2014

Improving The Service Design Process: Process Integration, Conflict Reduction And Customer Involvement

Sameer G. Tabbakh
North Carolina Agricultural and Technical State University

Improving the Service Design Process:

Process Integration, Conflict Reduction and Customer Involvement

Sameer G. Tabbakh

North Carolina A&T State University

A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department: Industrial and Systems Engineering

Major: Industrial and Systems Engineering

Major Professor: Dr. Paul Stanfield

Greensboro, North Carolina

2014

The Graduate School
North Carolina Agricultural and Technical State University
This is to certify that the Doctor's Dissertation proposal of

Sameer G. Tabbakh

has met the dissertation proposal requirements of
North Carolina Agricultural and Technical State University

Greensboro, North Carolina
2014

Approved by:

Dr. Paul Stanfield
Major Professor

Dr. Bala Ram
Committee Member

Dr. Lauren Davis
Committee Member

Dr. Xiuli Qu
Committee Member

Dr. Tonya Smith-Jackson
Department Chairperson

Dr. Younho Seong
Committee Member

Dr. Sanjiv Sarin
Dean, The Graduate School

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 (MBA) from the University of Hull, UK in 2003. He received the Master of Science degree in Industrial and Systems Engineering from NC A&T State University, U.S.A in 2010. Currently, he is a doctoral student in Industrial and Systems Engineering at NC A&T State University, U.S.A.

Table of Contents

List of Figures

List of Tables

List of Nomenclature

ABOPA	Asset-Based Opportunity Analysis
ABS	Asset-based System
ABSE	Asset-based System Engineering
ALPS	Petri Nets, A Language for Process Specification
ARM	Assets Relationship Map
BITAM-SOA	Service-Oriented Business-IT Alignment Method
BLOBs	Binary Large Objects
CA	Critical Analysis
CAJM	Customer Asset Journey Map
D4S	Designing for Services in Science and Technology-based Enterprises
DEA	Design Engineering Activities
EA	Enterprise Activities
EEAs	Enterprise-based Engineering Activities
FMECA	Failure Mode, Effects and Critical Analysis
FMEA	Failure Mode and Effects Analysis
GDP	Gross Domestic Product
HR	Human Resource
HRCA	Human Resources and Cost Activities
HRCM	Human Resources and Cost Service Model
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
ISDM	Integrated Service Design Model
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
OPA	Opportunity Priority Analysis
PSL	Process Specification Language
PIPE	Platform Independent Petri Net Editor
R&D	Research and Development
SAs	Service Activities
SD	Service Design
SDN	Service Design Network
SDP	Service Design Process
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
STM	Service Technical Model
TA	Technical Activities
UML	Unified Modeling Language

Abstract

Service design is the science of creating service experiences based on the customer's perspective, to make it useful, enjoyable and cost-effective for the customer. Although the field of service design is relatively new, it has been rapidly expanding in research and practice. Most researchers focus on the usefulness of the service, cost efficiency, meeting customers' needs, or service strategy. However, all service elements can benefit from improving the service design process. Current service design processes are suffering a lack of integration of activities, conflicts in decision-making processes, and exclusion of practitioners' methods. In prior research, information models were created to integrate the service design process across the enterprise.

As an extension, this dissertation introduces Petri Nets to improve the service design process. Petri Nets provide a uniform environment for modeling, analysis, and design of discrete event systems. Petri Nets are used to develop a new service design process that enhances the multidisciplinary approach and includes the practitioner methods.

Additionally, this dissertation uses the Lens Model to improve the decision-making mechanism. The Lens Model is to characterize decision-making policy in service design. Research shows that there is a conflict between the designer and the manager in service design decision-making. Single Lens Model systems are designed to capture the decision policy for the service designer and the service manager. A double Lens Model system is used to compare the perspectives.

Finally, this research suggests a new role for the customer in the design by applying an Asset-Based approach. Asset-based System Engineering (ABSE) is a recently introduced concept that attempts to synthesize systems around their key assets and strengths. ABSE is developed with as an innovative approach that views customers as a primary asset. Customer integration in the design process is achieved through several new service design tools.

