# Designing a Time-Aware Service System:
## *Bridging the Front and Back Stages in Service System Design*

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Abstract:
A service "system" implies a systematic strategy, design, implementation, operation, and evaluation of services. This systematic approach enables to more specifically define intrinsic problems of services and solve them. One of the problems involves time efficiency; it affects the quality of each service and, as a result, customer satisfaction. In other words, time efficiency has been one of the most critical factors in services' competitive power. Therefore, this paper recognizes the importance of time efficiency in a service system and then proposes the design of a time-aware service system which supports efficient service delivery and deployment. As for the complete design of service systems, the front and back stages should be considered together. This paper also addresses the time efficiency in terms of both the front and back stages. At the back stage, information for a time-aware service system is introduced and defined, and then the information is utilized in the front stage. Finally, the applicability of this paper is demonstrated through the example of the government agency service.

Keywords:
Service System Design, Services Science, Management and Engineering (SSME), Time Efficiency

## 1. Introduction

The services sector now accounts for over 70% of the U.S. Gross Domestic Product (GDP) and the economies of other industrialized nations are similarly segmented. Despite the expansion of its economic contribution, there has been relatively little emphasis on the scientific management of services such as service value measurement, service quality improvement and service design. It is obvious that little scholarly effort for service industry contrasts with the abundance of knowledge that has been developed in the design and engineering of manufactured products. Many of the current approaches to service design are slight modifications of experiences developed for new product development.

This paper starts with this recognition and takes SSME (Services Science, Management and Engineering) perspectives [9] proposed by IBM. In this paper, service is defined as a kind of action, performance, or promise that is exchanged for value between provider and client. Additionally, the more knowledge-intensive the service, the more the service process depends critically on client participation and input by providing labor, property, or information. Depending on customer participation and information, constituent activities of the service process should behave interdependently to return appropriate results to him/her. In order to achieve this, those activities can include seeking experts (people or knowledge) necessary for the activities, referring to other series of service activities or repeating feedback on their service output with the customers. This description means when designing a service, it can be simply treated as neither a single activity nor a simple collection of activities. Therefore, the complex interdependency among different activities, people and knowledge requires a systematic perspective on a service for the effective service management. IBM already defined this systematic approach as a *Services System*. Service system is a value co-production configuration of people, technology, internal and external service systems, connected to other systems by value propositions and shared information [6].

This paper uses the service system framework of analysis to explore service design and aims at improving the time efficiency of a service system. As will be discussed, rapid delivery of services and service provision in a favorable timeframe for customers definitely contribute to their satisfaction for the service. This leads to raising the competitive power of services. As such, t*ime efficiency in service systems* can be one of the most critical factors for the competitive service. This research will present strategies to create a time-aware service system, and propose how critical information that impacts timeliness is utilized at the front and back stages. Finally, the applicability of the perspectives outlined in this paper is demonstrated through examination of an example service system.

# 2. Service System

## 2.1 Science of Service Systems

As aforementioned, a service is never the result of a single moment of co-production between service provider and consumer; it is a result of a series of interactions and operations that have contributed to the final service interface [7]. These interactions are most likely to be part of a greater *service system*, which can be seen as an ecosystem of different actors who simultaneously consume and provide services. Thus, a service system consisted of actors intertwined by many different relationships. The provider's value proposition can be experience, simplification changing the consumer's state.

Modeling service systems is difficult because there are not only actors – people, technology and shared information – but also knowledge, activities, and intentions, to take into consideration [6][9]. These factors imply that managing a service system requires decision making based on knowledge from a variety of different disciplines. However, many disciplines have tried to tackle the service design problem from their individual perspectives [2][7]. Unfortunately, one discipline cannot cover the entire design space; services design needs new sets of skills and a comprehensive approach. This limitation leads to the emergence of new discipline, SSME, which is the "application of scientific, management, and engineering disciplines" to services [9]. In other words, this explains the need for a systematic approach to services design which proposes a formal methodology, with service-appropriate models and tools, and an integration of service experience components.

