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Cost Evaluation Method for Service Design Based on Activity Based Costing

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Abstract
As our economy matures, customers have begun to demand more services in addition to just industrial products. To address this problem, designers require a novel engineering methodology, called Service Engineering (SE). SE aims to create value by combining services and products. SE focuses more on increasing customer satisfaction, while general service developers need to take into account economic cost in order to be successful in business. This paper proposes a method to evaluate service from the viewpoints of customer importance and economic cost. The proposed method is verified through its application to a practical case.

Keywords:
Product/Service Systems, Design Support, Activity Based Costing

1 INTRODUCTION

Environmental problems have been quite serious over a couple of decades. To solve this problem, the production and consumption volume of artifacts should be reduced to an adequate, manageable size without making quality of our life lower than now. Consequently, our society must be changed to the new paradigm that aims at qualitative satisfaction rather than quantitative sufficiency, and thus the decoupling of economic growth from material and energy consumption [1]. To achieve this paradigm, products should have more values, supplied largely by knowledge and service contents, rather than just materialistic values [2]. On the basis of this concept, 'Product-Service Systems,' [3-5] for example, have been attracting considerable attention, since they can create value by coupling a product with a service. However, few studies have focused on the design of such services (for example, [6-7]).

Thus, the authors of this paper have launched conceptual research on designing services from the engineering perspective. This series of research is named 'Service Engineering (SE).' [8-10] SE aims to create value by combining services and products. SE differs from conventional engineering in that the design target is customer value, and the purpose is to increase customer satisfaction rather than to achieve more functional products or services. For SE, we have proposed service models and developed a computer-aided modeling tool system called as Service Explorer [8-10].

The purpose of SE, which is currently under development, is to fulfill the requirements of customers. However, in order to be successful in business, general service designers need to take into account the economic costs. In other words, service designers should evaluate a service from the viewpoints of both customer satisfaction and economic costs. In order to serve this need, this paper proposes a method to calculate the economic cost of a service and to support service designers in finding concrete ways to reduce the service costs. First, the modeling method of SE is adopted. In SE, service contents are represented as a set of functions and entities. Then, a management accounting method known as ABC (Activity-Based Costing) [11-15] is applied to the SE model. ABC is a costing methodology used to trace overhead costs for cost objects such as products, processes, and departments. With respect to a service, this is an appropriate method owing to the characteristics of the service: high rate of overhead costs in the total costs. On the other hand, in SE, a method has been developed to evaluate the importance of functions from the viewpoint of customer importance [16]. This method allocates customer importance to functions by adopting two methods: QFD (Quality Function Deployment) [17] and DEMATEL (Decision-Making Trial and Evaluation Laboratory) [18]. The results of this method are used in portfolio analysis to evaluate functions from the viewpoints of economic cost and customer importance. The present method is verified through an example presented herein.

The remaining paper is divided into the following sections. Section 2 introduces the concepts and models proposed in SE. Section 3 explains the models and procedures in ABC. Section 4 presents the proposed method, and Section 5 demonstrates its application. Finally, Section 6 concludes this paper.

2 SERVICE ENGINEERING

2.1 Definition of service

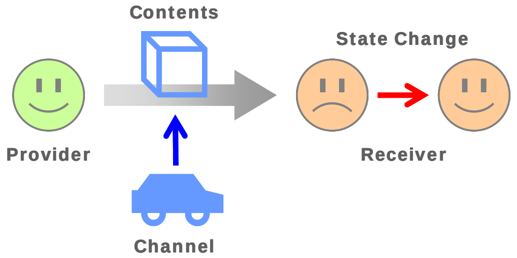

Figure 1: Definition of a service [8-10].

Service is defined as an activity between a service provider and a service receiver to change the state of the receiver [8-10]. According to the definition, a receiver is satisfied when his/her state changes to a new desired state. For the purpose of SE, the design of services must be based on the state change of a receiver. Therefore, it is necessary to find a method of expressing state changes of the receiver. States of the service receivers are represented as a set of parameters called receiver state parameters (RSPs), which represent customer value in SE [8-10]. All RSPs are assumed to be observable and controllable. RSPs are changed by ‘service contents’ and ‘service channels,’ as shown in Figure 1. Service contents are materials, energy, or information that directly change the receiver’s state. Service channels transfer, amplify, and control service contents. The parameters expressing service contents, which influence RSPs directly, are called contents parameters (CoPs). In the same way, the parameters of service channels are called channel parameters (ChPs), which influence RSP indirectly. Thus, in SE, customer requirements are represented as RSPs, and the design of a service is based on the degree of customer satisfaction represented as the change of RSPs.

