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A Functional Approach To Enterprise-Based Service Design Integration

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A FUNCTIONAL APPROACH TO ENTERPRISE-BASED SERVICE DESIGN INTEGRATION

by

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BIOGRAPHICAL SKETCH

Sameer G. Tabbakh was born on October 26, 1970, in Jeddah, Saudi Arabia. He received the Bachelor of Science degree in Electrical Engineering from King Abdul-Aziz University in 1994 and a Master of Science degree in Business Administration from the University of Hull, UK in 2003.

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LIST OF NOMENCLATURE

ALPS	Petri nets, A Language for Process Specification
BITAM-SOA	Service-Oriented Business-IT Alignment Method
BLOBs	Binary Large Objects
CAD	Computer-Aided Design
CAM	Computer Aided Manufacturing
CAPP	Computer Aided Process Planning
CNC	Computer Numerical Control
D4S	Designing for Services in Science and Technology-based Enterprises
DEA	Design Engineering Activities
EA	Enterprise Activities
EEAs	Enterprise-based Engineering Activities
ER	Entities Relationship
EXPRESS-G	EXPRESS Graphical
HR	Human Resource
HRCA	Human Resources and Cost Activities
HRCM	Human Resources and Cost Service Model

IBM	International Business Machines
IDEF0	Integrated Definition for Function modeling
IDEF3	Integrated Definition for Process Description Capture Method
IEEAs	Integrated Enterprise-Based Engineering Activities
IESDA	Integrated Enterprise-Based Service Design Activities
IGES	Initial Graphics Exchange Standard
IT	Information Technology
ITSM	Information Technology Service Management
MA	Marketing Activities
MSM	Marketing Service Model
MSP	Marketing Service Plan
MSPM	Marketing Service Plan Model
NPD	New Product Development
NSD	New Service Development
OOM	Object-Oriented Modeling
OOP	Object-Oriented Paradigm
PEA	Process Engineering Activities

PSL	Process Specification Language
R&D	Research and Development
SAs	Service Activities
SEA	Simulation Engineering Activities
SM	Service Model
SMM	Service Market Model
SOA	Service Oriented Architecture
SPM	Service Process Model
SRM	Service Resource Model
SSM	Service Simulation Model
SSME	Service Science, Management, and Engineering
STEP	Standard for the Exchange of Product Model Data
STM	Service Technical Model
TA	Technical Activities
UML	Unified Modeling Language

ABSTRACT

Tabbakh, Sameer G. A FUNCTIONAL APPROACH TO ENTERPRISE-BASED SERVICE DESIGN INTEGRATION. **(Major Advisor: Paul Stanfield)**, North Carolina Agricultural and Technical State University.

As consumer demand in the service sector increases and matures, it is necessary for service design to become more agile and integrated. Accommodation of the numerous, multi-faceted details involved in designing and providing a service requires the expertise of individuals from several disciplines. Although they often operate independently, these individuals should interact closely in order to integrate the activities and maintain unity throughout the service design process. Information Technology (IT) provides a means through which to integrate the activities.

This thesis describes and justifies an overall framework for information technology-integrated service design termed Integrated Enterprise-based Service Design Activities (IESDA). Building on existing tangible product development approaches and incorporating recent service design research, the thesis then develops novel core information models for three key elements of design: service concept, service resources, and service processes. Each information model is customized to adapt to special needs for services. Finally the three models are integrated for holistic design and information model scalability and expansion. Using the information models, persons involved in the service design process will be able to share the information simultaneously and interact with each other regardless of time, location and organizational barriers.

CHAPTER 1

INTRODUCTION

1.1 Research Background

The service sector produces “intangible” goods, such as health, education, communication, information, and business services (World Bank, 2009). Service-sector industries are, in part, characterized by a close interaction between intangible production and consumption and high information content (Gallaher, Link, & Petrusa, 2005). The service sector has enjoyed significant growth since the years just prior to 1974 (George and Barksdale, 1974). This growth is continuing and 2007 statistics show that services represent about 80% of the U.S.Gross Domestic Product (Bitner, Ostrom, & Morgan, 2007). In the developing world, the service sector has become increasingly important as well. Statistics show that most economies around the world are switching from manufacturing to service. According to IBM (2006) research, China’s service sector had grown by 191 percent during the last 25 years, and it comprises about 35 percent of the nation’s economy. Services account for more than 50 percent of the economies in countries such as Brazil, Germany, Japan, Russia, and the United Kingdom (Paulson, 2006). Figure 1.1 shows the professional and service occupations that are projected to grow most quickly between the years 2006 to 2016. The largest growth is in the service sector.

The productivity and the contribution of the service sector measured by research and development (R&D) activities are low compared to the manufacturing sector. The service sector shared only in about 40 percent of the total industry R&D,

even though the U.S. service sector is the largest sector of the economy (Gallaher et al., 2005).

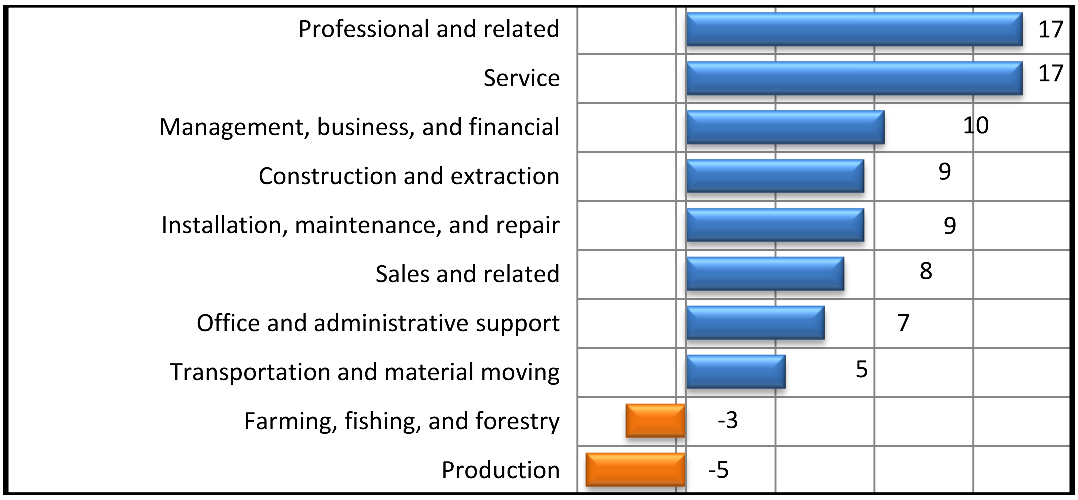


Figure 1.1. Projected 2006-2016 Professional and Service Growth (Paulson, 2006)

In particular, “New Service Development (NSD) has been relatively neglected in literature on innovation. Valuable insights are available in the extensive new product development (NPD) literature, which can be considered while developing services" (Shekar, 2007). Shekar also cites Johne and Storey’s (1998) comprehensive review of service development literature, which commented on the lack of effort to develop specific service design models, in spite of its importance to the industry. However, to lessen the gap in the area of R&D, professionals in the fields of education, research, industry, and government are moving to address service innovation objectives. Through these collaboration efforts, initiatives to develop new disciplines such as "*Service Science, Management, and Engineering*" *(SSME)* were recognized. The commonality among the disciplines created is their concern with using scientific and business tools to systematically design and improve services.

Service Science, Management, and Engineering (SSME) explores the theory and science behind knowledge-intensive service activities in all areas of the economy. The objective of the SSME discipline is to "offer systematic methodologies and formal practices to enable sustainable growth and service excellence" (Chen, Lelescu, & Spohrer, 2009). Information technology (IT) is one of the key enablers used in the SSME discipline. In the past, IT has been used in the service industry to support a variety of low-level tasks, in order to increase automation, define business processes in the area of payroll and accounting, develop discrete personal productivity applications (i.e.: word processors, mail and calendar) and conduct business transactions (online buying and selling). In contrast to the past, IT is now more frequently used for a higher level of business functions in the service industry.

Research conducted by IBM has shown that a new level of integration between technology and business processes is required in order to obtain the full benefits of IT. "And it must go a step further: no longer can automated functions simply replace human steps, especially in the realm of decision-making and judgment, but integration must include processes, technologies and the people managing and acting upon them" (IBM Research). This thesis is an application of high-level IT use. It focuses on the development of synergistic information models that potentially contribute to any one of the previously mentioned service innovation disciplines. Information models and an integrated approach within the enterprise for the service design activities are proposed.

1.2 Problem Statement

Cost, time and quality are important factors to consider when new (tangible) products are being designed and developed (Kulvatunyou and Wysk, 2000). Designers should consider all aspects of a product during the design cycle, including interactions among the various enterprises and engineering functions. These design activities may require a large mass of information to be managed and shared. In the case of the manufacturing, the process has developed over the years into well-recognized stages, but not in the case of services (Shekar, 2007). The interactions that take place in the service design process may be either external to or internal to the service organization. External interaction occurs between the enterprise, which takes into account the delivery of its service, and its customers, who take into account their own needs and satisfaction. Internal interaction occurs within the enterprise, among engineers, employees and managers. These interaction patterns could be at either a formal or informal level (Metcalfe and Miles, 2000)

Several models have considered these interactions including the New Service Development (NSD) model (Goldstein, Johnston, Duffy, & Rao, 2002), yet none of them efficiently approached an information-sharing model during the service design cycle that would facilitate these interactions. *Subsequently, there is no efficient collaborative service design model that integrates service design activities into a single information system and database and facilitates sharing the information process that takes into account the fundamental service design activities and the interactions*. As a result, there is a need for an innovative solution to this problem. The absence of such a model adversely affects the cost, time and the efficiency of developing or designing new services. As a result, this could have a detrimental effect on the growth of the service sector.

1.3 Purpose/Rationale/Research Questions

The purpose of this thesis is to develop information models that integrate service design activities. These models consider the interactions necessary to design a service, provide a favorable environment (medium) in which the service design activities may interact and establish the functional information integration of the enterprise with low cost, quality and efficiency. This functional information integration allows the people involved in the service design to share the service information and to interact simultaneously with each other in an efficient way, regardless of time, location, and organizational barriers. The framework that allows this interaction is called Integrated Enterprise-Based Service Design Activities (IESDA). The IESDA framework will provide the basis for a software developer to develop service design software.

The rationale of this thesis is that most service design models must have the ability to interact freely among designers/engineers and other related persons. Information models that use IT could provide new ways to interact and coordinate the service design (Service Engineering) activities within an enterprise. Kulvatunyou and Wysk (2000) suggested and tested information models and an integration approach for manufacturing of tangible products, called *Enterprise-based Engineering Activities* (EEAs). This evolving model allows product (design), process, and production system engineers to interact simultaneously with each other anytime and anywhere. The Enterprise-Based Engineering Activities (EEAs) have been tested and has implemented to demonstrate that "product development time, production lead time, and production cost can be reduced, and that resource information models are operational in the multi-enterprise engineering environment" (Kulvatunyou and Wysk, 2000). This result is a motivation to achieve the same with service design activities. The thesis research questions could be divided in two subsets:

1. The first subset seeks to answer the question “what is an appropriate overarching framework to facilitate service design integration?” More specifically:
   - What are the engineering and enterprise activities that should be considered during the service design cycle?
   - What is the most suitable existing service design framework that considers the differences, challenges and interactions of the service design process?
   - What are the categories of information models that allow the prospective stakeholders to share the service design information?
   - How do these information models interact together and what are their relationships to one another?
2. The second subset seeks to answer the question “how should one structure the core, foundational information models needed for the framework?” More specifically:
   - What are the key requirements and best representations for service design information to be exchanged between stakeholders during the service design process?
   - What is the best information model representation that could be used to represent data, entities and attributes within the information models to

facilitate the integration of the information and the interactions between the models.

- How are these core concepts created and how are they integrated?
- How might these models be expanded in future research work?

1.4 Thesis Structure

Chapter One covers service design definitions, problem statement and research approach. "Service Science, Management, and Engineering" (SSME) and "Service Engineering" disciplines definitions, objectives and activities are discussed. Chapter Two provides a literature review. It covers service design, its nature and how it differs from designing a tangible product. In addition, it describes the limited efforts in formalizing service design and the lack of high level information technology integration. Key elements for building the information models of service design as well as service design and IT are discussed.

Chapter Three presents the methodology and the proposed IESDA framework. It covers three points: framework development, service design process and integration information model design. In addition it provides an overview about the IESDA framework and its terminology, functionality, and interactions. Chapters Four, Five and Six cover the requirements, design representation, information model implementation, and suggested extensions for the three primary information models of the IESDA. Chapter Seven discusses the integration and interaction among these three information models. Chapter Eight covers the conclusion and future work.

CHAPTER 2

LITERATURE REVIEW

"When comparing the research on service topics with those research activities that focus on material goods, an obvious gap can be observed" (Bullinger, Fähnrich,& Meiren, 2003). Until recently, research conducted on service topics has been scarce. In this chapter, the literature review summarizes existing research on service topics. The chapter discusses service innovation and its goals and the fields in which research and development (R&D) have been performed. The review of literature will be organized and divided into three sections. The first section will cover the key terms used in service design. The second section will discuss the major service design information elements necessary to build the proposed information models. The final section will discuss the articles that connect service design and IT.

2.1 Service Innovation

The need for service innovation to fuel further economic growth and to raise quality and productivity levels of services is substantial (Fitzsimmons, 2007). Service innovation, according to the National Science Foundation, is the output of applied research and development efforts which has one or more of the three following goals (Fitzsimmons, 2007):

1. Pursue a planned search for new knowledge, regardless of whether the research has reference to a specific application
2. Apply existing knowledge to problems involved in creating a new service or process, including work to evaluate feasibility

3. Apply existing knowledge to problems related to improving a current service or process (Fitzsimmons, 2007)

Research and development (R&D) on services has been done to serve all three of these goals. The literature review will focus on the third goal, which is the aim of this thesis. Goldstein et al. (2002) mentioned that much of the related research on service design has focused on the following aspects:

- Process of service design and New Service Development (NSD)
- Dynamics of innovation
- Process of innovation
- Types of new services and service innovation
- Design of the service encounter
- Process versus service product innovation
- Capacity design
- Innovation methodologies
- Success and failure in service design
- Measurement of service design and innovation

Figure 2.1 shows all of these aspects. Other related research for this thesis will be mentioned in the review of literature. The aspect of service design upon which the thesis focuses is the process of service design and the use of IT to facilitate it. More precisely, it focuses on service design information-oriented integration.

Eversheim, Bochtler, Grabler, & Kolscheid (1997) stated that integration concepts could be classified into three categories:

1. Information-oriented integration: aims to facilitate information flow by improving the data exchange for a certain task or assignment, such as service design.
2. Organizational structure-oriented integration: an implementation of team-oriented concepts. It involves mixed teams, constituted of members from enterprise or simultaneous engineering to perform a specific task, such as development of new service.
3. Procedure-oriented integration: aims to optimize a task such as service or product development and is based on a process-oriented view (Eversheim et al., 1997).

Figure 2.1. Aspects of Related Research on the Service Design

2.2 Service Design Terminology

Four terms will be used throughout this thesis and must be well defined: service, service design, service design activities and information model. *Services* are “intangible” goods, such as health, education, communication, information, and business services (World Bank, 2009). In addition, the service components comprises a combination of processes, people skills, and materials that must be appropriately integrated to yield the ‘planned’ or ‘designed’ service (Goldstein et al., 2002). Service has four characteristics that distinguish it from a tangible product: intangibility, inseparability, variability and perishability (Shekar, 2007). For example, the intangible nature of service products makes distinguishing between product and process difficult (Gallaher et al., 2005). In addition, it means that "the service cannot be examined before purchase, it is produced and consumed at the same time, it varies from one service to another within the same category and it cannot be stored" (Shekar, 2007). Table 2.1 shows a comparison of manufacturing and service systems’ traits (Gallaher et al., 2005).

Service Design involves many issues, such as location definition, facility design and layout for customer and work flow, procedures and job definitions, measures to ensure quality, extent of customer involvement, equipment selection and adequate service capacity.

Table 2.1. Traditional Comparison of Manufacturing and Services Systems' Traits (Gallaher et al., 2005)

System Trait	Manufacturing	Services
Intellectual property rights	Strong; patents	Weak; copyright
Technology orientation	Technology "push"; science and technology led	Technology "pull"; consumer/client-led (co-terminality)
Research/innovation	"In-house"	Out-sourced—embodied in purchases, inputs
Labor productivity	High impact	High impact (since the 1980s)
Innovation cycle times	Short	Long (except for computer services)
Product characteristics	Tangible, easy to store	Intangible, difficult to store
Spatial scale of system or "reach"	National, global	Regional, national

Moreover, *Service Design* is a continual process without a definite end (Fitzsimmons, 2007). During this process, the four unique characteristics of service must be considered, as well as various physical and non-physical components. This is achieved by cooperation of designers/engineers and employees from the enterprise during the service design cycle. In designing a new service or improving an existing one, decisions must be made by managers and designers about each component of the service, from major decisions, like facility location to minor ones, like label color. For a complex or simple service, several decisions are made in its creation, from the concept stage to the design phase and then to a deliverable service. These numerous service design decisions are made at several levels in the organization, from the strategic level to the operational level.

A main challenge for "service organizations is the ensuring that decisions at each of these levels are made consistently, focused on delivering the correct service to targeted customers" (Goldstein et al., 2002). A review of service development by Cowell (1988) highlighted that in many services, customers are involved in the service design and development process. Service staff is also essential to this process. However, customers define a service as a singular outcome they are seeking; and service employees define the service they deliver as a single service (Goldstein et al., 2002). As a result of this divergence, an experienced development staff that considers both perspectives is essential to service development in service firms (Shekar, 2007).

Service Design Activities, as discussed in this thesis, will refer to actions or tasks that the enterprise staff and designers/engineers perform in order to achieve a particular design for a service. This includes all activities mentioned in Figure 1.2 of the New Service Development (NSD). *An information model* will refer to a database model (collection of organized information) that represents the types of data used and the relationships among them to specify data semantics for a determined scope of application. It presents the information in a sharable and consistent format (Burkett and Yang, 1995).

2.3 Service Design Information Elements

Entities, attributes, structure and process are key data elements in building service design information models. Entities and attributes represent the information models (database). These information models must be created, shared and managed in effective structures that make them helpful for the designers' use. Structures help organize the information, and process helps define the activities that will be performed among and within the information models. In addition, they will describe how these activities will interact with each other.

2.3.1 Entities and Attributes. Entities must be defined and organized in the information models. They relate to tables of information, especially associated with design or development of a new service. Some entities can be determined from service definition and enterprise activities related to service, and still others can be defined based on service engineering activities and designing tools. Attributes represent the characteristics of entities. Further entities and their attributes may be identified as a result of reviewing other research articles.

It has been mentioned above that service contains components with a combination of processes, people skills, and materials that must be suitably integrated (Goldstein et al., 2002). All of these components comprise the entities to be used in the information models. Spohrer, & Maglio (2005) define a service system as "a value-coproduction configuration of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws)". In addition, customer or market entity is an important entity to involve in service design activities. Kimita, Shimomura and Arai (2009) propose a model for expressing changes in customer requirements from the viewpoint of service design. They noticed that "customer requirements for services are easily affected by the services that they receive," so they propose their model to ensure a successful relationship with customers by considering all of the changes in customer requirements at the design stage. Moreover, they applied the methods proposed from the "marketing perspective to service components from the engineering design perspective."

They defined the service as "an activity between a service provider and a service receiver that results in a change in the state of the receiver," and they based their work on this definition. Their model helps service designers consider the changes that take place in what is important to the customer over time. In addition, it takes into account the marketing perspective to service design components from the engineering design perspective. However, the model does not use IT or show how the information is shared and the engineers' activities interact.

Another entity that needs to be considered during the service design cycle is the concept of service. Goldstein et al. (2002) discussed the service concept and stated that it plays a key role in service design and development. Heskett (1986) defines it as the way in which the "organization would like to have its services perceived by its customers, employees, shareholders and lenders" (Goldstein et al., 2002). The service concept defines the how and what of service design. This concept also includes the customer-built image of the service concept, whether defined by word-of-mouth or from actual service experiences (Goldstein et al., 2002). This information is vital for service development and design and must be considered during the design decisions at all levels of planning. In their work, Goldstein et al. presented three levels of discussion in relation to the service concept.

1. Define the service concept and how it drives decisions of the service design for new or developed services.
2. Describe how the service concept is valuable at the operational level during service design planning.
3. Use service recovery to show the usefulness of applying the service concept in designing service and enhancing service encounter interactions.

2.3.2 Structures and Processes. Some entities and attributes can be determined from the service design definitions and activities and others will be recognized from structure and process articles that will follow. The literature review of service design structures and processes will determine the activities that will be performed among or within the information models. Additionally, it will describe how these activities will work together within the proposed model. Several service design structures are used in the literature that address associated ideas of how service organizations design or develop new services. They consider ideas from either the customer's viewpoint or the organization's viewpoint. In addition, a number of process models used in the literature address linked ideas about how services are designed or developed from different perspectives.

Kimbell and Seidel (2008) collected essays resulted from exploratory research project on *Designing for Services in Science and Technology-based Enterprises (D4S)*. One focus area brought together design and enterprise by discussing about designing that occurs when practitioners within science and technology-based enterprises collaborate with service designers on projects to design (or re-design) services. They showed that as many opportunities exist for service design as there are challenges of applying design in a service context, especially when this takes place at the leading edge of science and technology. In the project, the participants came from several management disciplines including strategy and innovation, operations management and service operations; from design research including interaction design; and from emerging interdisciplinary areas of study such as complexity science. However, this participation shows a positive effect on service design, but was limited by time and location.

A recent model is the New Service Development (NSD), and there appears to be some degree of agreement on its meaning. As Johnson, Menor, Roth, & Chase (2000) mentioned, the NSD is the "overall process of developing new service offerings" and is concerned with the complete set of phases started from idea and end to launch (Goldstein et al., 2002). Figure 2.2 shows the NSD. Goldstein et al. (2002) suggested a process to design a service that considered the service concept. Figure 2.3 shows how this process looks between an organization's business strategy and delivery of its service products.

