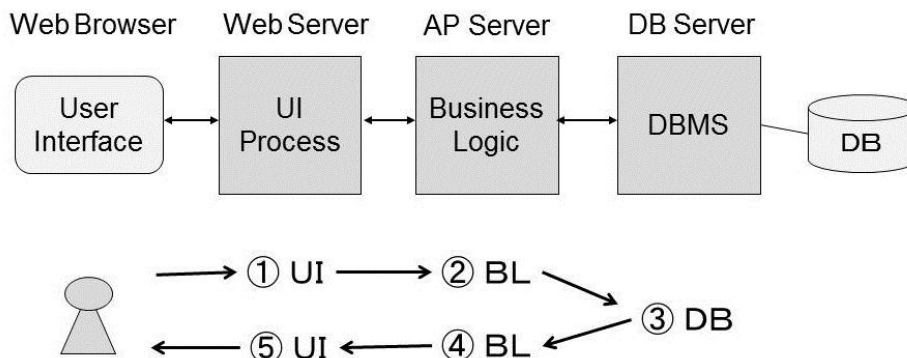

Figure 2. The three-tier architecture and UI-driven approach

Then the business logic from the view of the support system at the requirement specifications level is mapped into the combination of UI, BL and DB. The following template is introduced because the UI-driven approach is suitable for the end-user-initiative development:

(1) UI : The system gets a request from a client.
(2) BL : The system processes the request.
(3) DB : The system accesses sometimes the database.
(4) BL : The system processes the results from the database.
(5) UI : The system displays the results.

This template implies that the typical process for business logic is {UI -> BL -> DB -> BL -> UI} as shown in the lower part of Figure 2. It is easy for an end-user to understand this process because the end-user as a business professional or a domain expert is familiar with the following typical work flow such as getting a resident's card:

(1) A client fills out an application for the resident's card and hands the written application to the service counter in the city office.

(2) A clerk of the service counter checks the written application and passes it to a computer operator at the back.

(3) The operator enters the information about the client and gets the resident's card.

(4) The clerk receives it and confirms the contents.

(5) Then the clerk hand it to the client.

4.2. Identification and Qualification of Donors and Donees

Among the definitions about identification and qualification of donors and donees in the section 3.2, the following business rules are selected from the view of the support system:

(A-12) "If a citizen is a resident of the city or works in the city and is more than 17 years old, then register him or her."

(A-2) "Dealers cannot be registered."

(A-32) "If a citizen requests registration, then check the identification."

These rules are merged into one complicated rule from the view of the support system. Then the main process of the merged rule is shown as follows:

(1) UI : The system displays a form for registration and gets a request from a client.

(2) BL : The system checks the request according to these rules.

(3) DB : The system accesses the database for registration.

(4) BL : The system gets the results from the database.

(5) UI : The system displays the identification number.

In this process, some details are omitted such as error handling, identification check and identification number generation. The common error handling will be defined at the design phase. The method of the identification check depends on the status of e-Government. Citizens may already have an identification method via Internet or they must visit an actual service counter once before the use of the support system. As for the identification number generation method, the system will prepare a common method such as a sequential number generator and sometimes may make a user select a form of the identification number.

4.3. Registration of Items to be Reused

Among the definitions about registration of items to be reused in the section 3.3, the following business rules are selected from the view of the support system:

(B-14) "The system must require before the registration that the donor declares the item has been used in domestic life."

(B-23) "If large pieces of furniture or expensive jewels are not suitable for exhibition, then register them in the keeping at home."

(B-3) "A part of bulky refuse which is gathered such as furniture etc. is repaired and is exhibited for reuse."

However, if the reuse promotion services are limited to Web site services, the second rule is not necessary because it is considered that every item will be kept at home. Furthermore, the third rule may be dealt with in the different way because the bulky refuse which the local government gathers and repairs will be registered unconditionally. Then the main process of the first rule is shown as follows:

(1) UI : The system displays a form for registration and gets a request from a client.