2.2 Function design of service contents

As mentioned before, the design of services must be based on customer satisfaction. Therefore, service designers need a modeling method that represents the relationship among customer value, service contents and service channels. In SE, a sub-model called view model is proposed to represent a functional service structure [8-10]. A view model represents the mutual relationships among an RSP, CoPs and ChPs. An RSP changes only according to the contents of the service received. In other words, service receivers evaluate service contents when they receive the service. Service channels are evaluated indirectly by the receiver and thus do not influence the RSP. SE assumes that service contents and service channels are comprised of various functions. To describe these functions, Function Names and Function Parameters (FPs) are defined. Consequently, both CoPs and ChPs belong to FPs. These functions are actualized by entities. An entity in a view model represents not only physical products but also facilities, employees, information systems and so forth. As shown in Figure 2, a view model is expressed visually using a tree structure, and thus allows service designers to obtain relationships among an RSP, functions and actual entities.

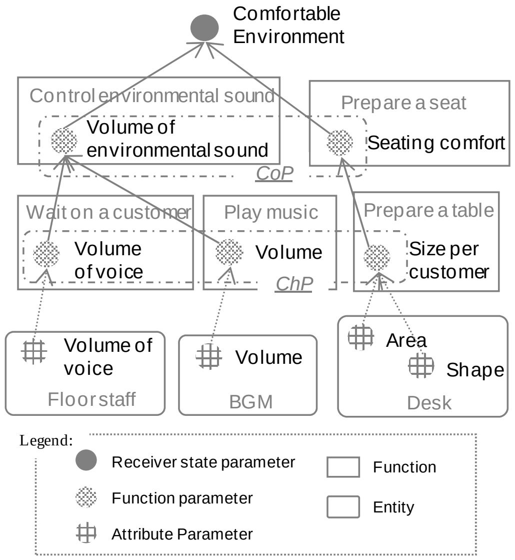

Figure 2: A simple example of view model [8-10].

2.3 Service activity design

Functions in a view model are realized by both human activities and product behaviors that are performed by entities. In SE, these entities are classified into four types: hardware (HaW), humanware (HuW), hardware-related software (Ha-SW), and humanware-related software (Hu-SW), as shown in Figure 3. These classifications are based on the Software, Hardware, Environment, and Liveware (SHEL) model [19] based on the study of human factors. For the description of the human activities and product behaviors, in SE, the activity/behavior blueprint is proposed [20]. A service blueprint, which is originally proposed by Shostack [21], is an effective technique for theoretically analyzing and designing the delivery of services, while the activity/behavior blueprint extends the service blueprint to include product behavior and its relationship to human activities as well as the connection among activities/behaviors, functions and customer value. Since activities and behaviors in the activity/behavior blueprint are related to functions in view models, it is possible for service designers to describe human activities and product behaviors while confirming their influence on the receiver’s state. In this model, the BPMN (Business Process Modeling Notation) model [22] is utilized to describe human activities and product behaviors (see Figure 4).

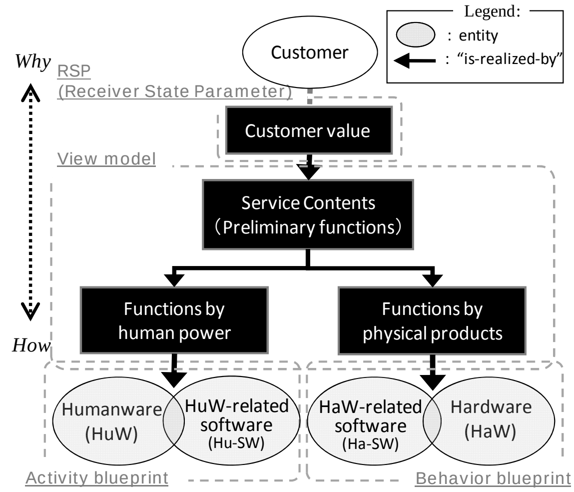

Figure 3: Overview of the modeling methods in Service Engineering [20].