To help navigate this complex conceptual terrain, Glushko [2] proposed the comprehensive approach for the front stage and back stage in a service system. Originally, the terms "front stage" and "back stage" derive from Teboul's analysis [8] which divides services into the front- and back-stage, where classification is based on which stage contributes most to the service consumer's value. Here, the front stage is referred to as a set of activities that customers can perceive as a service. The back stage refers to invisible, rich set of information and inferences that allow the front stage to support customers effectively. The line of visibility lies between the front stage and the back stage. While this distinction is useful, the demand is for a definition that can capture the different stages in addition to the person-to-person, person-to-computer, and computer-to-computer relationships that can compose a services interface [2]. As a result, this comprehensive approach is an appropriate framework for analyzing a service system, and this paper will employ this approach to enhance time efficiency in a service system.

In addition to representing these different relationships, it is also important to understand the role of information in enhancing the total service delivery process. Services span a spectrum from pure automation to pure experiences [7]. The automation happens if no human intervention is required for the services, and the experiences mean the participation of customers for the services. However, regardless of the service spectrum, the dissemination of information technology is leading to the combination of information and services (even traditional service). It should be premised that any service on the service spectrum should be informationized to be treated in a service system. Unless it is not bound with information, a service system cannot capture its status. Therefore, this paper supposes each service in a service system is digitalized and focuses on which information flows over a service system and which is useful to enhance time efficiency.

## 2.2 Time Efficiency in a Service System

Time efficiency has never been adequately discussed in the field of service systems. However, time efficiency is important in that it is one of the critical factors for service quality. In other words, more rapid and predictable service delivery can be regarded as better service for customers. As Heskett's paper [3] states, more customer satisfaction will leads to the success of a service company. Before time efficiency in a service system is discussed, I define time efficiency as follows:

**Definition 1 (Time Efficiency in a Service System)**

**Time efficiency** is a term indicating the value assigned to a situation by some measurement to reduce the amount of wasted time that may come from: undesirable features of people, information, and processes in the front and back stage of a service system.

If a service system is designed in consideration of time efficiency and behaves time-efficiently, it is called ***time-aware service system***. Now, in order to facilitate understanding a time-aware service system, two example service transactions are presented as following:

**Bank Teller:** Your name, Sir!

**Customer:** Ruth. I would like a loan of 10,000 dollars.

**Bank Teller:** Oh, your credit is really high. Even though you seem to be eligible to borrow money from our bank, we need to request more intensive loan approval procedures at our headquarters for more than 8000 dollars.

**Customer:** It is very urgent. So when can you make your final decision and how soon can I receive the money?

**Bank Teller:** Well, it typically takes 5 days. But, it depends on situation at headquarters.

Following this script, two situations for ambiguous response and inflexible service appear.

- **Ambiguous Response**

**Customer:** Is it not possible for you give me an exact time?

**Bank Teller:** Sorry, Sir! We cannot guarantee our processing time and can only let you know how long it takes on average. We also do not know what the ongoing status of headquarters is either.

- **Inflexible Service**

**Customer:** Could you finish my request earlier than your predicted time?

**Bank Teller:** Sorry, Sir! We have many customer requests to process, so it is difficult to prioritize only your request.

Those are typical issues of time efficiency in service offering. Bank tellers do not have any time information to let customers know, and the ongoing status of headquarters is seen as a black box. What if employees are on a time-aware service system?

- **Clear Response**

**Customer:** Is it not possible for you give me an exact time?

**Bank Teller:** Definitely, Sir! Currently, 15 approval requests are being processed at headquarters, and your request will be completed at 1:30pm on the 26th. You can visit me at 2pm on the 26th.

**Customer:** Wow. Is it really that exact?

**Bank Teller:** Yes, when you visit here on the 26th, you will not have to wait.

- **Flexible Service Delivery Time**

**Customer:** Could you finish my request earlier than your predicted time of 5 days?

**Bank Teller:** Yes, Sir! Since you are a premium customer, you are eligible to get expedited service. We will tag your loan request as "urgent." Even though headquarters is currently processing 10 approval requests, we can return the result on the 25th (i.e. 4 days later, not 5 days). You can visit us then.

These scenarios show the difference between a service system and time-aware service system. Through the examples, readers might already understand the differences. Briefly speaking, a time-aware system can think in terms of a whole service system (including other ongoing services), not a single service request. Also, the system can give exact completion date of service delivery and support flexible service delivery. Now, in order to realize these scenarios, it will be explained how a service system is designed in the following chapter.

## 3. Designing a Time-Aware Service System

As aforementioned, this paper starts with perceiving the importance of the connection between the front and back stage in a service system. Time efficiency issues are addressed by bridging both stages. Also, it is assumed that each service in a service system is intertwined and coordinated over networks (or perhaps the Internet).