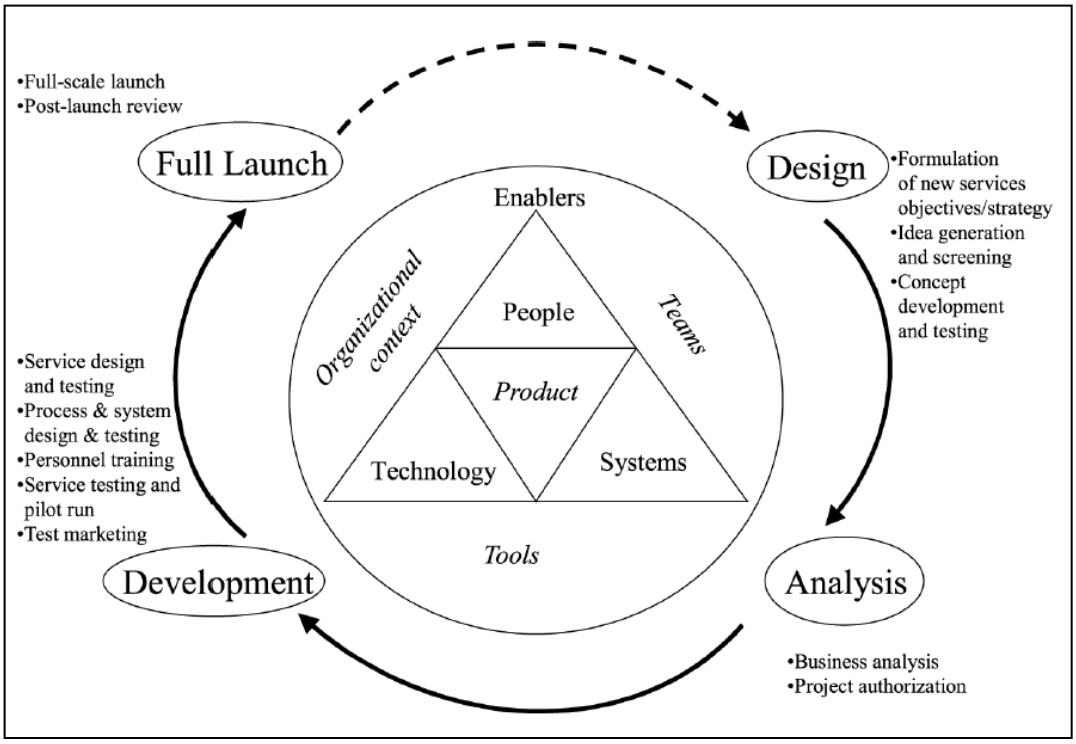


Figure 2.2. New Service Development (NSD) (Stevens, & Dimitriadis, 2005)

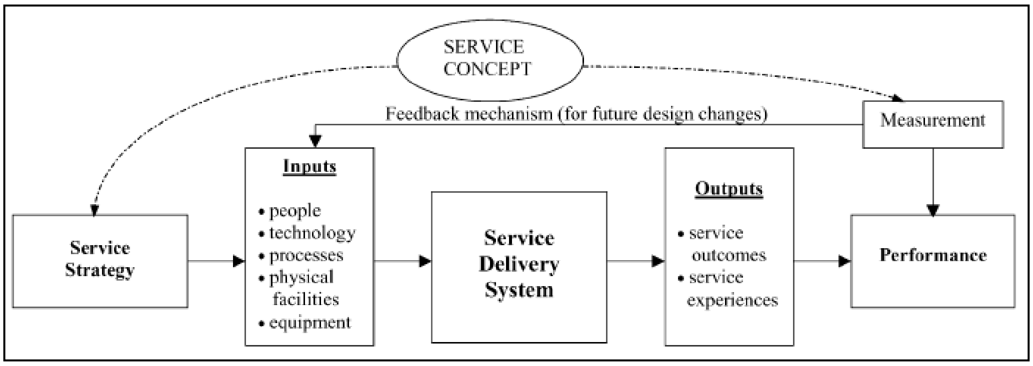


Figure 2.3. Service Design Planning Model (Goldstein et al., 2002)

Jiang (2008) focused on the service interaction. That interaction occurs between customers and service providers, to present a framework for designing services that includes nine elements. In addition, Jiang presents a process model of service design that realizes the integration of customer experience and service innovation strategy by "experience needs identify, experience design, service system design, experience testing, and new service launch." Figure 2.4 shows the framework of service design. Figure 2.5 shows the NSD process model for experience.

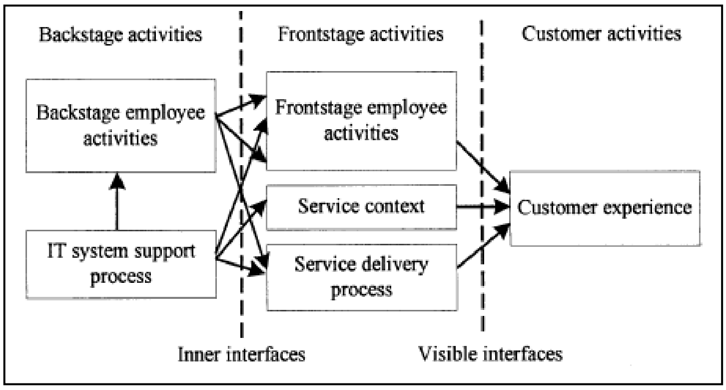


Figure 2.4. Framework of Service Design (Jiang, 2008)

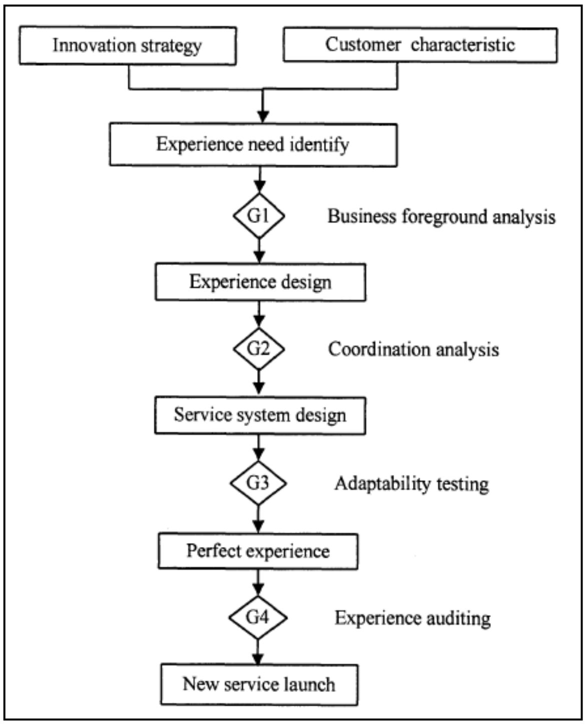


Figure 2.5. NSD Process Model for Experience (Jiang, 2008)

The framework of service design focuses on the service interaction between the customers and service providers. Moreover, the NSD process model for experience realizes the integration of customer experience and service innovation strategy. However, both of the models did not show how the information of these interactions will be mange or shared. In addition, the paper did not show the role of "IT system support" in the "backstage activities" will be in the new framework of service design.

Another effort from Kimbell and Seidel (2008) examines who designs services and who should design services. Table 2.2 shows the results of the survey that has been done by the UK Design Council Commission. Based on this survey Bruce Tether (2008).stated:

"Whereas nearly half of manufacturers recognized design as crucial to their competitiveness, this was true of only one in ten financial and business service firms and one in eight consumer service firms. Manufacturers were also significantly more likely to recognize creativity, research and development (R&D) and innovation as crucial to their competitiveness. "(p. 7)

Table 2.2. Role of Design in Manufacturing and Service Firms (Design Council Survey, 2005)

	Manufactures %	Finance and business service %	Customer service %
It is integral to the firm's operation	41	15	6
It has a significant role to play	35	18	15
It has a limited role to play	15	39	42
It has no role to play	9	38	37

Glushko and Tabas (2008) discussed front and back stage designers. They illustrated how front and back stage designers usually view service design from different perspectives. Front stage designer give more attention to the activities performed by the front stage personal and to the facility that within the customers' visibility. Back stage designers focus their attention on the activities running beyond customers' visibility. In addition, they noticed that there is often little collaboration and communication between them. They focused on the importance of capturing and flowing the information between front stage and back stage to enhance the customer's service experience. However, they did not suggest a solution to enhance the collaboration and communication between front and back stage service designers.

Chen (2008) stated that "organization needs a multi-dimensional business-IT alignment strategy—alignment via architecture, via governance and via communication—integrated with a Service Oriented Architecture (SOA) paradigm to develop their service-based system." SOA is a collection of services that communicate with each other. To help in that, Chen developed a 3-layer, multi-disciplinary Service-Oriented Business-IT Alignment Method (BITAM-SOA) Service Engineering Schematic that also serves as a process model for service design and management. Figure 2.6 shows the BITAM-SOA Service Engineering Schematic. The BITAM-SOA Service Engineering Schematic outlines a set of processes, models, methods and techniques and the ways in which these modules interact for service design, development and management. However, BITAM-SOA did not include all the service design activities and it did not give attention to information management during the interaction between the layers.

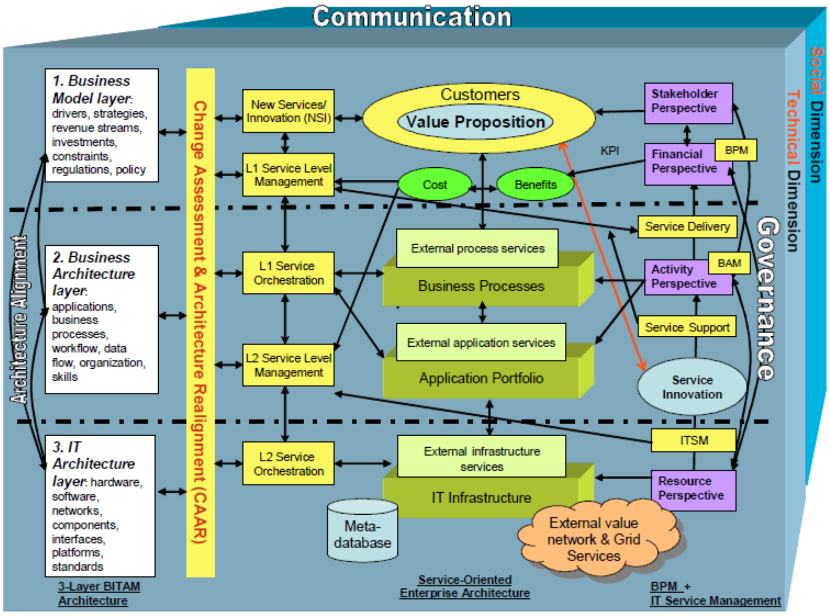


Figure 2.6. BITAM-SOA Service Engineering Schematic (Chen, 2008)

Numerous process and function representations for modeling the process data have been developed. Some examples of these representations are Integrated Definition for Function modeling (IDEF0), Integrated Definition for Process Description Capture Method (IDEF3), Petri nets, A Language for Process Specification (ALPS), AND/OR directed graph, Process Specification Language (PSL) (Kulvatunyou and Wysk, 2000) and Unified Modeling Language (UML) Activity Model Diagram.

IDEF0 and IDEF3 are two of sixteen IDEF modeling methods groups (for Integrated Definition). Each one is designed to capture a particular type of information through modeling processes. For example, IDEF0 methods are used to model the functions of a system, creating a graphical model that shows the functions, what controls them, who performs them, what resources are used in carrying them out, what they produce, and what relationships they have to other functions. A system can consist of an enterprise or any combination of hardware, software, and people. The IDEF0 model consists of diagrams which are the major components and text pages describing the diagrams (Waltman and Presley, 1993).

In the service information model, the UML Activity Diagram is a modern model used to represent the activities of an enterprise, creating a graphical model showing the activities, what controls them, who performs them, what resources are used in carrying them out and what relationships they have to other activities. Figure 2.7 shows an example of the UML Activity Diagrams of ordering and paying of goods with Mercata, an online web shop (Eshuis, 2006). Another important diagram used to describe the structure of systems or applications is the UML class diagram. It represents static structure diagram of the system that shows the system's classes, their attributes, and the relationships between their classes. Figure 2.8 shows an example of the UML class diagram (Purchase, Colpoys, McGill, Carrington, & Britton, 2001).

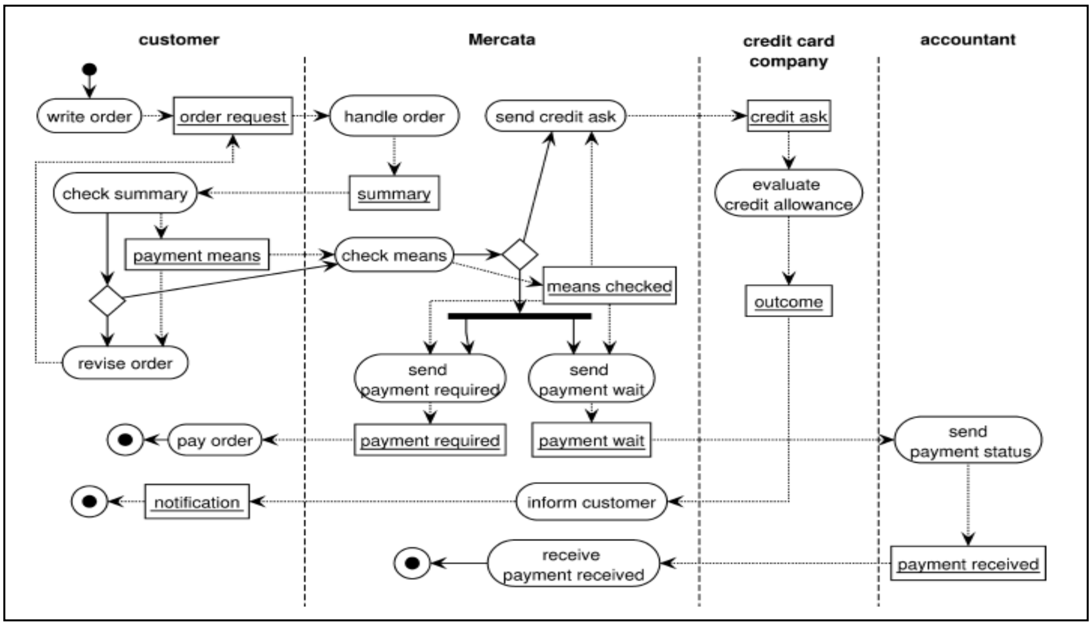


Figure 2.7. UML Activity Diagrams (Eshuis, 2006)

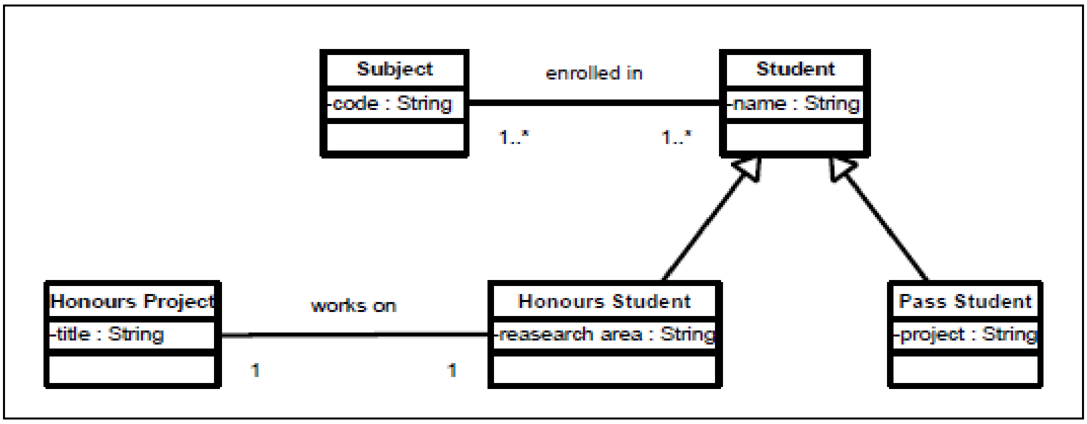


Figure 2.8. UML Class Diagram (Purchase et al., 2001)

Finally, Kulvatunyou and Wysk (2000) suggested the Integrated Enterprise-Based Engineering Activities (IEEAs). The IEEAs model establishes functional information models that allow enterprise-level information sharing and thus facilitates interactions among EEAs. In Figure 2.9, the EXPRESS-G model (EXPRESS graphical version) shows how these information models are utilized in enterprise-based engineering activities collaboration. Their work showed that four information models (production resource model, product model, process model, and manufacturing control model) are necessary to achieve enterprise-level integration. Production resource model adopts the inheritance mechanism from the object-oriented paradigm, product model uses AND/OR directed graph as process representation model and manufacturing control model ARENA simulation model is used.

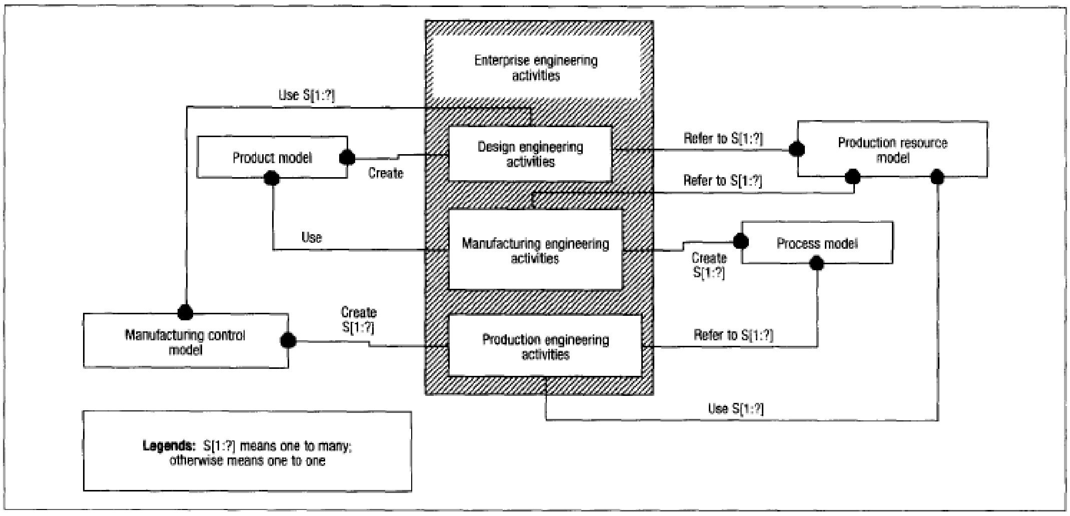


Figure 2.9. EXPRESS-G Model Representing Enterprise Engineering-Based Activities (Kulvatunyou and Wysk, 2000)

When such integration occurs, engineers are able to perform their individual tasks, while accomplishing concurrent engineering. This enables engineers to focus on productivity improvement, which comprises process improvement by the process engineer, production schedule improvement by the production engineer, and design improvement by the product engineer. However, the IEEAs are focused on manufacturing engineering activities. In addition, it doesn’t cover the all enterprise activities.

2.4 Service Design and Information Technology

Most service innovation work that uses technology or IT can be categorized in the previously mentioned, second service innovation goal. Examples of such innovations include self-service machines, websites for customer interaction, online purchases, E-Business and barcode readers. Some ERP software systems are dedicated to service for the purpose of integration. Most of them focus on the integration between the service and human resources, managing accounting functions, financial management, project management and customer relationship management. Service Oriented Architecture (SOA) is a business-centric IT architectural approach that supports integrating business as linked, repeatable business tasks or services (IBM website, 2009).

SOA is flexible to enable organizations to easily integrate systems, data, applications and processes through the linking of services. SOA also addresses critical security and privacy issues (Yu, & Ong, 2009). Figure 2.10 shows the SOA Process. Currently there are no known ERP or SOA systems that focus solely on service design activities. Some information systems help design the facilities through which services can be provided, but there is no known information system that integrates all the engineering and enterprise activities that are necessary to design a service.

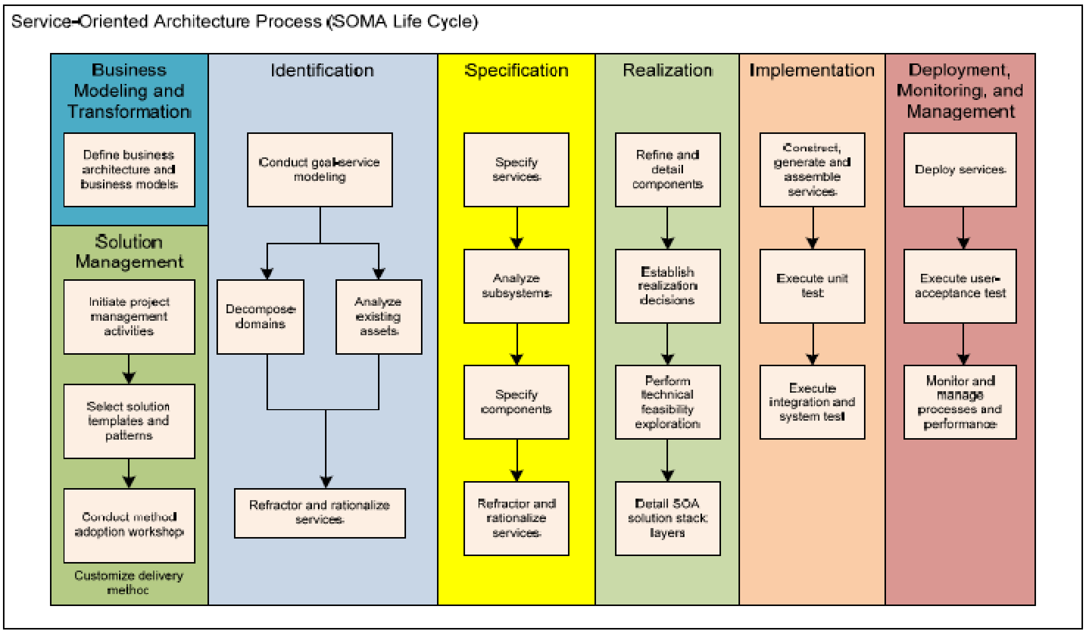


Figure 2.10. SOA Process (Yu, & Ong, 2009)

Hara, Arai, & Shimomura (2006) combine IT and design by studying a computer-aided service design system called "Service Explorer," which they propose and implement. The authors involved customer feedback on many levels of the service design. The architecture of the system focuses on customer satisfaction during the service design cycle. Figure 2.11 shows the system architecture of Service Explorer. Service Explorer was developed to represent the needs of customers and furthermore, the relationships between those needs. In addition, it is an effective environment that integrates various activities and tools for the design of services. By using Service Explorer managers, marketers and engineers can improve a service together in the process of design review in "concurrent engineering."