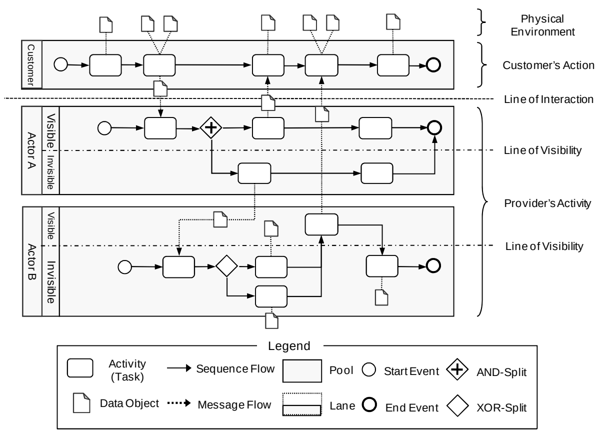

Figure 4: Activity/behavior blueprint described by Business Process Modeling Notation (BPMN) [20].

2.4 Service evaluation

In SE, a method is proposed for evaluating services [16] using QFD [17], which correspond to the view models. This method can quantify the importance of the service functions from the customer importance inputs obtained through QFD. A view model, which is represented by a graph structure, is converted into a matrix expression. A table similar to QFD is generated to appropriately reflect the EM (Engineering Metrics) of a product, i.e., a product’s quality characteristics, to meet the customer’s needs, or the VOC (Voice of the Customer). In addition, the DEMATEL method [18] is used to conduct a quantitative analysis by classifying the FPs into CoPs or ChPs, depending on whether or not they directly affect the RSP. Using this method, RSP importance, which is determined by the customers, is converted into FP importance. Consequently, service designers can obtain the function importance that reflects the customers' needs.

3 ACTIVITY BASED COSTING

ABC (Activity-Based Costing) [11-15] is a costing methodology used to trace overhead costs for cost objects such as products, processes, and departments. In ABC, the resource costs, which include the overhead cost, can be allocated to the cost objects based on the activities. Activities are the operations needed to implement tasks, and resources such as labor, electricity, and facilities are consumed to perform the activities. For example, in order to deliver a product, activities such as designing, assembly, and shipping are essential. Moreover, for these activities, the abovementioned resources are consumed.

The ABC procedure comprises two stages. In the first stage, the resource costs are associated with activities based on a cost driver. A cost driver is the criterion for cost allocation. In order to appropriately assign the resource cost to each activity, cost drivers have to be appropriately identified for each resource. For instance, the resource 'salary' may be driven by the amount of time the employee spends on an activity. In the second stage, costs are allocated to the cost objects instead of activities based on the number of activities the cost objects consume. This stage can be achieved by using cost drivers similar to the previous stage. Thus, ABC calculates the economic costs by allocating resource costs for activities.

Figure 5 illustrates the relationships among cost objects, activities and resources.

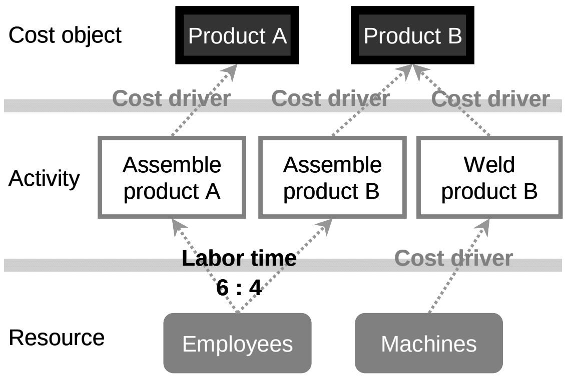

Figure 5: Relationships among resources, activities and cost objects.

4 THE PRESENTED METHOD

4.1 Approach

As mentioned in chapter 2, the design method proposed in SE aims to fulfill the requirements of customers. In order to be successful in business, however, general service designers need to take into account the economic costs. In other words, service designers should evaluate a service from the viewpoints of both customer satisfaction and economic costs. To serve this need, this paper proposes a method to evaluate a function from the viewpoints of customer importance and economic cost. For cost estimation of the function, ABC is applied to the Modeling method proposed in SE.