CHAPTER 1

Introduction

The service sector has been on the rise since 2003. Currently, the service sector accounts for nearly 80% of the US economy excluding the farming and agriculture sector (Palmer, 2012). Service activities in the U.S. account for nearly 80% of the private sector Gross Domestic Product (GDP) and 82% of all private sector employment (J. Miller, 2012). The U.S. is both the top exporter and the top importer of services in the world (Figure 1.1).

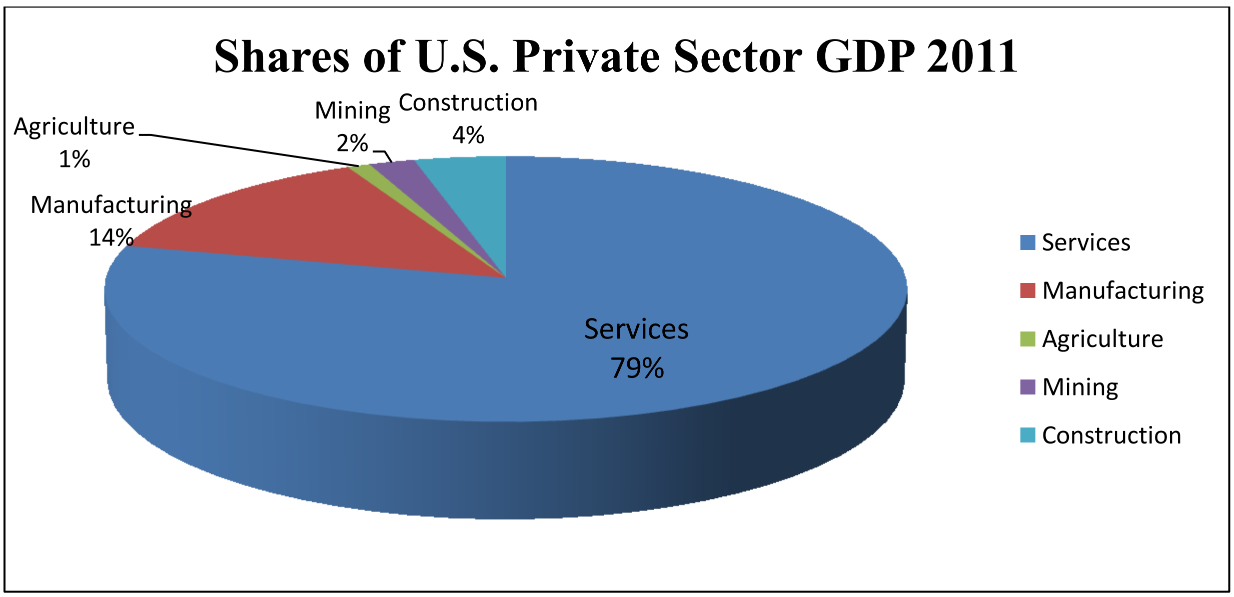


Figure 1.1. U.S. Exporter and Importer of Services.

According to the Bureau of Economic Analysis (BEA), the service sector accounted for 79.6% of U.S. (GDP) in 2009, or $9.81 trillion. Service jobs accounted for more than 80% of the U.S. private-sector employment, or 89.7 million jobs (The International Trade Administration website).

1.1. Background

As seen in the information above, the service industry is the largest category in the private sector. By definition, service is an intangible product or good that is provided an enterprise to fill the needs of customers. Service encompasses health care, education, transportation, financial services, retail and also hospitality. Additionally, even in the manufacturing sector, some functions still depend on service from both the customer and the supplier points of view. Services provide the basis for customer care, product development, execution service, distribution and supply chain functions that are significant for the manufacturing sectors or product firms. Thus, the integration between services and manufacturing processes is a critical issue.

Services have made many improvements in recent years driven by competition and austere economic conditions. Some of the improvements include the incorporation of enterprise activities, higher concern for customer experience, and the integration of technology. Some examples of this improvement are self-service options and online product purchasing. With the onset of austere economic conditions that make it hard to survive, there is competition and a continual need for more improvements in services. The manner in which a service is designed has become critical. The formal science of service design is the creation of a quality customer centered experience with the use of a package of tools (Stickdorn & Schneider, 2011). Service design is a relatively new discipline that aims to fulfill customer needs in order to create an improved customer experience and better enterprise practices. Nowadays, service design is likely a distinguishing and significant factor for the customer experience that can appeal to and attract consumers.