### 3.1 Creation and Utilization of Time-Aware Information: From the Perspective of Back Stage

This section explores design of the back stage of a time-aware system. Three sequential steps are explained. First, a platform for service system design and execution should be designed. This platform allows each service to choreograph each other and collect time-aware information. Second, time information necessary for a time-aware service system is introduced. Finally, it is explained how this information is utilized at the back stage to raise time efficiency.

**1)** ***Designing a Platform for Service System Design and Execution***

In order for each service to be implemented and executed in a service system, we cannot avoid relating it to processes, since every service has processes as its core functions. That means service design can include business process modeling and analysis. The way each service can formulate business processes and how those processes are choreographed is a central concern of Service Oriented Architecture (SOA).

Web services are the foundation of SOA. Each service transaction can be implemented in web services that exchange XML documents via standard interfaces. Ideally, this approach maintains loosely-coupled architecture, which is defined as architecture where two different applications can communicate each other with only minimally required messages for the interface that do not affect the internal implementation of each application, among each component of a service system. However, this approach pursues loosely-coupled relationship among services and supports only interface information exchange, but has some limitations for providing data of internal applications within each service. In the loosely-coupled architecture, neither a sender nor a receiver knows or cares about anything besides the format and content of request and response messages. There are multiple sub-services within a unit service on the architecture. While this architecture supports the efficient choreography of services, the time-aware behaviors of detailed sub-services within a unit service cannot be supported. Therefore, there are some limitations to support more time-aware service systems.

On the other hand, BPM (Business Process Management) represents an alternative approach to coordinating service systems than typically seen in SOA. BPM uses software systems to design, execute, monitor and analyze business processes, and constituent activities are regarded as units to be integrated with applications. This system coordinates more fine-grained activities than SOA does, and so supports more fine-grained data management (e.g. R&R clarification of each activity, remaining time of each activity, and current workload of participants for the activity). However, it is a stand-alone system, which corresponds to each service on the SOA architecture, and therefore supports the choreography of activities inside each unit service on SOA.

In this paper, I propose the combination of web services and BPM to be a platform to design and execute services. In other words, the flexible system architecture of web services and more fine-grained data and process management of BPM can be combined. While some set of services can be executed on a stand-alone BPM, this BPM should be able to be integrated with heterogeneous BPMs as web services are integrated with other web services through XML interfaces. I will call this combination of web services and BPM as *service platform* in this paper.

