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Abstract
No effective method has been proposed for improving a workflow type application system. This paper proposes a new method using Activity Based Costing Management (ABM), a well known procedure in the accounting field, to achieve such an application. The proposed system applies the ABM method to workflow analysis by allocating "information items" instead of costs to a product. Workflow type systems use two kinds of information items to produce products: value-added information and non-value-added information. Analyzing each process in a workflow in this way can identify unneeded information items on a product in a workflow application. The proposed method is a powerful tool for improving applications.

Keywords: Workflow, ABM, Value-added-information, application system

1. Introduction

It is difficult to design an effective workflow for an application system, such as a slip management system. The difficulty originates from the fact that few methods have been developed to evaluate/re-construct a workflow from a customer's viewpoint. Accordingly, an effective workflow re-engineering tool is needed.

Activity-Based Costing Management (ABM) is a well-known cost accounting method for business-process re-engineering (BPR)[1][2]. Value-added cost and non-value-added cost are allocated to final products. Conventional ABM has been applied to workflow analysis, but this is quite similar to conventional Industrial Engineering (IE)[6]. Such methods are not effective to optimize from global viewpoints.

This paper demonstrates a new ABM approach that allocates "*information items* " to a final product. An information item in a workflow is classified as either *value-added information* or *non-value-added information*. If information items are included on a final product, that is value-added information. On the other hand, information items which are not included on a final product are non-value-added information. Here, a data item received by the customer is value-added information when customer is a goal. On the other hand, if the customer doesn't receive a data item, this amounts to non-value-added information. Printer paper change is an example of non-value-added information. The workflow should be re-constructed to decrease non-value-added information apportioned to the customer, and a programmer must certify that sufficient value-added information is given to the customer.

The proposed method was applied to a realistic workflow for managing submitted papers, which is part of the actual submitted paper management system of the IEICE of Japan[1]. Furthermore, in this investigation we clarified redundancy and shortage of the workflow.
Section 2 describes conventional ABM, and the new ABM approach is demonstrated in

[1] IEICE of Japan: Institute of Electronics, Information, Communication Engineers of Japan.

Section 3. Section 4 shows experimental results and Section 5 gives concluding remarks.

2. Activity-Based Costing Management (ABM)

ABM is based on the Activity-Based Costing (ABC) accounting system[1][2]. This section first describes ABC and then shows how conventional ABM is applied to workflow analysis.

2.1 Activity-Based Costing (ABC)

Conventional cost accounting systems were designed for the era when direct labor and materials were the predominant factors of production. Recently, however, automation and computerization have reduced levels of direct labor and material costs. Design phase, production planning, transportation, storage and shorter product life cycles are now dominant factors. Thus, conventional cost accounting systems are no longer suitable for calculating accurate cost.

Activity-Based Costing (ABC) is a cost accounting system designed for the above production environment. The final product cost is measured by an "Activity Cost." The activity cost is derived from defining an enterprise's activities and tracing the factors of production apportioned to each activity. More specifically, it is expressed in terms of an activity measure by which the cost of a given process varies most directly.

Figure 1 shows an outline of ABC having a two-layered cost allocation. First, we define "Enterprise Resources" such as wages, buildings, and land. These resources are distributed into "Activity Centers" such as a division or function of the enterprise. If a division has 15 employees, wages for 15 persons are allocated to this division. In this case, the tracing factor is the number of employees. This tracing factor is called the "Resource Driver."

Each activity center often has "Cost Pools" for the detailed resource allocation. Now let's assume that the above division has two cost pools: Design Section having five design engineers and Manufacturing Section having 10 manufacturing engineers. Wages are allocated into these two cost pools in proportion to the number of engineers.

Next, the apportioned cost in each cost pool is allocated to final products. Let's consider the following two final products, A and B. We assume that a design engineer requires $50 for one person-hour and a manufacturing engineer requires $30.