Service design is an evolving field of study and therefore there are many opportunities for further research. The research priorities for service science were published in the Journal of Service Research in 2010. Based on the research of about 1,000 corporations, service design was defined as one of the nine most relevant topics for research in the field of service science (Mager & Sung, 2011). Even though the service sector is the largest percentage of the global economy (Paulson, 2006), research and development in service is often overlooked. Although the service sector occupies such a large portion of the economy, still more research is focused on the manufacturing sector and tangible products. Recently, there has been more attention given to research in the service field. From the research that has been published, a small portion of this has been devoted to service design and its related processes. Among the research describing new service development (NSD) processes, very few attempts have been made to provide a development model (Stevens & Dimitriadis, 2005b). In fact, most of this research focused more on reducing costs of the service and less on the quality of the service. Service design is about strategies, structures, processes and interactions with service (Birgit & Tung-Jung David, 2011), thus all these elements should be given attention in order to improve the service.

These investigations have revealed that the process of service design needs to be reevaluated and improved. There are many problems in the current academic service design models that are usually employed. First, even though it is commonly agreed upon that the service design is a multidisciplinary field, it is still lacking this multidisciplinary approach and the integration of all service design activities which should incorporate marketing, engineering, facility architecture and other fields activities. Furthermore, current academic research discusses a service design process (SDP) that does not actually reflect the current practices that are used by industry. For instance, the Service Design Network (SDN) and Engine and Design Council are using their own invented service design processes (Design-Council, 2005; Engine, 2013).

In addition, current service design models, developed through academic approaches by scholars, may not adequately incorporate the customer. These models focus primarily on organizational needs during their initiation process and they are not consumer focused.

In previous research, "Integrated Enterprise-Based Service Design Activities (IESDA)", three connected information models were proposed that facilitates the interaction of the design activities (Tabbakh, 2011). The research describes and justifies an overall framework for information technology-integrated service design termed Integrated Enterprise-Based Service Design Activities (IESDA). IESDA builds on existing tangible product development approaches (Kulvatunyou & Wysk, 2000) and incorporates recent service design research to develop 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. Using the information models, persons involved in the service design process are able to share the information simultaneously and interact with each other regardless of time, location and organizational barriers (Tabbakh, 2011). The IESDA addressed the information management and sharing problem and the interaction among persons involved in the service design process, but the other above listed design process problems still need resolution.

Furthermore, some research and books address the conflict between the designer and manager in the decision-making during the service design. Boland discussed in his book, *Managing as Designing,* the decision attitude of the manager and its discrepancy with the designer attitude. He found that designers have a different approach to decision-making than managers (Boland & Collopy, 2004). From experience working with a group of design experts in a workshop at the Service Design Global Conference 2011 and with other groups of professional designers and students from Savannah College of Art and Design (SCAD) in the Global Service Jam 2012 and New York City Global Service Jam 2013, it was noticed that most decisions were made by simple vote and based on intuition. Many alternatives and different perspectives existed but designers did not employ decision-making tools or systems to explore these options. Therefore, it has been noticed that there are many conflicts between the designer and the manager in terms of service design decisions. Sometimes there can even be conflicts between the designer and the client in a consulting case. There are no known research papers that discuss the decision-making process during the service design that address such conflicts.

Finally, although there are new practitioners that developed service design processes that are customer focused, they tend to underutilize the customer as an asset. The academic approaches start from marketing research which includes surveys and analysis of customers' needs and problems. For practical service design approaches, designers adopt the customer perspective for the SDP. In order to do that, they engage with users to identify the problem, opportunities and needs and then they define the solution space. They use some tools such as User journey mapping, User diaries, User shadowing and User personas to represent their understanding of the customers' behaviors, values and needs (Stickdorn & Schneider, 2011). In addition, designers place emphasis on involving customers in the design process. An example of this practice is implementing the co-design technique which means designing with stakeholders, especially with customers and staff. In the past, designers used adoption of problem-based or need-based thinking; however, this dissertation will introduce the asset-based concept and approach to the service design.

