國立中興大學科技管理研究所

Graduate Institute of Technology Management
National Chung Hsing University

碩士學位論文

A Thesis Submitted in Partial Fulfillment of the
Requirements for the degree of Master

服務系統模型設計

Models for Service System Design

指導教授：沈培輝 博士 Pui-Fai Sum, PhD

研究生：黃茂松 Mao-Song Huang

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中文摘要

在軟體工程中，系統分析與設計需要用到多種模型。在服務科學中，設計一個服務系統同樣需要用到多種模型。雖然很多服務研究學者提出用來設計服務傳遞流程的模型，但是一個用來設計總體服務系統的多模型架構卻尚未被提出。有鑑於此，本論文從管理及軟體工程界中選出了五種模型，這五種模型不只可以組成一套用來設計總體服務系統的模型，它們也都夠簡單以至於可以被管理專業人員所採用。而且，所有包括在服務系統中的人都可以輕易地了解並使用這套模型。這五種模型分別是商業模式圖、服務藍圖、流程圖、行為者網路以及組織結構圖。我們將這套設計方法分為四個步驟，第一個步驟是商業模式設計，第二步驟是服務接觸設計，第三步驟是核心流程設計，最後一個步驟是組織結構設計。在本論文中，我們以一家美式餐廳的用餐服務為例來描繪這套模型的運作，以及它們如何用來分析服務系統。

關鍵字：商業模式圖、服務藍圖、流程圖、行為者網路、組織結構圖、服務管理、服務科學、服務工程

ABSTRACT

In software engineering, several models are combined for system design and analysis. This concept is same in service science, service management, service engineering (SSME) for designing a service system. Though lots of service researchers have proposed models for designing a service delivery process, multi-model framework for holistic design of a service system has yet to be revealed. In the thesis, we have selected five models from the area of management and software engineering. These five models can provide a holistic design of a service system. Moreover, they are simple enough to be adopted by management professionals. People involved in a service system also can comprehend and utilize the models easily. These five models include business model, service blueprint, sequence diagram, actor network and organization structure. We will complete the holistic design in four steps, namely business modeling, service encounter design, core operation design and organization design. By giving an example of designing an America style restaurant, we elucidate the way of applying these models and how to use these models to analyze a service system.

Keywords: Business model, Service blueprint, Sequence diagram, Actor network, Organization structure, Service management, Service science, Service engineering

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1. INTRODUCTION

For many decades, researchers in service field have proposed several models for designing a service delivery process (Bitner, Ostrom, & Morgan, 2008; Glushko, 2008; McKay & Kundu, 2011; Patrício, Fisk, & Cunha, 2008; Patrício, Fisk, Cunha, & Constantine, 2011; Shostack, 1982, 1984; Zirpins, Baier, & Lamersdorf, 2003). Essentially, these models are variants of the Shostack's service blueprint (Shostack 1982, 1984), which depicts the core operations of a service firm in providing service. Precisely, it depicts how a customer gets the service, what activities the service firm has to do in the process of interaction and what physical evidences the service firm has to pay attention to so as high quality service could be delivered. Some models include designs of the interactions amongst the back-end staffs, the front-end staffs and the suppliers (e.g. Sampson 2011). The design of a service that delivered entirely by an information system can be accomplished (Glushko and Nomorosa 2012). On the other hand, models for designing an organization can also be found in the area of organization theory and design (Daft 2013) which focus primary on the organizational structure.

Holistic Design in Software Engineer: As learned from software engineering (e.g. Pressman & Maxim 2015), multiple models are needed for system design and analysis. Some are used for process design (c.f. operations design) and some are used for architecture design (c.f. organization design). These designs are inter-dependent. Changes in one design could lead to a modification of the other. Let us have an example of cloud storage service.

> *Cloud storage service: It is a platform allowing users upload and download files over the Internet. The service is supported by a single server. When the number of users has reached a certain level, two servers are installed to support the*

service. That is a change of architecture design from single-server to two-server. Let see what will happen on the process design. Under single-server architecture, all the programs are running in the same machine. The problem of data flow among programs can be ignored. For two-server architecture, data flow between machines could cause delay and thus affect the service quality. Hence, problem of data flow among programs has to be tackled. To solve this problem, developer needs to do two things. First, developer needs to look up the process design to determine the best partition of the programs (modular design) so that data flow between modules is minimized. Second, additional programs have to be added in the process design for handling this issue. As a result, the same quality service could be maintained.

The users are not aware of the changes as the core functions are still the same. But, actually, changes have been made. Another example can be given if the upload-download service is allowed for smartphone users. In the process design, additional program will be needed to handle the files transfer between the smartphone and the server. Moreover, additional server would be required particular for handle this new function. In either case, changes in one design would lead to changes in another. To have holistic design of a service system, multiple models will be needed. In software engineering, UML is in fact a multiple models framework for holistic design of a software system. However, UML has always been claimed to be a complex framework and the models in it are complicated (Bitner, Ostrom, & Morgan, 2008).

Motivation & Objective: Nowadays, due to the increasing demand on the product features and the service contents, the service system is getting more complicated than before, more factors need to be considered, as well as the people involved in. We could note that from the evolution of the telephone. In the early days, the telephone was simply a device for dialing number and making phone calls. Since the launching of iPhone, it provides us variety of services, besides making a phone call, such as

connecting to the Internet, searching the location of favorite restaurant on Google map, and listening to music on iTunes. We believe that the trend of becoming complicated will continue in the future and become even more fiercely. By only a single model, it is difficult to provide a holistic design of a service system. A holistic design includes service encounter design, service delivery process design, management process design, organization design, job design, information system and technology requirement design, quality design, exceptional situation handling design, and marketing activity design. However, in SSME, multi-model framework for holistic design of a service system has yet to be revealed. Fortunately, many models have been available in the literatures although they are scatted in different areas. To select which models to be included in our collection, we based on the following criteria.

1. *The model must be simple enough to be adopted by management professionals.*
2. *The information conveyed by the model must be rich enough. So, the characteristics of a service system can be fully depicted.*
3. *The information conveyed by the model must be understood by technical experts. So, the requirement of the information to be developed and the required technologies can be easily identified.*

As a result, five models are selected in the areas of management and software engineering. They are (1) business model, (2) service blueprint, (3) sequence diagram, (4) actor network and (5) organization structure. How these models are applied in (a) business modeling, (b) service encounter design, (c) core operations design and (d) organization design is outlined. With an illustrative example how these models can give a holistic design of a service system is elucidated. Finally, how these models can facilitate analysis for optimal design is described. Managers, operational staffs and IT/IS professionals are able to understand the design easily and treat it as the visual language for communication.

Organization of the Paper: It should note that the designing of a service system is just the very first step of service engineering. Therefore, in the next chapter, we will briefly present the conceptual framework of service engineering. Service engineering is composed of five stages, which are the stage of analysis, design, implement, testing, and maintain and review. In Chapter III, we will introduce two types of design models. Three existing models which have been widely used in service designing, including service blueprint, process chain network and sequence diagram will also be introduced. An example will be illustrated to compare these three models on the usage of designing a service. To achieve our objective, we will complete the design models with the five selected models in Chapter IV. Detail steps in designing a service system will be outlined. Chapter V discusses about the analysis which can be conducted by our models. The design principle of the models is then showed in Chapter VI, and the conclusion of the paper is presented in Chapter VII.

2. SERVICE ENGINEERING

Designing a service system is just the very first step in service engineering, aiming to build a system (c.f. develop a business). We perceive a service system as an ecosystem composing of people, process (i.e. the service delivery process) and tools/technologies; and its purpose is to deliver quality service to its end customers (or service consumers). Adopted from the IEEE definition of software engineering, we define "service engineering" as a system development process based on the application of a systematic disciplined, quantifiable approach to the development, operation, maintenance of service systems. Service engineering process consists of multiple stages namely analysis, design, implementation, testing and maintenance. The conceptual framework of service engineering and its relations to service science, software engineering and service management are shown in Figure 1 and Figure 2.

The aim of **analysis & design** is to attain the optimal design of the service system to be launched in the future. The works to be done in the stages of analysis and design include (i) transforming the verbal definition of the system to a serious of system models (via informal models like service blueprint and formal models like sequence diagram) (ii) analyzing the system model via analytical analysis and computer simulations; (iii) based on the analysis result giving the optimal design on the service delivery process and the service system (i.e. the organization structure). Specifically, the design includes the definitions of the service delivery process and the processes monitoring the quality of service, the roles of the suppliers & customers, the key professionals to be involved and their job descriptions, the organization structure, the operation manual, and the requirement specifications of the tools, technologies and information systems. Moreover, the key performance indices and the level of quality are

defined. Analysis and design are the scope in which service science focuses.

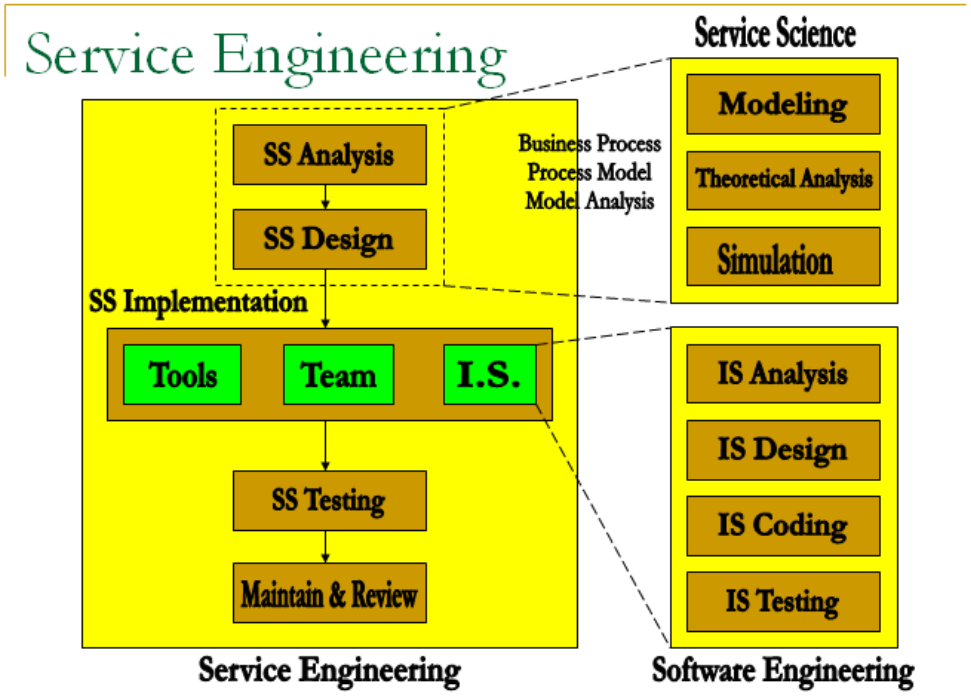


Figure 1 Conceptual framework of service engineering. SS refers to service system, while IS refers to information system.

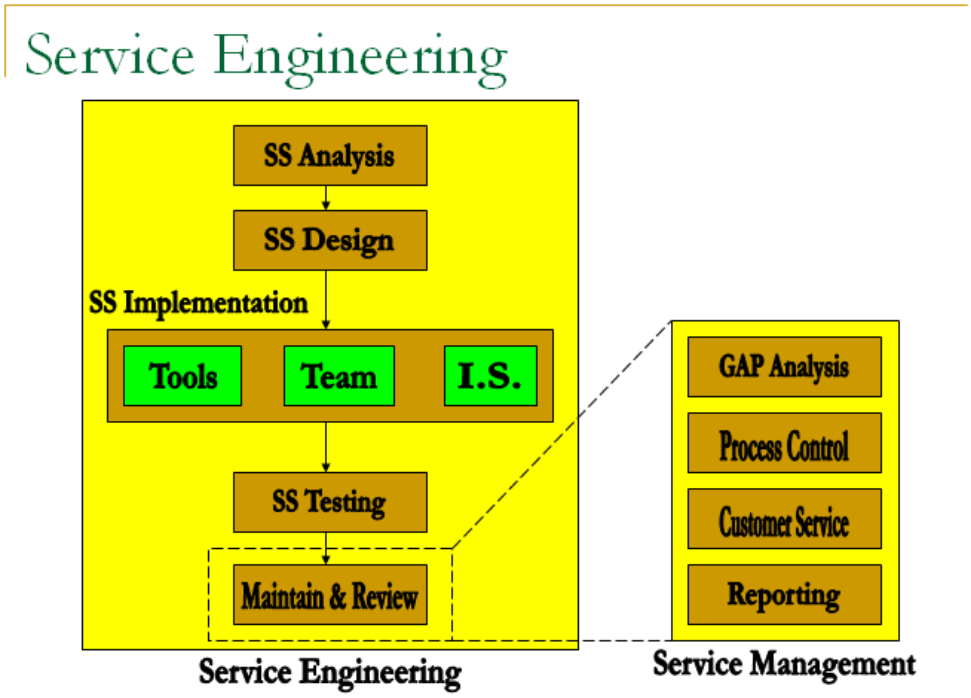


Figure 2 Service engineering and service management.