In the Modeling method in SE, functions in a view model are realized by entities. In the activity/behavior blueprint, on the other hand, human activities and product behaviors are described for each entity, and are related to the functions in the view model. Since functions in view models are regarded as cost objects in this method, these human activities and product behaviors can be identified as the operations needed to actualize these functions. In addition, since entities are utilized to perform these human activities and product behaviors, entities in view models correspond to the concept of resources in ABC.

With regard to quantifying customer importance of the function, the service evaluation method, introduced in section 2.4, is adopted. Based on the results of both analyses, critical functions for the improvement of the service can be identified.

The remainder of this section introduces the analysis procedures, described in Figure 6, in detail.

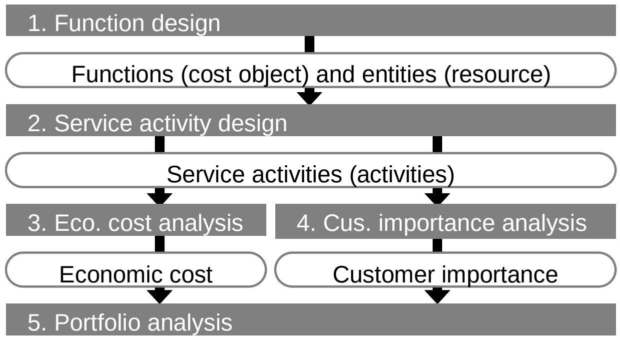

Figure 6: The proposal procedures.

4.2 Analysis procedures

This analysis begins with the determination of functions in the service under consideration. Service designers, at first, develop view models introduced in section 2.2. In the view models, function hierarchy that realizes customer requirements is determined, and then entities that actualize the functions are identified. Next, the service designers develop service activities, using activity/behavior blueprint. These activities and behaviors are associated with the functions in the view models. Thus, service designers can identify the relationship among functions, service activities and entities (see Figure 7).

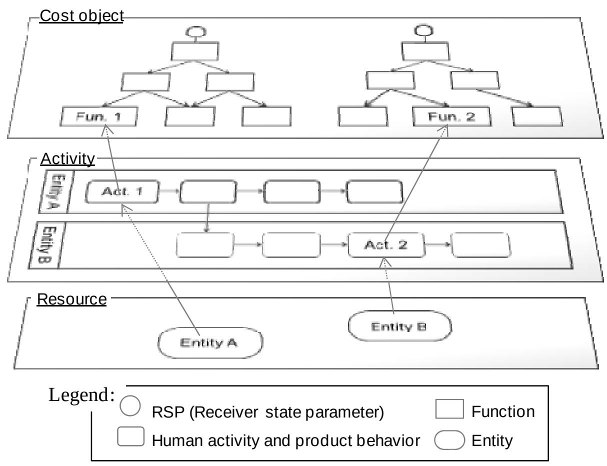

Figure 7: Relationships among functions, service activities and entities.

Next, the function analysis is performed with respect to economic costs and customer importance. The economic cost analysis is carried out according to the procedures of ABC. Firstly, the cost of the entities, corresponding to resource cost in ABC, is estimated with reference to existing services, and then is allocated to the service activities. For this allocation, the service designers need to define cost drivers for each human activity and product behavior, for example working hours for a human activity and running time for a product behavior. Subsequently, the cost of each activity is allocated to the functions that are regarded as cost objects. In this allocation, the degree of association between the functions and the activities is utilized as cost drivers.

With respect to the customer importance, the service evaluation method introduced in section 2.4 is adopted.

Finally, these results are used in portfolio analysis to evaluate functions from the viewpoints of economic cost and customer importance. Depending on the results of quantification of its economic costs and its importance for the customers, a function is placed in the prepared portfolio. According to the area in the portfolio, recommendations of strategies for the following service design stages are given as shown in Table 1.

Table 1: Recommendation strategies.

Customer importance	Economic cost	Recommendation strategy
High	High	Realize function and reduce economic cost
High	Low	Realize function
Low	High	Leave out function
Low	Low	No recommendation

5 APPLICATION

The proposed method was implemented by considering an example from the support service for the introduction of an IT system. This service involves supporting a client firm in introducing an IT system. It includes a survey of the current business process, taking decisions on the concept of IT introduction, and so on. In this application, the design-planning phase in IT introduction was considered as the scope of the application. This section explains the application by focusing on the evaluation of economic costs.