The new generation of challenges is complicated and hard to resolve with traditional methods. These challenges require a system with an innovative approach. This dissertation's main contribution is the proposal of the solutions for these problems in the service design process, the conflicts between designers and managers and introduction of an asset-based approach for service design with emphasis on customers

1.2. Problem Statement

In previous research, an Integrated Enterprise-Based Service Design Activities (IESDA) framework that provided an information-oriented integration model for service design was proposed. 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 (Tabbakh, 2011). As an extension of this research, this dissertation tries to solve more problems related to the service design. The problems are classified into three directions: the process for service design, the designer-manager conflict in decision-making and an asset-based customer approach for service design. Figure 1.2 depicts the three research directions and it illustrates them. These directions are:

1. *Service design process integration and unification*. The lack of an integration of service design activities from the engineering and enterprise sectors is addressed as well as the discrepancy between the academic service design models and the current practice. In addition, the last SDP model developed in 2000 by Johnson et al. (J. A. Fitzsimmons & Fitzsimmons, 2007; Gottfridsson, 2011; Stevens & Dimitriadis, 2005b) does not properly involve all design participants, adopt a concurrency in order to shorten the design process or feedback for assuring quality. Since that time, no known attempts by academics were made to develop a new model.

2. *Service designer-manager conflict in decision-making*. Decision-making conflicts and managing the unlimited amount of alternatives is a big challenge in the complexity of the service design. This part will improve the decision-making process in the service design. There are many conflicts between the in-house designer/out-source consultant and the manager/client in terms of service design decisions. This conflict is caused due to their different perspectives of enterprise and business decisions. Exploiting these conflicts and encouraging understanding of each other's perspective can lead to diverse solutions. Misunderstanding each other's perspectives could cost the enterprise money and time.
3. *The customer as a contributing resource for the service design*. It may not be enough to consider the customers' needs in the design or to make the process customer-focused; the customer needs to be utilized in new creative ways. Traditional service design approach is limited by using a need-based or problem-based foundation. The service design thinking approach tries to know more about customers to understand the customer perspective and visualize it for the designing activities. Both approaches failed to consider customer contribution or supplementary benefits in the service system. Opportunities may exist for an approach that is asset-based to utilize the resources, including the customer, in a better way. In the next section of this chapter, these three proposed solutions will be summarized in a purpose statement of this dissertation.

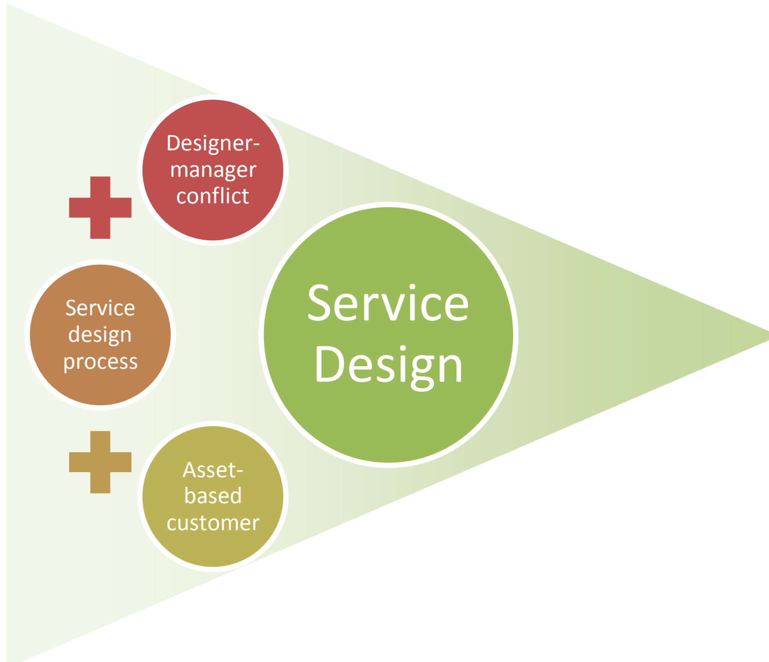


Figure 1.2. Research Directions.