In the **implementation** stage, the tools, the technologies and the information systems are built (or acquired). The staffs are trained to do their jobs. After that, it comes to the stage of system testing. The service delivery process can be testified by running rehearsals to make sure that the system is able to meet the key performance indices and the level of quality.

Once the all the tools are ready, the workers have been well trained and the information systems have been installed, the next step is to conduct a **testing**. The purposes of testing are three folds: (1) to check if the team performs as anticipated in the design stage when the business running in a normal condition; (2) to figure out if the team performs as anticipated in the design stage under different exceptional conditions; and (3) to identify if there is other missing exception situation that needed to be handled. A major challenge in service engineering is in the stages of implementation and testing. As customer is normally not involved in these stages, the true customer perception on the service quality cannot be obtained. We can only rely on the feedback and comments from the employees to examine if the performance of the service delivery process is acceptable.

If everything is fine, it comes to the stage of system **maintenance and review** in which the system is launched and customers are able to get the service from the organization. In other words, it is the stage that the business is running – the restaurant is now open for business. All the actors follow what have been specified in the detail job descriptions. The service management process puts in place by the shop manager. Reviews on both the performance of the system and the customer perception on the service quality are conducted in regular basis. GAP model and SERVQUAL (Parasuraman, Zeithaml, Berry 1985, 1988) could be used as the tools for such survey and analysis.

3. EXISTING DESIGN MODELS

There are two types of design models, formal model and informal models. Formal models are models that analysis could be accomplished theoretically (for instance by queuing theory and scheduling theory) and computer simulations can be conducted to anticipate any exceptional behaviors might appear. Moreover, the waiting time, the time to deliver and the operation cost can be estimated. In other words, the performance of the (future) service system can be validated and thus the optimal design on the service system can be achieved. If measure on customer experience is defined, the satisfactory level could be anticipated. Its main purpose is to define a vigorous model for a system with no ambiguity. OMG Unified Modeling Language (UML), OMG Web Service Business Process Execution Language (WSBPEL), OMG Business Process Modeling Notation (BPMN) and IDEF (Integration Definition) are the example of formal models.

On the other hand, informal models, also called qualitative or descriptive models, are models that analysis could best be accomplished by quantitative methods. Most models appear in the service management or service marketing textbook are informal models. Their common feature is that the characteristic of each of the task/interaction is defined descriptively. No any mathematical model is defined side-by-side with the description. Service blueprint and process chain network are two of these models. While the sequence of interactions amongst the customer, the workers in the focal firm and the workers in the suppliers have been depicted, the actual processing time in each task/interaction has not been defined. For identifying the potential limitations and failures as what a management professional normally do, it is good enough. However, to analyze the performance, it is not possible.

Nowadays, there are many models on the usage of detailing a service system.

While each model has its pros and cons for detailing a service system, it is necessary to investigate if there are any existing models which are better off than the others. Due to the great quantity of the models, we only select three models which have been widely applied in service modeling to introduce in this section. These models include the service blueprint, process chain network and sequence diagram. Service blueprint shows how the customer will get a service step by step, and what the operational staffs have to do and when they have to do. Process chain network captures the interrelationships between the firm processes and customer processes. Sequence diagram shows the responsibilities of each person who is involved in the process and when they have to be involved. We will compare these three models, and illustrative examples are also given to highlight the similarities, the differences and the difficulties in using such models for modeling a service. Besides these three models, in the last sub section, we will also briefly introduce four design models which are very close to formal model.

3.1. Service Blueprint

Service blueprint is a map or flow chart which depicts the service delivery process in detail. It was first presented by Lynn Shostack in the Harvard Business Review in 1984(Lynn, 1984). Service blueprint lets anyone who is involved in the service delivery process, whatever their roles (from executive managers to receptionists) or tasks (from front line staffs to logistic staffs) are in the process, can comprehend the whole service delivery process. It makes the communication between different levels or departments become more effectively and efficiently, and so does the service delivery process.

Service is intangible, so it not only leads to the evaluation of the service value largely depending on our feeling and subjective judgment, but also brings big challenge to the service designers, because they don’t know whether the customers will be

satisfied with the service or not until the service is provided to them. Service blueprint solves the problems by providing physical evidence of the service. It is the tangible that customers are exposed to that can influence their quality perceptions, so the designers can evaluate the service value by it instead of their subjective judgments. Physical evidence is only one of the five components of service blueprint, and the others will be briefly illustrated in the following paragraph. Service blueprint differentiates the processes by the visibility of them. Appearing below the physical evidence are the customer actions, they are the actions what customers will take in the service delivery process. The onstage actions are separated from the customer actions by a “line of interaction”. These are the actions which interact with the customers directly face to face. Separating from the onstage employee actions by a “line of visibility” are the backstage actions. These are the actions between employees and customers, but they can’t see each other, such as the telephone or Internet service. The support process is the least part of service blueprint, separating from backstage actions by “line of internal interaction”. These are all the necessary actions which are taken by individuals or units within the company who don’t interact with the customers. Without these actions, the service won’t be delivered successfully, and the representative example is the information system.

Comparing with the product, innovation in service is relatedly lacking. Due to the characteristic of service, such as intangibility, dynamic, or fluid, tradition innovation tools used for product do not work well on service. There are not preferred tools for service innovation until service blueprint was developed. Service blueprints are relatively simple and their graphical representations are easy for all stakeholders involved—customers, managers, and frontline employees—to learn, use, and even modify to meet a particular innovation’s requirements(Bitner, Ostrom, & Morgan, 2008).

It can enable a company to innovate services for customers, as the company can visualize the entire service delivery process and the concerns of the customers about the service. Currently, most of the service models can be used for service innovation, and service blueprint becomes the pioneer of them.

There are six processes of building a service blueprint. Take Figure 3, the dining service of a restaurant, for example. The first step is identifying the service process that is supposed to be blueprinted, especially the processes that the customer can't see, and it is also the most difficult and important step, because it is hard to determine all processes. In this example, the processes are the actions like take order, deliver food, and so on. Secondly, identifying what customers the service is going to provide to. People who are going to have a meal are the customers in this example. After completing above two steps, the designers can start to build the diagrams, the last four steps, which are picturing customer actions, picturing onstage and backstage employee actions, linking them together, and the last, adding the physical evidence of service for every customer action step. The designers must depict the service processes from the customer's perspective, so it can avoid them from focusing too much on the processes which make no differences to the customers.

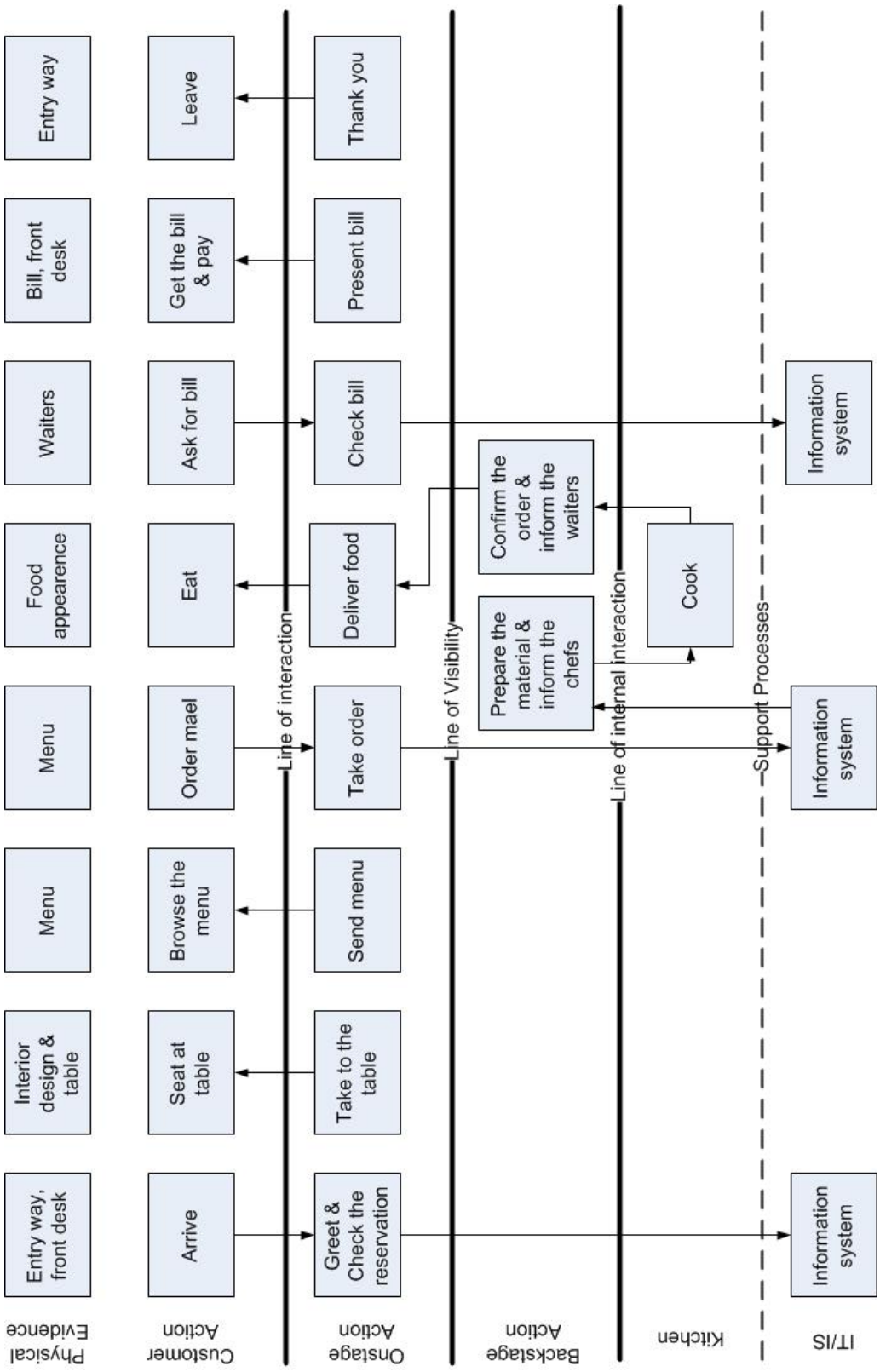


Figure 3 Service blueprint of the restaurant.

3.2. Process Chain Network

Process chain network diagram is a new tool for service design, which was presented by Scott E. Sampson in 2011(Sampson, 2012). Its framework is composed of four elements. The most fundamental component is the process. Process is defined as a sequence of dependent steps, and it is usually performed by entities and act on resources. As matter of fact, a step is equivalent to a task which is defined in service blueprint. When there is an identifiable purpose of a sequence of steps, it is a process chain. Taking a process chain with the purpose of serving a meal for example, the first process step is taking the order of customers, secondly, the cooks have to prepare the meal, and the last, serving the meal to the customers. A process entity is any entity that participates in a process, such as the companies or the customers. The key ability of a process entity is to make decisions about the initiation or progress of some portion of a process chain. Each process entity has a process domain, which includes all processes that are directly performed by the entity. Unlike the service blueprint, Process chain network differentiates the process steps by the nature of interaction rather than the visibility of the processes. It separates the process steps into three regions of a process domain, including the direct interaction, the surrogate interaction and the independent processing. The direct interaction means that people are interacting with people, such as the process step of the waiter takes the order of the customer. The biggest difference between process chain network and the service blueprint is the surrogate interaction, and it is also the concept that never considers in service blueprint. It means that people are interacting with the nonhuman resources of another entity, such as the customer makes reservation on the website of a restaurant. The last one is the independent processing. By the definition, it means that the entity only acts on its own resources. However, there

still are some limitations of the process domain, one is no representation of things autonomously acting on things, like the automatic car wash, another is if there is something that acts on people, what region it belongs to.

Figure 4 is an example of the dining service of a restaurant. The first step of building the process chain network is same with the service blueprint, identifying the service process that is supposed to be built. The second step is identifying the process entities that participate in the processes. This usually includes a firm and the customers. In this example, restaurant and customer are the process entities. Next, the designers need to record the steps which mark the start and end of the processes. They usually start with the need of customers and end with the fulfillment of the need. It starts with “arrive at the restaurant” and end with “eat leftovers” in this example. At last, filling in intermediate steps, showing which process domain and region each steps occurs in.