Hara et al. focused on implementing a system that can help to perform the activities of the service design more than focusing on integrating the service design activities or on how these activities will share the service information. The Service Explorer architecture does not show how customer feedback will go through the different enterprise activities. The model does not provide the integration with other activities that are needed for the service design. In addition, the information models were not clear in the system architecture. It does not show how managers, marketers and engineers can improve a service together in the process of design review in "concurrent engineering".

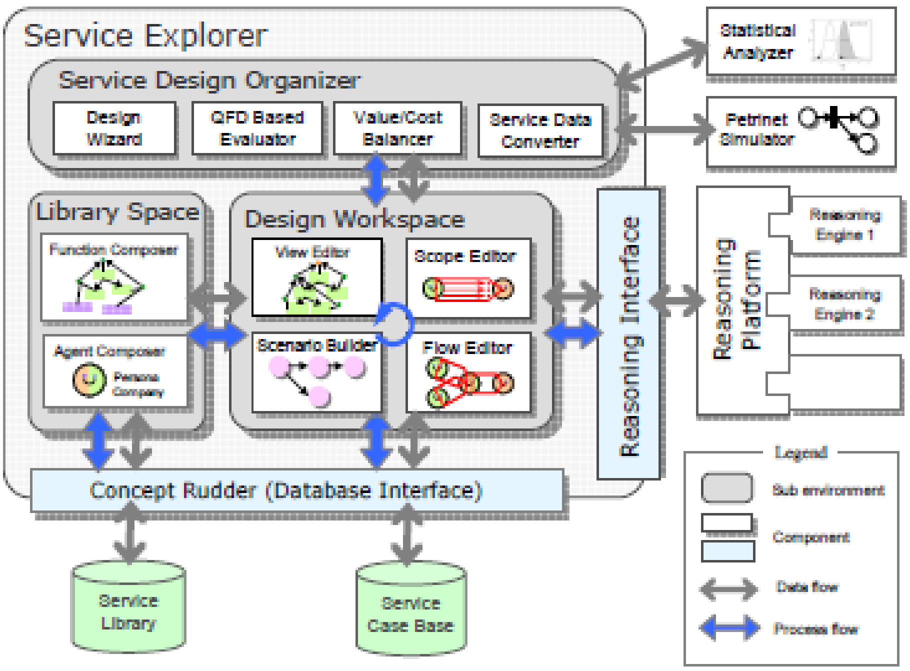


Figure 2.11. Service Explorer System Architecture (Hara et al., 2006)

Another integration model for organizing IT service management by Black, Draper, Lococo, Matar, & Ward (2007) provided development of architecture for Information Technology Service Management (ITSM) and design integrated solutions. The model proposed an integration model for designing, developing, and deploying ITSM products and solutions. The model also provides a structure that describes what the services are (service definition aspect), and links the service definition information to how the service is delivered (service delivery aspect). These two aspects are divided into a total of six domains. One of these domains is called the service provision domain and identifies the base set of services and sets them into a hierarchical structure. Figure 2.12 shows the service provision domain. The service provision domain contains some of the service design models, shows the relationship among them and the interaction with all other domains. This model still lacks some components and is only applicable to ITSM.

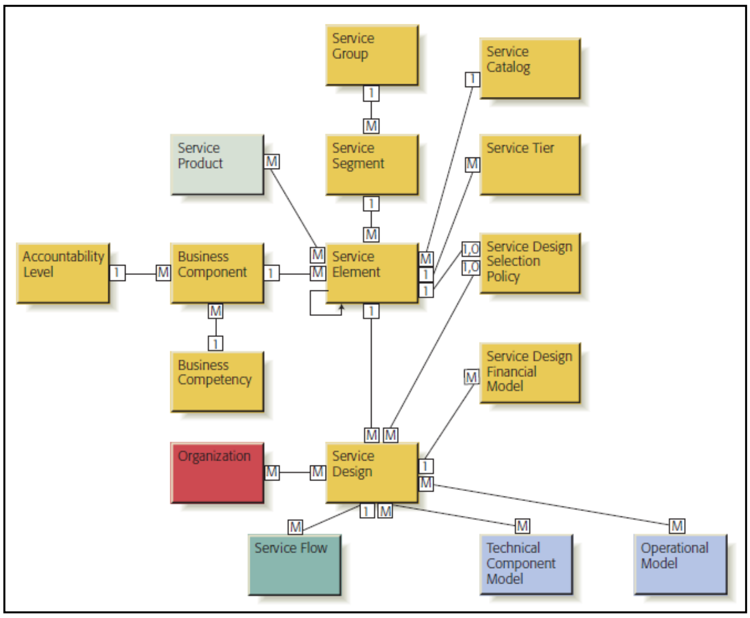


Figure 2.12. Service Provision Domain (Black et al., 2007)

2.5 Review Summary

A small, but growing number of research efforts address the process and tools for the design of new services. The literature review demonstrates that little work has been done to design services through the use of IT. Bullinger et al. (2003) stated that "while there exists a broad range of models, methods and tools for the development of goods, the development of services has hardly become a topic of scientific literature." Moreover, most of the work does not show integration between the enterprise activities and did not clarify the interactions and the relationships between the activities of the service design.

CHAPTER 3

IESDA FRAMEWORK DEVELOPMENT

This thesis applies information technology (IT) to the problem of facilitating service design by creating information models that provide an effective means of integrating design activities. These information models enable asynchronous and long distance interaction between engineers and service system stakeholders during service design. This contribution improves the current service design process by introducing processes and structures for service design information models, that allow service engineers to create, manage and share design information more efficiently.

In this chapter, an overarching framework, Integrated Enterprise-Based Service Design Activities (IESDA), for service design integration is developed and its main components described. The chapter does not provide details of the data structure; it provides the basis for development of the core service design data models in subsequent chapters. In addition, this chapter uses a “Use Case” model as a tool to build a shared vision of the IESDA and illustrate its idea to the software developers, in order to build a solution.

3.1 Product Design Foundation

This thesis develops the service design information models that include critical information necessary to facilitate the design–related activities. As suggested in the literature review, the associated framework builds initially on more mature product design approaches. Figure 3.1 depicts the overall concept of the service/production system, in which two inputs are combined to produce the product for the market.

The first input is the service “concept” that must be designed. The service concept is analogous to physical product design for a tangible product. For tangible products, a large number of design techniques and tools exist including Computer Aided Design (CAD). In addition, product representation is straightforward and standardized IT-based product information exchange format are well-established. For services, no standardized computational tools or IT-based service concept representation exists and its development is complicated due to service product intangibility.

The second input represents the resources that are used for delivering the service. These resources have associated data and processes. With a tangible product system, often the resource data are described in the context of a simulation system or production control approach. Typically, it is just the resource data that is maintained in a relational database. With service industries the resources tend to be much more labor intensive.

The intersection of a product/service and resource represents the process the resources perform relative to the delivery of the product. With tangible products, often the routing and transforming operations might be determined automatically by Computer Aided Manufacturing (CAM) and Computer Aided Process Planning (CAPP) systems. No such process development automation exists for service industries which also lack standardized process languages such as Computer Numerical Control (CNC). As described in Kulvatunyou and Wysk (2000) activities associated with the creation of the different elements of the system include product engineering, process engineering and production system (simulation) engineering. These same activities form the core of the activities associated with service design.

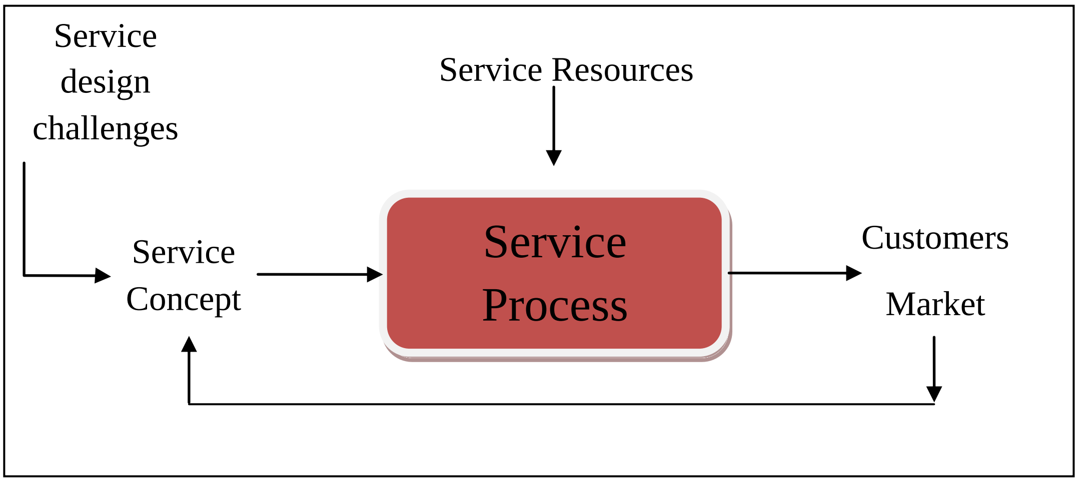


Figure 3.1. Overall Concept of the Service System

3.2 Service System Extension

In addition to the analogous tangible product inspired design activities, other activities much be considered. This requirement is based on the higher level of enterprise and customer interaction in the design and development of service. For core design activities, there exist related enterprise operational activities which must be integrated into the design process as it matures. Initiation of product design activities is dependent upon enterprise-based marketing activities, because conception of a design must take into consideration the customer's perspective. Like the service design core activity, marketing focuses on the development of the service concept.

Additionally, enterprise functions for human resources (and associated costs) may present challenges to the service design activities, by potentially affecting the service process and its delivery. Due to the labor intensive nature of service, human resources constitute the primary resource base. Like the service resource design core activity, human resources focus on the development and sustainment of the service resources.

Finally, the service process itself may be significantly different that the manufacturing processes used for tangible products. These differences are incorporated into this framework and described later in this thesis. The activities used to sustain these processes (and associated non-HR resources) are termed “Technical” activities. Like the service process design core activity, technical activities focus on the development and sustainment of the service processes. These three activities types, marketing, HR/cost, and technical are located in the IESDA framework and labeled Enterprise Activities. This initial framework of the IESDA framework is shown in Figure 3.2. The figure depicts the activities involved in service design.

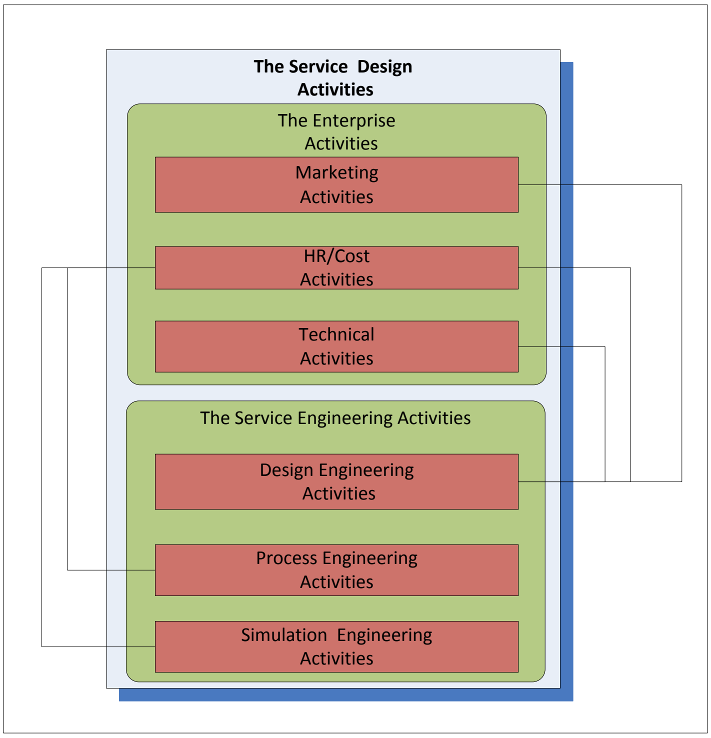


Figure 3.2. Initial Framework of the IESDA

In order to determine the information models to be used in the IESDA that can manage the abovementioned components, the activity interactions, functions, components, and characteristics to be considered in the service design are identified. In general, the information models exist in each of the traditional product design areas – with an information model to contain service concept data (Service Model), an information model for service resource data (Service Resource Model) and an information model for service process data (Service Process Model). An additional core service design information model is included termed the Service Simulation Model which integrates service resources and process within the production control context to evaluate system performance. In addition, information models exist to communication enterprise data relative to each of the three areas: a Marketing Services Model, a Technical Services Model and an HR/Cost Services Model.

Important differences between service design and product design must be handled by the IESDA framework. These differences help to address the service design challenges. One difference is that a tangible product can be tested and fixed before reaching the customer, but services face a challenge in doing this. Moreover, human interactions can be translated directly into service design (Cook, Bowen, Chase, Dasu, Stewart, & Tansik, 2002) and customers are more involved in service design, unlike with a manufacturing process. Accordingly, there is a need to design the service encounters well, in order to enhance the customer's experience during the process. The service encounter is an engineering tool, a concept that originates from psychology and sociology (Cook et al., 2002). It is viewed as a triad of customer, contact personnel and an environment. All three parties must work together to create a positive service encounter (Cook et al., 2002). Figure 3.3 shows the service encounter triad.

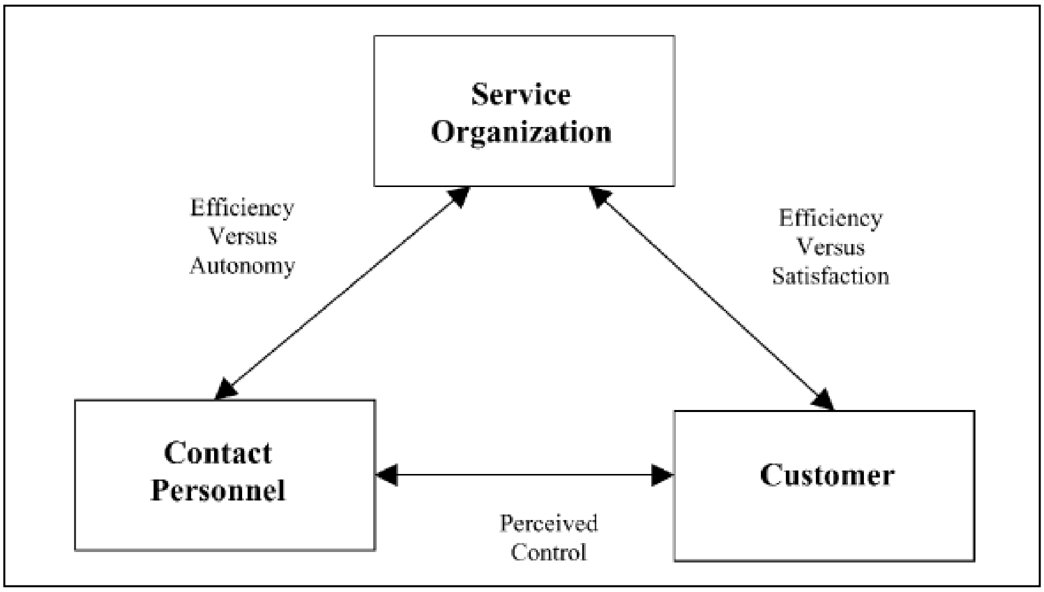


Figure 3.3. Service Encounter Triad (Cook et al. 2002)

From the literature review, the following differences will be considered in the proposed model:

- Intangibility: services cannot be examined before purchase.
- Inseparability: services are produced and consumed at the same time.
- Variability: services vary from one service to another within the same category.
- Perishability: services cannot be stored.

These differences are considered in the *Service Simulation (SSM)* and *Service Technical (STM)* models. The SSM represents a simulation model of the service, because of the nature of service, as described above. The STM contains small details about service derived from professionals, who could help design the service encounter. In addition, human interaction (employee-to-service or employee-to-customer) is given greater consideration in the IESDA framework. It could affect the cost and the customer experience as shown in the “Service Encounter.” The *HR/Cost Service Model (HRCM)* covers this information.

Customer requirements and needs are factors (attributes) considered in the proposed IESDA framework. This comes from Kimita et al. (2009) proposed model. In addition, it should be integrated with the marketing functions. However, the proposed IESDA framework clarifies where this information will be allocated and how it is created and used. As a result, a *Service Market Model (SMM)* is suggested as a component of the IESDA framework.

Goldstein et al. (2002) mentioned that "it is critical to clearly define the service concept before and during the design and development of services." They proposed a service design model that shows how the service concept should be considered during the designing cycle. Their model is considered in the IESDA framework. As a result, this information is located in the Service Model, and highly specified, expert information is located in the Service Technical Model.

3.3 Service Design Process

Before describing the IESDA framework in more detail, an associated service design process is cited in order that one might understand the IESDA in the design process context. The process of building the information in the IESDA framework follows the NSD process. The NSD model is found to be the modern model that considers most of the factors that should be considered in the proposed IESDA framework. Following the NSD process, the SMM is located as the first information model in the IESDA, and the *Marketing Service Plan (MSP)* is located as the last step. The process of building the information in the IESDA follows the NSD process. Additionally, Unified Modeling Language (UML) representations are preferred in terms of the design process to facilitate future automation of the associated processes. Specifically, class, activity, and use case representations are used in this thesis.

Finally, as with the (D4S) project mentioned in the literature review, prior service design participation was limited by time and place. For this reason, this proposed information model is designed to avoid this limitation and by allowing participants to interact simultaneously with each other regardless of time, location, and organizational barriers.

3.4 Integrated Enterprise-Based Service Design Activities (IESDA)

The IESDA framework provides information-oriented integration model for the service design. The framework is based loosely on that presented in Kulvatunyou and Wysk (2000). The purpose of this information-oriented integration is to establish functional information models that allow enterprise-level information sharing and thus facilitate the service design activities. For example, service engineers use the service process information model to interact with process engineers. The wholeness and compatibility among service designing information functions are infrastructures that will allow unlimited Enterprise-Based Service Design Activities interactions.

Figure 3.4 shows the graphical version of the proposed IESDA framework and illustrates how these information models are integrated in Enterprise-Based Service

Design Activities collaboration. In the IESDA framework, the Service Activities (SAs) have been divided into two groups of activities: *Enterprise Activities* (EA) and the core *Service Engineering Activities* (SEA).

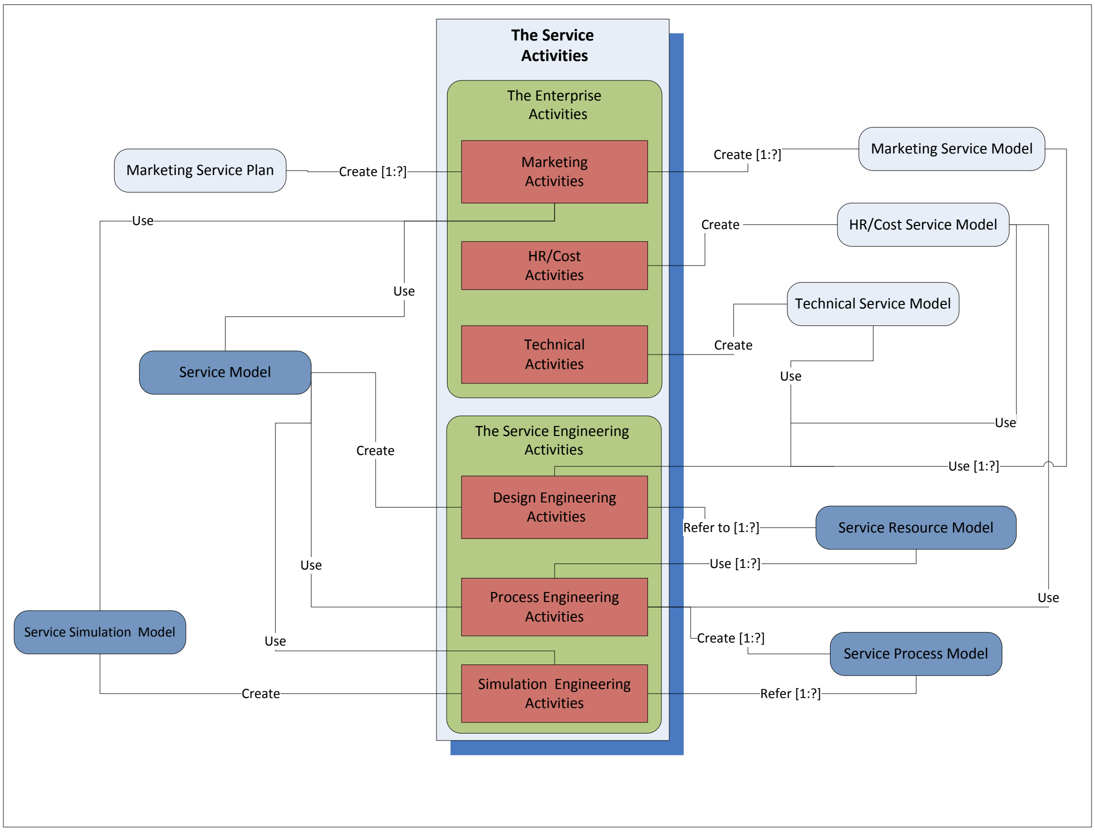


Figure 3.4. Integrated Enterprise Service Design Activities Framework

- ***The Enterprise Activities (EA)***: The Enterprise Activities (EA), as envisioned in the IESDA framework, are operational activities related to the service design, and have important impact on the design. In particular, they are the activities that the enterprise performs and indirectly affect the service design

In the IESDA framework it has been assumed that these activities are as follows:

- Marketing Activities (MA): Marketing Activities are related to the service design and have a significant impact on the design. Applying marketing research, determining which new service to offer, estimating size of market for new service and pricing are some of the examples of these marketing activities.
- HR/Cost Activities (HRCA): Human Resources / Cost Activities are related to the service design and have significant impact on the design. Activities include, but are not limited to: deciding manpower plans and needs, recruiting and training plan and estimation, managing the approach to employee salary structure, standardizing benefits and compensation, preparing procedures and forms related to Human Resources, preparing job descriptions, estimating time-labor cost, preparing HR Budget and preparing various statistical information reports relative to the competitors' employees.
- Technical Activities (TA): Technical Activities are performed by technicians, or specialists to produce the service concept, and should be considered during the service design activities. Edvardsson and Olsson (1996) define the service concept as the "detailed description of what is to be done for the customer (what needs and wishes are to be satisfied) and how this is to be achieved" (Goldstein et al., 2002). For example, in a restaurant, the chef is the technician (professional or specialist) and cooking is his activity.