1.3. Purpose and Approach

The purpose of this dissertation is to introduce solutions for these three problems: the process for service design, the designer-manager conflict in decision-making and an asset-based customer approach for service design. The major causes of service failure are due to a lack of market research or a poor service process (Shekar, 2007). For all the process problems listed above, there is a need for a new SDP that can rectify the above issues. Further investigation is needed in the SDP that will incorporate enterprise operations in the service design sector. From this investigation, a new process will be created to accurately reflect real operations, correctly utilize resources, and incorporate a multidisciplinary approach in order to improve service design. The investigation will be done with an established engineering analysis tool. The elected tool provides a mapping technique that supports the behavioral and structural analysis and that describes and studies the processing system of the service design. The behavioral and structural properties are the main strengths of Petri Nets that support the analysis of many properties and problems related to concurrent systems (Murata, 1989). That makes Petri Nets a promising tool for describing and studying the SDP system that is characterized as being concurrent, asynchronous, distributed, parallel, nondeterministic, and stochastic (Murata, 1989).

To utilize the conflict in the decision-making, a scientific approach and a quantitative model should be used to prevent subjective decision-making by managers and designers. This model should not be used to eliminate the conflict because both perspectives of the manager and designer are important. It should help both sides to understand each other better. Currently, there is no model that can support the decision-making during this conflict and help the manager and designer reach a decision by providing the each other's viewpoints. These conflicts certainly lengthen the SDP and greatly affect the final output. Understanding the decision policy of the designer could help the manager to see their perspective, while understanding the decision policy of the manager could help the designer to integrate this into their design.

These two perspectives need a decision support model during this conflict process that helps them reach a decision by providing the opposing viewpoint to both the manager and the designer. The Lens Model is appropriate for this study owing to the fact that the design (environment) is represented by various factors (cues), which must be properly identified by managers and designers.

Finally, an asset-based approach could be the suitable resolution for the new challenges being faced in service design. It is a method that could help to improve many fields through the way that it analyzes resources and the situation overall. In previous research, an IESDA information model was proposed that facilitates the interaction of the design activities (Tabbakh, 2011). One model within this framework dealt with the resources that designers use for creating their service design projects. The structure of the resource model was object-oriented; however, in this dissertation the resource model structure will be changed to an asset-based structure and the customer will be a core asset in the system. This new approach will allow the designer to be an asset-based innovator instead of focusing on need-based problem solving. In addition, dealing with customers as core asset will enhance the design thinking and the asset-based thinking as well.

Thereby, the dissertation purposes are to:

1. Create a new unified service design model that improves and integrates the service design participants, both from enterprise and engineering, that reflects the current practice of the service design, and incorporates quality. The new model will be created by using engineering analysis tools (Petri Nets).
2. Create a model to capture the decision-making policy of the designer and manager during the service design process to reduce the conflict, exploit diversity and encourage understanding of each other's perspective in order to support their decision-making process and diverse solution.
3. Create customer-integrated service design tools that adapt the asset-based approach for the service design and focuses on the customer as a core asset in the service system.

Figure 1.3 is an illustration of this dissertation's organization. The dissertation topic will be covered in seven chapters as outlined in Table 1.1.