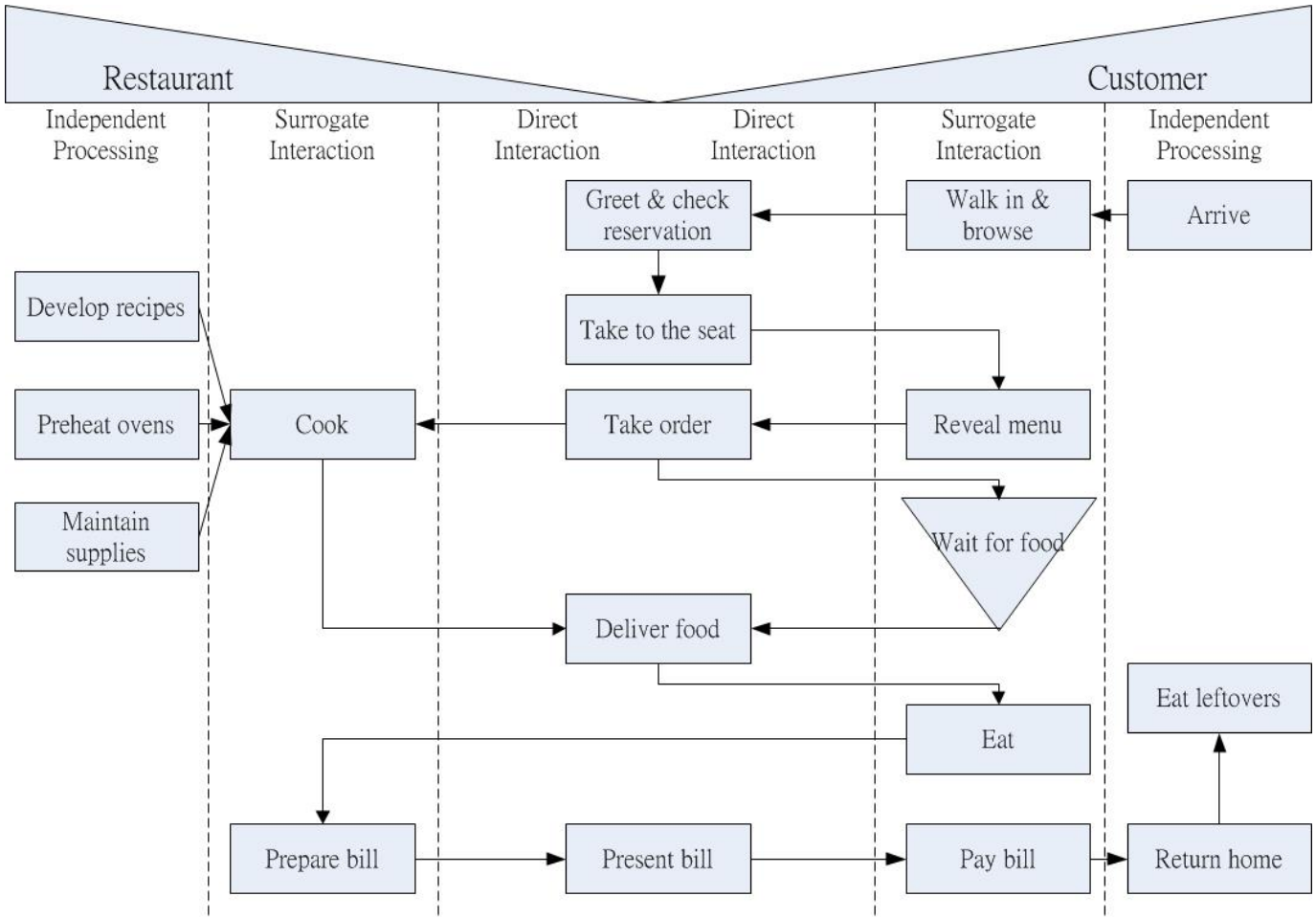


Figure 4 Process chain network of the restaurant.

3.3. Sequence Diagram

Sequence diagram is one of the UML diagrams, which shows the interaction between each role in terms of a sequence of messages. Sequence diagram consists of four elements, which are role, lifeline, message and activity. Roles are the targets that the messages can be sent to them. Every role has a lifeline below it, and it will extend for as long as the role exists. The interaction between each role is displayed by the message, which is illustrated with horizontal arrows with the message name written above them. The solid arrow lines are used to represent the message sending, and the dashed line for message response. Activity demonstrates how much time the role has to spend on an operation. It usually illustrates with a square frame, which mantles the lifeline. With sequence diagram, the designers can consider how to exchange the message between each role. Moreover, with the concept of the timeline, sequence diagram can express the activities in the order.

Figure 5 is the same example with above two models, and so does the first step of building sequence diagram. The designers need to identify the processes initially. Next, find out the roles in the processes. In this example, the roles are receptionists, waiters, backstage waiters, chefs, and the information system which supports the processes. At last, determine the interaction between each role, which becomes the message.

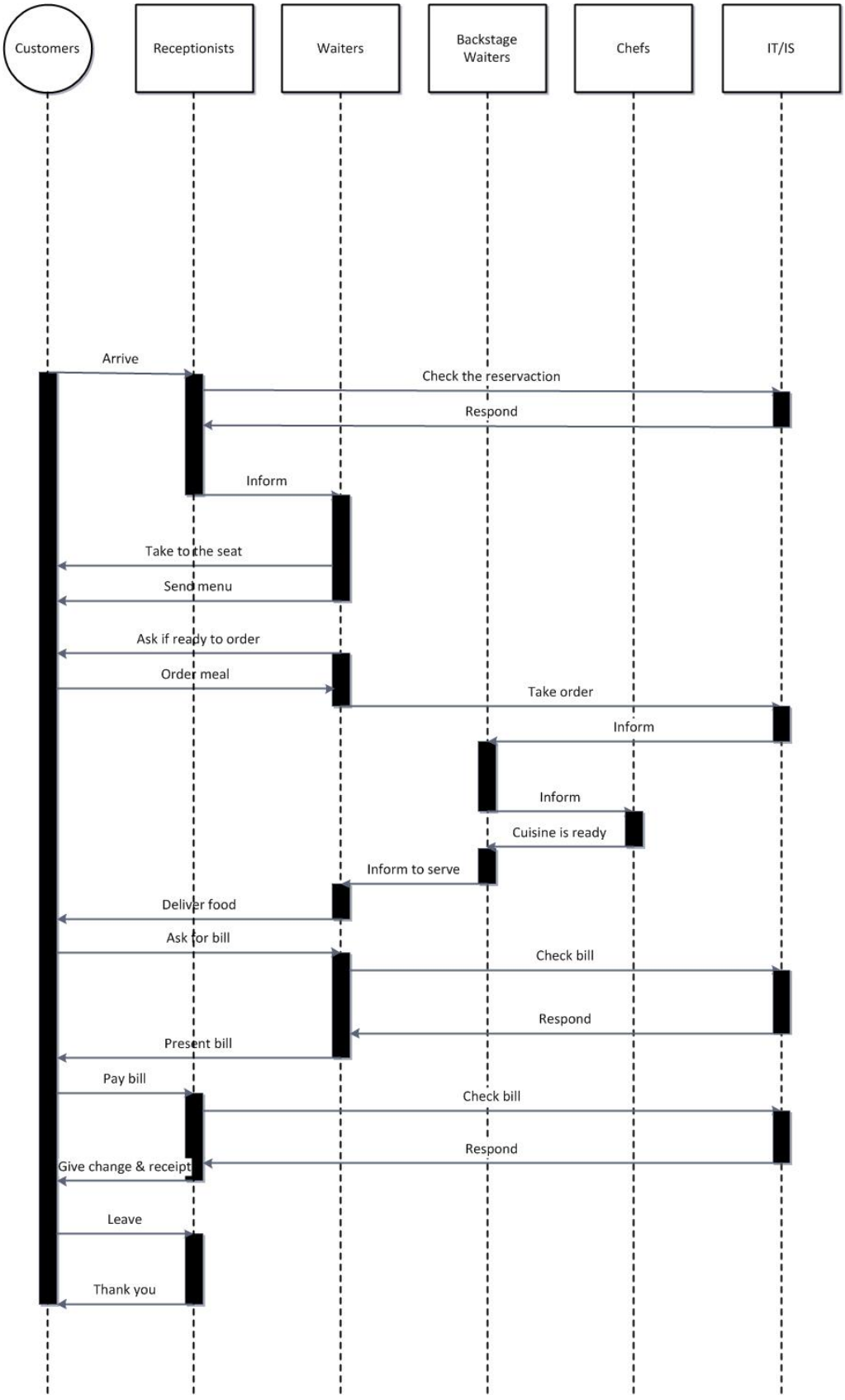


Figure 5 Sequence diagram of a restaurant.

3.4. Comparisons Among These Models

We compare these three models, and find out the difference on the usage of modeling a service between them.

3.4.1. Service Blueprint vs. Sequence Diagram

Service blueprint looks very similar to sequence diagram. If we rotate the service blueprint 90 degrees, we will find that it will become a sequence diagram. Although their appearance is very similar, there still are some differences between them. Service blueprint is a labor intensive model. For machine intensive service systems, such as cloud services and telecom services, service blueprint can't be easily defined, but sequence diagram can. One of the reasons is that sequence diagram is the diagram which is originally used in computer science. Therefore, it is easy for it to define the machine intensive service systems rather than service blueprint since service blueprint is brought up by management people. However, the main reason is that information system in a service blueprint is treated as a supporting process and its operations are defined qualitatively. Finally, it generates a gap between the management team and the development team on the requirement of the information system. The situation will also occur in sequence diagram when it is used independently, but as mentioning in preceding article, sequence diagram is one of the diagrams in UML, as a result, it can coordinate with other UML diagrams, such as use case diagram and component diagram, and makes it able to describe a service systems with no ambiguity. Unfortunately, there isn't any diagrams can coordinate with service blueprint.

3.4.2. Service Blueprint vs. Process Chain Network

Due to the similarity between service blueprint and sequence diagram, we only compare service blueprint with the process chain network. First one is that process

chain network considers the nature of interaction, rather than process visibility, to be the primary basis for differentiating processes steps. Processes steps are distributed by the involvement in an interaction, regardless of whether the processes steps are visible to others. Besides, process chain network can depict a network representation of service processes, which means it can span an unlimited number of entities that can each operate independently or interactively with other entities. It suggests that process chain network can depict the network and the interactions simultaneously with an integrated approach while service blueprint need to conduct it subsequently. In others words, the scope of process chain network can extend from firms and customers to the suppliers, but the scope of service blueprint is only limited to the firms and customers. Therefore, the modeling level of process chain network is higher than service blueprint. At last, service blueprint, as well as the sequence diagram, is considered as the behavioral model. It means that they both focus on the incidents which occur in the models. So that, both service blueprint and sequence diagram are suitable for defining the standard operation procedures (SOP) in a firm. On the other hand, process chain network and the data flow diagram are essentially the same. They are process models, which classify the same nature of processes together into a model. As a result, they are suitable for defining the organizational structure of a firm.

3.5. Other Models

Besides the models which we have introduced in the previous paragraph, there are also many models which have been proposed for service modeling. Different from the three models, in this section, we will introduce four models which are so complicated that they are hard to be adopted by management professionals. These models are very

close to formal models, including component business model, agent based model, computational and configurable service system model, and service systems meta-model.

3.5.1. Component Business Model

Component business model (CBM), which was developed by IBM in 2005, is a tool for modeling and analyzing an enterprise(Pohle, Korsten, & Ramamurthy, 2005). According to the view of CBM, an enterprise is an aggregation of business components. Each business component plays a specialized role which creates value in the organization, such as material management, allocation, or advertising. Through CBM, all components will be categorized by business competencies and accountability level. Business competencies define the type of the values provided by the components. Therefore, they vary from different enterprises in different industries. Each component should line up down a particular competency. Unlike business competencies, the accountability level of every enterprise is same. Components will be divided into three levels, including the direct, the control, and the execute level. With CBM, the executives can illustrate every business activity functioned as a linked set of modules on a single diagram. Thus, they can align the business capabilities and the investments to the enterprise strategies. The redundant or overlapping business capabilities will also be identified. Besides, CBM can let the executives rearrange the sources for different components. After mergers or acquisitions, it also can provide a comprehensive and unified roadmap for integration.

3.5.2. Agent Based Model

Agent based model (ABM) is a computational model which is used for simulating the actions or the interactions of autonomous agents(Bonabeau, 2002). Its purpose is to evaluate the effects of the entities on the whole system. Autonomous agent generally

refers to an intelligent agent or entity that makes its own choices about how to act in its environment without any influence from a leader. In today dynamic and complex environment, with ABM, we can predict the appearance of complex phenomena by simulating both the operations and interactions of multiple agents. There are five steps of designing an ABM. At first, the designer needs to identify the active entities or agents, which can be the people, companies, or products. Secondly, the behaviors of the entities are defined, such as the main drivers, reactions, or states. Then, the designer will put them in a certain environment. After establishing the connection among the entities, the designer can subsequently run the simulation. Nowadays, ABM has been widely applied in many industries. It can solve a lot of business and technology problems, such as the complex optimization problem or the modeling of consumer behavior.

3.5.3. Computational and Configurable Service System Model

Computational and configurable service system model (C^2S^2) provides a computational approach to modeling a service system(Qiu, 2009). Compared to manufacturing, service system mainly focuses on people. As people participant in the service system, from production to consumption, it is necessary to consider people's physiological and psychological issues, cognitive capability, and sociological constraints in modeling a service system. Therefore, due to the dynamics and adaptiveness of service system, computational thinking is regarded as a preferred way for modeling and managing a service system. Through C^2S^2, service system is formularized by using a structured workflow language and π-calculus based on the concept of business process management (BPM). The process-driven BPM approach provides an appropriate choice to display all the necessary interactions, interdependencies, and relationships within the service system. The symbols from Yet

Another Workflow Language are also adapted and revised by C^2S^2. In conclusion, C^2S^2 is a computational model which mainly focuses on the future enablement of system configurability by taking into account human interactions and consequences.