(2) BL : The system checks the request according to the rule.

(3) DB : The system accesses the database for registration.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the results including the item registration number.

In this process, some details are omitted also. The displayed form includes the check box for the declaration in addition to the information about the item.

4.4. List of Items not to be Registered

Among the definitions about the list of items not to be registered in the section 3.4, the following business rules are selected from the view of the support system:

(C-14) "The system must require before the registration that the donor declares the item has not been included in the list."

(C-15) "The registered item data is checked manually by the manager before the exhibition."

Then the main process of the first rule is shown as follows:
(1) UI : The system displays a form for a declaration and gets it from a client.
(2) BL : The system checks the declaration according to the rule.
(3) DB : (Skip)
(4) BL : (Skip)
(5) UI : The system displays the message for registration or rejection.

Actually, this process is merged into the main process of the first rule, (B-14), in the section 4.3 while adding the check box for the declaration about the list of items not to be registered. On the other hand, the second rule, (C-15), may be dealt with in the different way. The following process is for a system administrator, not for a client:
(1) UI : The system displays a page for administrators and gets a request for check.
(2) BL : The system makes the request to the database for the check of temporarily registered items.
(3) DB : The system accesses the database for retrieving the data.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the list of temporarily registered items.

Next, the following process is continued:
(1) UI : The system gets decisions from the system administrator.
(2) BL : The system makes the request to the database for registration or deletion.
(3) DB : The system accesses the database for registration or deletion.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the results from the database.

It is easy for an end-user to define these processes because the end-user is both the developer and the administrator of this system.

4.5. Registration Procedure

Among the definitions about the registration procedure in the section 3.5, the following business rules are selected from the view of the support system:

(D-1) "A donor is required to show the identification for registration."

(D-21) "If a donor registers an item, then confirm that the donor has not already registered more than four items."

(D-31) "If a donor registers some items, then collect two dollars for each item from the applicant."

The first rule is replaced with the login procedure. Then the main process of the first rule is shown as follows:

(1) UI : The system displays a login form and gets account information from a client.
(2) BL : The system checks the data.
(3) DB : The system accesses the database for authentication.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the results.

Then the main process of the second rule is shown as follows:

(1) UI : The system gets a request for the item registration.
(2) BL : The system makes the request to the database for the check of the registered items.
(3) DB : The system accesses the database for retrieving the data.
(4) BL : The system gets the results from the database and confirms that the donor has not already registered more than four items.
(5) UI : The system displays the results.

Actually, this process is merged into the main process of the first rule, (B-14), in the section 4.3. The third rule, (D-31), was found in an actual charity shop supported by a local government. It seems that this rule is not necessary if the reuse promotion services are limited to Web site services. If necessary, it is considered that a software package for payment should be prepared instead of the procedure definition by end-users.

4.6. Attributes of Registration Items

Among the definitions about the registration procedure in the section 3.6, the following business rules are selected from the view of the support system:

(E-1) "The photographs can be attached to the registered item."

(E-21) "If some photographs are attached to the registered item, then confirm that the number of photographs is less than four."

(E-31) "If some photographs are attached to the registered item, then confirm that each photograph do not include images of some people."

(E-4) "There are free items and nonfree items."

(E-52) "If an item is priced, then confirm that the price is not more than 60 dollars."

The first rule is merged into the main process of the first rule, (B-14), in the section 4.3 while adding the facility for uploading photographs. Furthermore, the second rule, (E-21), may request similar process to (D-21) in 4.5. Then the third rule requests the same process as (C-15) in 4.4.

The fourth rule requires a price column and is merged into the fifth rule. Then the fifth rule is merged into the main process of the first rule, (B-14), in the section 4.3 while adding the check for the upper limit of price.

4.7. Decision of a Donee

Among the definitions about the decision of a donee in the section 3.7, the following business rules are selected from the view of the support system:

(F-11) "If a citizen applies for an item, then notify the applicant of the information for contact with the donor of an item as the applicant negotiates by himself or herself with the donor."