(Although enterprise activities, such as marketing and human resources, do impact service design, they are not developed fully in this thesis because they do not directly relate to the engineering aspect of service design.)

- ***The Service Engineering Activities (SEA)***: In the IESDA framework, SEA focuses on core service design functions. The activities used in the IESDA framework are:
  - Design Engineering Activities (DEA): The activities performed by design engineers to design the service. These activities include the following: determining the location, designing the facility and layout and designing measurement tools to ensure quality and equipment selection. AutoCAD, Cadrail and Service Blueprint may be used at this phase.
  - Process Engineering Activities (PEA): The activities, as envisioned in the IESDA framework, performed by the engineer to define the service process. Some tools that could be used include IDEF0, UML Activity Diagram and project management.
  - Simulation Engineering Activities (SEA): The activities, as envisioned in the IESDA framework, performed in order to build a simulation model for the service. Simulation engineers can use any simulation software for performing this activity such as AnyLogic, CircuitLogix, Dymola, iGrafx Process, Khimera, RoboLogix and Arena.

  Moreover, the IESDA framework will contain eight information models. These models are:

- ***Marketing Service Model (MSM)***: A Marketing Service Model (MSM) is defined as an information model that consists of market analysis data. This data contains information about market needs, market demands and comparative data. In addition, MSM consists of information about the new service or development aims, objectives and scope that were defined with respect to the organization’s vision and strategic goals. This information is built by conducting marketing research to reflect customer perspective and by gathering internal information from service staff. *(This model is beyond scope of this thesis)*

- ***HR/Cost Service Model (HRCM)***: HR/Cost Service Model (HRCM) is the information model that contains data of the cost and human resource needs. These two challenges that the service designers face should be clarified during the design cycle. The HRCM consists of data about the human resource needs with regard to the qualifications, specifications, training and labor cost. *(This model is beyond scope of this thesis)*
- ***Technical Service Model (TSM)***: The Technical Service Model consists of data of the technical information and the service concept. In service design it is very important to consider the supporting resources, including human resources, physical and technical resources, and the company’s organizational culture. (Zhou and Tan, 2008). The TSM will provide the technical information that the designer will need. This information comes from the specialists and professionals in that specific service area. In addition, it consists of the service concept information. Service concept is defined as a specific description of customer needs (Zhou and Tan, 2008) that defines the how and what of service design. Moreover, service concept information

reflects the customer's image of the service, as defined by word-of-mouth or from real service experiences. *(This model is beyond scope of this thesis)*

- ***Service Resource Model (SRM)***: The Service Resource Model characterizes all the resources necessary to design, perform or produce the services. In addition, it consists of the requirements and regulations that should be considered in order to provide a specified service, to obtain a license for the service.
- ***Service Process Model (SPM)***: The Service Process model consists of data that specifies all operations, activities, resources and constraints necessary to perform or produce the service. SPM describes how the outcomes of a service are achieved. In addition, SPM consists of information about all the service activities, their order, time duration and their holder.
- ***Marketing Service Plan Model (MSPM)***: The Marketing Service Plan Mode is defined as the information model consists of data of launching service plan from the marketing perspective. Examples of such data are capacity, demand, marketing programs and marketing plans to accommodate customer requirements. *(This model is beyond scope of this thesis*)
- ***Service Model (SM)***: Service Model (SM) consists of the service contents and the structural plan of the service products. It is supposed to contain all the service information such as location definition, facility design and layout for effective customer and work flow, measures to ensure quality, equipment selection, and adequate service capacity.
- ***Service Simulation Model (SSM)***: Service Simulation Model (SSM) is a simulation model for the service. It is prepared by the simulation engineers

and used by the marketing staff. As mentioned above, service cannot be stored or tested, but this model will allow the marketing staff to virtually store and test the service before the customers. (*This model is beyond scope of this thesis, because it employs existing software programming and applications. It uses the data originated from the other models within the IESDA.)*

In addition, the tools used to generate this information should be associated with each model. For example, marketing analysis tools should be connected to the MSM and labor costing estimation tools should be connected to the HRCM. In Figure 3.4, each model is an interconnection between the various types of service design activities. Graphically, it can be concluded that the Marketing Service Model, HR/Cost Service Model, Technical Model, Service Model, Process Model and Service Resource Model, and Simulation Model effectively integrate enterprise-based service design activities. For example, if the service resource model is missing, it will be impossible to create the service model; consequently, service design cannot be evaluated.

3.5 Use Case of the IESDA Framework

A Use Case is an explanation of a system's behavior as it responds to a request that starts from outside of that system. The objective of employing the Use Case Technique is to help the system design to understand the system and determine its behavior requirements. This will be achieved by going through the scenario of the system's functions in detail, thereby creating a bridge between the conception of the system and its development.

Figure 3.5, shows the Use Case model of the IESDA framework. It illustrates how all these information models are integrated in enterprise-based service design activities collaboration. In the IESDA framework, the related Service Design Activities (SDA) have been divided into two groups of activities: *the Enterprise Activities* (EA) and *the Service Engineering Activities* (SEA).

The Enterprise Activities (EA) create three information (database) models that will be used by the Service Engineering Activities (SEA). These three information models are Marketing Service Model (MSM), HR/Cost Service Model (HCSM) and Technical Service Model (TSM). Marketing activities create one or more marketing service models (MSM), HR/Cost activities create one HR/Cost service model (HCSM) and technical activities create one technical service model (TSM). *(Although enterprise activities, such as marketing and human resources, do impact service design, the MSM, HR/Cost and TSM are not considered in this thesis because they do not directly relate to the engineering aspect of service design.)*

For Service Engineering Activities (SEA):

- Design engineering activities do the following:
  - Refer to one or more service resource models for facility, process and man power constraints. In addition, SEA refers to SRM for requirements and regulations needed to provide specified service, or to obtain the license for the service and for the technological specifications.
  - Use one or more marketing service models (MSM) for market analysis, new service design or development aims, objectives and scope that were defined with respect to the organization's vision and strategic goals.
  - Use the HR/Cost service model (HCSM) for labor cost estimation and

- Use the technical service model (TSM) for using the service concept information in the service design.

  The relationship between design engineering activities and RSM and MSM are one-to-many types because the design engineering activities may refer to several resources (including resources external and internal to the enterprise), and use several marketing service models with HR/Cost Service Model (HCSM) and Technical Service Model (TSM) to obtain an optimal design.

- Process engineering activities (PEA) map service resources to a service model, use the one or more RSM for resources and use HR/Cost service models (HCSM) for job description to create one or more process models. The relationship between process engineering activities and the process model is one-to-many type because the process engineer may provide several process plan alternatives for the office responsible for control of operations.
- Simulation Engineering Activities (SEA) use a service model and refer to one or more process models to create a service simulation model (SSM). The relationship between simulation engineering activities and the service process models is one-to-many that means simulation service model for several service process models and situations.

Figure 3.5 shows the Use Case model of the IESDA framework. It describes the behavior of a software system that will use the concept of the IESDA framework. In addition, it helps to build a shared vision of the IESDA proposed model at hand by bridging the gap between the people who understand the problem that IESDA solves and the people who understand how to build a solution.

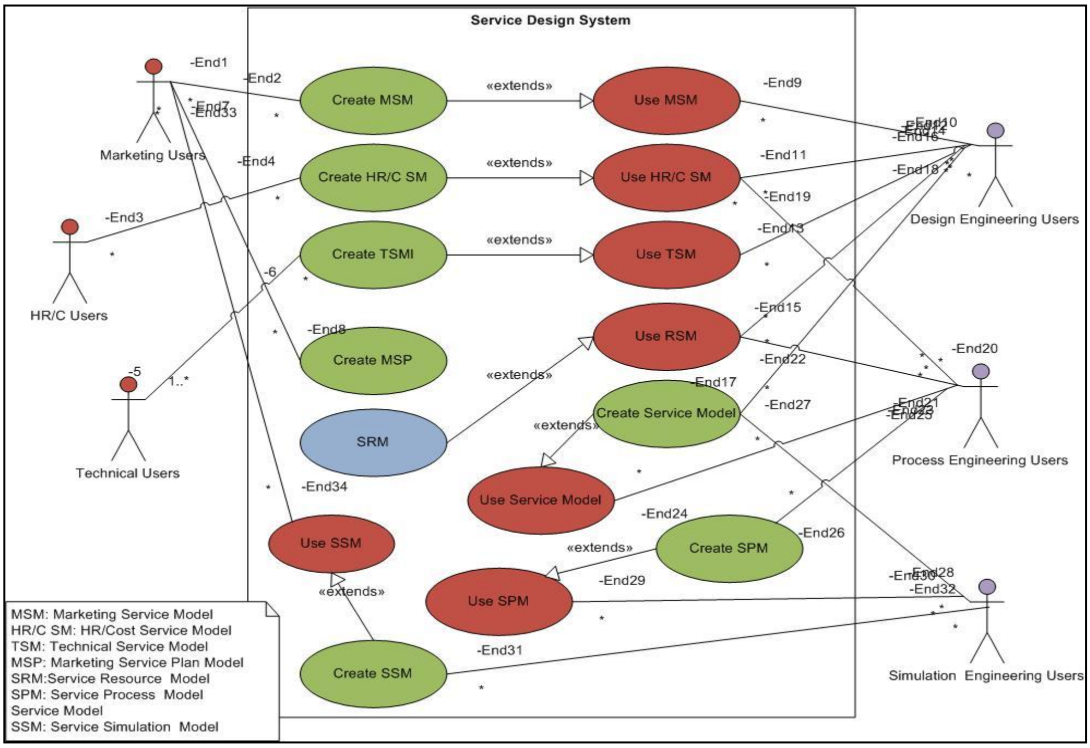


Figure 3.5. Use Case Model of the IESDA Framework

3.6 IESDA Framework Development

Given this framework, it is necessary to develop the core elements of the information models. This is the primary contribution of this thesis. To achieve this, these steps should be followed:

1. Illustrate any information models that have been used for service design and their advantages and disadvantages to be considered in the IESDA framework. This work is done in the literature review.
2. Determine what information should be considered and what information models should be created in the IESDA framework to generate, store and manage this information. Specifically, this step includes:
   - Determine the needs requirements for the information model.

- Determine the information representation for design process participants.
- Implement the representation in a relational database structure.

3. Define the relationships and the interactions among the information models within the IESDA framework. Moreover, the roles inside the model (who will create the models and who will use them), the models' components and the IESDA working process will be clarified.
4. Determine the service design tools that will be used within the information models.
5. Set up process to create, manage and use the data within the information models.
6. An example specific service will be used throughout this work to validate the usefulness of the proposed model.

3.7 Service Example

For more clarification of the IESDA framework, an example of specific service, a hotel, is used throughout this work to illustrate the usefulness of the IESDA. The hotel provides many services. It provides lodging, food, entertainment and laundry service. It contains many facilities: rooms, restaurants, banquet halls, meeting rooms, health center and lobby.

3.8 Summary

This chapter discussed the steps that have been taken to develop the IESDA framework. The framework is built on the foundation of mature product design processes with emphasis on enterprise engineering information integration. The framework is modified to include service design specific element such as higher integration of operational activities in design process. The framework is consistent with emerging service design process such as NSD. Finally, the framework is flexible for application to a variety of service industries. Figure 3.6 illustrates the framework for the next chapters.

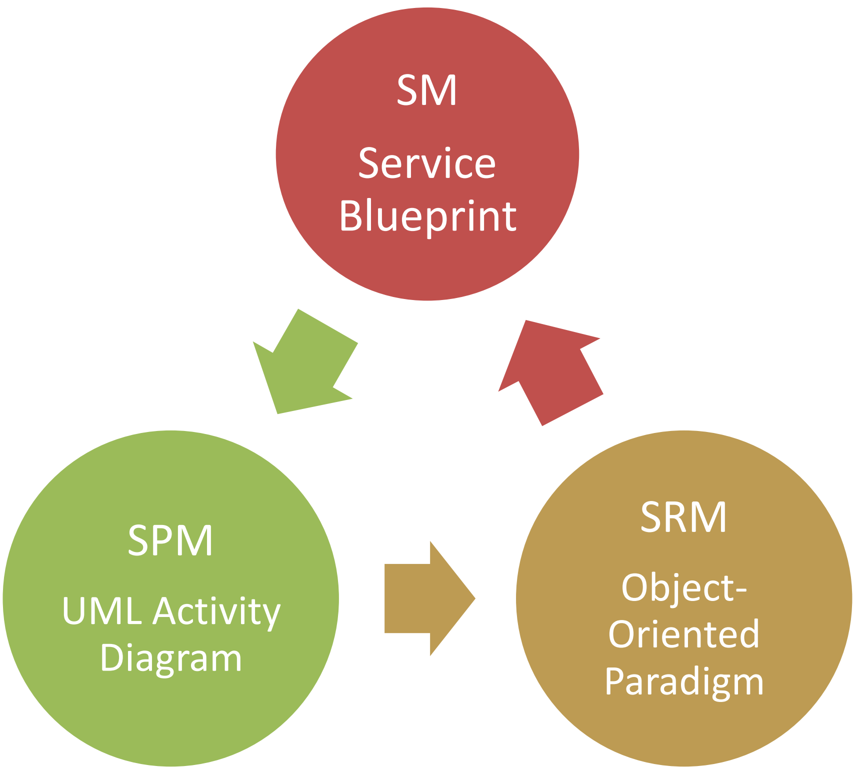


Figure 3.6. Initial IESDA Information Model Development

The following chapters consider the Core\Foundational concept of the SM, SRM and SPM models. They define the characteristics, structures and systematic creation and integration of these three models. Each of these models has a unique method of creating and performing its functions. The SM uses the “service blueprint” as a core for its function. The service blueprint is created by a new method within the SM model. The SRM uses the Object-Oriented Paradigm (OOP). The OOP structure and the classes’ relationship enable the SRM to perform its function more efficiently and to achieve the information integration with other models. The SPM uses the UML Activity Diagram to present the service activities. The UML Activity Diagram is created by a new method, in order to allow it to represent the service in different classifications. In addition, new methods of information integration among these three models and interaction among each model user are proposed in Chapter 7.

CHAPTER 4

SERVICE MODEL

The service model is the information model that contains the information that represents the “service concept”. It is analogous to the product design information models that represent product physical geometry (such as IGES - Initial Graphics Exchange Standard) or those more mature representations which include other product and customer attributes (such as STEP – Standard for the Exchange of Product model data). The ISO-based STEP protocol was used in the Kulvatunyou and Wysk (2000) framework. In this chapter, the requirements definition, representation, information model implementation and example application for building the Service Model are explained. In addition, a new method of inputting a service blueprint is illustrated.

4.1 Service Model Requirements Definition

The Service Model (SM) contains all of the service information needed to communicate the “service concept” to design process participants. The model information must enable the design process participant to “visualize” the service in order that they might contribute to its development. The chief challenge in developing this model is the intangibility of services. As a result, the representation of the service concept is subjective and relatively abstract. This challenge is exacerbated by the wide variety of service industries. No IT-based standardized representation exists for the service concept.

Several important characteristics of service design should be reflected in the approach to developing and implementing the SM. These characteristics include:

1. The service concept representation should be easy for all design participants to understand – likely advocating a graphical representation.
2. The model should have a minimal core information content that does not overload the design participant.
3. The representation should facilitate the "visualization" of the service concept.
4. The core service concept representation should be consistent across a wide variety of service systems – but might be extended with customization for industry specific features.
5. The service concept will likely have more intricate links to the resource and process data, which should be easily facilitated by its representation.
6. The representation should enable the service to be viewed holistically: from the viewpoint of the customer and in relation to the entire service delivery process.

4.2 Service Model Representation

In order to meet the requirements above, the "service blueprint" is suggested as the core of the service model representation. The service blueprint provides a concise and holistic view of the service concept. This core is supplemented with layout/site data for a more comprehensive customer interaction view to efficiently portray the overall service concept to design process participants. In addition, improvements to the service blueprint process are suggested.

4.2.1 Service Blueprint. A powerful tool that service designers use is the "service blueprint." The traditional blueprint is a drawing diagram that captures the most of the new design components. It shows what the product will look like and the specifications of its construction (Fitzsimmons, J, & Fitzsimmons, M. 2008). G. Lynn Shostack suggests using the blueprint in the same manner for the design of service. Service blueprints should be developed by the service engineers. The service blueprint information should be the key part of the Service Model information and contain data in the form of charts and text.

4.2.1.1 Service Blueprint Benefits and Features. Service blueprinting has many benefits. It is more specific than written or verbal explanations of the service; it helps solve problems preemptively and can identify failure points in a service operation (Bitner, et al, 2007). Moreover, it helps the enterprise become more customer-focused. It is the best tool "*for plotting the customer process against organizational structure.*" (Bitner, et al, 2007)

Many features of the blueprint make it the ideal tool to use as the core of the SM. The distinction between onstage and backstage activities and the combination of the process and the service structure allow the blueprint to integrate with various types of service data and interact with several design activities. Another advantage of the service blueprint is its simplicity. The graphical representations of the blueprint are easily understood, used or even modified by all involved personnel. Figure 4.1 shows an example of the service blueprint for a hotel.

4.2.1.2 Service Blueprint Description. The service blueprint is a *"map or flowchart of all the transactions constituting the service delivery process"* (Fitzsimmons, J, & Fitzsimmons, M. 2008). It consists of five components represented in fixed layers: the physical evidence, the customer action, onstage contact person, backstage contact person and support processes. Figure 4.2 shows the five fixed stages of the service blueprint. At the top of the blueprint, is the physical evidence which is the facility with which the customers come into contact and within they interact with the service organization. These facilities are tangibles that can influence customers' perceptions of the quality of the service.

The customer actions are the actions that the customers will take with each component of physical evidence throughout the process of service delivery. Placing the customer's actions at the top of the blueprint demonstrate that they are central to the creation of the blueprint. All other activities support the value proposition available to or co-produced with the customer. This also differentiates the blueprint from other flowcharting approaches used to represent the actions or processes. (Bitner, et al, 2007)

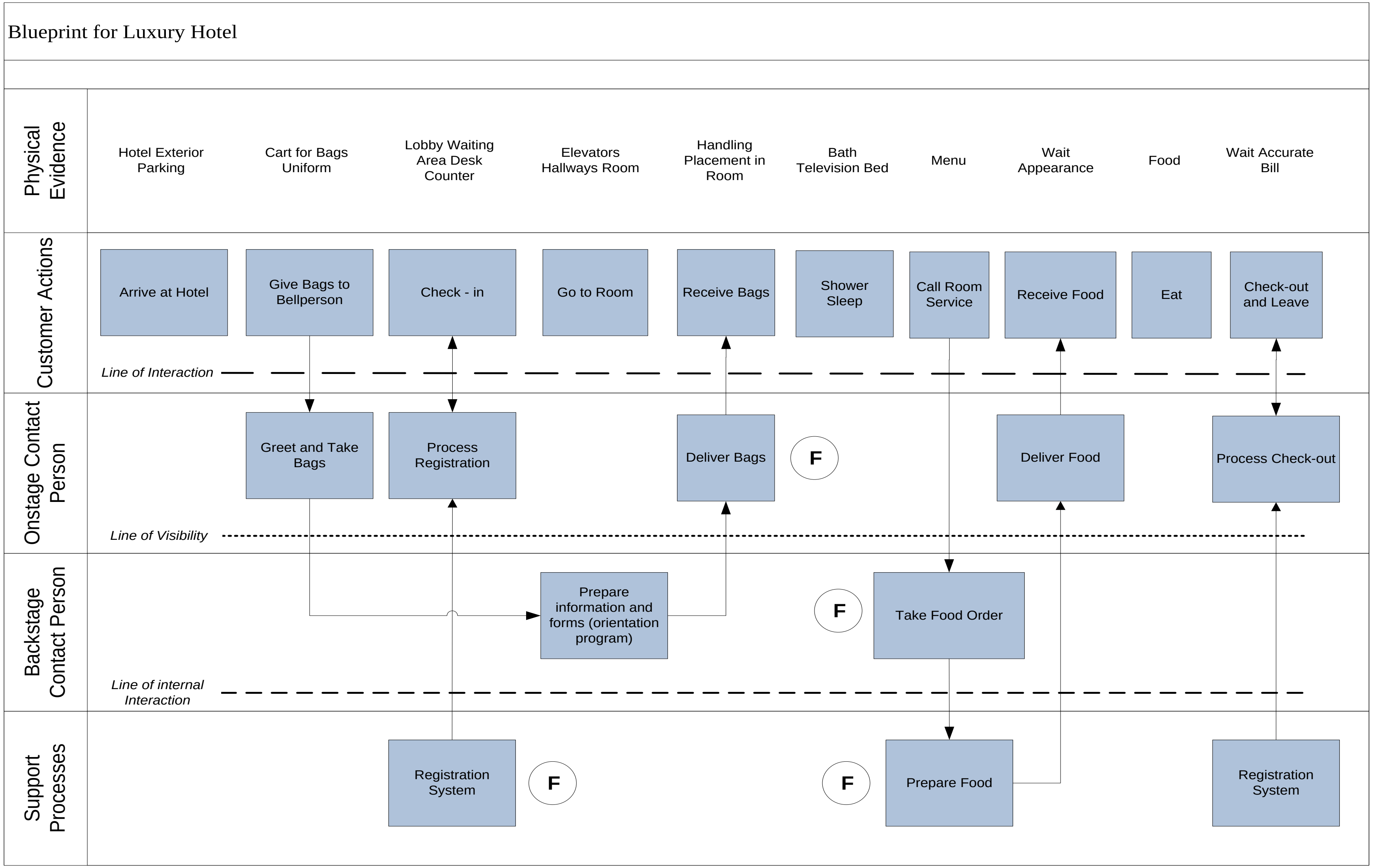


Figure 4.1. Service Blueprint for a Hotel (Fitzsimmons, J, & Fitzsimmons, M. 2008)

The name of the service	
Physical Evidence	
Customer Actions	
Onstage Contact Person	
Backstage Contact Person	
Support Processes	

Figure 4.2. Five Fixed Stages of the Service Blueprint

The onstage contact person phase represents the actions to be taken as a response to the customers' actions. These actions are face-to-face encounters. The backstage contact person phase represents the actions that must be taken before the onstage contact person's action, as well as actions taken beyond the sight of the customer. They are separated from the onstage actions by the line of visibility. The final stage includes the support processes in which all the activities that must occur in order for the service to be ready for delivery, are performed by individuals or systems within the company.