3.5.4. Service Systems Meta-Model

Strictly speaking, service system meta-model is not the model which is directly used for modeling a service system(Böttcher & Fähnrich, 2011). The term meta-model has been widely applied in software and system engineer. It is a model of a model. In other words, it provides the rules, frames, and theories for modeling. As numerous different approaches have been used for service modeling nowadays, there is lacking of a certain modeling understanding for them to base on while each of them represent particular aspects. Therefore, the proposal of service systems meta-model provides an adequate modeling theory for service system modeling. Service systems meta-model is composed of four sub-meta-models. Each sub-meta-model refers to the specific aspects of service systems. First sub-meta-model is the component model. Through component model, a service system is composed of many service components based on the concept of modularity. Each component has its functional or non-functional properties. Resource model is the second sub-meta-models. It defines the specification of the component's resources. The definition of interdependencies of service components relevant for configuration is defined by product models, the third sub-meta-model. The last model is the process model. It provides the rules for temporal sequences among the service components. In conclusion, service systems meta-model provide a formalized, precise and detailed way in modeling a service system.

4. COMPLETE DESIGN MODELS

To have a good design of a service system, one should realize that it is a process involving the service designer, the operational staffs and the managers, Figure 6. Service designer is responsible to design the service system regarding the information provided by the operational staffs and the managers. Operational staffs implement the service delivery process while the managers conduct quality control activities. Missing the effort of any one of them, the design can hardly be complete. At the same time, the design needs to consider the services delivered and their quality levels. Moreover, the design has to align with the strategies laid by the service firm. These factors are considered in the design of the service system. Once the contents of these factors have been determined, the design process can be accomplished a four-step design process, as depicted in Table 1, which include business model design, service encounter design, core operations design and organization design. In addition, these steps are circulated. After analyzing the service system, the designers may revise one of the models, and the other models will need to revise, too. In conclusion, the designers will review and revise the models again and again until providing the most preferred service quality to the customers. For illustration, we use a restaurant as an example and we assume that the restaurant has not yet existed.

Restaurant: After a couple of meetings and brainstorming, the owner of the restaurant decides that the new restaurant is going to serve American style five courses meals. Each meal consists of soup, appetizer, main course, dessert and drink. For each course, there are a few options for selection. For instance, sirloin steak, rib or T-bone can be ordered as the main course. Coffee, tea or soft drink can be ordered as the drink. The average price of a standard five courses meal is USD50. The decoration of the restaurant is like TGI Friday. The restaurant will treat every customer as an honor guest and make each customer

feel like eating at home.

The restaurant will have a receptionist stand at the front door. The interior design will be like bar and restaurant style. The design of the front door, the receptionist stand, the dining hall, the kitchen and the menu are shown in the Appendix.

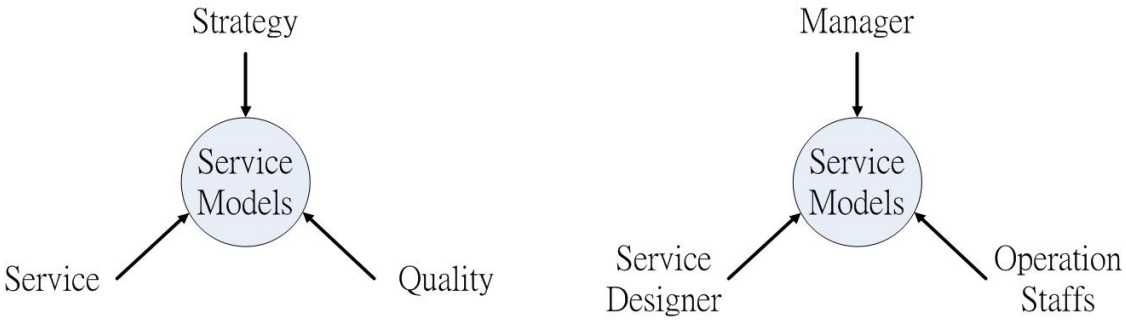


Figure 6 Factors and people involved in service models.

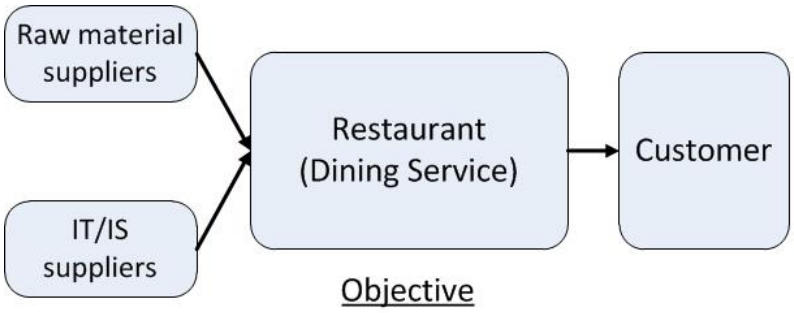
Table 1 Steps of Designing a Service System.

Steps of Designing a Service System
Step 1: Business Model Design. Step 1.1: Design the services to be delivered. Step 1.2: Design the service supply chain. Step 1.3: Define the quality model. Step 1.4: Define the strategies
Step 2: Service Encounter Design. Step 2.1: Design the service encounters in the service delivery process. Step 2.2: Design the service delivery process by service blueprint.
Step 3: Core Operations Design. Step 3.1: Convert the service blueprint to sequence diagram. Step 3.2: Augment the interactions with the suppliers. Step 3.3: Augment activities for quality control. Step 3.4: Augment activities that implement the strategies.
Step 4: Organization Design. Step 4.1: Convert the sequence diagram to actor network. Step 4.1.1: Design quality models for the actors. Step 4.1.2: Design necessary operations for quality control. Step 4.1.3: Compile job descriptions for the actors. Step 4.2: Design the organization structure. Step 4.2.1: Compile job descriptions for the departments. Step 4.2.2: Define the report structure. Step 4.3: Compile computer program like job descriptions for the actors.

4.1. Business Model

Business model is the first model of the integrated system of models. It determines the product or the service content provided by the company. In other words, business model determine how the company make profit, by selling what products or providing what services. Through the business model, the objectives of the company can be determined, and the company can develop the strategies to achieve the objectives subsequently. Business model also identifies the suppliers of the company. Broadly, business model provides an overall picture of a company. Thus, the following three types of models are depicted based on it.

With reference to the information above, the business model is shown Figure 7. Its core service is dining. The objective of the restaurant is treating every customer as the honored guest, in order to let the customers be willing to consume once again. Five strategies are developed to achieve the objective. First, the restaurant should never let customers wait, or this will make customers unsatisfied with the service. Second, the staffs of the restaurant should respond to customers' opinions or requirements immediately. Third, the restaurant will provide some additional service that do not provide by most restaurant, such as valet parking, calling taxies, or celebrating the birthday for the customers. Forth, the staffs, especially the waiters, should remember the names of regular customers, and treat them as friends. Lastly, in order to provide the freshest cuisine, the cuisine is decided based on the material of the day. There are two suppliers of the restaurant. One is the raw material suppliers, which provide the raw material or dining utensils. Another is the information systems supplier which is in charge of maintaining the information systems.



Objective

Treat every customer as their honored guests.

Strategies

1. Never let customers wait.
2. Respond to customers' opinions or requirements immediately.
3. Provide some additional service, such as valet parking.
4. Remember their names, and treat them as your friends.
5. Provide the cuisine based on the freshest material.

Figure 7 Business model of the restaurant.

4.2. Service Encounter Design

After determining the service to be provided by the restaurant has been determined, the next step is to design the service encounters, which determine the interaction between customers and service providers, which is diagrammed by a service blueprint (Bitner, Ostrom & Morgan 2008). Service encounter represents the core factor of a service process. It is what mainly influences the overall quality of the service. We introduce service blueprint as the preferred model for designing the service encounters.

As shown in Figure 8 Once a customer has arrived, the receptionists will check the availability of the table being reserved and call the waiter to take the customer to the table. Once the customer has been seated, menu and water are served. Once the customer has placed the order, the waiter enters the order information in the IS. The information will be shown on the screen of the terminal in the kitchen immediately. The backstage waiter, after seeing scud information, will prepare the food materials for the chef. The chef then cooks the meal. Once finished, the backstage waiter informs the

front-stage waiter to get and deliver the food to the customer. Once the customer has finished the meal and asked for bill, the waiter will enter the table number on a nearby terminal, get the printed bill and give it to the customer. The customer gets the bill and goes to the receptionist settling the bill. Afterward, the receptionist enters the IS to update the information of the table, gets the printed receipt and presents it to the customer.

4.3. Core Operation Design

To complete the core operations design, sequence diagram is used. There are two reasons for this. First, the natures of service blueprint and sequence diagram are the same. Second, sequence diagram is included in UML IT-professionals are familiar with. Thus, service blueprint and sequence diagram can serve as a bridge for the IT professionals and the non-IT professionals.

Conventional sequence diagram includes only the information flows among the "roles" in the system. They model the interactions among the people and the IS. An activity is diagrammed by a solid black rectangle and how the customer enjoys the service is shown from top to down. It is diagrammed by an arrow and the attribute of the arrow is the information. To apply it to model a service system, the attribute of the arrow can be information or physical stuff. So, by using a sequence diagram, a service system consists of flows of information or physical stuff and the activities to be done by each "role". Sequence diagram can thus be extended to illustrate the interactions among the operational staffs, the suppliers and the managers simply by adding a few more vertical lines and arrows. Additional actions for implementing strategies can be designed and augmented on the sequence diagram. Thus, complete picture of a core operations design will be attained.

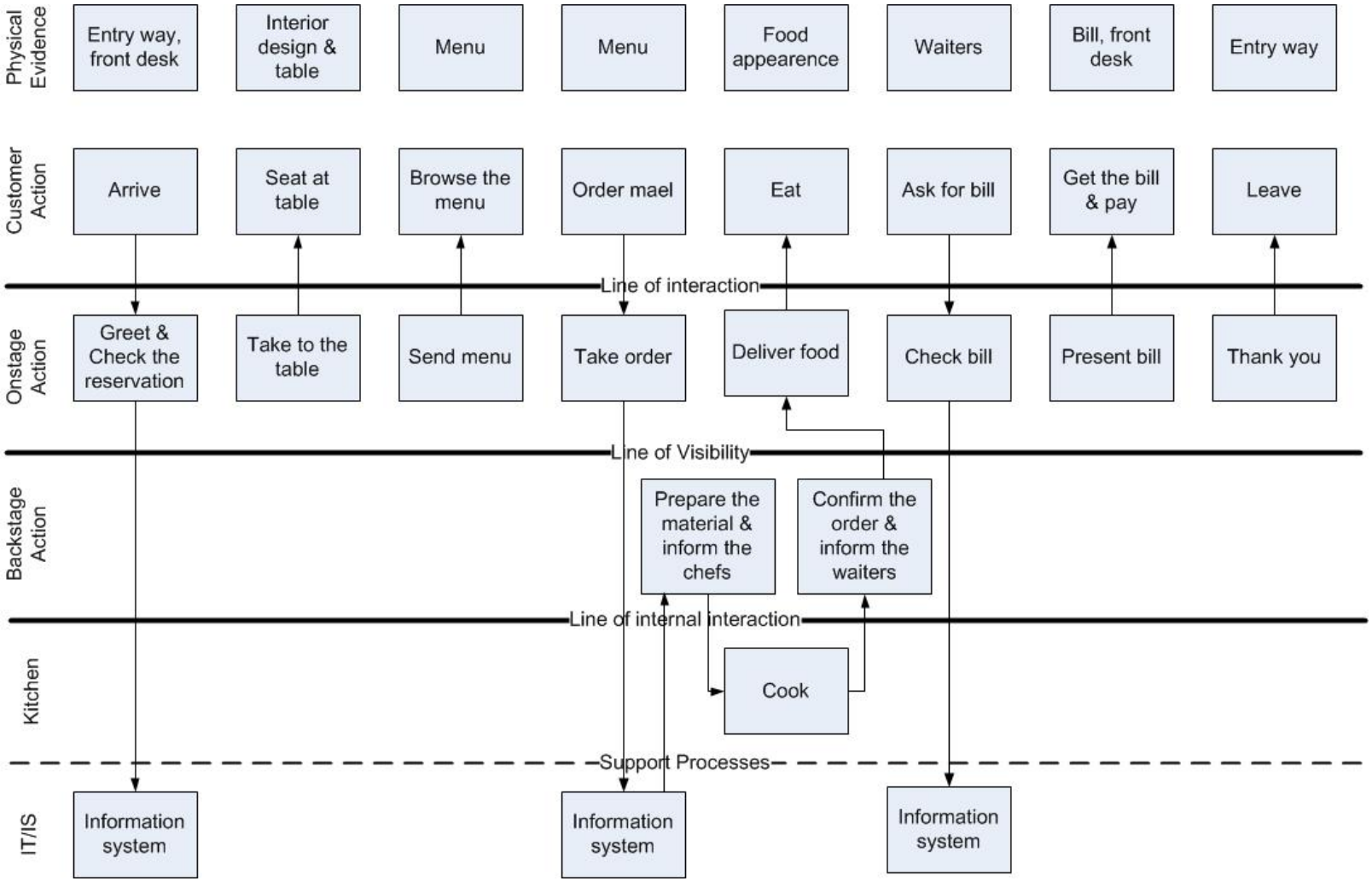


Figure 8 Service blueprint of the restaurant.