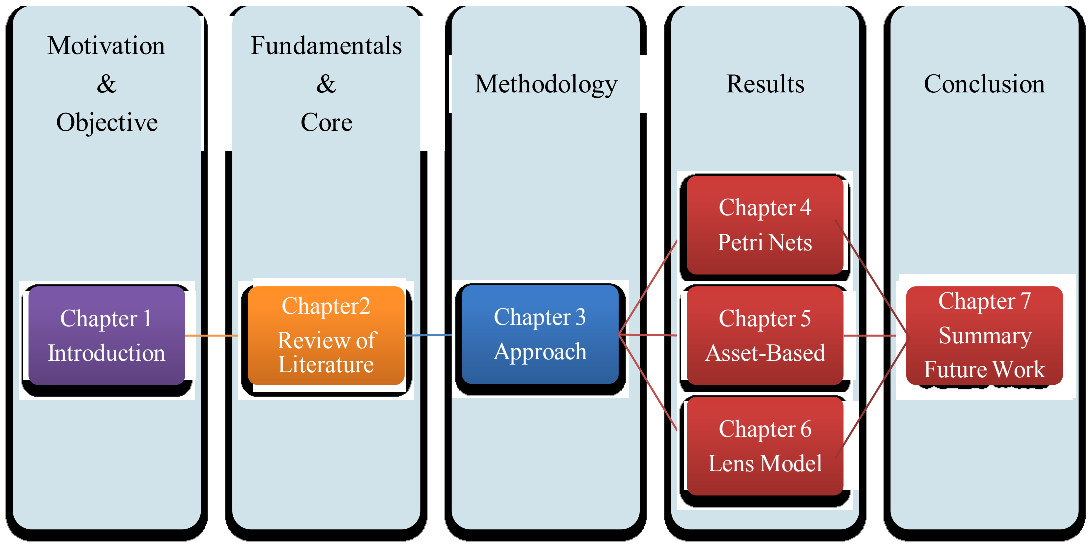


Figure 1.3. Dissertation Framework.

Table 1.1

Frame Work of the Dissertation's Chapters

Chapter	Content
1-Introduction	Introduction previews the motivation, background preface, and statement of the problem, purpose of the dissertation and overview of chapters.
2-Review of Literature	Existing research significant to the topic of the dissertation is discussed in Chapter 2. The main topics include service design models, Petri Nets, Lens Model and asset-based.
3-Methodology	In this chapter, the framework that will be followed to achieve the goal of the research will be explained. It will include a description of the methods and models.
4-Integrating the Service Design Process	In this chapter, Petri Nets, a tool to improve the service design process, are used. A new process will be proposed as a result of using Petri Nets.
5-Lens Model and Service Design	Using the Lens Model in the service design is discussed in this chapter. Single and double design systems are analyzed to solve the conflict problem in the service design.
6-Asset-Based Service Design System	The asset-based approach and how it will be implemented in the service design process isdiscussed in this chapter.
7-Conclusion	Results, recommendations, conclusion and the future work are given.

CHAPTER 2

Literature Review

In this chapter, the relevant information, articles and research are presented. The four main topics are service design, Petri Nets, the Lens Model and the asset-based systems as shown in Figure 2.1. The chapter contains a summary of the important articles or research with a synthesis of this information. The main contribution of the dissertation aims on improving the process of designing and developing a service.

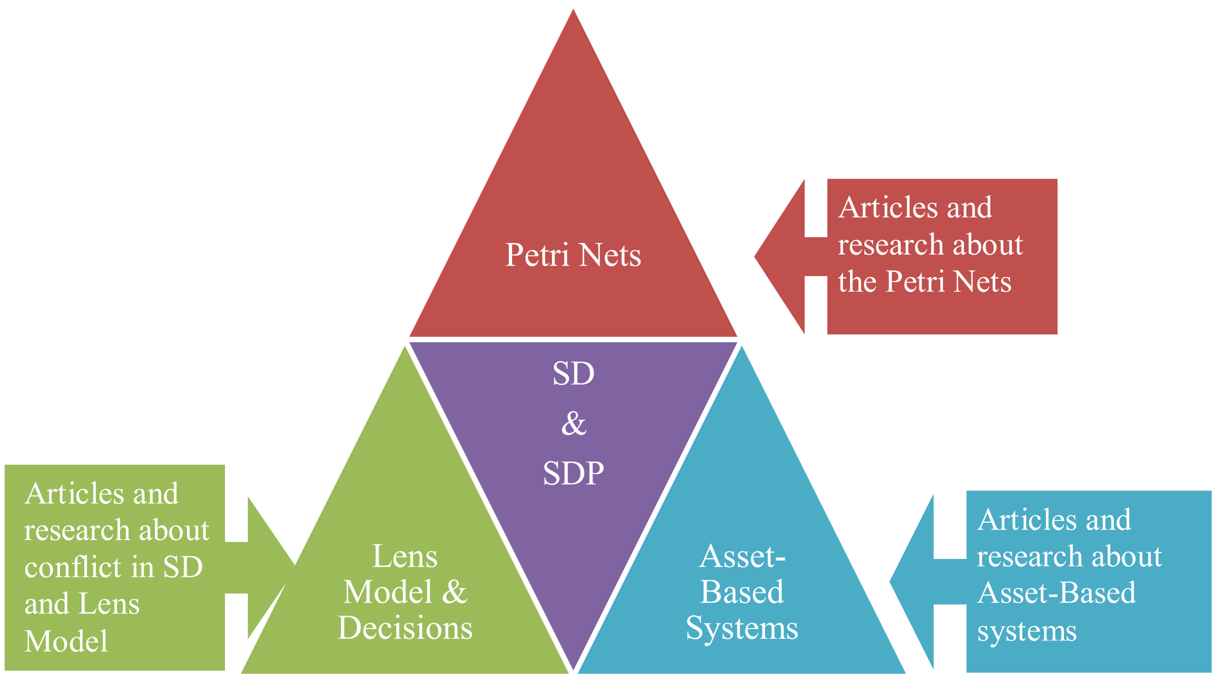


Figure 2.1. Literature Review Sections.