First, function design was implemented to obtain the functions of service contents and entities corresponding to resources. This was executed according to the view model. First, the requirements of the client firm (corresponding to RSP) were determined through a brainstorming session. Consequently, three RSPs were enumerated: design quality of IT introduction, planning efficiency with respect to its design, and planning quality of its design. Next, these RSPs were decomposed into functions and entities that realized the state change of the RSPs. Consequently, eighteen functions were enumerated (see Table 2). With regard to entity, the employees that consist of class-A consultant, class-B consultant and system engineer were chosen. Second, the service activity design was implemented based on the view model established in the previous step. Consequently, 17 activities were enumerated (see Table 3).

Next, each function was analyzed from the viewpoint of economic costs by using ABC. The initial step was to allocate the resource costs to activities based on the cost driver. In this case, the resource and labor costs were allocated to service activities based on the amount of time the employees spent on each activity. As mentioned before, since service activity is a means of actualizing a function, they are associated with the functions. Therefore, the entities that are related to a certain service activity are identified from the relationship between the functions and entities, if there exist several entities in service. Figure 8 shows the relationship between the activities and resources (entities). The economic cost of each activity is described on the lowest line in Figure 8.

Next, the cost of each activity was assigned to functions. Each activity cost was divided among the functions related to the service activity according to the proportion of contribution. For instance, the cost of the service activity "Survey the current situation" was divided into two functions: grasp the current situation and assess the current business process with the customer. The ratio of the contribution was 0.3 and 0.7, respectively. However, no widely authorized recommendation is provided with respect to quantifying the contribution. Thus, the allocation should be executed by a team of experts to ensure good quality of results. Finally, the economic cost of each function was calculated, as shown in Figure 9 (on the lowest line).

Simultaneously, a customer importance analysis was conducted. Further, by using the results obtained from the analysis of the functions from the viewpoints of economic costs and customer importance, portfolio analysis was conducted, as shown in Figure 10. Depending on the area in the portfolio, the improvement strategies for each function can be generated. For instance, for an area with high economic costs and high customer importance, the improvement strategy is to realize this function by reducing its economic cost, e.g., 'Design IT introduction clearly'. For an area with high economic costs and low customer importance, the improvement strategy is to exclude this function, e.g., 'Obtain the customer's consent to the design'.

Table 2: The list of the functions.

ID	Function
F1	Grasp the current situation
F2	Expose customer needs
F3	Assure the achievement of goals
F4	Design IT introduction clearly
F5	Design innovative and attractive IT system
F6	Obtain the customer's consent to the design
F7	Enhance the feasibility of the design
F8	Create the plan of IT introduction
F9	Enhance the appropriateness of IT introduction
F10	Set the price of IT introduction properly
F11	Enhance cost-benefit performance
F12	Planning the design of IT introduction quickly
F13	Lower the cost of the design planning
F14	Clarify the process to draw up the design plan
F15	Execute drawing up the design plan effectively
F16	Build organization
F17	Customer support
F18	Do precise report

Table 3: The list of the activities.

ID	Activity
A1	Survey the current situation
A2	Extract issues and problems
A3	Survey technology trends of IT
A4	Report the survey result
A5	Build organization
A6	Model the current business process
A7	Assess the current business process with the customer
A8	Report the plan on the occasion with president
A9	Model the future of the customer's business
A10	Extract issues toward the future
A11	Describe the future on the occasion with the president
A12	Make decision on the concept of IT introduction
A13	Put system modeling in execution
A14	Assess the effects of IT introduction
A15	Draw up the design plan of IT introduction
A16	Review the plan of IT introduction with customer
A17	Sum up the blueprint of IT introduction

(Unit: 1,000YEN)