There are four steps of designing the core operation by the sequence diagram. We will apply the sequence diagram in modeling the core operation of a restaurant as an example.

4.3.1. Convert the Service Blueprint to Sequence Diagram

First, we convert the service blueprint to sequence diagram. Figure 9 shows the initial sequence diagram of a restaurant. We can see that this sequence diagram only considers the process between the operational staffs and the customers. As we discuss in preceding article, its scope is too narrow and become an incomplete design of core operation. We will extend it step by step in the following three steps.

4.3.2. Augment the Suppliers Interactions

In this step, we will design the interaction with the suppliers and augment them on the sequence diagram obtained in Step 1. Figure 10 shows the augmented sequence diagram of a restaurant. The staffs of the restaurant will check whether the raw material in stock is sufficient or not by information system. If it is not enough, the backstage waiters will inform the suppliers to resupply.

4.3.3. Augment the Management Process

After extending the sequence diagram to the interaction with the suppliers, next we will design the management process and augment it on the sequence diagram obtained in Step 2. Figure 11 shows the augmented sequence diagram with the management process of a restaurant. In addition, flow chart is utilized in detailing the management process. In a restaurant, the managers need to check the quantity of raw material and brief the staffs what they need to do today before opening. During the opening time, the managers will also ask customers for any opinions about the service, such as whether the customers satisfied with the service, as the reference to improve the service quality.

After closing the store, the managers need to check the financial account, and keep the revenue securely. The customers' feedback report will also be read.

4.3.4. Augment the Actions Aligning Strategies

In the business model, we have determined the objectives of the company and the strategies which can achieve the objectives. Subsequently, we need to design some additional actions for implementing each strategy, and augment them on the sequence diagram obtained in Step 3. Then, the design of the core operation will be completed. Figure 12 shows the final version of the sequence diagram of a restaurant. We design eighth additions actions for implementing the strategies which developed in the business model. First, the managers will train every waiter to follow the standards of the restaurant, such as providing the water and the menus within one minute after customers take a seat or responding to customers' requests as fast as possible. The manager will hold a quiz of the standards every morning to examine the waiters. Second, every customer's cuisine will be served at same time at same table as far as possible. By doing so, no one will just sits there and watches his or her partners having the meals, and there will be a strong probability that he or she will finally get impatient and angry. Third, the waiters will provide the feedback questionnaires for customers to fill when they are having desserts or drinks, and all feedback questionnaires will be read by the manager as the reference to improve the service quality. Forth, the receptionists will take the initiative to ask if the customers need any of the additional service when they make a reservation. For instance, the restaurant will celebrate the birthday for the customers or prepare the facilities and cuisine for the children.

Fifth, if a regular customer arrives, the receptionists will call the customer's name and welcome him or her loudly. It will make the customers feel prestigious as they are

the honored guest of the restaurant. Sixth, the chefs need to figure out new cuisine once every two or three week, in order to let the customers have the feeling of freshness, and the new cuisine will refer to the flavor of the regular customers or market research. Seventh, there is a cloth stand for customers to hang their overcoats, and a basket to put their bags. Eighth, the waiters need to have the knowledge of every cuisine, such as the material, characteristics, and how to cook, and illustrate to the customers when they are ordering. Table 2 shows the degree of the implementation of the strategies for each additional action.

Table 2 The degree of the implementation of the strategies.

	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
Action 1	***	***	**	**	*
Action 2	***	*	*	*	*
Action 3	*	***	**	*	*
Action 4	*	*	***	*	*
Action 5	*	*	*	***	*
Action 6	*	*	*	**	***
Action 7	*	*	*	*	*
Action 8	*	***	*	*	*
***(high degree) **(medium degree) *(low degree)					

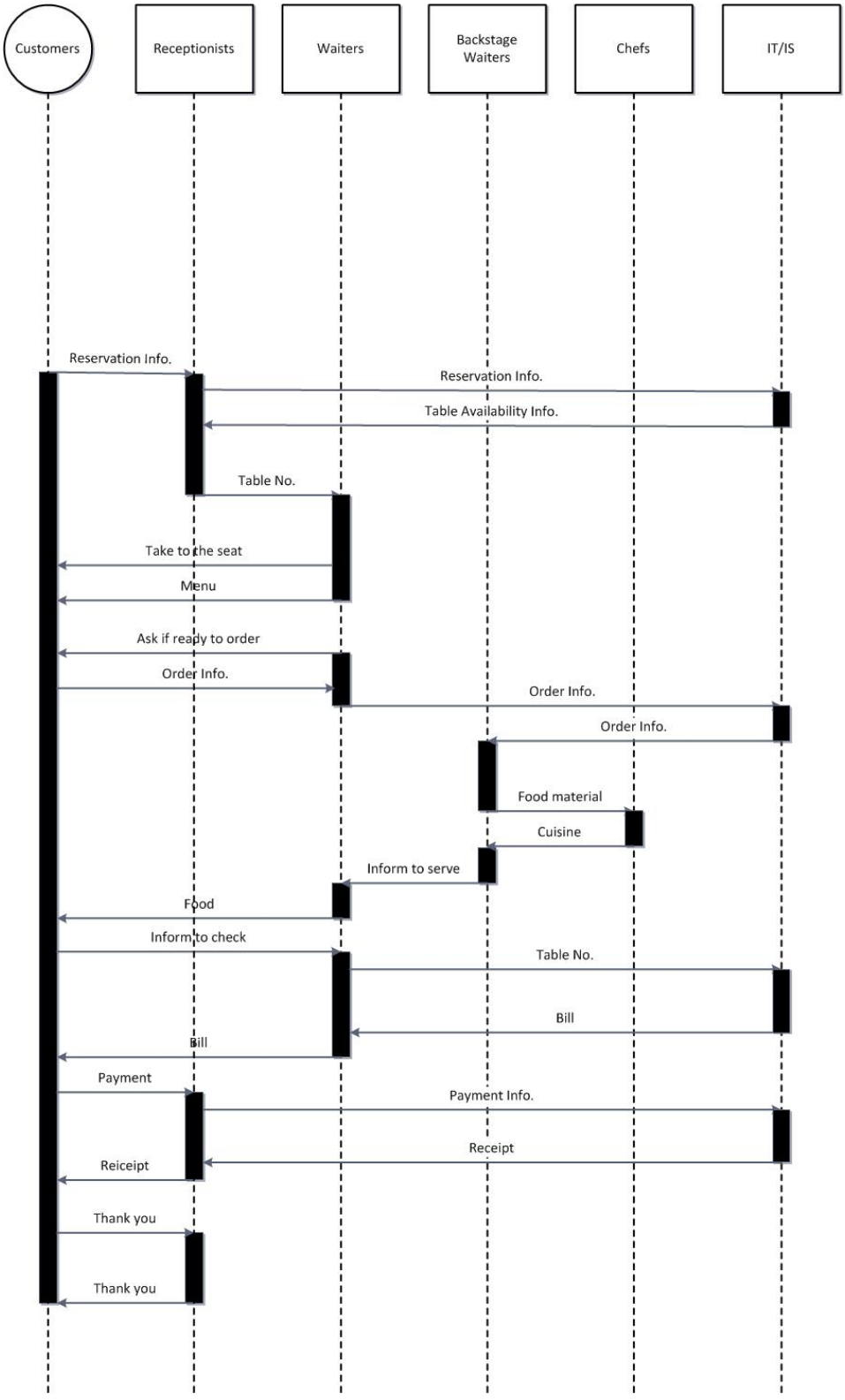


Figure 9 Initial sequence diagram of the restaurant.

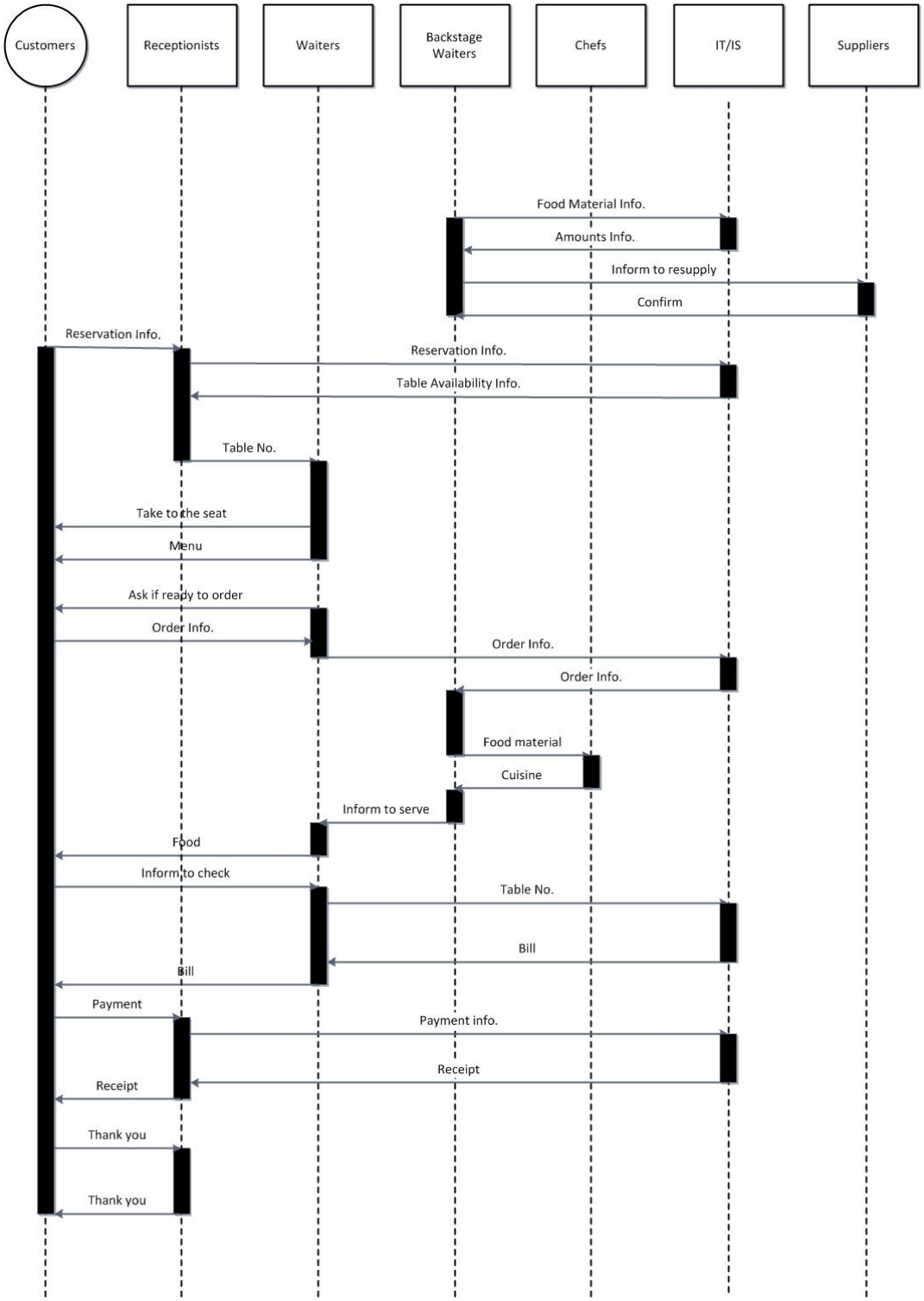


Figure 10 Augment interactions with the suppliers on the sequence diagram.