Three vertical lines of interaction exist between these stages: the line of interaction with customers; the line of visibility, the interaction between the organization's personnel beyond the customer visibility; and the line of internal interaction that shows the interaction between the support systems and the actions. All of the activities that appear above the customer's line of visibility are seen, while everything below is unseen.

The features of the service blueprint and its five components allow it to become the central tool for most of the service design tool. Thus, it is used in the SM as a core tool that is built by exchanging data between tools. In the example of the hotel blueprint shown in Figure 4.1, represents the actions of customers as part of the service delivery process. These lists of customer actions depict the entire customer service experience from the customer's point of view: from arrival at a hotel until check-out and departure. Onstage action is performed by the front desk employees who check in customers. Employees who prepare information and forms are also engaged, but in a backstage capacity. The registration system, which is necessary to support the above activities, is located in the support processes stage.

4.2.1.3 Steps for Building a Blueprint. The service designer usually creates the service blueprint by using chart diagram software or similar software that has such capability. For example, Microsoft Visio is one type of software used specifically to generate such diagrams, while creating charts is just one capability of Microsoft Word. The customary steps for building a Blueprint progress in the following manner:

- Clarify the service processes or sub-processes represented in the Service Blueprint.
- The actions of customers should be defined. The customers' actions are inserted into the diagram (usually in chronological order from the beginning of service delivery to the end).

- The next step is defined by the onstage and backstage phase. At this step, the contact person's actions, followed by support processes, are added to the diagram.
- During these steps, links between customers' actions to contact employee activities and support functions can be created.
- The final component added to the blueprint is the physical evidence (Bitner, et al, 2007).

4.2.2 Additional Service Model Representation. While the service blueprint is the main tool for service design and is the center of the SM, it does not give a complete picture of the customer experience in terms of the service. Thus more elements must be designed and more tools used for the service design in the SM. Table 4.1 shows the elements of service design and some of the popular tools used to design them. All of these elements are explained in *Service Management: Operations, Strategy, Information Technology* (Fitzsimmons, J, & Fitzsimmons, M. 2008).

Some of these tools are used to expand exchanging data within the service blueprint, such as tools used to design a queue schematic or model and encounter triad. To use these tools, the designer must know where the possibility exists for a queue to form, based on the presence of physical evidence in that location on the service blueprint. In the next two sub-sections, two interrelated types of design information are shown and used to supplement the service blueprint in the proposed service model representation.

Table 4.1. Element and Popular Tools of the Service Design with Type of Data

Design Elements	Sub elements	Popular Tools	Type of content
- Structural			
Delivery Facility design	Service Blueprint	Blueprint	Chart and Text-data
	Service Capes	Service Capes	Chart and Text-data
	Architecture		Image and Text-data
	Layout	AutoCAD	Image and Text-data
Location	Site selection	GIS	Numeric and Image
Capacity planning	Queuing models	A/B/C	Text-data, numeric
	Planning criteria		Text-data, numeric
- Managerial			
Information	Technology	Find the role	Text-data
	Scalability		Text-data
	Use of interne		Text-data
Quality	Measurement	SERVQUAL	Text-data
	Design quality	HOQ	Image and Text-data
		Six-sigma	Text-data
Service encounter	Encounter triad		Chart and Text-data
	Supply		Text-data
	Outsourcing		Text-data
Managing capacity and demand	Yield manage		Text-data
	Queue manage	Queuing Schematic	Image and Text-data

4.2.2.1 Layout Data. Layout data is an example of the image and text-data that provides information about the physical facilities with which the customer interacts. This information includes images like layout diagrams or potentially web page designs. A designer can use any software to create images and then upload them to the graphics database. One function of the service blueprint is to show the layout designer which parts of the facility (kitchen, lobby, and offices) will be seen by the customers. By taking this into consideration, the designer may plan the specifications, such that spaces within the customers' visibility will have a more visually pleasing layout. Service process engineers use layout data to plan the execution of the service being provided.

4.2.2.2 Site Selection Considerations. Site selection consideration is one of the tools used for the service design location. The site selection is essentially a view of the customer outside, but in proximity to, the service organization facility. It presents an example of the numeric and text-data type. The site considerations tool lists many physical attributes that are considered during the site selection process (Fitzsimmons, J, & Fitzsimmons, M. 2008).

4.3 Service Model Implementation

Given the combination of the service blueprint and layout/site information to represent the core service concept, it is necessary to design the relational database implementation. The comprehensive entity-relationship diagram is shown in Figure 4.3. Note that the attributes of the data models might be service industry specific (particularly in the case of layout and site data), but the entity and relationship structure would be consistent across all service industries.

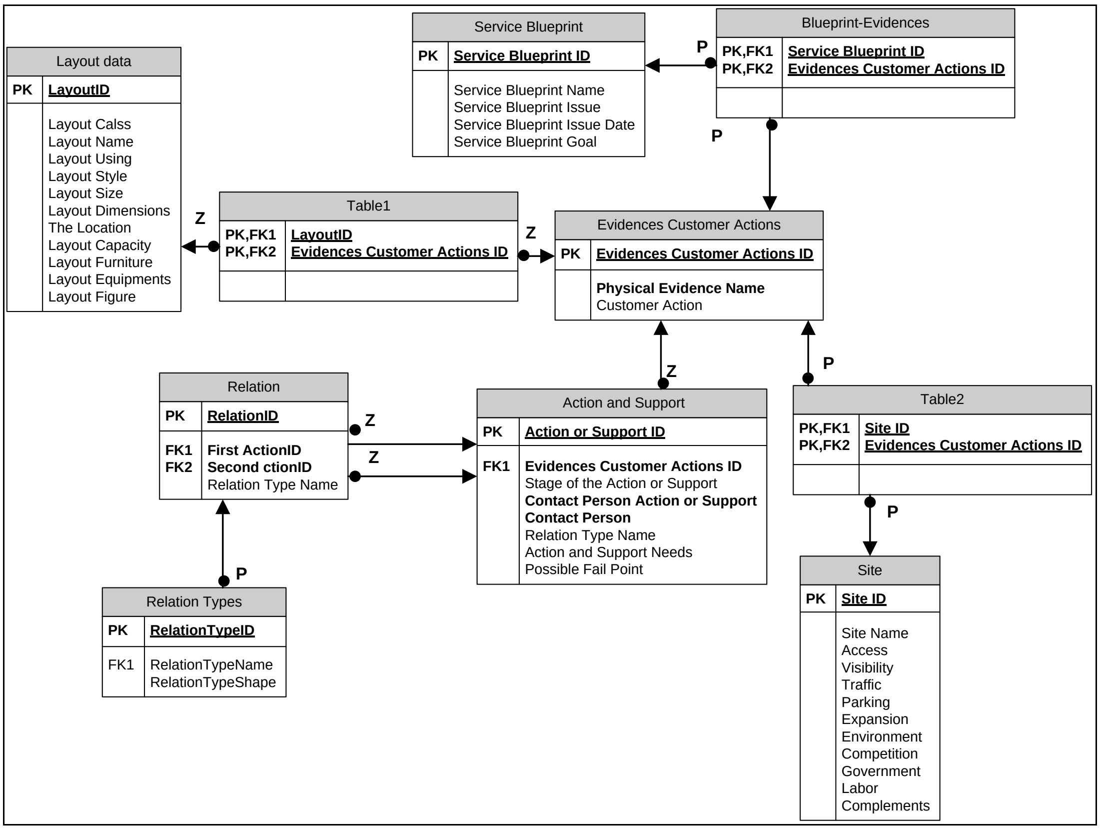


Figure 4.3. ER Diagram of the SM

4.3.1 Service Blueprint Data Model. The database implementation of the service blueprint is described first. This database approach has the advantage to the designer of enabling him to insert data as text, and the software system creates the chart diagram. This allows the design engineers to focus more on the design data rather than the graphic work. In addition, this feature gives data flexibility to transfer to or from the blueprint diagram, in order to accomplish information integration with other tools and models as shown later. Finally, it facilitates reuse of service blueprints. To build the service blueprint in the SM, several entities should be used.

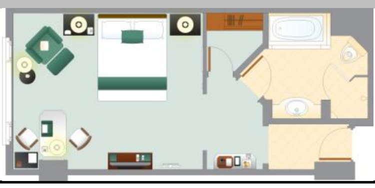
1. The first table is the service blueprint table. It should contain the service name, the version and the goal of the design. Table.1 shows the attributes of the Service Blueprint entity table.(See appendix)
2. The second table is the Physical Evidence and the Customer Action Table. The relationship between this table entity and the previous one is many-to-many because one service blueprint can have one or more Evidences Customer Actions, and these may appear in one or more service blueprint. To solve this problem, an intermediate table has been created. A user can insert more than one action with certain physical evidence, but the system will generate a different ID for each action. Thus, the relationship between the physical evidences and the action becomes one-to-one. Table.2 shows the attributes for the Evidences Customer Actions entity table. (See appendix)
3. The third table is the Action and Support Entity table. After inserting the Evidences Customer Actions table information, the user must define the organization personnel's response actions and the Support Process Systems. The System Process could be an action or a system that will support any kind of actions (customers or organization). Table.3 depicts the attributes of the Action entity table (See appendix). More attributes, such as the contact person information and action or support resources needs, are added to the activities entity, making it more valuable to designers. The relationship between the Action and Support entity and the Evidences Customer Actions entity is zero-to-many. For example, an action, such as the Backstage Contact Action, may occur even when no direct relationship exists between it and the Evidences Customer Actions.

4. The Action Relationship entity table. The relationships between the actions and support systems should be defined. These relationships could flow in one direction or bi-directionally. They could be among or within the Backstage Contact Person Actions, Onstage Contact Person Actions and Support Process System. Table.4 shows the attributes for relation entity table. This entity table has a zero-to-many relationship with the Action entity table. (See appendix)
5. After inserting the data of these entities the system should create the Service Blueprint diagram as shown in Figure 4.1.

The system should allow users to change data and update the diagram simultaneously. It allows the users to retain the old information and create a new Service Blueprint diagram with a new ID and new version number.

4.3.2 Layout/Site Data Model. The data model allows the physical evidence in the service blueprint to be associated with any number of layouts and vice versa. Table 4.2 provides a description of the attributes which might be included in a layout for the hotel example. In addition, Table 4.3 shows the attributes of the Site Selection Consideration entity table that might use in the service blueprint data. This new approach of using the tools suggested in this thesis, applies an analytical process to allocating weights (order ranking) to the respective alternative location.

Table 4.2. Example Data of the Attributes of the Layout Data

Attributes	Data Example1
Layout ID	The ID number of the Layout
The Class of the Layout	The layout class: Building, Room, Lobby, Recreation..etc.
Layout Name	Room 102
Layout Use	Guest Room
Layout Style	Deluxe Room 1
Layout Size	45-square-meter
Layout Dimensions	9x5 meter
Layout Location	Building 1, level 5
Layout Capacity	2 Guests
Layout Furniture	King Bed, sofa chair, carpeting covers the floors
Layout Equipments	32-inch LCD television, Plug and Play" High Speed Internet Access,
Layout Figure	

This new method allows service designer engineers to compare many locations by rating them according to each factor to be considered. The system will subsequently generate analysis reports and flowchart diagrams of the results of the comparisons based on the consideration factors. Adding the rating system to the Site Selection Consideration tool creates a more dynamic method of evaluating the potential sites, thereby increasing the value of this component of the model. In addition, the designers have a direct connection to the site data and they can pick up any location to use for the physical evidence of the blueprint.

Table 4.3. Site Selection Consideration Entity Table (Fitzsimmons, J, & Fitzsimmons, M. 2008)

Site Selection Consideration	Description	Rating
Site ID	The ID number of the Site	
Site Name	The Site name	
Access	Convenient to freeway exit and entrance ramps. Served by public transportation.	
Visibility	Set back from street	
Traffic	Traffic volume on street that may indicate potential impulse buying	
Parking	Adequate off-street parking	
Expansion	Room for expansion	
Environment	Immediate surrounding should complement the service	
Competition	Location of competitors	
Government	Zoning restrictions and Taxes	
Labor	Available labor with appropriate skills	
Complements	Complementary service nearby	

The data derived from the synthesis of information from within the model will be expressed in a variety of formats, for example: bibliographic, full-text, numeric, image, directory entries or statistics. In addition, some could create and translate from type to type for easy usage. In this thesis, examples of different types of data content are used to illustrate the SM. The Service Blueprint is an example of the chart and text-data type, the Layout is an example of the image and text-data type and the Site Selection Considerations is numeric and text-data.

4.4 Service Model Example

Figure 4.4 shows how the interface of the MS with all these tools could appear if the system were automated. It shows that the user can click on any box in the service blueprint to review or update the data. Table 4.4 provides an example of how some of the service blueprint in Figure 4.1 might be implemented in the database model (data given as joined query view rather than separate tables).

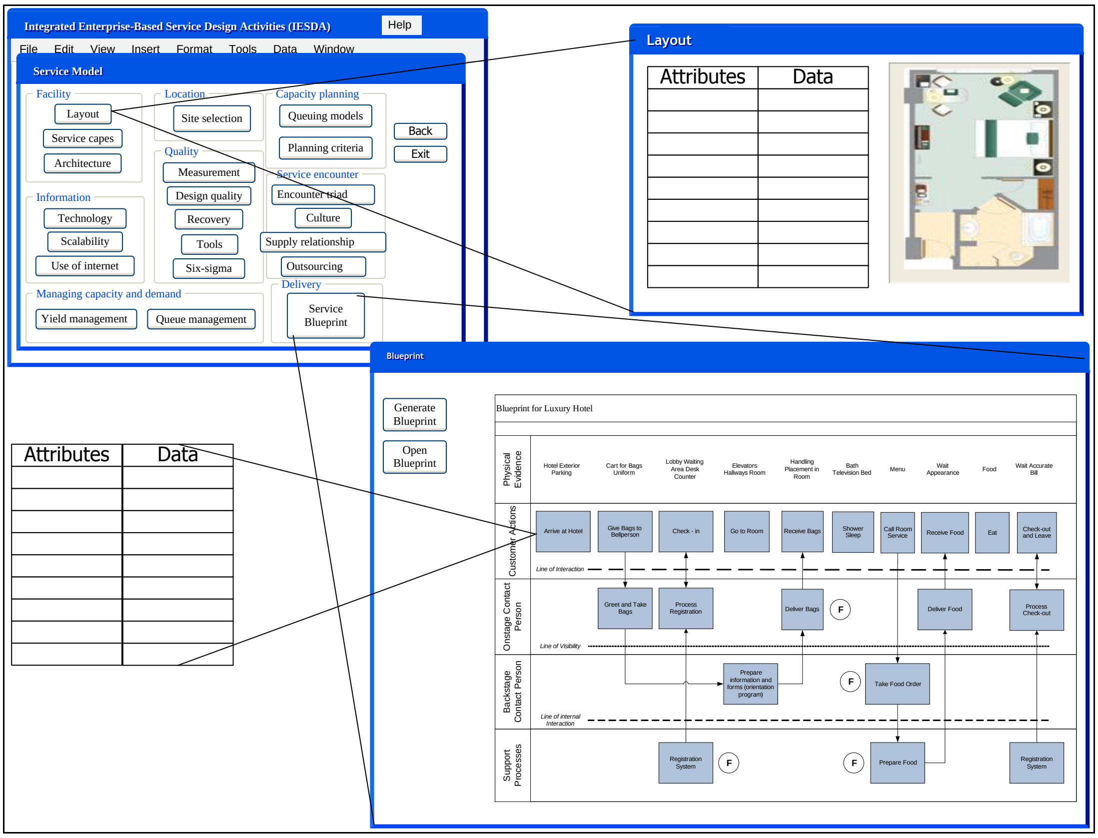


Figure 4.4. Interface of the SM Database

Table 4.4. Example Data of the Hotel Blueprint Attributes

Service Blueprint Name: Hotel, Service Blueprint Version: 1.1 and Service Blueprint Version Date: 10-10-2010.

	Physical Evidence Name and ID	Customer Actions	Stage of the Action or Support	Contact Person Action and ID	Contact Person	Relation Type Name	Action and Support Needs	Possible Fail Point	First Action ID	Second Action ID	Relation Type Name and ID
1	Hotel Exterior Parking. 00008	Arrive at Hotel	-	-	-		-	-	-	-	-
2	-	-	Backstage Contact Person	Prepare information and forms. ID: 00220	Administrator		-	-	-	-	-
3	Cart for Bags Uniform:	Give Bags to Bell person	Onstage Contact Person	Greet and Take Bags. ID: 00202	Bell person	To	Uniform and trolley	No	Greet and Take Bags. ID: 00202	Prepare information and forms. ID: 00220	From. ID: 00101
4	Lobby Waiting Desk counter. ID: 00010	Check in	Onstage Contact Person	Process Registration. ID: 00012	Front Desk	bi-directionally	Check in form and access to the registration system	Yes	Process Registration. ID: 00012	Registration System	From. ID: 00010
5	Elevators Hallways Room	Go to Room	-	-	-		-	-	-	-	-

Table 4.4. (cont.) Example Data of the Hotel Blueprint Attributes

	Physical Evidence Name and ID	Customer Actions	Stage of the Action or Support	Contact Person Action and ID	Contact Person	Relation Type Name	Action and Support Needs	Possible Fail Point	First Action ID	Second Action ID	Relation Type Name and ID
6	Handling Placement in Room	Receive Bags	Onstage Contact Person	Deliver Bags	Bell person	From		Yes	Deliver Bags	Prepare information and forms. ID: 00220	To. ID: 00020
7	Menu.ID: 00015	Call room service	Backstage Contact Person	Take food order. ID: 00013	Worker	To	Telephone connection, Menu.	Yes	Take food order. ID: 00013	Prepare Food. ID:00120	From. ID: 00030
8	Bath Television Bed. ID: 00020	Shower Sleep									
9	Wait Appearance	Receive Food	Onstage Contact Person	Deliver Food	Server	From		Yes	Deliver Food	Prepare Food	To. ID: 00040
10	Food	Eat	-	-	-		-	-	-	-	-
11	Wait Accurate Bill	Check-out and Leave	Onstage Contact Person	Process Check-out	Front Desk	bi-directionally			Process Check-out	Registration System	To. ID: 00050

4.5 Service Model Summary

This chapter discussed the requirements definition, representation, database implementation, and example of the Service Model. The challenges of constructing such a model were presented. The combination of service blueprint with layout/site data provides a new construct to convey service concept. This simple approach is the major contribution of this chapter. The database implementation provides the contribution of a basis for standardized and integrated interchange with potentially simplified designer input.

This chapter showed how the integration information and tools within the SM facilitate the exchange of data between the tools. Three forms of information or three tools of service design are used to illustrate the model function and systematic performance: service blueprint, site location consideration and layout data. The service blueprint is used as the core of the SM, because its features and components make it the best choice for this purpose. In the IESDA, its diagram is automatically generated by the system. This method provides greater flexibility of data transfer between the blueprint and the other tools. As shown later, greater flexibility of data transfer between the service blueprint and the other models will be illustrated. More tools are suggested and data formats are recommended by this thesis. This data form recommendation could be used in future work to expand the data exchange.

CHAPTER 5

SERVICE RESOURCE MODEL

To perform or deliver a service, resources, such as personnel, facilities, and consumables are acquired, managed and utilized. Increasingly specific information about these resources is determined and used by engineers, because the execution of the final design depends on the available resources and capabilities. The method of organizing and structuring this information within the SRM is explained and illustrated below. This chapter covers the definition, characteristics, requirements and steps for building the Service Resource Model (SRM). It discusses how an Object-Oriented Modeling (OOM) technique is recommended as the most appropriate method of organizing and specifying data within the SRM. Furthermore, a novel relational database implementation of this modeling approach is presented.

5.1 Service Resource Requirements Definition

The *Service Resource Model (SRM)* is defined as the information model that characterizes all the resources and the enterprise facility's assets that are directed toward the finished or performed service. The SRM information helps service design engineers know the standard specifications that they consider in the new service design. The resource information in the SRM is general and covers the minimum requirements of the resources.

Several important characteristics of service resources should be reflected in the approach to developing and implementing the SRM. These characteristics include:

1. Resources have both associated data/parameters and associated processes performed in service delivery.
2. Resources may be selected from those already in the possession of the service provider or progressively designed from “scratch” by the design team.
3. Resource identification, with respect to service design is a process of advancing from abstract concept to more concrete configuration and specification.
4. Resources are combined in a system hierarchy where some resources may be composed of other resources.
5. The model should help with the connection of human resources to the HRCM and non-HR resources and process to the TSM.

The requirements of Service Resource Model necessary for IESDA integration can be classified into representational and functional requirements, as follows:

- Representational Requirements:
  - Complete engineering information of the main technological specifications for the equipment used in the service
  - Characterization of all the resources that are directed toward the finished service or performed services (processes, people, and materials)
- Functional requirements
  - Computer interpretable
  - Hierarchical fashion and implying the inheritance mechanism from the object-oriented paradigm

- Ability to share information with designing engineering systems, process engineering systems and simulation systems throughout the service design cycle.