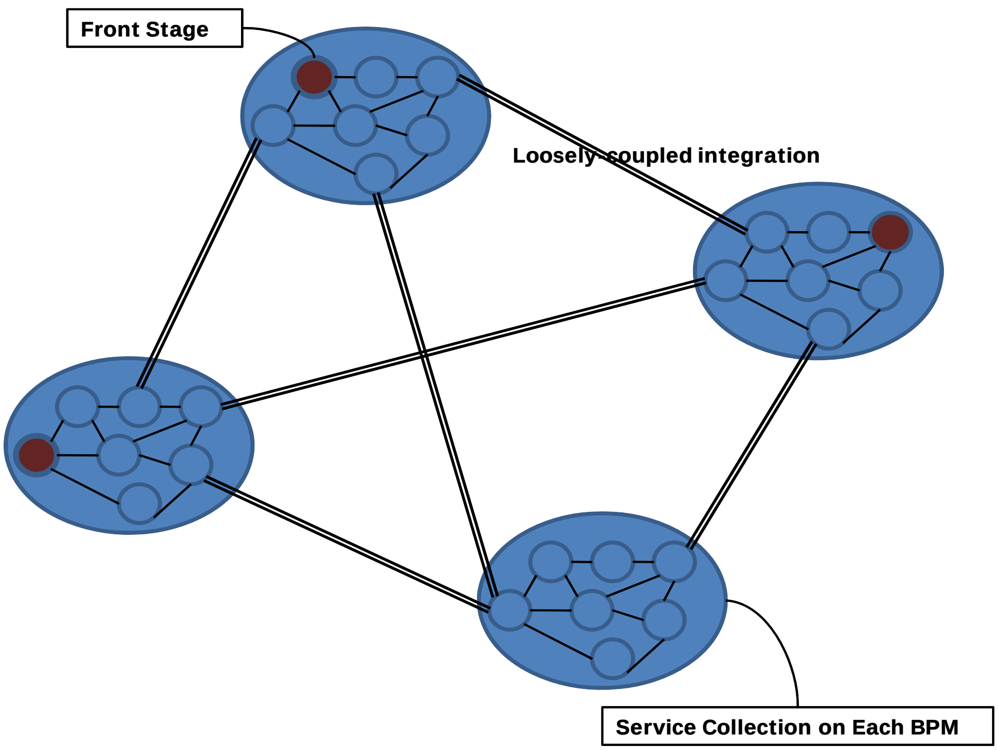


Figure 1. Platform for Service System Design and Execution

**2) *Defining Time-aware Information***

Once the platform for the service design and execution is prepared, the next step is to define information for the time-aware system and then combine methodologies with the platform, which methodologies create this information. Tabas [7] emphasizes that information flow within a service system directly affects the consumer's perception of quality, so the follow-through of the information should be focused during the service delivery process. Therefore it is important to identify which information is necessary and useful to create a time-aware service system. Please note this paper focuses on time-aware information, not the methodology itself to create the information. Different business process modeling methodologies can probably be used to help identify and characterize information required for time-aware systems, but exploration of these methods is beyond the scope of this paper. The following discussion explores some typical parameters that will be commonly needed to develop time-aware services.

***Completion Time***

Completion time in a service system is defined as the time when a single service is finished and delivered. Once this information is calculated, employees at the front stage can inform customers of exact service delivery date. This completion time requires a bunch of empirical data about average completion time of the work of employees at both stages and simulation models which can predict completion time exactly inputting the empirical values. However, in this paper, only the introduction of completion time is introduced. For more details on simulation, readers can refer to [1].

***Critical Path & Slack Time***

Suppose a service system has multiple paths which are sequenced by a series of activities. Then, the critical path, a traditional technique for project management, is the path which it takes longest time to finish among any other paths. For a single service, this path is calculated. In other words, each service can have a different critical path. This path indicates which activities are delayed so that employees on the critical path know when to expedite their services.

Slack time is time information which activities on non-critical paths can get by subtracting the completion time of critical path and non-critical paths. For example, if the completion time of critical path and non-critical path is 10 and 7 respectively, activities on the non-critical path take their slack time 3. This information contributes to flexible time management of employees on non-critical path, because a whole service is finished only when critical path is completed. They can get subtracted time to work on other services until critical path is done.

***Resource Workload***

Resource workload is a value that is relevant for each employee. It is defined as the summation of completion time of tasks which remain unprocessed on each employee’s work list. Borrowing the terms from TOC (Theory of Constraints), I can use CCR (Capacity Constraints Resource) whose resource workload is highest among any other employees and so determine the performance of a whole service system [5]. CCR needs to be managed to accelerate his services to expedite a whole service system as well as his own work. In other words, the analysis of resource workload allows service architects to identify bottlenecks in a service system and improving its performance.

***Service System Pace***

Service system pace is defined as rate at which a single service is finished and delivered. If the service system pace is lower than the rate of a customer request, a service system will be full of ongoing services (i.e. work-in-process) within it. If the rate of a customer request and the service system pace are known, the service system could adjust their pace by distributing the customer requests to other collaborators, or committing more employees to the service system. Therefore, this information indicates the health status of a service system and allows managers to invest in human resources or change response strategy of customer requests.

**3) *Executing a Service System Timely***

The third step shows the generated information can be also utilized at the back stage before it is delivered to the front stage. While the platform choreographs distributed, composite services and executes them, the time information can allow the platform to sense time-relevant problems and then conquer them.

***Service Allocation***

If resource workload is calculated, one can see who is available and busy at a certain point of time. Also, bottlenecks (or CCRs) can be defined. The platform with this information can behave in two intelligent actions: load balancing and CCR control.

***Load balancing*** can be applied to non-CCRs. Employees with the responsibility for the same or similar service activities can be substitutable. If the assignment of services to a certain employee is biased, the platform senses this and then does the load balancing by distributing them to alternative employees. Thus, the potential for a certain employee to be a CCR will be substantially reduced and then the performance of a service system can be efficiently stable.