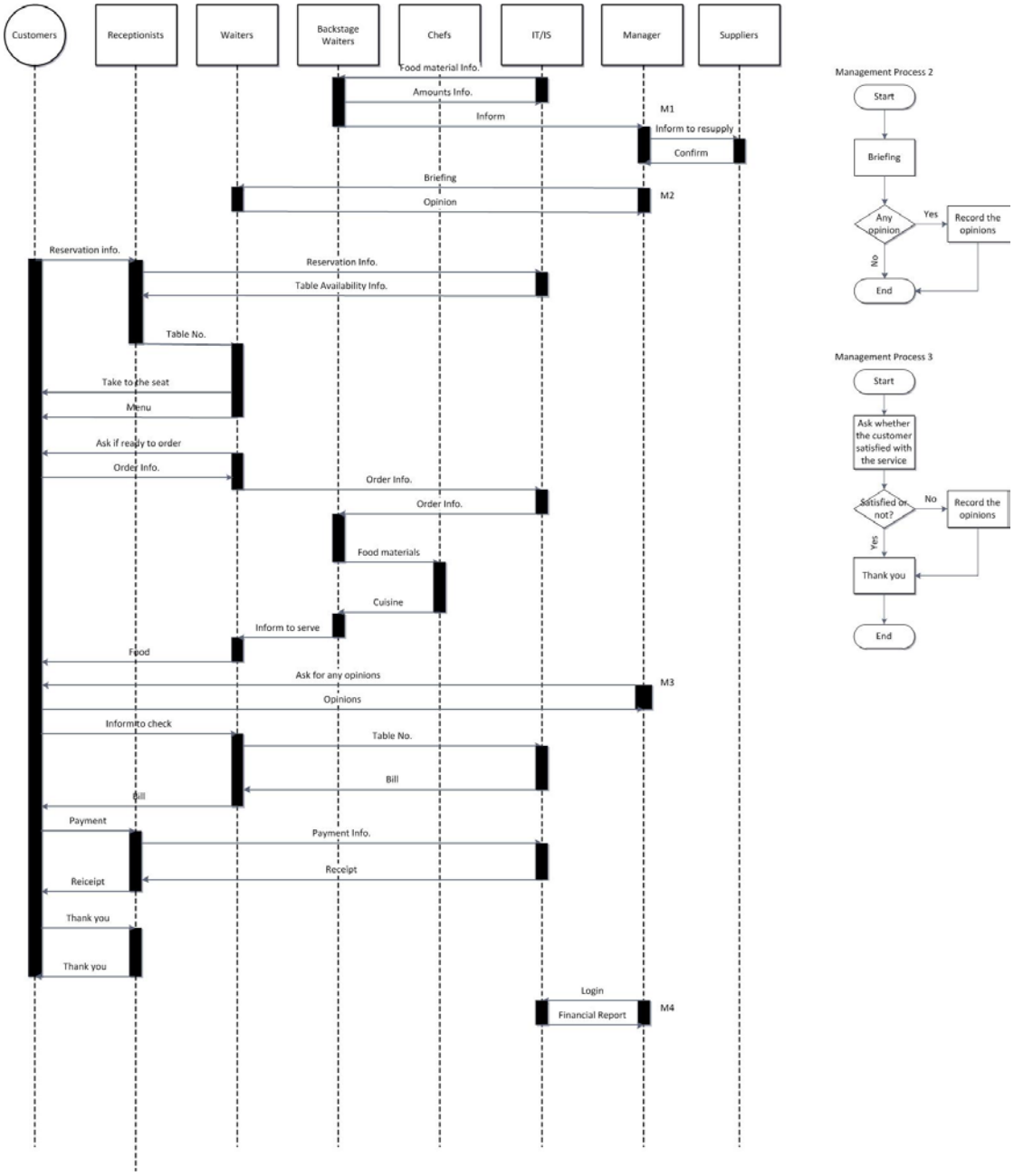


Figure 11 Augment management process on the sequence diagram.

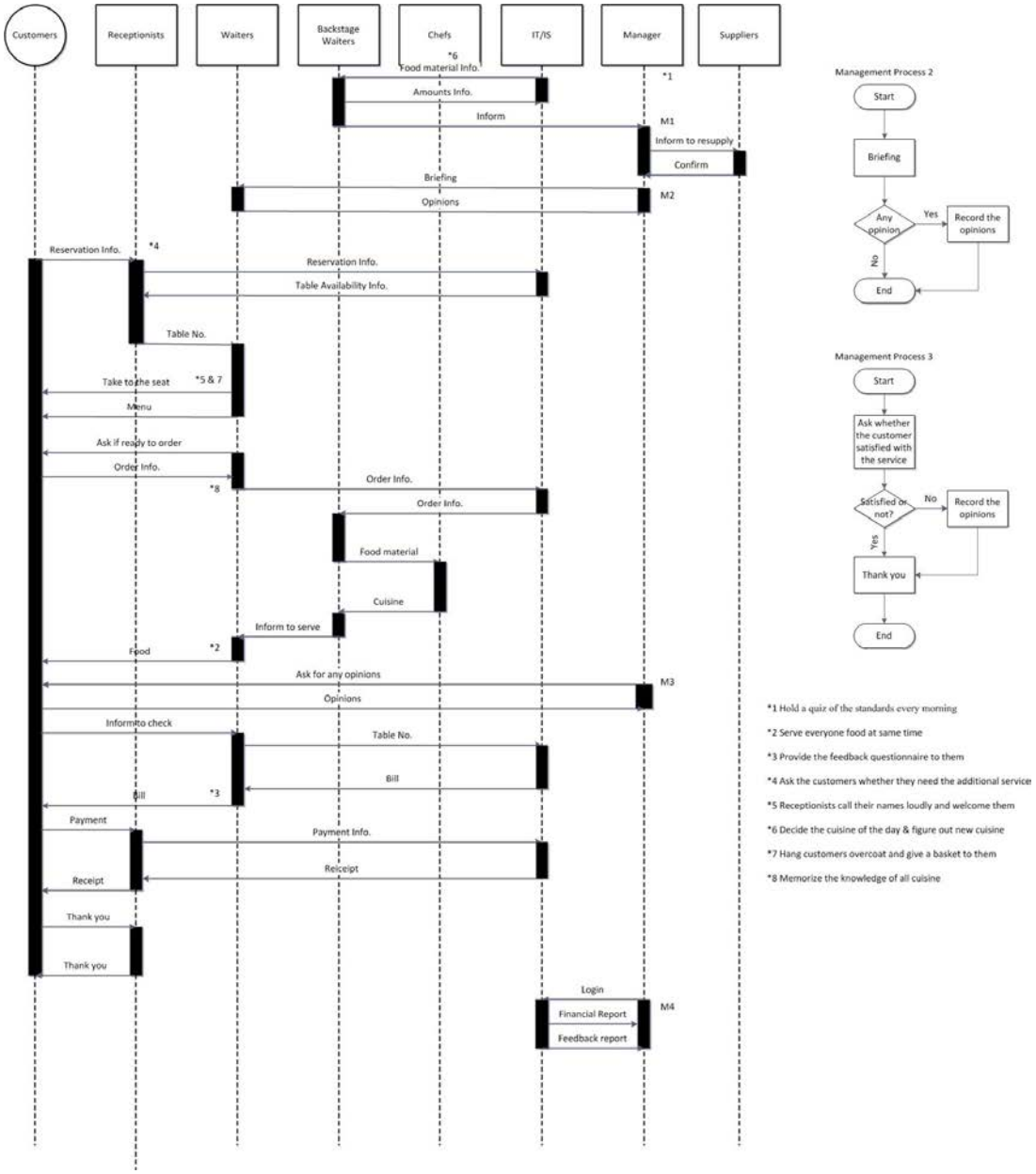


Figure 12 Augment additional actions on the sequence diagram.

4.4. Organization Design

The last type of models in the integrated system of models is utilized for organization design. Actor network (Garrety 2014) is used to model the social network among the actors involved in the operation. By applying the concept of modularization design, the actors can be grouped into different groups and thus the organization structure can be designed. Modularization design can make clear division of labor, and reduce the opportunity of communication overlap. Thus, we can compile the job description. Figure 13 shows the example of actor network in modeling a restaurant, and the extension to organization structure in Figure 14. The restaurant consists of three departments and a manager. We group waiters and receptionists together in Front-Stage department. Backstage waiters and chefs are grouped together in Back-Stage department. While the information system is supported by the vendor, we still put a department in the structure. In addition, job descriptions of the actors are shown in Figure 15. The job descriptions of the waiters are depicted Table 3.

It should be noted that actor network model resembles the agent-based model (Lin & Pai 2000, Bonabeau 2002, Tay & Lush 2007). Each person in a system is modeled as a software agent, i.e. a program. The activities to be done by a person are written in structured English. Each job appeared in the job descriptions turn out to be a case in the program. The following is a pseudo code specifying the Job 12 of a waiter: Serve Bill & Feedback Questionnaire.

This job is triggered when a customer has requested for the bill. Waiter need to go to the terminal, key in the table number and then wait for the printed bill. Once the printed bill has collected, the waiter takes it to the customer together with a feedback questionnaire (FQ), go to the table again and serve the customer the bill. If the customer

is willing to fill in the form, the waiter needs to wait and then collect the FQ. After that, the waiter needs to tell the customer to settle the payment at the receptionist counter. Finally, the waiter needs to nicely ask the customer if any opinion about the service. If yes, write it down.

SERVE BILL & FEEDBACK QUESTIONNAIRE

WHEN informed by the customers for bill
GO to the IS
INPUT the table number and WAIT for the printed bill
SERVE the bill and the feedback questionnaire to the customers
    IF the customers are filling the FQ
        WAIT until the customers have finished
        COLLECT the FQs
INFORM the customers to pay at the receptionist counter
    ASK if they have any opinions about the service
    IF yes, WRITE down the opinions

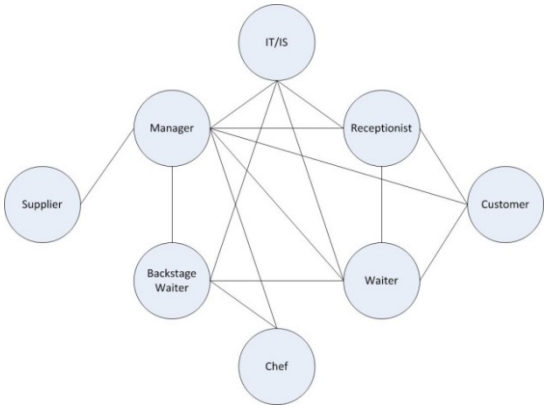


Figure 13 Actor network of a restaurant.

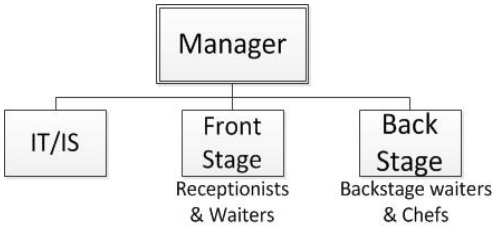


Figure 14 Organization structure.

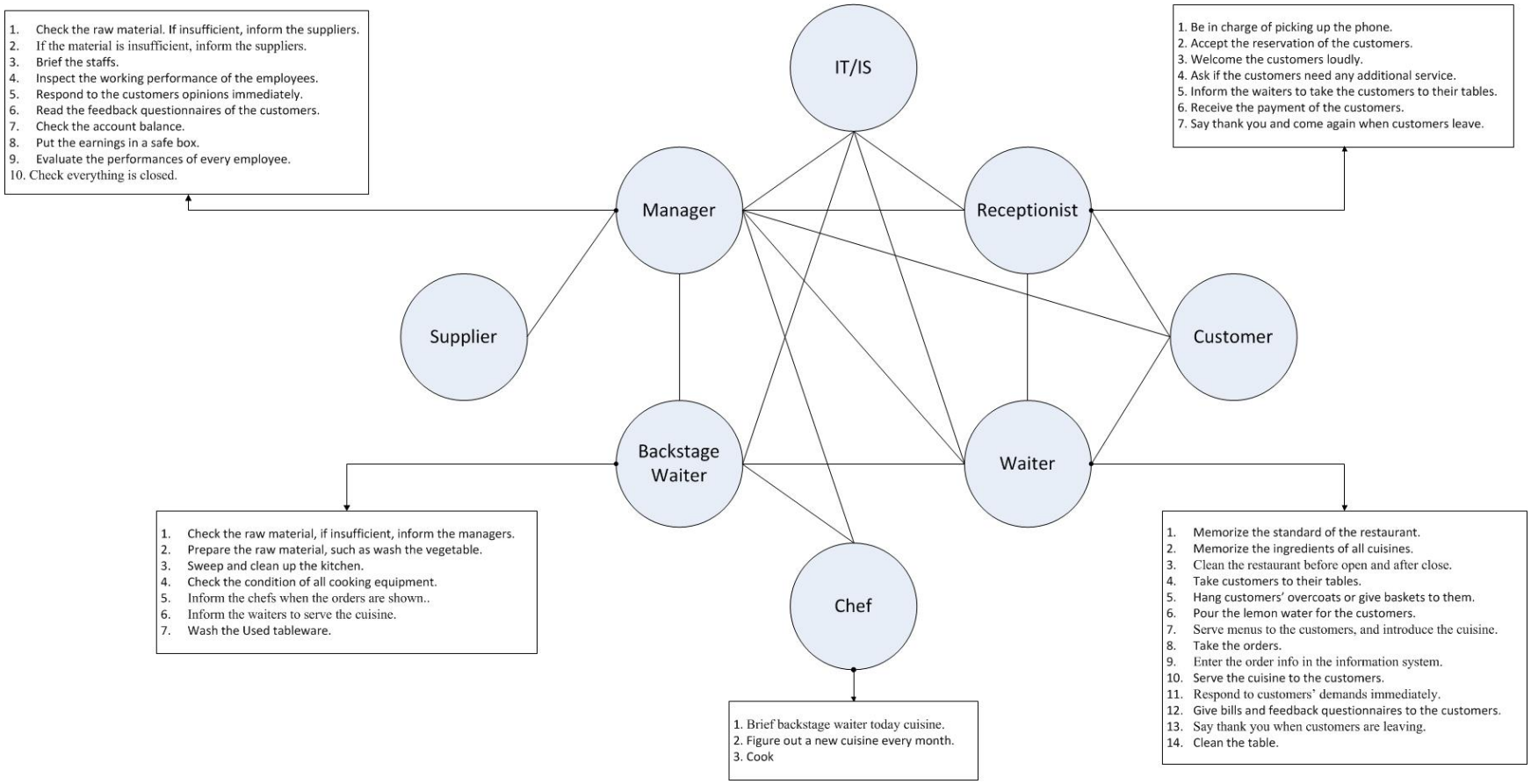


Figure 15 Job description of the restaurant.