5.2 Service Resource Representation

This thesis advocates the use of object-oriented class diagrams to represent the resources. The UML expression is well-understood by software engineers facilitating future system automation. This type of representation is implied in the Kulvatunyou and Wysk (2000) framework. Their Integrated Enterprise-Based Engineering Activities model (IEEAs) has been mentioned and discussed. However, the case of the Manufacturing Resource Model in the IEEAs is different than the case of the Service Resource Model in the IESDA. The National Institute of Standard and Technology (NIST) formed a Manufacturing Resource (MR) Modeling Research Group as part of the Rapid Response Manufacturing (RRM) project to be responsible for defining the MR specification (Kulvatunyou, & Wysk 2000). However, nothing such as these efforts have been done for the services.

In the proposed approach, resource information is structured and organized in a manner that allows that information to be created, retrieved and managed in object classes. Managing the data in this way helps avoid data redundancy. This structure also allows for future expansion of object types. In addition, the structure of this data should support the aim of this model which is information integration. Thus, this information is organized and specified in a hierarchical manner and adopts the inheritance and composition mechanism from the Object-Oriented Paradigm (OOP). The OOP has the capability to present data in class structure and considers the data and functions to be performed on that data simultaneously, as shown in the next section. The model covers all combinations of service resource components, including people (HRCM) and processes and facilities/equipment (TSM) that must be appropriately integrated to result in the designed service.

5.2.1 Object-Oriented Modeling. The service resource representation is essential for the enterprise service design integration. As has been shown in figure 3.2 and 3.3, it is necessary for nearly all the service engineering activities. The service design engineer refers to the model's technical specifications to select the facility, layout and equipment to be used in the service. This information is essential to create the service model that contains all the details of the service. The service process engineer uses the SRM to create the service processes used in scheduling, controlling, performing and delivery of the service.

The SRM should be organized and specified in a hierarchical fashion and adopt the inherited mechanism from the object-oriented modeling (OOM). This mechanism allows subtype resource to inherit all attributes belonging to its super-type. Using the object-oriented paradigm simplifies for designers the process of organizing the SRM data, creating, using and managing the service resources data. The object-oriented method considers the data and the functions to be performed on that data simultaneously from the beginning of the system analysis process and throughout the design and implementation (Post, 2002).

Other approaches of analysis focus on one element at a time. For example, the data-oriented method focuses mainly on analyzing the necessary data and its relationship to other data, and designing the way it will be stored in a database. The function-oriented method focuses on what the application does with the data. Data structure design and any database are secondary (Post, 2002).

Using this mechanism helps to organize data and processes in hierarchical levels and structure. In addition, it occupies small storage space and utilizes data in a way that avoids redundancy. The object-oriented paradigm also makes effective use of classes and objects, encapsulation, inheritance and polymorphism, as defined in the next sections, as related to the SRM data. In addition, it is illustrated that they provide a more suitable paradigm for the SRM.

5.2.2 Classes and Objects. "Fundamentally, objects are abstracted entities that encapsulate state and behavior" (Alhir, 1998). "Attributes are representational constructs of structural characteristics of entities and determine the possible states of an object. Operations are representational constructs of behavioral characteristics of entities and determine the possible behaviors of an object as invoked in response to receiving a message" (Alhir, 1998).

For each object, the descriptive attributes, their state, relationships to other objects and behavior (or functionality) should be defined. In the service resource representation, the objects are the resources, which come from the service components. The service components, as have been mentioned, are not just physical entities; they are a combination of people, facilities and possible processes that must be appropriately integrated to result in the designed service (Goldstein et al., 2002). In this thesis, the service components are considered to be resources and process. The resources include people (human resources), facilities and the consumed resources. The Service Resource Model (SRM) in the IESDA framework should comprise all of these main components in the class diagram.

Two types of relationships between SRM objectives (objectives) have been established to characterize the object-oriented paradigm in a relational database. These two relationships types are interheritance ("Is a") and composition ("Has a"). Table 5.1 shows descriptions and examples of these two relationships (Kulvatunyou and Wysk 2000).

Table 5.1. Descriptions and Examples of the Two Relationships

Relationship	Description	Example
"Has a"	Indicates possessive between objects, the attributes of them that could be inherited	An object that has another object receives all attributes. E.g. " Hotel" Has a" resources"
"Is a"	Indicates a subtype between resource abstractions.	If an object is a subtype of another object, it inherits all attributes of that object. E.g. "Equipment is a type of resource."

5.3 Service Resource Implementation

The representation of production or service system resources using an object representation is not new. However, no known approaches address the relational database implementation of such an object model. "Object-oriented" databases exist, but they tend to focus more on the storage of complex data objects or Binary Large Objects (BLOBs). Numerous challenges exist in the relational database implementation of such object diagrams to maintain the integrity of the inheritance and composition relationships while avoiding data redundancy.

The database structure itself is directly created from the object diagram. Though the most abstract levels of the object diagrams (resource, personnel, facility, and process) would be consistent for any service, the remainder of the diagram structure would be unique to service system. The database construction would reflect this customization. As a result, the example of the service resource ER diagram is preceded with an example class diagram for the hotel application. The class diagram is shown in Figure 5.1.

The first component shows the resources, which represent all of the resources that could be used to perform or deliver the service. Hotel service resources include consumed resources, facility resources and human resources. Each resource represents an object in the class diagram. The group of objects represents a class that possesses common attributes (the resource's attributes), relationships and behavior although the actual values for those properties are usually different for each object in the class. They also have their own specific attributes. The same is true for each class level. For example, the facility is an object. This facility (object) is a support facility, building or furniture. The group of them composes a class that possesses the same set of attributes (the facility's attributes), relationships and behavior although the actual values for those properties will usually be different for each object in the class, which, individually possesses its own set of attributes.

The second component is the process, which in the SRM, provide the designers with a list of the main process to perform their service. In addition, this list will contain some information that could be considered as standard of this process from the designer's perspective. In the case of a hotel, the essential process of guest check-in has certain requirements, such as registration forms, method of payment and room key delivery. These exchanges may be electronic or face-to face, depending on the vision of the service designer. Without these essential resources and processes, the contents of the service would not function correctly.

Figure 5.2 shows a portion of the ER diagram of the SRM. This portion shows how inheritance relationships are implemented using category operators in the ER model. Tables showing the attributes of the all SRM entity tables are shown in appendix. Composition relationships are maintained in a separated table dedicated to the storage of composition relationships. This table is enabled by having a common super class for all resource objects.

A key contribution of this process is the portrayal of data to a system user. The database administrator would construct automatically generated queries to enable a data view which integrate data across inheritance relationships to produce data in what appears to be a single table. This enables user-friendly maintenance of the inheritance relationships without redundancy. A second key element of implementation is the allocation of records for "abstract" objects. The abstract object would contain "default" data for that object type. This enables the design to insert an abstract object early in the design and progressively detail the object as the design progress. It should be noted that the emphasis in this initial version of the service resource model is on the resource object classes and primarily on resource attributes and not methods. Service processes and associated with resources are covered in chapters 6 and 7.

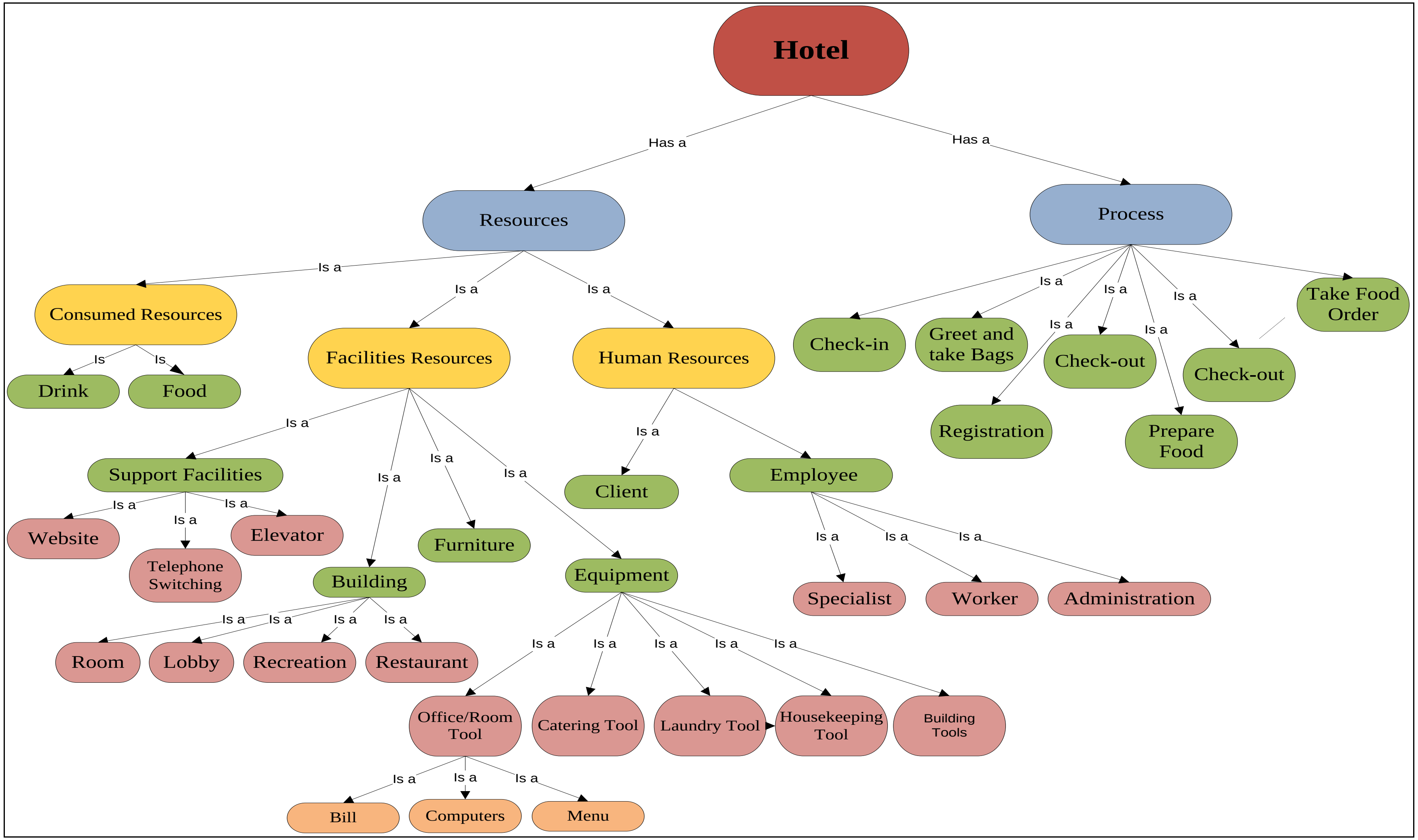


Figure 5.1. Example of Class Diagram of Service Resource Model

The ER diagram shows the entities, their relationships and the attributes. These entities are the objects in the class diagram. To design the “Is a” relationship, the “Abstraction” feature is used as one of the OOP features. To apply this feature, similarities and differences among the attributes of a set of entities must be identified. Common attributes must be found and distinct attributes avoided, in order to define a single representation entity possessing those common attributes. An example of this single representation entity is the facility and its attributes are common for its “Is a” entities. The behavior (or functionality) of the attributes is not defined in this thesis, but its benefits are utilized in the integration among the models. Chapter 7 discusses this integration.

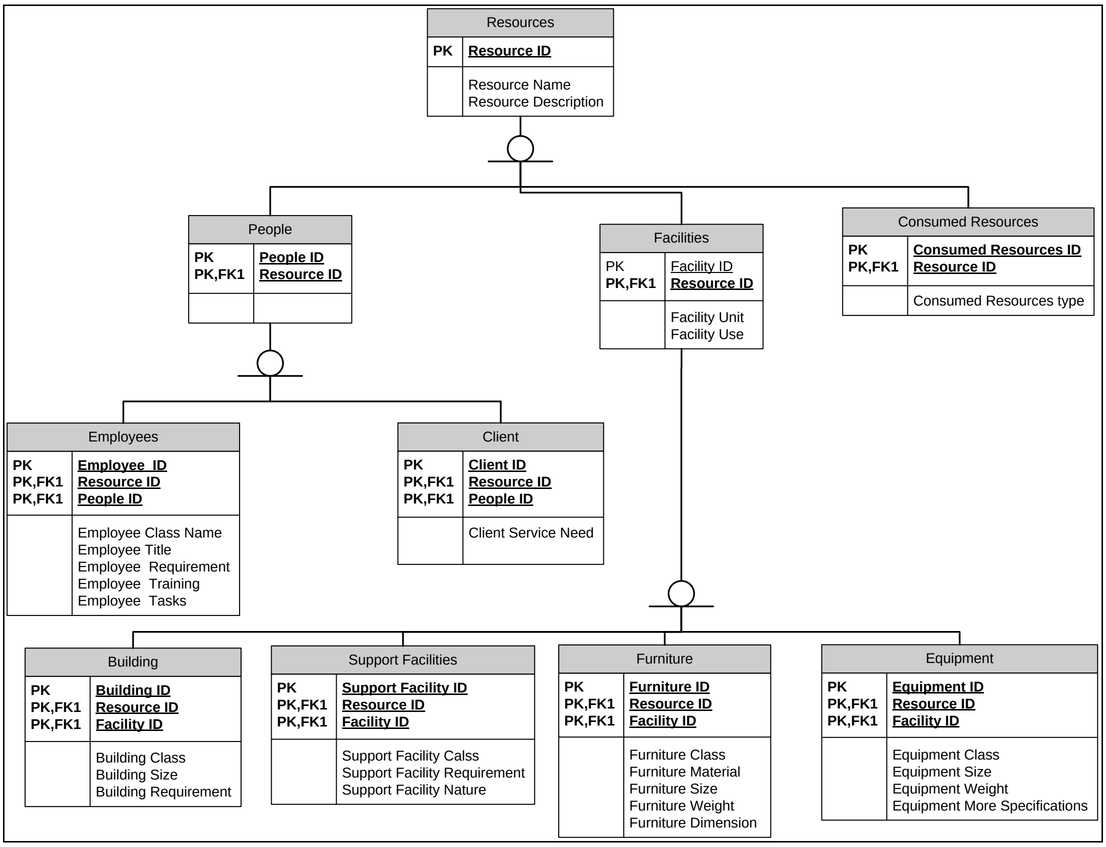


Figure 5.2. Inheritance Structure of Resources Entity on SRM Data

5.4 Service Resource Example

A class diagram for the hotel service system was portrayed in Figure 5.1. A hotel service system may consist of meeting rooms, guest rooms, lobby, staff, and other complementary equipment (overhead projectors, computers, laundry machines). Some of these components are physical and some of them are not. SRM should provide information about the technological specifications for the material or equipment integral to service design and delivery. A technological consideration to be made in a hotel is telephone switch capacity. The ability of the switch to handle calls must be sufficient for the size of the planned hotel. When this information is entered into the SRM, designers can access it; plan their components of the overall service accordingly, then save the final design in the SM.

A general process for creating such a model follows. Service resource data should be created specifically for each service design software package utilized in the enterprise. Thus, to build the resource information model these steps should be followed:

1. The service resource data must be created specifically for each service design software package utilized in the enterprise
2. The service resource model should be created and shared within the enterprise. So, the enterprise personnel from all departments, engineering designers and software developer need to collaborate decide what resource data they need in the service design software.
3. Define the entities from the main service components (process and resource). These components are general and may be applied to all types of services. In addition, starting from these two components helps establish the class diagram

for the SRM data and covers all resources (tangible and intangible) that the service design and process engineers need in order to build the service design. It should cover the essential components of the service that must be present for the service to be delivered. In addition, the attributes of these entities should be defined.

4. Use the first principle of the OOM. This is the "*Abstraction" or formulation* of representations *by* focusing on the similarities and differences among these entities to extract the common characteristics (represented by the attributes) and avoid the distinguishing characteristics in order to define a single representation having all those common characteristics.
5. Build the inheritance structure and define the relationship between the classes.
6. Define the standards and regulations that must be observed in delivery of the service (federal, state and county regulations). Standards and regulations data should be connected to the main components of the service (process, people and material).
7. Build the database system and create the data provided by the enterprise and the designers.
8. The software developers should devolve standard interface that be employed throughout the enterprise. *This will result in an accurate and multi-enterprise-enabled **service** resource model*

The SRM structure will be the same for services with similar functions. For example, the SRM structure for another hotel would be the same, but the data it includes may differ. These data created by the software developer with coordination with all personnel involved in the service could be considered as default data. The system should allow the designers to create more resources or modify the existing resources data. In addition, some attributes are default such as the ID number and facility unit, while other attributes are abstract, such as the resource description. Decisions about the characteristics of these attributes are dependent upon the individual enterprise. Figure 5.4 is an example of what the SRM interface page could look like. In addition, it shows an example of the data tables of the material and the equipment. This table gives an example of the data display unified across inheritance relationships.

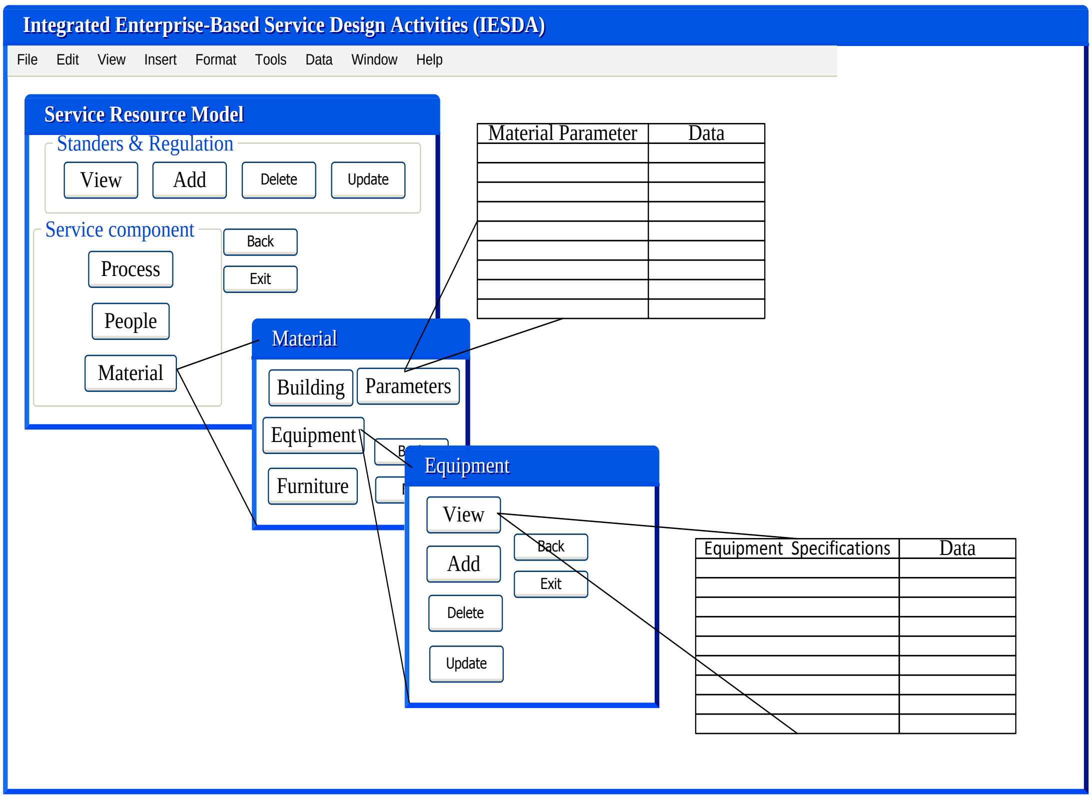


Figure 5.3. SRM Interface Page

Table 5.2. Data Example for Furniture

Resource Name	Furniture Class	Furniture Material	Furniture Size	Furniture Weight	Furniture Dimension	Facility Unit	Facility Use	Resource Description
Club Chair	Leather	Leather , Wood	93cm h x 76cm w x 91cm d		37"h x 30"w x 36"d	Piece	For guest room	The room's furniture for guest using.
Sofa	Leather	Solid oak wood frame, metal legs, and steel mechanisms and leather	Cushion is 17" high off the ground, depth is 21" back height is 18"	85 pounds	71W x 36D x 33H inches	Piece	For guest room	The room's furniture for guest using.
Bed king size	Leather	Leather , Wood	90L x 93W x 61H inches		90L x 93W x 61H inches	Piece	For guest room	The rooms furniture for guest using.
Cocktail Table	Leather	Leather , Wood		20 pounds	18.25 in. H x 48 in. W x 19 in. D	Piece	For guest room	The room's furniture for guest using.

*More tables with data attribute examples showed in appendix.

5.6 Service Resource Summary

This chapter discussed the definition, characteristics, requirements and steps for building the Service Resource Model (SRM). Moreover, it discussed how a Object-Oriented Modeling (OOM) technique is recommended as the most appropriate method of organizing and specifying data within the SRM. In addition, it illustrated how the data structured to implement.

The primary contributions of this chapter go beyond the representation of the service resources as objects with super classes for personnel, facilities/equipment, and processes. The approach enables resource representation reuse and facilitates automation by software engineers familiar with UML. The primary contribution is the database implementation that conserves inheritance and composition relationships without creating redundancy. The approach includes a way to represent data across inheritance relationships in a manner which is intuitive to the user. Finally, the approach allows records for abstract objects enabling progressively detailed resource specification.

CHAPTER 6

SERVICE PROCESS MODEL

In the IESDA framework, the data of the service processes is created, stored and managed in the Service Process Model. Service process engineers are responsible for this function. The service process should obtain information about the service from the SRM and SM, and then, create the SPM. To facilitate this function within the SPM, the UML Activities Diagrams is used and created in a new unique method. In addition, this new method of generating the UML Activities Diagrams can be in numerous classifications. This chapter will cover the requirements definition, representation, database implementation, and the steps for building the Service Process Model (SPM).

6.1 Service Process Requirements Definition

Service Process Model (SPM): The Service Process model consists of data that specifies all operations necessary for the tasks needed to deliver a service. SPM describes the steps necessary to achieve the outcomes of a service. The service model should incorporate the following characteristics:

1. The process model should be hierarchical to enable high and detailed level views of the process.
2. The representation should be easily interpreted by any service design process participant – typically achieved by graphical flowchart type representations.
3. The representation should be able to depict potentially complex sequence flows include series, simultaneous, and alternative.