Product A:

	Design	5,000 person-hours
	Manufacturing	1,000 person-hours in total (10 person-hours/product)
	Number of products	100

Product B:

	Design	2,500 person-hours
	Manufacturing	10,000 person-hours in total (20 person-hours/product)
Number of products		500

Wages, allocated to the Design and Manufacturing Sections, are apportioned to Products A and B. Products A and B have the following activity cost per one product.

Product A: Design 5,000*$50/100 = $2,500

	Manufacturing	10*$30 =	$300
	Total		$2,800
Product B:	Design	2,500*$50/500 =	$250
	Manufacturing	20*$30 =	$600
	Total		$850

Although Product A requires fewer manufacturing person-hours than Product B, Product A is expensive. This is a result of the small production quantity. ABC accounting derives accurate costs in this case.

On the other hand, in a conventional accounting system, the overhead cost is allocated depending on the number of products. Total design overhead cost is $375,000 (=(5,000+2,500)*$50). Thus, the final cost per product is as follows.

Product A:	Design	$375,000/600 =	$625
	Manufacturing	10*$30 =	$300
	Total		$925
Product B:	Design	$375,000/600 =	$625
	Manufacturing	20*$30 =	$600
	Total		$1,225

Product B is more expensive in the conventional cost accounting system. This result is strange and quite different from that of the ABC accounting system: mass-production produces more expensive products. Here, the conventional cost accounting system is inaccurate.

2.2 Activity-Based Costing Management (ABM)

Activity-Based Costing Management (ABM) is an expansion of ABC for business process reproduction (BPR). Activity costs are classified as ***value-added cost*** or ***non-value-added cost***. Final product cost is measured from the viewpoint of value-added cost and non-value-added cost. If the product has much non-value-added cost, the source activity center for the non-value-added cost should be re-constructed.

ABM can be easily applied to a workflow in a software application system, as will be explained later. The activity center is a "process[2]" of the workflow in this case. A process is usually a user-interface screen on a CRT display or a group of user-interface screens.

2.2.1 Sample Workflow

Figure 2 shows a sample workflow. This workflow is part of the actual management system for submitted papers used by the IEICE of Japan; here, it's simplified for explanation. An author submits a paper draft to an academic society (Process A in Fig.2). A member of the society's secretariat checks the draft (Process B) and inputs initial data into an application system (Process C).

[2] An element of workflow is called "**Process**" in this paper.

Next, the system sends a receipt for the draft to the author (Processes D, E, F), and the author receives a receipt postcard (Process G). A sheet of address labels used for the postcards has 10 labels and usually some of them have already been torn in previous printing. Thus, when the secretariat member orders a new print-out, she/he has to designate the starting position to the system. Of course, she/he has to replace white printer paper for normal use with an address label sheet before printing, and the address label sheet needs to be replaced after printing.

Next, the responsible member of the secretariat selects an editorial committee member for the referee process of the submitted paper (Process H). The editorial committee member in turn selects referee candidates for the paper (Process I). Finally, the secretariat selects one referee[3] for the paper (Process J).

2.2.2 Conventional ABM for Workflow Applications

The ABM process can be applied to the above sample workflow as illustrated by the block diagram in Fig. 3.

(STEP I) Define Resources, Activities and Final Products
Resources are wages for members of the secretariat in the workflow application system, and activity centers are processes in the workflow. Final outputs are services for the user. For instance, a draft receipt postcard is the final output of the submitted paper management system.

(STEP II) Allocate Resources to Activity Centers
The wages for the secretariat are allocated to each activity center. Here, activity center is each process of the workflow and equal to each user interface screen of the submitted draft management system. Each user interface has value-added cost and non-value-added cost from the viewpoint of ABM. Waiting time for printer paper replacement and software start-up are non-value-added costs. Data input time is value-added cost.

(STEP III) Allocate Resources to Final Products
The cost of each process is allocated to a final product. For instance, a draft receipt postcard receives value-added cost and non-value-added cost from the three Processes D, E, and F in Fig. 2. If the non-value-added cost is very large, the workflow has a problem and is inefficient.