Table 3 Job descriptions of the actors in a restaurant.

Job Descriptions	
Manager	1. Open the door, and turn on lights, air conditioners and IS.
	2. If the material is insufficient, inform the suppliers.
	3. Brief the staffs.
	4. Inspect the working performance of the employees.
	5. Respond to the customers opinions immediately.
	6. Read the feedback questionnaires of the customers.
	7. Check the account balance.
	8. Put the earnings in a safe box.
	9. Evaluate the performances of every employee.
	10. Check everything is closed.

(a) Job descriptions of manager

Job Descriptions	
Waiter	1. Memorize the standard of the restaurant.
	2. Memorize the ingredients of all cuisine.
	3. Clean the restaurant before open and after close.
	4. Take customers to their tables.
	5. Hang customers' overcoats or give baskets to them.
	6. Pour the lemon water for the customers.
	7. Serve menus to the customers, and introduce the cuisine.
	8. Take the orders.
	9. Enter the order info in the information system.
	10. Serve the cuisine to the customers.
	11. Respond to customers' demands immediately.
	12. Print customer's bill
	13. Give bills and feedback questionnaires to the customers.
	14. Say thank you when customers are leaving.
	15. Clean the table.

(b) Job descriptions of waiter

Job Descriptions	
Receptionist	1. Be in charge of picking up the phone.
	2. Accept the reservation of the customers.
	3. Welcome the customers loudly.
	4. Ask if the customers need any additional service.
	5. Check the availability of the table.
	6. Inform the waiters to take the customers to their tables.
	7. Receive the payment of the customers.
	8. Say thank you and come again when customers leave.

(c) Job descriptions of receptionist

Job Descriptions	
Backstage Waiter	1. Check the raw material, if insufficient, inform manager.
	2. Prepare the raw material, such as wash the vegetable.
	3. Sweep and clean the kitchen.
	4. Check the condition of all cooking equipment.
	5. Inform the chefs when the orders are shown on the terminal.
	6. Inform the waiters when a cuisine has been ready.
	7. Clear the “waiting order” on the terminal.
	8. Wash the used tableware.

(d) Job descriptions of backstage waiter

Job Descriptions	
Chef	1. Brief backstage waiter today cuisine.
	2. Figure out a new cuisine every month.
	3. Cook.

(e) Job descriptions of chef

5. FACILITATE ANALYSIS

To analyze a service system, service designers mostly focus on qualitative analysis by using service blueprints that have been adopted for many years as a tool of service system design. To conduct quantitative or mathematical analysis, other models are required. With this integrated system of models, we can design and analyze a service system comprehensively. This chapter describes how to analyze the efficiency; the competitiveness and other aspects of a service system with this integrated system of models.

5.1. Qualitative Analysis

In the past, service designers usually developed a new service by trial-and-error, and it certainly caused loss. This method for service designing continued until the appearance of service blueprint. With service blueprint, the service designers can depict all the processes of a new service on a number of diagrams. Designers can then easily find out the potential failure points and all the uncertainty factors in the new service. Then, the performance of the design can be analyzed and the procedures for exceptional handling can be developed for the manager who manages the service system. For example, in the illustrated example of a restaurant, one of the potential failure points is that if the information system is crashed, the restaurant can't operate anymore. To handle this exceptional situation, the restaurant will prepare some paper orders. When the situation occurs, it can replace the electric orders and let the operation sustain.

5.2. Mathematical Analysis

Through the actor network, or agent-based model, the tasks of each actor are clearly visualized, and so do the interactions amongst actors. This model is equivalent to an event driven model in the context of computer science research. Once an actor has

started execution, it will trigger other related actors. Each actor could thus be treated as a program function in a program. The actors can be formally defined by mathematical equations. For instance, the arrival time of customers could be modeled as a Poisson process and the service time of the chef as exponential distribution. Then, the actor network could be modeled as a stochastic system or queuing network. The expected service time and waiting time can be analyzed by using queuing theory.

5.3. Simulation Analysis

Following the mathematical analysis, if the models of the actors are too complicated, it is difficult to analyze by mathematical analysis. We will need the aid of computer simulations. Thus, we can determine the expected service time and waiting time under different conditions by simulating every possible condition which will occur in the operation. Moreover, simulation analysis can aid the service designer to forecast the performance of the service system under various exceptional situations that are identified in Qualitative Analysis. So, contingency plans can be designed to cope with these exceptional situations.

5.4. Value Network Analysis

Value network analysis is the analysis of the members and the interactions of these members within a value *network*. It evaluates on the benefit brought by the participants individually. The analysis is conducted through visualizing the dependencies of the actors in the actor network, as *an actor network could be treated as a value network*. We can then precisely define *value propositions for each actor with reference to the dependencies amongst actors*. As suppliers and customers are actors included in the actor network, value propositions amongst the customers, the firm and suppliers could also be defined.

5.5. Supply Chain Analysis

In the previous paragraph, we only consider the interaction between the firm and the customers in an actor network. Nevertheless, we can also add the suppliers as actors in the actor network, and analyze the supply chain performance. *Supply chain analysis aims at evaluating from each stage of the service delivery process if there is any management activity, interactions amongst suppliers and information should be added to improve the overall performance of the supply chain*. The purpose is to determine which stages of the process can be shortened or made better, and improve the efficiency of the supply chain. To have a comprehensive analysis, model for service encounter design (i.e. the *service blueprint*), models for core operations design (i.e. the series of *sequence diagrams*) and the *actor network* would be used.

5.6. Information System Requirement Analysis

As we can clearly visualize the service delivery process on service blueprint and sequence diagram, and even the tasks and the interactions among the actors on actor network, it is easy for the firm to determine the requirement of information systems. These models can aid the firm with the analysis of which stage of the operation can be improved by information system, and even the development of information system. Imagine that information systems (like web server and database server) are incorporated in the process of service delivery process, and the information systems are needed to be developed, it is no wonder that UML diagrams will be needed. It would be much convenience for the information system developer if the service delivery process is modeled by sequence diagram. As the diagram which can link with UML, the developer does not have to do a re-modeling. To have a comprehensive analysis, model for service encounter design (i.e. the service blueprint), models for core operations design (i.e. the

series of sequence diagrams) and the actor network would be used.

For the restaurant that we illustrate in the previous chapter, the requirements of the information system can be obtained by checking the detail job descriptions of the actors, as shown in Table 4.

Table 4 The requirements of the information system of the staffs.

Manager	Job 2: If the material is insufficient, inform the suppliers. Job 7: Check the account balance. Job 9: Evaluate the performances of every employee.
Waiter	Job 1: Memorize the standard of the restaurant. Job 2: Memorize the ingredients of all cuisine. Job 9: Enter the order info in the information system. Job 12: Print customer's bill.
Receptionist	Job 2: Accept the reservation of the customers. Job 5: Check the availability of the table. Job 7: Receive the payment of the customers.
Backstage waiter	Job 1: Check the raw material, if insufficient, inform manager. Job 5: Inform the chefs when the orders are shown on terminal. Job 7: Clear the "waiting order" on the terminal.
Chef	None

5.7. Technology Requirement Analysis

Same as the information system requirement analysis, the integrated system of models can aid the firm with the analysis of which stage of the performance can be improved by technologies, such as the special cooking equipment and a tablet for ordering. To have a comprehensive analysis, model for service encounter design (i.e. the service blueprint), models for core operations design (i.e. the series of sequence diagrams) and the actor network would be used. In the illustrative example, one technology is the wireless communication headset. Receptionist speaks over the microphone to inform a waiter to take the customers to their table. Backstage waiter speaks over the microphone to inform a waiter to pick up the cuisine. Ventilation system installed in the kitchen is another technology required in the restaurant.

5.8. Other Analysis

Besides the analysis we have discussed in the previous paragraph, some type of the analysis needs further work and discussion to be implemented. Our future work is to make our models be able to facilitate such complicated analysis.

5.8.1. Gap Analysis

Apart from the core operation, the marketing process is also necessary to be considered. The firm needs to investigate their customers, and find out the expected quality of the service. *Gap model*, developed by Parasuraman et al, would be used for this analysis(Parasuraman, Zeithaml, & Berry, 1985). It is a model on the usage of measuring the quality in the service sector. In accordance with the finding from the gap analysis, service designer would need to re-view and re-design the service delivery process. As service delivery process can be clearly visualized by the *service blueprints*, the *sequence diagrams* and the *actor network*, the firm can easily find out the gap between the actual performance and the expected performance. Then, the firm can figure out the ways to improve the service quality immediately.

5.8.2. Market Analysis

Market analysis aims at improving the competitive advantage of the firm. This analysis helps the firm to comprehend the various factors in the market and how these factors can be used to gain the competitive advantage. Actor network can extend to illustrate the industrial structure of the firm by adding the external factors, such as competitors, as the actors in it. Besides the additional actors, the relationship among the firm and those external actors can also be illustrated. Thus, we can analyze the market of the firm by other management analysis, such as SWOT analysis or five forces analysis. Subsequently, the firm can define their business strategies.

6. DESIGN PRINCIPLE-MODULARITY

The concept of modularity has been applied in many design activities, including production design (Starr 1965), marketing process design (Sanchez 1999), product design (Mikkola & Gassmann 2003), software design (Pressman & Maxim 2015) and service design (Voss & Hsuan 2009). Readers can refer to (Dorbecker & Bohmann 2013) for a literature survey on the related works on modularity. In accordance with Baldwin & Clark (1997), modularity refers to the *building of complex product or process from smaller subsystems that can be designed independently yet function together as a whole*. A good modular design should have the least coupling among subsystems while the cohesion of each subsystem could be very high.

Take the restaurant as an example. In organization design, as already shown in Figure 12, is to group receptionists and waiters under the Front-Stage division. The backstage waiters and the chef are grouped under the Back-Stage division. In the Back-Stage division, the cohesion among the workers is very high as the backstage waiters and the chef work closely together to effectively produce good food. So as in the Front-Stage division, the waiters and the receptionist work closely together to give the best quality of service to the customers. The only interaction between the Front-Stage and the Back-Stage is when the food has been ready. Backstage waiter will call the waiter to come and get the food. Thus, coupling among different divisions would be minimized. In the job design, one could divide the jobs into three groups, (1) jobs to be done before opening hours, (2) jobs to be done during opening hours and (3) jobs to be done after opening hours.

To apply the concept of modular design in process design, we take traditional Chinese restaurant as an example. For the traditional Chinese restaurants especially in

southern China, Guangzhou, a kitchen could have more than ten chefs and many apprentices. A kitchen is normally divided into three divisions (modules). One division is responsible for making cuisines like fried rice/noodle/vegetable, seafood cuisines, pork/cow/sheep cuisines, soup. One division is responsible for making dim sum. One division is responsible for making roast ducks/goose/pig, soybean oil fried chickens and Char Siu. For each division, a master chef will lead a number of assistant chefs and apprentices. The work to be done by each member in the division is clearly defined. All three divisions are working together to delivery good foods to the customers. It is a good example showing the modular design in operations.

One should note that it is always not easy to attain an optimal modular design. One reason is that. If only one model is of concern, the design is simple. However, as advocated in this paper, we need multiple models to attain a holistic design. In such case, a good modular design of a model might lead to a poor modular design of the other. Therefore, reviews and modifications are always needed to ensure a balancing modular design for all the models.

7. CONCLUSION

In the thesis, we have introduced a set of five models for designing a service system. Business model defines the goal, the services to be delivered, its quality requirement and the strategies. Service blueprint defines all the interactions between the customer and the service firm during service encounter. Sequence diagrams are used for designing the core operations, supplier interactions, activities for quality control and activities implementing the strategies. The sequence diagram is thus mapped to an actor network model, with job descriptions for each actor can then be defined and the organization structure can be designed. Each job specified in the job descriptions for an actor is then pseudo-coded by a program indicating when the job has to be done and what have to be done. These five models originally are scattered in the areas of management and software engineering. Through combining them together, they can give a holistic design of a service system. Management and IT/IS professionals are able to comprehend and communication with the models.

The thesis also discusses how these models can facilitate analysis. With the integrated system of models, qualitative analysis, mathematical analysis, simulation analysis, value network analysis, supply chain analysis, information system requirement analysis, technology requirement analysis can be conducted. However, analyses like gap analysis and market analysis are not able to be implemented yet. With further work and discussion, we believe that the models can facilitate such complicated analysis. It is one of our future works. Since we have not presented the extension of the design to the design of the information system and the technologies supporting in the thesis, how to convert these results to the actual design of an IS and the technologies would be other two of our future works.