2.1. Service

Service products are different than physical products from the supply, designing, management and the buying points of view (Johne & Storey, 1998). Service is characterized by four characteristics: intangibility, simultaneity, variability in service provision and perishability (Boone & Ganeshan, 2002). The intangible characteristic 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). Service components comprise a combination of processes, people skills, and materials that must be appropriately integrated to yield the 'planned' or 'designed' service (Goldstein, Johnston, Duffy, & Rao, 2002).

2.1.1. Service Design (SD)

According to Mager, service design addresses the form and the functionality of services from the clients' perspective. It aims to ensure the usefulness, usability, and desirability of the service interfaces from the client's point of view. Also, it aims to insure the effectiveness, efficiency, and distinctiveness from the supplier's point of view (Forlano, 2010) (Mager & Sung, 2011).

Thereby, service design seeks to create a service to make it useful, unique and cost-efficient for the customer. This design includes, but is not limited to, the following issues:

- Service identity
- Service concept
- Service encounters or touch-points
- Work flow
- Procedures and job definitions
- Measures for quality assurance
- Equipment selection and adequate service capacity
- Facility layout
- Supply chain system

Design activities' key issue is satisfying the customer's needs and expectations in an economical way (Huertas-García & Consolación-Segura, 2009). For example, the service encounter is an engineering tool, a concept that originates from psychology and sociology which is viewed as a triad of customer, contact personnel and an environment(Cook et al., 2002). All three parties must work together to create a positive service encounter and unique customer experience (Cook, et al., 2002). Figure 2.2 shows the service encounter triad.

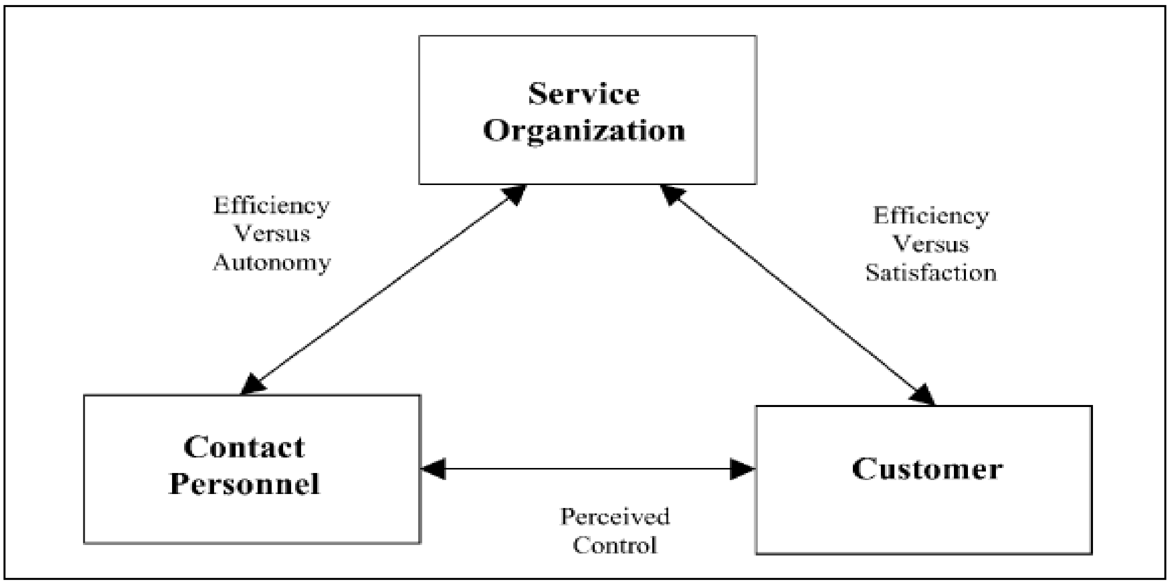


Figure 2.2. Service Encounter Triad (Cook, et al., 2002).