The other alternative is ***CCR control***. CCR determines the service system pace, because the rest of the services wait for his service completion. Therefore, making CCR more efficient is no different than making a service system more efficient overall. In order to do this, every employee should specify the limitation level of his workload. This level will give a signal that if the workload of a certain employee is beyond his level, he is most likely to be a CCR. In this point of time, the platform should notify the rest of service participants who can take over the CCR's unprocessed work. If substitute employees are found, the platform assigns CCR's work to them until CCR's workload becomes below the limitation level. This idea is an effective way in that focusing only a certain resource, not necessarily all the employees, can contribute to the efficient operation of a service system.

### 3.2 Utilization of Information from the Back Stage: From the Perspective of the Front Stage

This section explored how information created at the back stage is utilized at the front stage. The way information is used is twofold: information delivery to customers and information utilization of front stage employees.

**1)** ***Information Delivery to Customers***

The completion time and the service system pace can be relayed to customers so that they are assured of their service delivery date. The completion time is not an average time of a bunch of services, but rather is a calculated time for each service. Therefore, the completion time implies customized information for each customer. Additionally, the service system pace shows that the system is available enough to complete their service at their desirable date. Customers can be assured from this information because if employees say just "yes or no" not informing "why or why not", the reliability of customers for the service will be decreased.

***2) Information Utilization of Front Stage Employees***

Employees can utilize this information to enhance their efficiency, and so ultimately raise the service quality for their customers. In this paper, two scenarios are proposed: intelligent dispatching and workload management.

Dispatching in a service system means the standard for choosing a service to be processed first when each employee select a work item from the collection of his to-do-lists. Representative examples include FCFS (First-Come-First-Served), EDD (Early Due Date) and SPT (Shortest Processing Time). In this paper, beyond the traditional dispatching, ***Intelligent Dispatching*** is proposed, whose effectiveness has been already demonstrated through [4]. This is realized by using critical path and slack time. Once the critical path and slack time are calculated, this information tells employees which service is urgent or has slack. It is straightforward that the less the slack time of service, the more urgent it is. Therefore, it is policy that employees should prioritize services with the least slack time. It is noted that critical path and slack time is calculated considering a whole service system even though this information is assigned to a single service. Therefore, using this information automatically leads employees to behave in terms of a whole service system.

***Service Allocation*** is also proposed. As discussed, the service platform also uses resource workload analysis to help accomplish load balancing and CCR control for back stage processes. In contrast, service allocation at the front stage is conducted by employees, not the service platform. Suppose an employee receives help request from a customer. If the employee is too busy to provide service with the customer at customer's desirable time or the customer asks to finish it urgently, the employee needs to check other employees' workload as well as his own workload. If he finds a service worker available, he can recommend the customer to visit the other worker. This customer response strategy is called *forwarding*. While the load balancing and CCR control are automatic management, forwarding is judged by service workers. Forwarding decisions could contribute to flexible customer management in terms of time urgency.