4. The service data model should facilitate integration with the service and service resource database models. (Recall that the process was the intersection of service concept and service resource in Figure 3.1).

- The data requirements for the representation include:
  - Complete list and flowchart of all processes used in the service
  - Characterization of processes in three levels (onstage, backstage and support)
  - Enable information about the activities used in the service (time, cost)
- The functional requirements include:
  - Computer interpreTablemong enterprises that allowing transformations from data to flowchart diagram and vice versa.

6.2 Service Process Representation

The Kulvatunyou and Wysk (2000) framework proposed the use of And/Or digraphs which represent the process as a network of alternative, simultaneous, and/or successive steps. To represent the processes within the SPM, this thesis proposes that UML Activities Diagram be used. A service process model can be hierarchically structured to reduce complexity of information. However, this will depend upon the size of the service system. A high-level process may specify only which pieces of equipment or material are necessary to create a service. The mid-level process specifies setups; low-level process specifies the operations.

The structure of each process could be designed in multiple stages. In this thesis, these stages are classified by facility resources, people resources or service blueprint stages (onstage, backstage, and support). The designer can select any one of these classifications to present the hierarchy of each process. For the classification based on the facility resources as a stage, the diagram represents the activities sorted by facility resources. It shows the activities that use specific facility resources within one group. The same is true for the resources or service blueprint stages.

In the service blueprint stages, the backstage process level consists of the activities that happen beyond customer visibility: the service preparation activities that must be completed before providing or delivering the service. Once the service is ready to be provided or delivered, the tasks are moved or assigned to the front office level. The onstage process level consists of the activities that occur within the customer's visibility. Most of them include carefully-designed encounters with customers. The support process level consists of a set of process instructions and supporting activities that are necessary for the back office and front office.

Using these different classification diagrams enables designers to represent their service in different forms for different design components. It also allows them to design their processes and services well, because of the availability of several diagrams of the same process represented from different points of view. The representation of the Service Process Model necessary for IESDA integration can be classified into representational and functional requirements.

6.3 UML Activity Diagrams

Numerous process and function representations for modeling the process data have been developed. Some examples of these representations are Integrated Definition for Function modeling (IDEF0), Integrated Definition for Process Description Capture Method (IDEF3), Petri nets, A Language for Process

Specification (ALPS), AND/OR directed graph, Process Specification Language (PSL) and Unified Modeling Language (UML) Activity Diagrams. In the SPM, the UML Activity Diagrams will be used. It is a contemporary model, used to model the activities of an enterprise, creating a graphical model shows the activities, what controls them, who performs them, what resources are used in carrying them out and what relationships they have to other activities.

UML Activity Diagrams, consist of nodes and arcs. Figure 6.1 gives an example of the nodes (Eshuis, 2006). The Invocation nodes are an activity node that includes behavior. Object nodes indicate the availability of objects that are used in activities. Control nodes are used to identify choice and parallelism. Such as control nodes: decision nodes, merge nodes merge, fork nodes, join nodes, initial node and final nodes. Two sorts of activity edges are used in the UML Activity Diagrams. *Object flows* link to object nodes *Control flows* link control nodes (Eshuis, 2006). These node types enable service process models to represent a superset of all the process configurations available from the AND/OR digraphs.

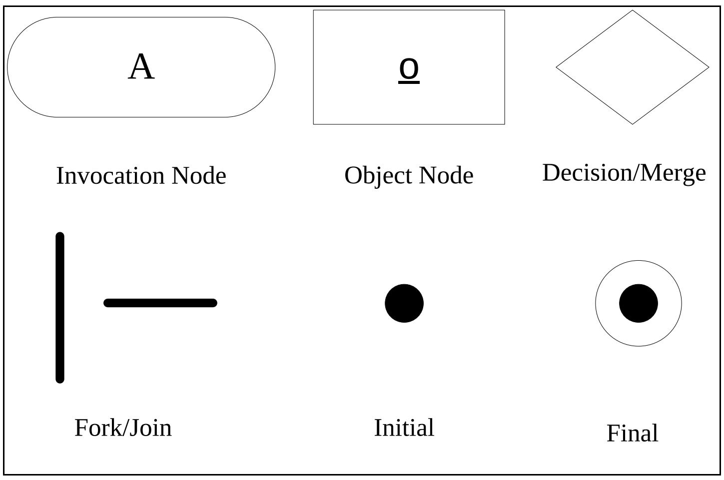


Figure 6.1. UML Activity Diagrams Nodes

One of the most important features of the UML Activity Diagrams is that it represented the activities in class diagram. That group of activity or object nodes can have a pre or post condition or requirements that can be represented by. These features are very essential in the SRM and make UML Activity Diagrams the best choice for the represent the processes in the SRM.

The SRM data is a combination of flowchart diagrams and text-data. Figure 6.1 shows an example of the UML Activity Diagrams for check-out classified by the service blueprint stages.

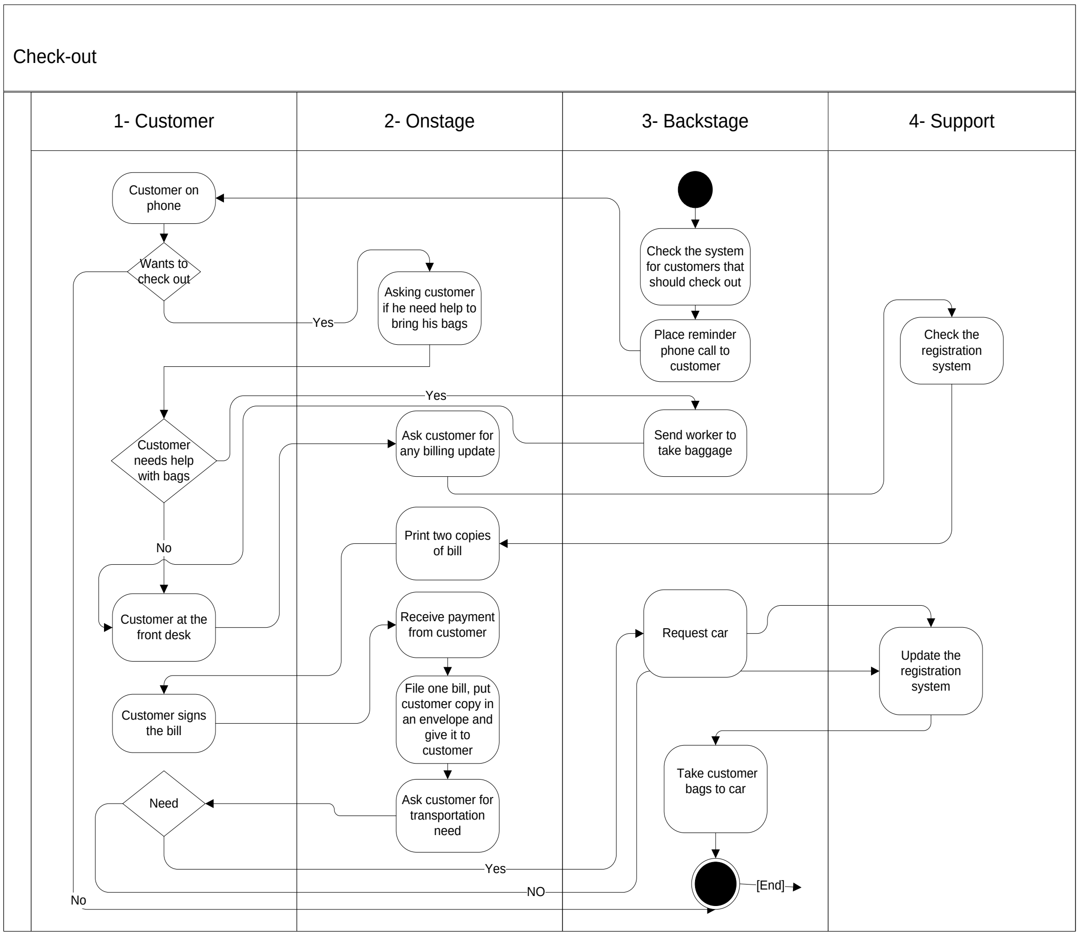


Figure 6.2 UML Activity Diagrams for Check-out

6.4 Service Process Implementation

In the SPM, the process to create the UML Activity Diagrams is different than what usually occurs. The normal way is to draw the activity blocks and connect them together. However, in this thesis, the user will follow another process for creating the UML Activity Diagrams. This process will give the user the advantage of focusing on the actual service design data rather than focusing on drawing the UML Activity Diagrams. In addition, this new method gives the data the flexibility to transfers to different diagram forms based on three classifications. Figure 6.2 shows the ER diagram of the service process model and the relation between the entities.

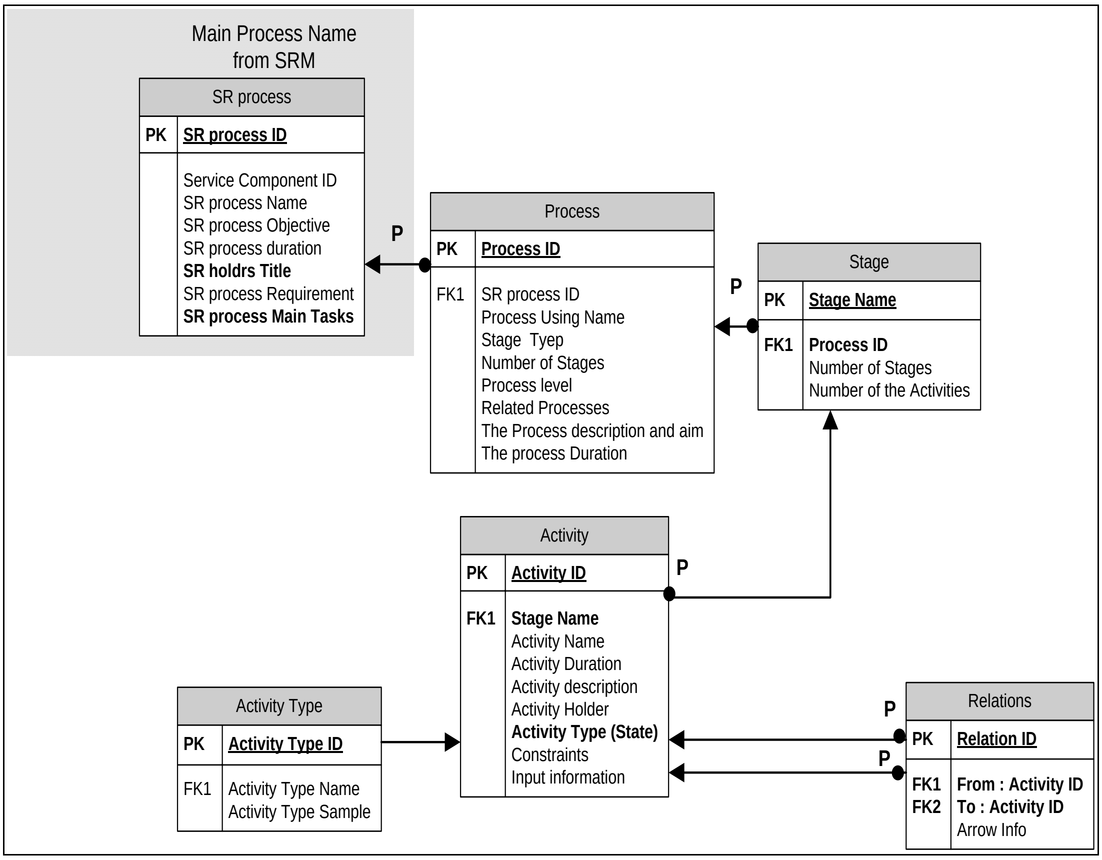


Figure 6.3 ER Diagram for the SPM.

Software developer should build the SPM based on this method that allows the processes text-data to transfer automatically and create flowchart diagrams in different classifications. Without this proposed method of generating these different classification diagrams, process engineers must use more time and effort to produce the same information.

To arrive at such ER diagram for the SPM for any specific process, the user should follow these steps:

1. Create new process: that requires the user to insert the main information about process. Table 6.1 shows a description of the process attitudes.

Table 6.1. Process Attitude

Attitude	Description
Process ID	The auto-generated identification number of the process
Process Name	What the process will be called
Process level	Reduction of the level of information complexity required by the back office or the front office, a service process model can be hierarchically structured in levels.
Related Processes	Names of some processes related to this process.
Process Description	Information about the process
Process Aim	Information about the process aim
Process Duration	How long the process will last

2. Insert the activities data. The user should enter the activities data. Table 6.2 shows description of the activity attitudes.

Table 6.2. Activity Attribute Data

Attribute	Description
Activity ID	The auto-generated activity identification number
Process ID	The process identification number
Activity Name	What the activity will be called
BP Stage	The name of the service blueprint stage in which the activity will occur
Activity Duration	How long the activity will last
Activity Description	The description of the activity
Activity Holder	The holder person for the activity
Activity Type (State)	The same activity types used in UM; for example: action state, initial state, transition join
Constraints Resources	Constraints resources of the activity
Input Resources	The input resources for the activity

3. Select the representation class. This step requests the user to select the type of process flowchart diagram to be used. The type will be the service blueprint stages, people classification or facility classification. As soon as the user selects the method of the presentation, the system will generate the flowchart diagram. See figure 6.4, which shows the process flowchart diagram for hotel check-out.
4. Next step is defining the relationship between these activities. Each relationship has ID number. The one activity can have one or more relationship. Examples of these activities are decision activity, merge activity, fork activity nodes or join activity.

5. In addition, user is able to select any activities or relations by clicking on them, to change the data. In addition, the user can generated another flowchart diagram with another method of presentation.

After inserting all these activities' attributes the system should allow the designer to select the classification to generate the UML Activity Diagrams. These classifications are based on the three classes explained before. The figure 6.1 has shown the UML Activity Diagrams in the blueprint classes.

6.4 Service Process Example

Table 6.3 is an example of the process model data. This example reflects the data of the UML Activity diagram for the for Check-out process that has shown in Figure 6.1. Notice that the data in the rows enable the activity diagram to be automatically constructed with a blueprint stage or resource configuration. This flexibility in representation assists with model integration.

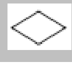
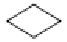
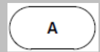
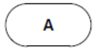
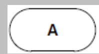
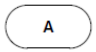
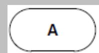
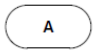
6.5 Service Process Summary

This chapter covered the issues related to the Service Process Model (SPM). It explained the definition, characteristics, requirements, and the steps for building the SPM. The UML activity diagram is used as the suggested choice to represent the processes within the SRM. It has the features to represent the activities in class diagram for a variety of complex service systems. The new method allows the designer to generate the UML Activities Diagrams in various configurations and to represent their service in numerous forms for different design components.

Table 6.3. Data Example of Activity Data

Activity Name	BP Stage	Activity Duration	Activity Description	Activity Holder	Activity Type (State)	Constraints Resources	Input Resources	Relation to	Arrow Info
Initial point	Backstage	-	-	-	Initial state		Computer system	Check the system for customers that should check out	-
End point	Backstage				Final		Computer system		
Check the system for customers that should check out	Backstage	Two minutes	Check the system for customers that should check out	Front Desk	Action A	Customer Information.	Computer system	Place reminder phone call to customer	
Place reminder phone call to customer	Backstage	Two minutes	Call the customers to remind them	Front Desk	Action A	Customer Information.	Computer system	Customer on phone	
Customer on phone	Customer	Two minutes	Customer respond on phone	Custome r	Action A	Customer Information.	Computer system	Wants to check out	
Wants to check out	Customer	Two minutes	Customer decision	Custome r	Decision	Customer Information.	Computer system	Customer asks for help to bring bags	Yes
Wants to check out	Customer	Two minutes	Customer decision	Custome r	Decision	Customer Information.	Computer system	End point	No
Asking customer if he need help to bring his bags	Backstage	Two minutes	Find out is customer need help to leave	Backstag e	Action A	Customer Information.	Computer system	Customer needs help with bags	

Table 6.3. (cont.) Data Example of Activity Data

Activity Name	BP Stage	Activity Duration	Activity Description	Activity Holder	Activity Type (State)	Constraints Resources	Input Resources	Relation to	Arrow Info
Customer needs help with bags	Custome r	Two minutes	Customer decision	Customer	Decision 	Bell ready	Trolley	Send worker to take baggage	Yes
Customer needs help with bags	Custome r	Two minutes	Customer decision	Customer	Decision 	Bell ready	Trolley	Customer at the front desk	No
Send worker to take baggage	Backstag e	Five minutes	Send the bell to the customer room	Backstage	Action 	Customer Information	Computer system	Customer at the front desk	
Customer at the front desk	Custome r		Customer come for check -out	Customer	Action 	Customer Information	Front desk	Ask customer for any billing update	
Check the registration system	Support system	Three minutes	Check the system for the customer	Front desk employee	Action 	Customer Information	Registratio n system	Print two copies of bill	
Print two copies of bill	Onstage	Two minutes	Print the customer bill	Front desk employee	Action 	Customer Information	Registratio n system and printer	Customer signs the bill	
Customer signs the bill	Custome r		Customer reviews the bill and signs it	Customer	Action 	Customer Information	Bill form, Ben	Receive payment from customer	
Receive payment from customer	Onstage	Two minutes	Get the money	Front desk employee	Action 	Customer Information	Payment methods	File one bill, put customer copy in an envelope and give it to customer	

CHAPTER 7

INTERACTION AND INTEGRATION

The IESDA framework provides service engineers a new way to interact with each other, freely and efficiently, regardless of time, location, and organizational barriers. The previous chapters explain how different service information data is created, managed and used. Each type of information is entered into its corresponding information model. In addition, the way in which the integration of these data facilitates the exchange between the tools within the models is illustrated. In this chapter, a new method of interaction and integration between models is proposed. This new method allows designers to utilize the data in each model, to exchange data between the models and to interact in an efficient way.

7.1 Activity Interaction

Interaction occurs in two ways.

1. Interaction Through Use of Database:

The IESDA framework allows service engineers to organize service information in a regular structure that makes it accessible by a computer software program for storing, retrieving and manipulating. In addition, this software has the capability of user authorization management. For example, service process engineers and service design engineers use some models and create others. These will be managed with different authorization. Table 7.1 illustrates an example of the authorization management in the IESDA framework.

Table 7.1. Example of the IESDA Framework Authorization Management

Engineer/Model	SRM	SM	SPM
Design Engineers	Reviewing and retrieving	Creating, storing, reviewing, changing, deleting, adding and retrieving.	Reviewing and retrieving
Process Engineers	Reviewing and retrieving	Reviewing and retrieving	Creating, storing, reviewing, changing, deleting, adding and retrieving.

The service design engineers refer to the SRM and use the SPM to create the SM. They do not have authorization to add or create. They will only review and retrieve. They use the data to obtain the general information about the service components and to create their model (SM). The structure of each data model makes this usage easy. The OOP in the SRM makes the access to the data easy for both of the services and process designers. Its structure is very clear and connects all the service resources in the simple relationship that could be use straightforward. In addition the simplest of the service blueprint make it easy to read and use by all designers.

2. Interaction Through Use of the Feedback Entity Table

For greater usability, the IESDA framework has the capability to allow engineers to interact with each other. It is recommended that a new entity table be added to each information model for this purpose. This table will appear in each model with added authorization for all service engineers. In addition it must include the feature of saving all the feedback and the comments in a log file for the service engineers. This log file should be represented by the topic and the update date. Table 7.2 shows the attributes of the feedback tables in the SM and Table 7.3 for SPM.

Table 7.2. Attributes of the Feedback Table in SM

Attribute	Description
The SM Feedback ID	The ID number of the feedback
The SM Feedback Title (Service Tool)	The title of the feedback
Feedback of the Engineer	The concept of the feedback
Engineer field	The field of the engineer designer (Service or process)
Feedback Date	The date of the feedback

Table 7.3. Attributes of the Feedback Table in SPM

Attribute	Description
The SM Feedback ID	The ID number of the feedback
The Process Name	The name of the process that related to the feedback
Feedback of the Engineer	The concept of the feedback
Engineer field	The field of the engineer designer (Service or process)
Feedback Date	The date of the feedback

7.2 Information Integration

The information integration could be achieved by using the entity data of a model to create another model. For example, service design engineers refer to the SRM to create the SM. If the concerned entities connect to each other with the appropriate relationship, service design engineers can select the physical evidence in the service blueprint directly from the SRM. They can use the resources table data to define the physical evidence for the customer. If they do not find a suitable match, they can create it in their data (SM). In addition, service design engineers can use the SPM data to assign specific processes to one of the onstage, backstage or support actions on the service blueprint. If they do not find a process that connects to one of the actions, they must use the feedback table to inform the process engineer. The OOP data structure supports this integration. Its class diagram feather that allows each class to have its attributes' state and behavior is the best chose for the data integration between the IESDA's models. In addition, it makes any new change in the data structure possible without changing in the all structure or coding. Moreover, the service process engineers can use the table entity from the SRM to insert the resources in the activity database. Figure 7.1 shows this information integration framework. In addition, Figures 7.2, 7.3 show the ER diagrams of the SM and SPM integration with SRM.

7.3 Summary

This chapter explained new methods for interaction and integration between the IESDA frameworks. These methods are resulted of the special structure of each models used in the IESDA. Specifically, the models enable interaction through the use of a feedback mechanism and data structure. Additionally, the models are integrated to associate resources with physical evidence elements and to associate blueprint phase or resource with an activity diagram task.