(F-21) "If the number of applicants is over the number of items, then select donees by lot."

(F-31) "If a citizen applies for an item at an event for a lottery, then confirm that the applicant has not applied for more than two other items."

(F-4) "If a failure or an accident on the item is happened, the donee and the donor should deal with the trouble each other."

The main process of the first rule is shown as follows:
(1) UI : The system displays a form for application and gets a request from a client.
(2) BL : The system checks the request according to the rule.
(3) DB : The system accesses the database for getting information about the donor.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the results.

In this process, some details are omitted also. For example, at the first step, the list of registered items may be displayed in registration number order or the list of categories to be selected by the donee may be displayed.

On the other hand, the main process of the second rule is shown as follows:
(1) UI : The system displays a form for application and gets a request from a client.
(2) BL : The system checks the request according to the rule.
(3) DB : The system accesses the database for registration of the candidate for the donee of the item.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the results.

Then, when the deadline date passes, the following process is executed for a system administrator, not for a client:
(1) UI : The system displays a page for the system administrator and gets a request for the lot.
(2) BL : The system makes the request to the database for retrieving the candidate of the donee for the item.
(3) DB : The system accesses the database.
(4) BL : The system gets the results from the database and decides donees by lot.
(5) UI : The system displays the results.

Next, the following process is continued:
(1) UI : The system gets a request from the system administrator.
(2) BL : The system makes the request to the database for getting information about the donee and the other candidates of the donees for the items.
(3) DB : The system accesses the database.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the results from the database.

Finally, the system administrator may select the button for sending the results of the lot to the donee and the other candidates by e-mail. Furthermore, the administrator may delete the item from the list of registered items to be reused.

The process of third rule, (F-31), is similar to the process of (D-21). The process of the fourth rule, (F-4), is merged into (F-11), (F-21) or (F-31) while adding the check box for the declaration to the displayed form.

4.8. Deletion of Registered Items

Among the definitions about the deletion of registered items in the section 3.8, the following business rule is selected from the view of the support system:

(G-11) "If the items remain in the list after five weeks, then return the items to the donors."

This rule is found in the Web site of some ward of Tokyo which supports reuse promotion services that citizens can leave items for sale at the counter. Actually, it is considered that every item will be kept at home if the reuse promotion services are limited to Web site services. Then this rule is changed as follows:

(G-13) "If the items remain in the list after five weeks, then delete the items and inform to the donor."

The following process is executed for a system administrator, not for a client:

(1) UI : The system displays a page for the system administrators and gets a request for deletion of items which display time have passed.
(2) BL : The system makes the request to the database.
(3) DB : The system accesses the database.
(4) BL : The system gets the results from the database.
(5) UI : The system displays the results including the information about the donor of the deleted item.

Finally, the system administrator may select the button for sending the results to the donors by e-mail.

4.9. Results of Case Studies

These are examples of the case studies, not a full set of business logic for the reuse support system for a charity shop or a thrift store. The business logic in the section 3 was expressed as requirement specifications by using the template of {UI -> BL -> DB -> BL ->UI} in this section.

Although it is supposed that there are a lot of variations in business logic, it is confirmed that the template is useful for defining the requirements based on the typical three-tier architecture of user interfaces (UI), business logic (BL) and database (DB). The definitions of business logic by using this template will promote the end-user-initiative development, especially when the domain-specific application framework and the domain-specific visual modeling tool are introduced. This is because it must be easy to understand the necessary facilities for business logic.

5. Conclusions

This paper described the classification of the business logic for the end-user-initiative development of Web applications. At the first step, case studies that business logic for a reuse support system was classified into five categories at the requirement level were tried. Next, based on this classification, requirement specifications for business logic are defined from the view of the service providers or the support system by using the template of {UI -> BL -> DB -> BL ->UI} which is proposed in this paper. As a result, it is confirmed that this template is useful for end-users themselves to define the requirements of the Web application to be developed by using domain-specific technologies.

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