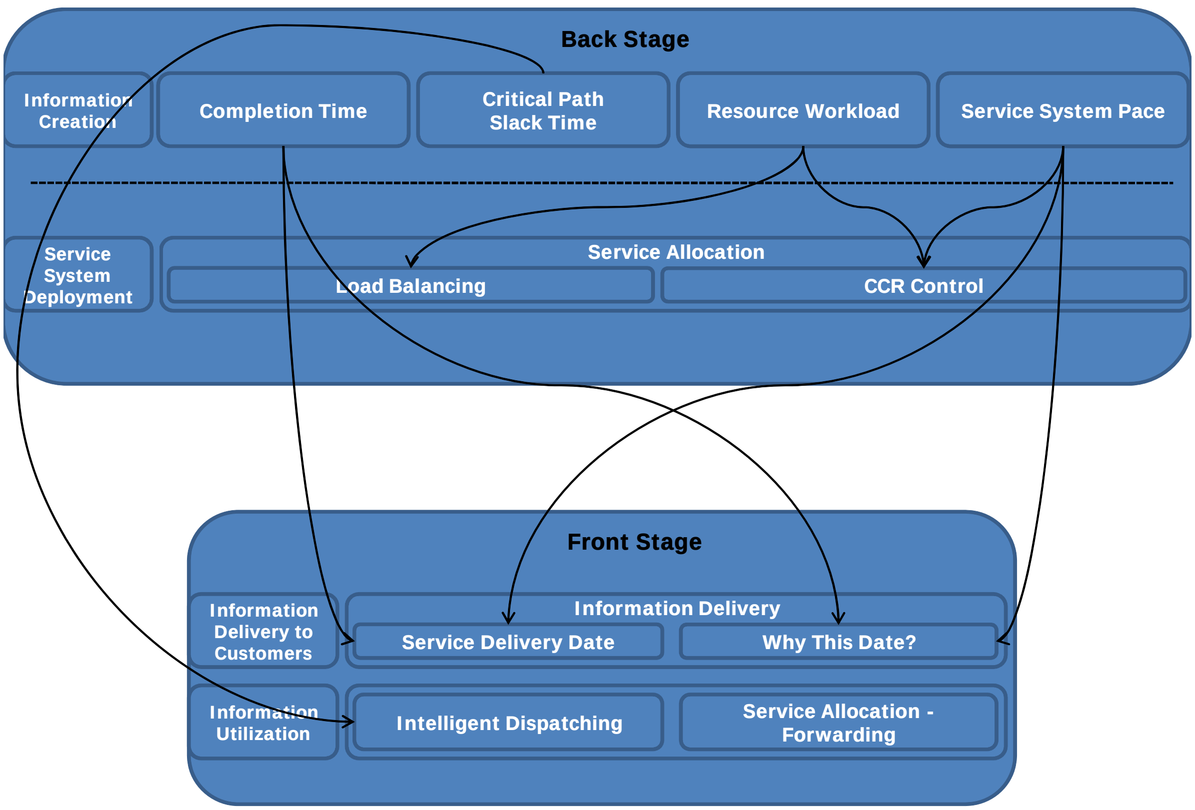


Figure 2. Time Information Flow over the Front and Back Stages

### 3.3 Measurement of Time Efficiency

As discussed, time information can be usefully introduced into both the front and back stages of service systems. Time information can also be used to establish clear metrics to measure the performance of a service system. As discussed, time efficiency is one of the factors for service quality. However, objective measurement of service quality is a challenging task. Therefore, the introduction of appropriate time metrics for application in service systems could be important step in the field of service quality measurement.

Obviously, it is an ultimate goal that a service should be delivered to customers according to their desired and expected schedule. In order to guarantee this goal, constituent elements of a service system need to be predictable and efficient. The elements of a service system usually consist of people, information and processes. Therefore, when we evaluate the time efficiency of service systems, performance indicators must be considered in at least three elements as follows:

Table 1. Time Measurement Index for a Service System

| **Components** | **Time Measurement Index** |
|---|---|
| **People** | - Utilization of employees in the front stage (e.g. actual working hours during given time)<br>- Productivity of each employee in the front stage (e.g. the number of customers to whom he offers services successfully)<br>- Constraint capacity resources in both the front and back stages |
| **Information** | - Delayed time of either the front or back stage due to inaccurate information from the back stage |
| **Processes** | - Delivery Time of a service to an end customer<br>- Time to do all of the back stage activities<br>- Elapsed time to do both the front and back stage |

## 4. Applicability Demonstration through a Real Service System

In this chapter, the applicability of this proposed time-aware service system is demonstrated. It cannot be said that the proposed system fit for all kinds of service systems. Therefore, it is important to identify the types of services where this system can be applied. In this paper, three conditions are supposed.

1) ***Multi-step Service***: Basically, a time-aware service system is more effective for services that are time-consuming and require complicated steps.

2) ***Composite Services***: Rather than a single service, the composite form of distributed services beyond internal organizations is more likely to have problems with time management. Therefore, there is more room for enhancing their time performance.

3) ***Computerized Service***: This doesn't mean only person-to-computer and computer-to-computer services. Even though it is a person-to-person service, employees can process their task using

information systems. Computerized services imply the time information (e.g. start date and completed date) of each service can be created and then shared with other services. This information sharing is a prerequisite for realizing a time-aware service system.