Resource	Resources cost	Survey the current situation	Extract issues and problems	Survey technology trends of IT	Report the survey result	Build organization	Model the current business process	Assess the current business process with the customer	Report the plan on the occasion with president	Model the future of the customer's business	Extract issues toward the future	Describe the future on the occasion with the president	Make decision on the concept of IT introduction	Put system modeling in execution	Assess the effects of IT introduction	Draw up the design plan of IT introduction	Review the plan of IT introduction with customer	Sum up the blueprint of IT introduction
Consultant (A)	3,800	0	0	0	1,900	0	0	0	1,900	0	0	1,900	0	0	0	0	1,900	0
Consultant (B)	5,100	5,100	10,200	0	5,100	10,200	10,200	15,300	5,100	20,400	15,300	5,100	20,400	15,300	10,200	15,300	5,100	15,300
System engineer	8,900	89,000	71,200	35,600	26,700	53,400	124,600	124,600	26,700	213,600	151,300	26,700	178,000	160,200	53,400	160,200	26,700	133,500
***Activity cost* (YEN)**		94,100	81,400	35,600	33,700	63,600	134,800	139,900	33,700	234,000	166,600	33,700	198,400	175,500	63,600	175,500	33,700	148,800

Figure 8: Activity-resource matrix.

(Unit: 1,000YEN)

Activitie	Activity cost	Grasp the current situation	Expose customer needs	Assure the achievement of goals	Design IT introduction clearly	Design innovative and attractive IT system	Obtain the customer's consent to the design	Enhance the feasibility of the design	Create the plan of IT introduction	Enhance the appropriateness of IT introduction	Set the price of IT introduction properly	Enhance cost-benefit performance	Planning the design of IT introduction quickly	Lower the cost of the design planning	Clarify the process to draw up the design plan	Execute drawing up the design plan effectively	Build organization	Customer support	Do precise report
Survey the current situation	94,100	33,607	20,164		6,721			6,721	6,721	6,721	6,721				6,721				
Extract issues and problems	81,400		6,783		20,350		20,350	6,783	6,783		6,783				6,783				6,783
Survey technology trends of IT	35,600					15,257	5,086			5,086	5,086								5,086
Report the survey result	33,700			4,814	4,814		4,814											4,814	14,443
Build organization	63,600							19,080				6,360	6,360	6,360	6,360	6,360	6,360	6,360	
Model the current business process	134,800			33,700	33,700		33,700												33,700
Assess the current business process with the customer	139,900	13,990	13,990		13,990	13,990	13,990	13,990					13,990				13,990	13,990	13,990
Report the plan on the occasion with president	33,700						16,850									5,617		5,617	5,617
Model the future of the customer's business	234,000				29,250		29,250		29,250				29,250	29,250	29,250			29,250	29,250
Extract issues toward the future	166,600				11,900		35,700	11,900	59,500				35,700	11,900					
Describe the future on the occasion with the president	33,700						6,740									6,740	6,740	6,740	6,740
Make decision on the concept of IT introduction	198,400				33,067				33,067				99,200						33,067
Put system modeling in execution	175,500								43,875		43,875		43,875						43,875
Assess the effects of IT introduction	63,600				9,086		27,257		0		9,086							9,086	9,086
Draw up the design plan of IT introduction	175,500				58,500		58,500		58,500										
Review the plan of IT introduction with customer	33,700			6,740	6,740		6,740	6,740	6,740										
Sum up the blueprint of IT introduction	148,800				49,600		49,600												49,600
***Function cost* (YEN)**		47,597	40,938	45,254	277,718	29,247	308,577	65,215	244,436	11,807	71,551	6,360	228,375	47,510	49,115	18,717	27,090	75,857	251,236

Figure 9: Function-activity matrix.

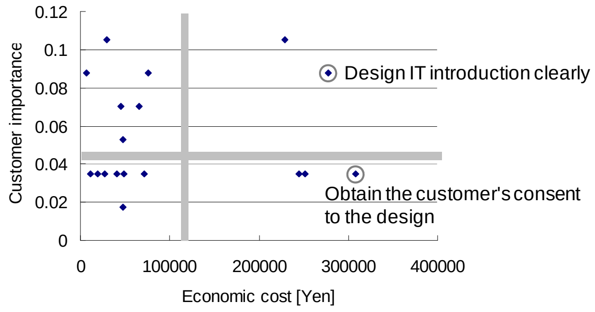

Figure 10: Portfolio analysis.

6 CONCLUSION

This paper proposed a method to evaluate service from the viewpoints of customers' demands and economic cost. Concretely, the presented method enables service designers to calculate economic cost of functions of service. The application suggested that the method could support service designers with finding improvements for reducing cost.

Future works include developing well established method to quantify the contribution that is used to allocate activity costs to functions.

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