ABM can be easily applied to workflow applications as described above. This is, however, quite similar to the IE (Industrial Engineering) method. Such methods are not effective to optimize from global viewpoints. New method to downsize an application system is needed.

3. New ABM Approach: Information Apportionment

This section proposes a new ABM approach using information apportionment, where "Information items" (data items) are apportioned as "cost" of conventional ABM. When a series of processes in a workflow output one final product, data items in the final product are

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[3] The number of referees in the actual IEICE referee process is usually two. This is a simplification for easy discussion.

called "value-added information," and the other information items in the series of processes are called "non-value-added information."

3.1 Example of Information Apportionment

An author receives a "draft receipt postcard" in Process G of Fig. 2. This postcard can be regarded as a final product. Information items printed on the card are value-added information. Table 1 shows the displayed, inputted or printed information items in each process. Mark "O" shows that this information item will be printed out on the receipt card and is value-added information. Mark "X" shows that the information item will not be printed out and is non-value-added information.

"Field codes" in Table 1 are for the professional field of the draft. Based on field codes, a member of the secretariat selects one editorial committee member and the editorial committee member selects referee candidates.

The final product is the draft receipt postcard shown in Table 1. Three activity centers, Processes D, E, and F, contribute to the final output. A small address label is affixed to the address side of a postcard. The author's name, draft ID number, and paper title are printed on the message side of the postcard.

An A4-size label sheet for the printer has many labels. Thus, the label position should be informed for the label printing process. Author name, paper ID, and paper title are printed directly on the card in process E. This means that a member of the secretariat must replace paper in the printer equipment before and after the printing in Processes D & E.

The label printing position is non-value-added information in Process D. The paper title and author name in Process E are value-added because the author reads the information on the receipt card. As mentioned before, printer paper needs to be replaced before and after the printing by a member of the secretariat. This means that a kind of information is supplied to the secretariat. This paper change is non-value-added information.

Results of information apportionment are as follows. Here, "V" shows value-added information and "NV" shows non-value-added information[4].

(Information items apportioned to a draft receipt postcard)

NV:	Paper ID #	1
NV:	Position of Label Printing	1
NV:	Change of printer paper	4
NV:	Label Sticking on a Postcard	1

__Non-value-added information: Total 7__

V:	Author Address	1
V:	Author name	2

[4] Here, the author address is displayed on the CRT screen for this process and printed twice on the card. Although the same information item is accessed many times, the number of information items counted is one when only one process refers to it.

V: Paper ID # 1
__Value-added information: Total 4__

This apportionment shows the following results.

(1) Much non-value-added information:
There is much non-value-added information. The information is never allocated to the final customer. This disadvantage comes from the fact that a label sheet is not interchangeable with normal printing paper. Re-structuring is needed for this label printing process E.

(2) Duplication of value-added information:
Author name is printed on the postcard twice. This is redundant.

The following method is one of the re-structuring proposals to solve the above problems.

i) The secretariat buys a small laser printer for exclusively printing postcards. Postcards are always stacked in the printer.
ii) Author address, paper title, paper ID, and author name are printed directly on only one side of a postcard in one process of the workflow; no label sheet is used.
It is not necessary to change paper as a result of the solution given above. This is an example of business process re-production using information apportionment of the proposed ABM approach.

(Information items apportioned to a draft receipt postcard)

V:	Paper ID #	1
V:	Author Address	1
V:	Author Name	1
V:	Paper Title	1

__Value-added information: Total 4__

3.2 Activity Based Information Management

The following procedure is a formal description of our proposal.

(STEP I) Define resources, activities and final products
All resources in a workflow application system are "data items." Candidates of resources are displayed as inputted data on each CRT screen or produced as printed data of the workflow application. All the control information generated by the workflow system[5] for the operator also provides resource candidates. In this case, activity center is a process of the workflow and the final product is a service for a customer.