Now, an example service about government agency is presented. This example meets the three criteria important for time-aware services discussed above. This example would give readers an illustrative example of how the proposed time-aware service system works:

> *ISE Corporation has a lot of experiences on business exhibition abroad through the help of the government agency. Today, the company heard that the US government agency service became incomparably faster. In fact, the company nearly gave up their business exhibition in Korea, which is planning to be held 10 days later, because they knew approximate turnaround time (one month) from the exhibition request to the US government to the notification of its fixed schedule. Now, they are relieved that they can host business exhibition in Korea for the advertisement before they start business in Korea. The company appreciates the inconceivably fast government service.*
>
> *Surprisingly, the government agency didn't change their business processes and employees. First, the company should turn in an exhibition request form to the US government agency. Once the agency receives this service request, they check the eligibility of the company through credit rating and financial statement and then make approval decision. If this request is accepted, they should support the preparation of the company for the exhibition in Korea. Above all, the agency contacts the Korean government agency and asks to introduce an appropriate exhibition hall and schedule, and inform Korean potential business partners of this exhibition. Once the agency gets response from the Korean agency, it notifies the company of the fixed place, schedule and potential guests.*

If the agency provided much more rapid services with no organization transformation, the agency can be classified as a time-aware service system. Employees at the agency would supposedly work like this:

> *When the company requests the exhibition, an employee A at the front stage can monitor a whole service system for this service (from the exhibition request to the arrangement*

*for the exhibition). However, he has already a lot of services on his to-do-list to be processed. So, he quickly finds who is available to help the company and then recommend the company to visit an employee B next to him (i.e.* ***Service Allocation****). Now, this new employee B first checks the completion time for this service (i.e.* ***Service Delivery Date****). This completion time is the result which considers the ongoing status of participants in the service system. The company is really surprised that the completion time is much faster than the service delivery time in the past.*

*During the processing of this service, the service system detects that the workload of employees (i.e.* ***CCR****) for the credit rating is drastically increasing, creating a bottle neck where employees of following services are waiting for completion of credit processing before they can continue with other required tasks. The system starts to find supplemental workers for the credit rating processes, finds two people, and then assigns the CCR's work to them (i.e.* ***CCR Control****). But, one of the two has already his to-do-list full of unprocessed services. Stopping the assignment of the CCR's work to the substitutable employees, the system allocates the CCR's to only the other participant who is relatively available (i.e.* ***Load Balancing****). After a while, the CCR starts to get some slack again and so the system resumes the assignment to the CCR.*

*In the meanwhile, some employees checking financial statement have multiple service requests to be processed. Before the time-aware service system was introduced, they completed their requests sequentially. Now, they can become conscious of the processing order for their work (i.e.* ***Intelligent Dispatching****) which is beneficial for the whole government agency service system. Throughout this time-aware detection and real-time remedy, the company can really get the result of their service request at predicted time.*

This example shows the applicability of time-aware service system concepts. Significantly, a time-aware service system requires three main criteria (***Multi-step, Composite, and Computerized***) for applicability. However, this scenario does not guarantee the effectiveness of the proposed service system. Obviously implementation issues are complex, and will likely determine the effectiveness in implementing time-aware service concepts. Testing the applicability and the effectiveness of these concepts would require verification through carefully designed simulation experiments and real-world implementations.

## 5. Conclusion and Further Research Issues

More comprehensive and systematic approaches to service design are beginning to get attention from both academia and industry to support the scientific management of service offerings. This leads to regarding services as existing within an eco-system consisting of many different actors and relationships among them. As a result, IBM [6] proposed the concept of a service system that is value co-production configuration of people, technology, internal and external service systems, connected to other systems by value propositions and shared information. Meanwhile, Glushko [2] proposed the framework for the service system design, bridging the front and back stage in a service system design. This concept can give service system designers a clearer view on how to start the design of service systems and which weapons are required to do this. Therefore, this paper used this framework for designing a time-aware service system.

In addition, Tabas [7] emphasizes that information flow over a service system directly affects the consumer's perception of quality, therefore promoting the demand for a focus on the information follow-through during the service delivery process. This emphasis also is applied to the context of time-aware service system. So, this paper recognized the kinds of information created and how they flow, and then how they are utilized at the front and back stages. At the back stage, four time information are created: completion time, critical path (and slack time), resource workload and service system pace. They are utilized to deploy a service system efficiently and allow front stage employees to enhance the customer's perception of service quality by providing the information. Finally, the applicability of the time-aware service system is demonstrated through the example of the government agency service.

Further development of this paper should raise some research issues. First, methodologies to calculate proposed information should be developed. Second, new information should be able to be more investigated. Also, information needs to be classified and segmented along with the multi-dimensional classification of service systems. Finally, it should be analyzed whether the tradeoff between efficiency and effectiveness (i.e. accuracy) exists. In other words, since a time-aware service system may sometimes sacrifice the accuracy of service, the design of a time-aware system should be able to accommodate the perspective of service effectiveness together.

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