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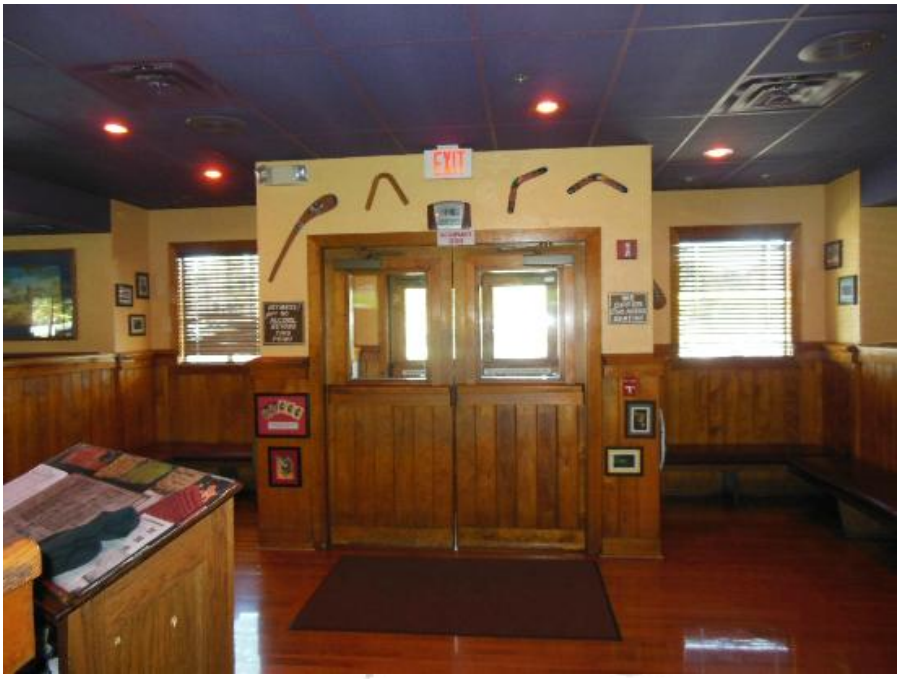
APPENDIX

A. The receptionist stand, decoration, and equipment of the restaurant

1. The front door and the receptionist stand of the restaurant

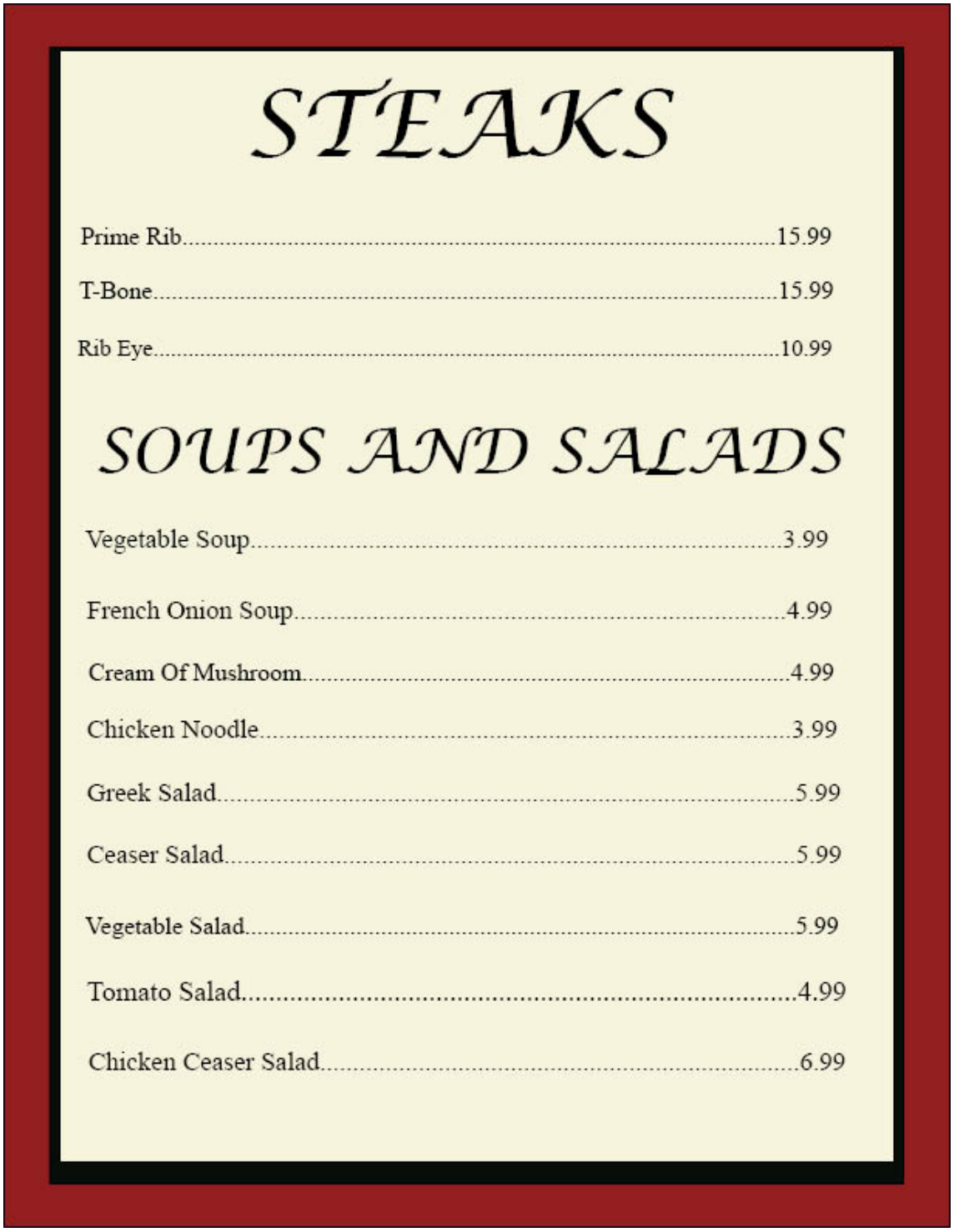


2. The dining area of the restaurant

3. The kitchen of the restaurant

4. The information system of the restaurant

5. The menu of the restaurant



STEAKS

Prime Rib.....15.99

T-Bone.....15.99

Rib Eye.....10.99

SOUPS AND SALADS

Vegetable Soup.....3.99

French Onion Soup.....4.99

Cream Of Mushroom.....4.99

Chicken Noodle.....3.99

Greek Salad.....5.99

Ceaser Salad.....5.99

Vegetable Salad.....5.99

Tomato Salad.....4.99

Chicken Ceaser Salad.....6.99

BEVERAGES

Chocolate Milk	2.99
Orange Juice	2.99
Apple Juice	2.99
Iced Tea	2.99
Any Type Of Pop	3.99
Beer-Any Brand	4.99
Wine-Any Brand	5.99

DESSERTS

Ice Cream	5.99
Sundae	4.99
Vanilla Cheesecake	6.99
Apple Pie	4.99
Fudge Cake	7.99
Lemon Meringu Pie	8.99
Chocolate Lave Cake	7.99

OTHER

Wings.....5 for 3.99.....10 for 8.99.....20 for 17.99
Comes in 5 delicous flavours: bbq, honey bbq, plain breaded, hot, and mild.

Hamburger.....5.99
Our delicous sirlion burgers are the best that they get, with any topping of your choice, you can make it your own. You will be satisfied.

Chicken Balls.....10 for 6.99
They are just irresistable.

Jumbo Shrimp.....5 for 6.99.....10 for 11.99.....20 for 20.99
We guarantee that you will love our shrimp, you can get breaded or non-breaded and you can also choose the flavour that you would like.

Ribs.....17.99
Our signature ribs come in a dry bbq rub or our special bbq sauce that never fails. You will enjoy.

Poutine.....7.99
Fries, cheddar cheese, gravy, bacon, jack cheese and all the other good stuff you cant resist.

Fresh Walleye.....2.99/fillet
our delicous fish caught on the lake were the resturaunt is, is deep-fried with our special recipie thet only the chef knows and you will deffiantly love it

B. Specifying the jobs in a restaurant by pseudo code

This section shows the comprehensive and detailed job description which we have briefly outlined in Figure 13 and table 3.

Manager
Before opening hour
1. WHEN arrive at restaurant OPEN the door and TURN on the light, air conditioners and IS
2. WHEN the restaurant prepares to open IF informed by the backstage waiters the raw materials is insufficient INFORM the suppliers BRIEF the staffs what they need to do today ASK the staffs for their opinions WRITE down opinions CHECK if everything is ready
During opening hour
3. INSPECT the working performance of the staffs and WRITE it down
4. WHEN customers have any opinions RESPOND to customers opinions immediately
After opening hour
5. WHEN the restaurant has closed READ every FQ CHECK the account balance ENTER the info. into the accounting report system TURN off the IS PUT the earnings in a safe box COMPLETE the performance evaluation form for each staff CHECK if all the windows and back doors is closed in the restaurant CHECK if all the electric appliances have been turned off in the restaurant CHECK if all the cooking equipment has shut down in the restaurant CLOSE the door

Waiter
Before opening hour
1. WHEN the restaurant prepares to open, CLEAN the floor, windows, walls and tables READY the tableware CHECK if other things are ready
During opening hour
2. WHEN informed by the receptionists GO to counter TAKE customers to their table IF customers wear coats, HELP hanging them up IF customers have bags, SERVE them baskets SERVE the menu

ASK if it is the first time they come IF yes, INTRODUCE to them the popular cuisine POUR lemon water for the customers
3. WHEN customers be seated for 5 minutes ASK if ready to order IF yes, WRITE down the orders and INPUT them orders in the IS ELSE SAY “thank you” and WAIT for another 5 minutes
4. WHEN informed by the backstage waiters the food is ready GO to the kitchen GET the food DELEVER the food to the table SAY “enjoy your food” and leave
5. WHEN a customer has finished a course ASK “finished?” IF yes, TAKE away the plate ELSE, SAY “thank you”
6. WHEN informed by the customers for bill GO to the IS INPUT the table number and WAIT for the printed bill SERVE the bill and the feedback questionnaire to the customers IF the customers are filling the FQ WAIT until the customers have finished COLLECT the FQs INFORM the customers to pay at the receptionist counter ASK if they have any opinions about the service IF yes, WRITE down the opinions
After opening hour
7. WHEN the restaurant has closed CLEAN the tables CHECK if the customers have left anything TURN off the terminal which in charge of CLEAN up the restaurant

Receptionists
Before opening hour
1. WHEN the phones ring ANSWER the phones IF customers want to make a reservation ASK customer to wait for a while CHECK the computer if there are any available tables IF yes, ACCEPT the reservation and CONFIRM with customers ASK if customers need any additional services IF yes, RECORD it on the computer ELSE, SAY “sorry” RESPOND to any questions politely and WRITE down any opinions (NOTE that this task may occur at any time)
During opening hour

2. WHEN customers enter the restaurant
    WELCOME them loudly
    IF they are the regular customers
        CALL their names loudly
    ASK if the customers have made the reservations
        IF yes, ASK for their names and CHECK the computer
            ASK if customers need any additional services
                IF yes, RECORD it on the computer
                INFORM the ones in charge of the additional services
            ASK them to wait for a while and INFORM the waiters
        ELSE CHECK if there are any present available tables on computer
            IF yes, ASK them to wait for a while and INFORM the waiters
            ELSE SAY "sorry" and GIVE them a business card

3. WHEN customers come to pay the bills
    CHECK the bill information on the computer
    GIVE the change and the receipt to customers
    SAY "thank you and welcome again"

After opening hour

4. WHEN the restaurant has closed
    CLEAN the counter
    TURN off the terminal which in charge of

Backstage Waiter

Before opening hour

1. WHEN the restaurant prepares to open
    CLEAN the kitchen
    CHECK the amount of raw materials
        IF insufficient, INFORM the manager
    CHECK the condition of each cooking equipment
        IF something wrong, INFORM the manager to call for maintenance
    CONFIRM with chefs about today cuisine and PREPARE the materials
    CHECK if other things are ready

During opening hour

2. WHEN the information of a new order is shown on the terminal
    INFORM chefs
    SEND materials to chefs
    PREPARE the plates ready
    HELP chefs with anything they need

3. WHEN the cuisine is ready
    CONFIRM the orders on the terminal
    INFORM the waiters to serve by earphones

4. WHEN once no orders has been shown
    WASH the dishes
    DRY it in the dish drier

After opening hour

5. WHEN the restaurant has closed
    WASH and DRY the remaining tableware
    CLEAN the kitchen

TURN off the terminal which in charge of CHECK if all cooking equipment is turned off

Chef
Before opening hour
1. WHEN the restaurant prepares to open BRIEF the backstage waiters today cuisine COOK soup PREPARE salad, bread, appetizer, dessert and drink ready CHECK if other things are ready
During opening hour
2. WHEN informed by the backstage waiters COOK the cuisine
After opening hour
3. WHEN the restaurant has closed DISCUSS with manager about customer opinions of the cuisine