(STEP II) Allocate Resources to Activity Centers
The information items are apportioned to each activity center. This means that data items in each process are classified as value-added information or non-value-added information. Value-added information appears on the customer service[6]. Non-value-added information

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[5] As mentioned before, if the printer equipment is activated, the printer name is a kind of information. This name is one of the resource candidates. Also, if printer paper is changed, the action is an information item and one of the resource candidates.
[6] This means that Value-added or non-value-added in each process depends on the selection of the final product.

doesn't appear on the service.

(STEP III) Allocate Resources to Final Products:
Value-added information and non-value-added information are collected. If the ratio of non-value-added information is large or the same information item has been accessed repeatedly, there is redundancy in the workflow. A programmer has to identify the reason for the redundancy.

One of the most important points in the above analysis is "*customer's view checking*." Programmers have to check redundancy and shortage of information to improve workflow type application system.

4. Practical Evaluation

This section evaluates more practical examples.

4.1 Draft Receipt by E-mail

Section 3 analyzed a draft receipt card. If the Processes D, E, and F in Fig. 2 are re-constructed into an E-mail version, the allocated information items are the following. In this case, a printer for postcards is unnecessary and Process D and F can be eliminated. The resultant workflow becomes very simple.

(Information items apportioned to a draft receipt E-mail)

V:	Paper ID #	1
V:	Author E-mail Address	1
V:	Author Name	1
V:	Paper Title	1

__Value-added information: Total 4__

4.2 *Information Apportionment from Plural Processes*

Usually, one customer service relates to many processes. Next, we focus on the referee selection, Processes H, I, and J in Fig. 2. Finally, The system sends paper title, paper ID, editorial committee member name, and referee name to DBMS and the editorial committee member[7]. The responsible member of the society's secretariat is a customer in this case. Processes H, I, and J involve no printing, but only changing of the data items on DBMS. The secretariat has the following information items for the referee selection.

(Information items apportioned to the referee selection)

NV:	Paper Title	2 (in Processes H & I)
NV:	Paper ID #	2 (in Processes H & I)
NV:	Field Codes	2 (in Processes H & I)
NV:	Candidates of Editorial Committee Member	1 (in Process H)
NV:	Name of Editorial Committee Member	1 (in Process H)
NV:	Candidates for referees	1 (in Process I)
NV:	Referee Name	1 (in Process I)

[7] This is not shown in Fig. 2 workflow for simplification.

__Non-value-added information items   Total: 10___

V:	Paper Title	1
V:	Paper ID #	1
V:	Name of Editorial Committee Member	1
V:	Referee Name	1

__Value-added information items   Total: 4__

The number of non-value-added information items is large. This is natural because this service relates to many processes. Duplication of the paper title and the paper ID are inevitable. A candidate for workflow re-engineering is duplication of "Field Codes." The system activates the date for candidate search by an editorial committee member in Process H and for candidate search by a referee in Process I. One solution is referee candidate search in Process H instead of Process J. In this case, the system sends a list of referee candidates to the editorial committee member by E-mail.

This information apportionment approach enables the programmers to detect redundant data item access. From the viewpoint of the conventional Functional Point Method [5], application system development cost depends on the number of data items on each user interface screen and the number of user interface screens. Thus, the proposed method decreases the development and maintenance cost of workflow application software.

4.3 From the viewpoint of Customer Satisfaction

Redundant data supply and shortage of information should be avoided from the viewpoint of customer[3]. The proposed methods give two measures to realize the objective.

(1) Minimize the Number of Data Accesses
A customer should have the necessary and minimum amount of information. Of course, all programmers understand this principle. If all the data items are supplied from one process of a workflow, the checking is easy. However, it is not easy when customer service depends on many processes in the workflow. The proposed method is a powerful tool for checking from this global viewpoint.

(2) Decrease Non-value-added Information
It is undesirable that the same data item is repeatedly accessed for a single customer service or that an unnecessary data item is accessed. This is also checking from a global viewpoint. Plural processes should be checked simultaneously. The proposed method provides a powerful tool for this global checking.