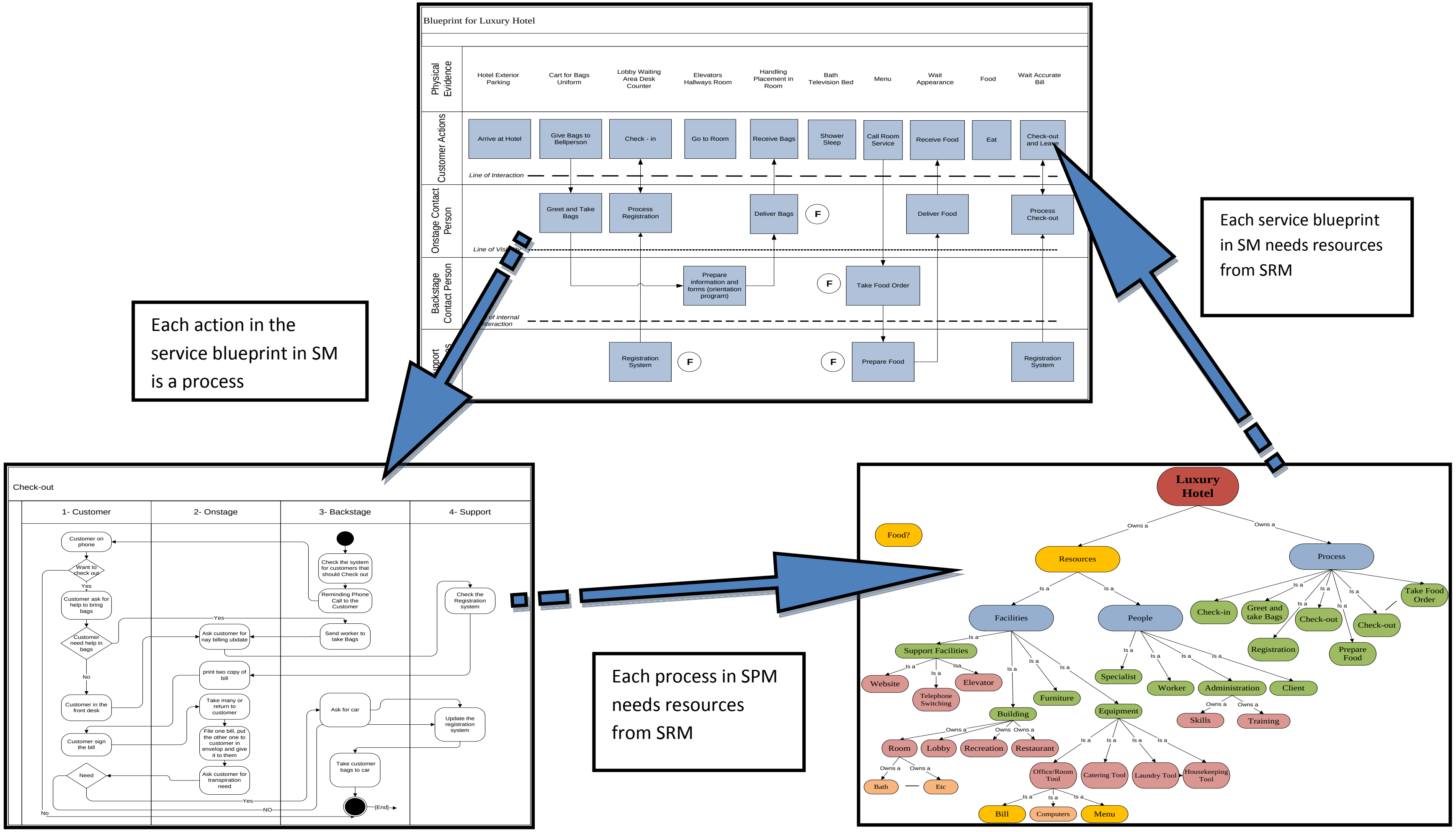


Figure 7.1. Information Integration Framework

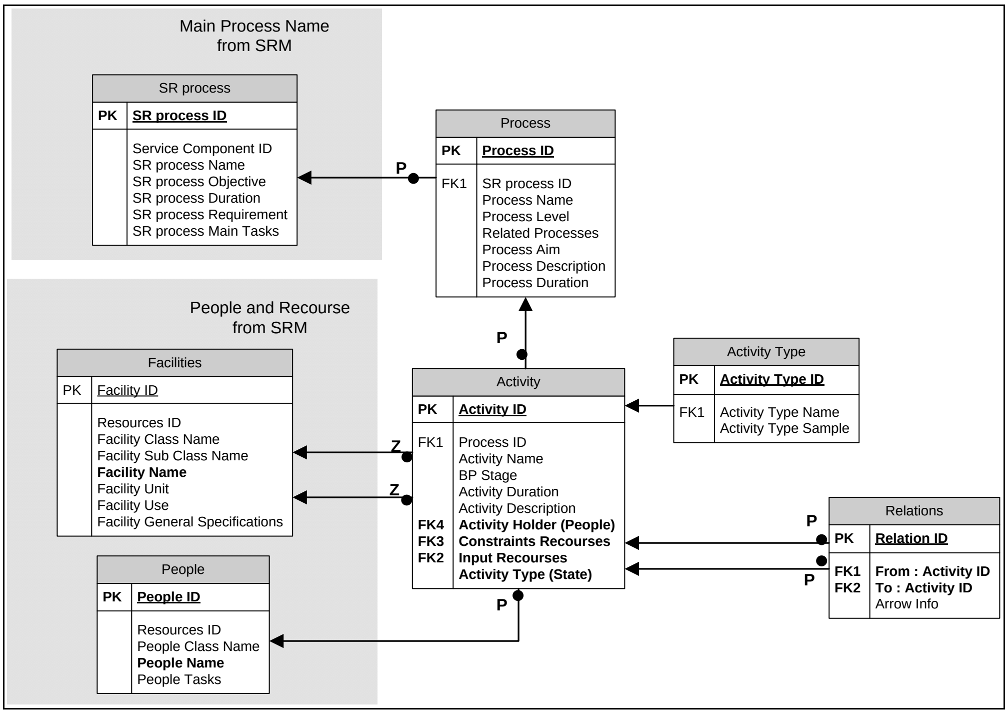


Figure 7.2. ER Integrated Diagrams of the SPM

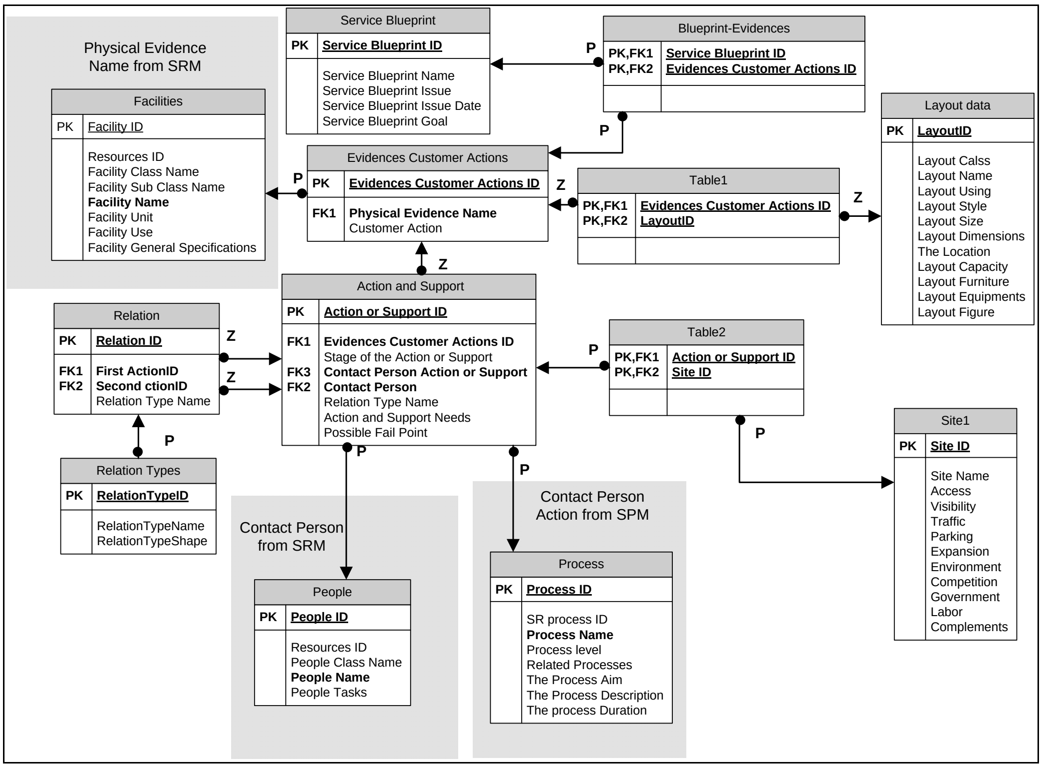


Figure 7.3. ER Integrated Diagrams of the SM

CHAPTER 8

CONCLUSION

8.1 Thesis Summary

The service sector has grown during recent years and has become increasingly important. Economies around the world are switching from manufacturing to service. With this movement, services should advance to meet customers' needs and designed to meet customers' expectation. However, the nature and characteristics of the service make the process of new service development more difficult. The new framework and associated information models proposed in this thesis facilitates the process of new service development. It proposes an IESDA framework that contains information models for the service data. These information models allow service engineers from different fields and the other related persons within the enterprise to share the information that is needed for designing the service. By using the proposed information models, all involved will be able to interact concurrently with each other regardless of time, location and organizational barriers.

The proposed IESDA framework contains eight information models: SMM, HRCM, STM, MSPM, SSM, SRM, SPM and SM. Each individual will use at least one of the abovementioned models to insert and share data among all concerned persons, following a particular process and structure. The new model compiles the information of all persons involved in the design of a service, including engineers and enterprise personnel, in one information-integrated model. While this thesis focuses on the information input and use by service designers, it is also essential to involve the activities of enterprise personnel that are related to the new or developing service, in the model, because service engineering activities are based on information that they initiate. In addition, to insure that the new service system and process is focused on customer needs and requirements.

This thesis discusses the definition, characteristics and requirements of SRM, SPM and SM that are directly related to service engineering activities. In addition, it illustrates the mechanism of these models and how it facilitates function interaction and information integration. The SRM, as proposed by this thesis, organizes and specifies in a hierarchical fashion and adopts the inherited mechanism from the object-oriented paradigm. It stems from the service components in the methods of semantic network relationships. Object-Oriented Paradigm (OOP) technique is suggested as the most suitable method of organizing and specifying data within the SRM. Its features allow all the function of the SRM to be performed.

The SM and SPM are created as a way to assist the designer to focus on the service design process and its quality and give data the flexibility to transfer to the diagram forms. In the SM, the service blueprint is created and used in a way that allows service engineers to give more attention to the service design data and to the core design information. The new method of creating the service blueprint is based on translation of data to diagrams and use of other service information models to insert data.

In the SPM, the UML Activity Diagram is used in a way that allows process engineers to give more attention to the service process data. The new method of creating the service blueprint is based on translation of service process data to diagrams and categorizes it by using other service information models. In addition, the SPM data is used by other models to insert their data.

A new interaction method between designers and a new integration method between the information models are also proposed. These methods allow designers not only to exchange data within the models, but also between them. In addition they will be able to interact with each other in an effective means and keep record of these interactions within the system.

The other models, which are indirectly related to the service design, must be defined with the cooperation of the relevant enterprise personnel (HR, Marketing, and Accounting) and more tools could be used within the defined models, too. Additionally, software programmers could use this model and implement it as a database or software program that will be utilized in service design.

8.2 Thesis Contributions

A number of research contributions are made from this thesis. An IESDA framework is created which provides a structure for information model exchange to facilitate collaborative, asynchronous, and long-distance design. The framework builds on prior product design approaches and adds enterprise activities. Then three core information models are developed. The Service Model presents an approach to service concept visualization by combining the service blueprint and layout/site data. The data based approach removes the need for graphical input and makes blueprint exchange more efficient.

The Service Resource Model uses an object representation. The contributions here include the relational database implementation that maintains inheritance relationships without redundancy and offer user transparency through data views. The approach also encourages design of increasing detail and resource information reuse. The Service Product model uses an Activity Diagram representation with a database implementation that enables both blueprint phase and resource based graphical construction. Finally, ways that the models might increase interaction and exhibit integration are included.

8.3 Future Work

This thesis represents the beginning of research in this area. Future research should include:

- Extension of the SM, SRM, and SPM information models;
- Initial creation of the other information models indicated in the IESDA;
- Application of the method to different service industries; and
- Development of the associated software systems to facilitate the interaction and integration.

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APPENDIX

Table.1. Attributes of the Service Blueprint Entity Table

Attributes	Description
Service Blueprint ID	ID number of the Service blueprint
Service Blueprint Name	The Name of the Service blueprint.
Service Blueprint Version	The Version of the Service blueprint
Service Blueprint Version Date	The Date of the blueprint Version
Service Blueprint Goal	The goal for the new Service Blueprint

Table.2. Evidences Customer Actions Entity Table

Attributes	Description
Evidences Customer Actions ID	ID number of the evidences customer actions
Physical Evidence Name	Physical evidence name is the name of service layout that the customer see
Customer Actions	The customer action with the physical evidence

Table.3. Action and Support Table

Attributes	Description
Actions or Support ID (PK)	ID number action
Evidences Customer Actions ID (FK)	ID number of the evidences customer actions
Stage of the Action or Support	Onstage Contact Person, Backstage Contact Person or Support System Process
Contact Person Action	The actions
Contact Person	The action must be taken
Action and Support Needs	List of the tangible and intangible needs.
Relation Type Name	The name of the relationship type (from, to or bi-directionally)
Possible Fail Point	Potential activity of failure. This parameter will present as a F in the circle at the blueprint. (Yes or No)

Table.4. Attributes for Relation Entity Table

Attributes	Description
Relation ID (PK)	ID number of the relation
First Action ID	The ID of the first action
Second Action ID	The ID of the second action
Relation Type Name	The name of the relationship type (from, to or bi-directionally)

Table.5. Attributes of the Layout data

Attributes	Description
Layout ID	The ID number of the Layout
The Class of the Layout	The layout class: Building, Room, Lobby, Recreation..etc
Layout Name	The name of the layout
Layout Use	What the layout will be used for
Layout Style	The style of the layout (Classification)
Layout Size	Actual size of the layout in square feet
Layout Dimensions	Layout dimensions in feet
Layout Location	The building and level that the layout is located in
Layout Capacity	The layout capacity by person
Layout Furniture	The furniture used in the layout
Layout Equipments	The equipment used in the layout
Layout Figure	Figures and diagram structure of the layout

The service blueprint data example:

Table.6. Example Data Attributes of the Service Blueprint Entity Table

Attributes	Data Example1
Service Blueprint ID	00010
Service Blueprint Name	Hotel
Service Blueprint Version	1.1
Service Blueprint Version Date	10-10-2010
Service Blueprint Goal	Hotel general series

Table.7. Example Data of Evidences Customer Actions Entity Table

Attributes	Data Example1	Data Example2
Evidences Customer Actions ID	00010	00015
Physical Evidence Name	Lobby waiting area desk counter	Menu
Customer Actions	Check in	Call room service

Table.8. Example Data of the Action table

Attributes	Data Example1	Data Example2
Actions & Support ID (PK)	00012	00013
Evidences Customer Actions ID (FK)	00010	00015
Stage of the Action or Support	Onstage Contact Person	Backstage Contact Person
Contact Person Action	Process Registration	Take food order
Contact Person	Administrator	Worker
Action & Support Needs	Check in form and access to the registration system	Telephone connection, Menu..
Possible Fail Point	No	Yes

Table.9. Example Data of the Attributes for Relation Entity Table

Attributes	Data Example1	Data Example
Relation ID (PK)	00101	00102
First Action ID	00202 *(Greet and Take Bags)*	00220 *(Prepare information and forms)*
Second Action ID	00220 *(Prepare information and forms)*	00223 *(Deliver bags)*
Relation Type Name	From	From

Table.10. Standards and Regulations Attributes Table

Attribute	Description
Standards and Regulations ID (PK)	The standard or regulation identification number (Auto generated).
Service ID	
Standards and Regulations Class Name	The class name of the standard or regulation (Federal, state, city ..).
Standards and Regulations Name	The name of the standard or regulation.
Standards and Regulations Code	The code of the standards or regulations in the original resource.
Standards and Regulations Content	The content of the standard or regulation.
The Related Service Component	The name of the service component related to this standard or regulation.

Table.11. Service Attributes Table

Attribute	Description
Service ID (PK)	The service identification number (Auto generated).
Service Name	The name of the service.
Service Category Name	The name of the category to which the service belongs.
Service Component Description	The description of the service component.
Explicit Benefits	The list of the benefits that are clearly noticeable by the sense and that consist of the essential or fundamental features of the service.
Implicit Benefits	The list of the psychological benefits that the customer may sense only unclearly, or the additional features of the service.

Table.12. Process Attributes Table

Attribute	Description
SR process ID (PK)	The Process identification number (Auto generated)
Service ID (FK)	The service identification number.
SR process Name	The name of the process.
SR process Objective	The objective of the process.
SR process Duration	The duration of the process (Hours or days)
SR process Requirements	The resources requirements for the process.
SR process Main Tasks	The main tasks (activities) for the process.

Table.13. Resources Attributes Table

Attribute	Description
Resource ID (PK)	The resource identification number (Auto generated).
Service ID (PK, FK)	The service identification number.
Resource Name	The name of the resource.
Resource Description	The description of the resource.

Table.14. Consumed Resources Attributes Table

Attribute	Description
Consumed Resources ID (PK)	The service benefits identification number (Auto generated)
Resource ID (PK, FK)	The service identification number
Consumed Resources type	The type of the consumed resources.

Table.15 Facilities Attributes Table

Attribute	Description
Facility ID (PK)	The facility identification number (Auto generated).
Resources ID (PK, FK)	The resource identification number.
Facility Unit	The measurement unit for the facility.
Facility Use	The use of the facility.
Facility General Specifications	The general specification of the facility.

Table.16 Support Facilities Attributes Table

Attribute	Description
Support Facilities ID (PK)	The support facility identification number (Auto generated)
Facility ID (PK, FK)	The facility identification number.
Resource ID (PK, FK)	The resource identification number
Support Facility Class	
Support Facilities Requirement	The requirement resources of support facilities.
Support Facilities Nature	The nature of the support facility (System, webpage, paper ..)

Table.17. Equipment Attributes Table

Attribute	Description
Equipment ID (PK)	The equipment identification number (Auto generated).
Facility ID (PK, FK)	The facility identification number.
Resource ID (PK, FK)	The resource identification number
Facility Class	
Equipment Size	The size of the equipment.
Equipment Weight	The weight of the equipment.
Equipment More Specifications	More specifications about the equipment.

Table.18 Building Attributes Table

Attribute	Description
Building ID (PK)	The building identification number (Auto generated).
Facility ID (PK, FK)	The facility identification number.
Resource ID (PK, FK)	The resource identification number
Building Class	
Building Size	The size of the building
Building Requirement	The resources requirement for the building.

Table.19 Furniture Attributes Table

Attribute	Description
Furniture ID (PK)	The furniture identification number (Auto generated).
Facility ID (PK, FK)	The facility identification number.
Resource ID (PK, FK)	The resource identification number
Furniture Class	
Furniture Material	The name of the furniture material (wood, metal, plastic …) .
Furniture Size	The size of the furniture.
Furniture Weight	That weight of the furniture.
Furniture Dimension	The full dimension of the furniture.

Table.20. People Attributes Table

Attribute	Description
People ID (PK)	The people identification number (Auto generated).
Resource ID (PK, FK)	The resource identification number.

Table.21. Client Attributes Table

Attribute	Description
Client ID (PK)	The client identification number (Auto generated).
People ID (PK, FK)	The people identification number.
Resource ID (PK, FK)	The resource identification number
Client Service Need	

Table.22 Employees Attributes Table

Attribute	Description
Employee ID (PK)	The employee identification number (Auto generated).
People ID (PK, FK)	The people identification number.
Resource ID (PK, FK)	The resource identification number
Employee Class Name	The class name of the employee (Management, Worker, Specialist..)
Employee Title	The title of the employee.
Employee Requirement	The minimum requirement for the employee.
Employee Training	The minimum training for employee.
Employee Tasks	The main tasks that the employee performs.

Table.23. Service Example Data Table

Attribute	Data Example 1	Data Example 2
Service ID (PK)	00001	00001
Service Name	hotel	hotel
Service Category Name	Hospitality	Hospitality
Service Description	Providing room, food, entertainment, ..etc for guests	Providing room, food, entertainment, ..etc for guests
Explicit Benefits	Comfortable room and hall, and good food	Comfortable room and hall, and good food
Implicit Benefits	Good environment	Good environment

Table.24. Process Example Data Table

Attribute	Data Example 1
SR process ID (PK)	0000001
Service ID (FK)	00001
SR process Name	Check out
SR process Objective	Get the money and close the client account.
SR process Duration	Five minuets
SR process Requirement	Computer system and credit machine
SR process Main Tasks	Check the services the customer use and print bill, get money

Table.25. Resources Example Data Table

Attribute	Data Example 1	Data Example 2
Resource ID (PK)	000010	000020
Service ID (PK, FK)	00001	00001
Resource Name	Sofa	Video/Computer
Resource Description		

Table.26. Consumed Resources Example Data Table

Attribute	Data Example 1	Data Example 2
Consumed Resources ID (PK)	001011	001022
Service ID (PK, FK)	0001	0001
Consumed Resources type	Food	Drink

Table.27. The Facilities Example Data Table

Attribute	Data Example 1	Data Example 2
Facility ID (PK)	001021	001701
Resources ID (PK, FK)	000010	000020
Facility Unit	Piece	Piece
Facility Use	Guest setting	Piece
Facility General Specifications	Leather	Display Type: "0.95 Max Play DMD DLP Resolution HD (1920 x 1080)

Table.28. The Equipment Example Data Table

Attribute	Data Example 1
Equipment ID (PK)	000263
Facility ID (PK, FK)	001701
Resources ID (PK, FK)	
Equipment Class	
Equipment Size	20.5in.x8.9in.x21.6in
Equipment Weight	36.6 lbs
Equipment More Specifications	Input : 2xHDMI,1xComponent 1xS-Video,2xComposite 1 x RGB D-Sub 15pin

Table.29. The Furniture Example Data Table

Attribute	Data Example 1
Furniture ID (PK)	000034
Facility ID (PK, FK)	001021
Resources ID (PK, FK)	
Furniture Class	
Furniture Material	Solid oak wood frame, metal legs, and steel mechanisms
Furniture Size	Cushion is 17" high off the ground, depth is 21" back height is 18"
Furniture Weight	85 pounds
Furniture Dimension	71W x 36D x 33H inches