Now, let's consider a real sample. The IEICE of Japan employs an E-mail referee form. The IEICE sends this referee form to referees. A submitted draft has two referee processes. All papers have the first referee process. If the first decision of the editorial committee is "Conditional Acceptance (small revision before publish)," the modified draft should be re-submitted and refereed again. In this case, the IEICE sends the E-mail referee form twice.
The E-mail referee form of IEICE has paper ID, paper title, referee name, and editor name. These values are automatically inserted by the system. Today, the same referee form is sent for the first and second referee processes.

This is strange from a customer's view. The referee usually wants to read her/his first referee comments for the re-submitted draft. The first E-mail sending date of the referee form by the referee should thus be inserted in the form for customer convenience. If she/he knows this date, she/he can easily find her/his old referee comments in her/his mailbox.

The first and second referee processes have a nearly equal process sequence. Usually, workflow designers tend to recognize that the second referee process is the same as the first one. If the designers check the workflow from a superficial workflow view, it is rather difficult to have this kind of critical and global perspective. The proposed method is one kind of counter-approach to overcome this limitation in the conventional approach.

5. Conclusions

We have proposed a new evaluation approach that uses Activity-Based Costing Management (ABM) to re-construct a workflow in software applications. A significant feature of the proposed method is the apportionment of "*information item*" instead of "cost" as done in conventional ABM. Information items are allocated to the final customer service from plural processes in a workflow.

For instance, displayed, printed and inputted items in a workflow are information items. In addition to these information items, the proposed method regards control information in a workflow as information items. For instance, paper change of printer equipment and sticking an address label onto a postcard or a letter envelope are information items.

From the viewpoint of ABM, information items are classified into two classes: value-added information and non-value-added information. If information items are supplied to the final customer, the information is value-added. If the information items are not supplied to the customer, they are non-value-added. Non-value-added information items and duplication of the information items should be eliminated.

"If a data item is inputted into a system, the data item will never be re-inputted and should be re-used as much as possible." This is a well-known principle in software design. This paper appends two new principles to the old one: "Eliminate data items that are not provided for customers," and "Eliminate access to the same data in a workflow." These are global viewpoints that are not new to software engineers. However, if engineers check from only a superficial workflow view, application of these principles is very difficult. The proposed method provides a powerful tool for realizing these global views.

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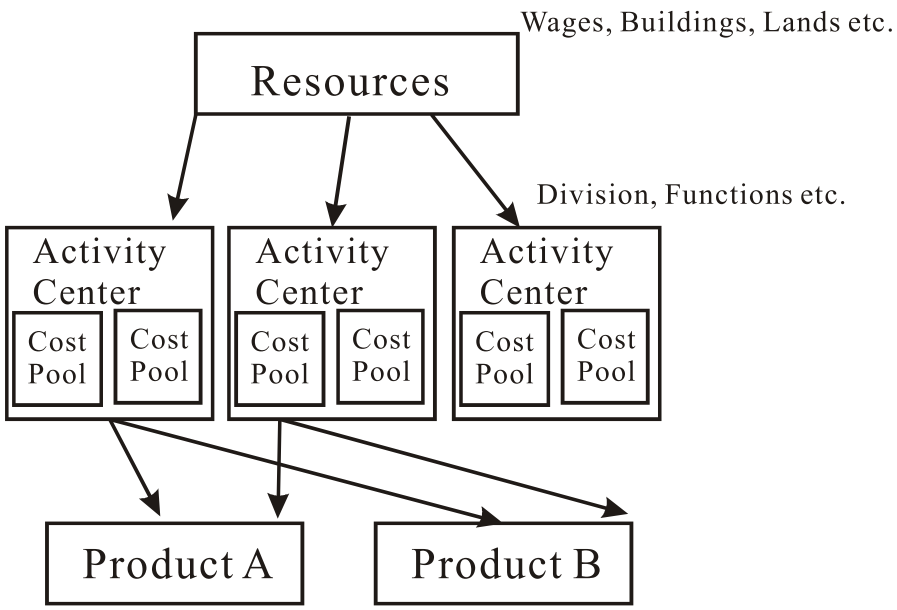

Figure 1. Outline of ABC

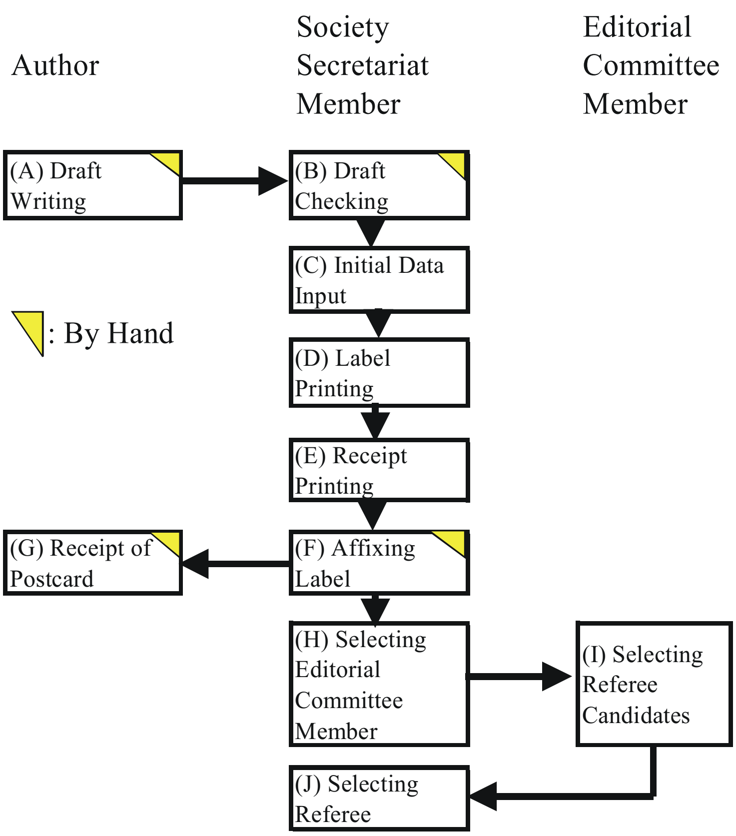

Fig. 2 A Sample Workflow

Table 1. Value Added Information and Non-value Added Information for Each Process

Process ID	Process Name	Process Activity Contents	Type of Processing	Draft ID #	Author Name	Author E-mail Address	Paper Title	Author Address	Position of Label Printing	Field Codes	Candidates of Editorial Committee Member	Name of editorial committee member	Candidates of Referees	Referee Name
A	Draft Writing	Draft Writing by Author	hand											
B	Draft Checking	Draft Checking by Society Secretariat	hand											
C	Initial Data Input	Inputting Draft and Author Information	system	X	X	X	X	X		X				
D	Label Printing	Printing Address Label with printer*)	system	X	O			O	X					
E	Receipt Printing	Printing Draft Receipt with printer*)	system	O	O		O							
F	Affixing Label	Sticking Label on postcard	hand											
G	Receipt of Postal Card	Receipt of Draft Receipt by Author	hand											
H	Selecting Editorial Committee Member	Selecting Editorial Committee Member for Draft	system	X			X			X	X	X		
I	Selecting Referee Candidates	Selecting Referee Candidate by Editorial Committee Member	system	X			X			X		X	X	X
J	Selecting Referee	Selecting Referee by Society Secretariat	system	O			O					O		O

(NOTE1) "O" is value-added information, "X" is non-value-added information from the customer satisfaction viewpoints.
"O" or "X" depends on the selection of the customer.
(NOTE2) "*)" shows that the printer paper has to be changed twice.

Figure 3. Draft Receipt Postcard