In general, new service development/design (NSD) emphasizes adding value for customers in the service and making a profit. However, most of researchers in the service design focus on these three issues: usefulness of the service, cost-efficiency, and meeting client expectations (Goldstein, et al., 2002).

The design of services emerged as a concept in the 1990's (Nixon, 2010). Today, service design is new discipline in some schools such as the Savannah College of Art and Design (SCAD) in the USA. The SCAD service design program prepares their graduates to work as application designers, retail design managers, customer experience managers, online services design managers, exhibition and museum designers and user experience designers (SCAD.edu, 2013)

2.1.2. Service Design/Development Process

The process of the service design/development includes the steps that are followed by the designer to design a new service or improve an existing one. The service development process activities and research techniques have similarities to and differences from the product development process.

Although the process of the new service design/development has many similarities with the new product design/development process, the relative importance of each step in the process and how each step is carried out is affected by these service characteristics: intangibility, simultaneity, variability in service provision and perishability (Johne & Storey, 1998). Moreover, the interaction process is typically a vital part of a service; therefore, the new service design/development process is usually far more complex conceptually than the development of a new physical product (Johne & Storey, 1998). This interaction process is similar to consumption and has high informational content. Thus, the new service design/development has emerged as a vital research topic in service innovation and service marketing (Jiang, 2008). However, little research has addressed detailed steps in the development process for new services (Boone & Ganeshan, 2002). Among this research describing the new service design/development processes, very few efforts have been made to provide a development model (Stevens & Dimitriadis, 2005b).

The "stage-gate" model by Cooper (1994) is based on a linear conception of the development that flows logically from the initial idea to the launching (Stevens & Dimitriadis, 2005b). In 1999, Johnson, Menor, Roth, and Chase proposed the most recent model for New

Service Development (NSD) (J. A. Fitzsimmons & Fitzsimmons, 2007). The NSD model is the "overall process of developing new service offerings" and is concerned with the complete set of phases starting from an idea and ending with its launch (Goldstein, et al., 2002) Their NSD model divides the sequence of the service development in four broad stages and 13 tasks. These 13 tasks must be completed to launch a new service or new development. In addition, they describe the components of the organization that are involved in the process (Stevens & Dimitriadis, 2005b). Figure 2.3 shows the Johnson et al. diagram of the NSD model.

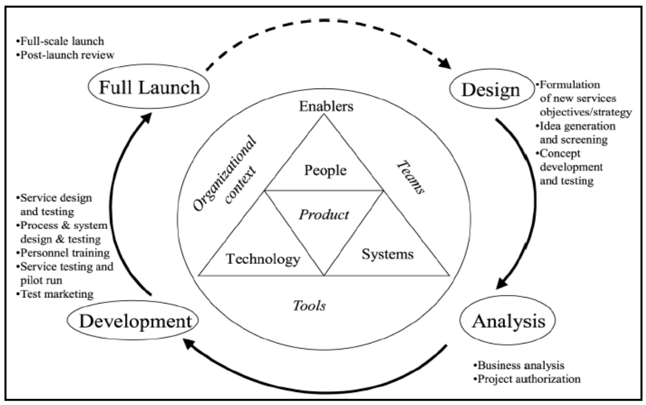


Figure 2.3. Johnson et al. New Service Design Model (Stevens & Dimitriadis, 2005).

The NSD model is one of the most popular models used in the SDP. It is a service innovation that requires a unique process and design approach rather than incremental innovation (Johne & Storey, 1998). Since that time, little work has been done to overcome the shortcomings in this model.

Moreover, people, technology, systems, enablers, teams and organizational contexts are in the center of the NSD diagram, but details of these elements and the approach for utilizing them was not specified. Scheuing and Johnson, 1989 (Johne & Storey, 1998) (M. J. Fitzsimmons & Fitzsimmons, 1999) proposed a model that added more details about the internal inputs and outputs of NSD process. In addition, this model makes a distinction between two different designing processes which are the design of the service and the design of the delivery process as shown in Figure 2.4.

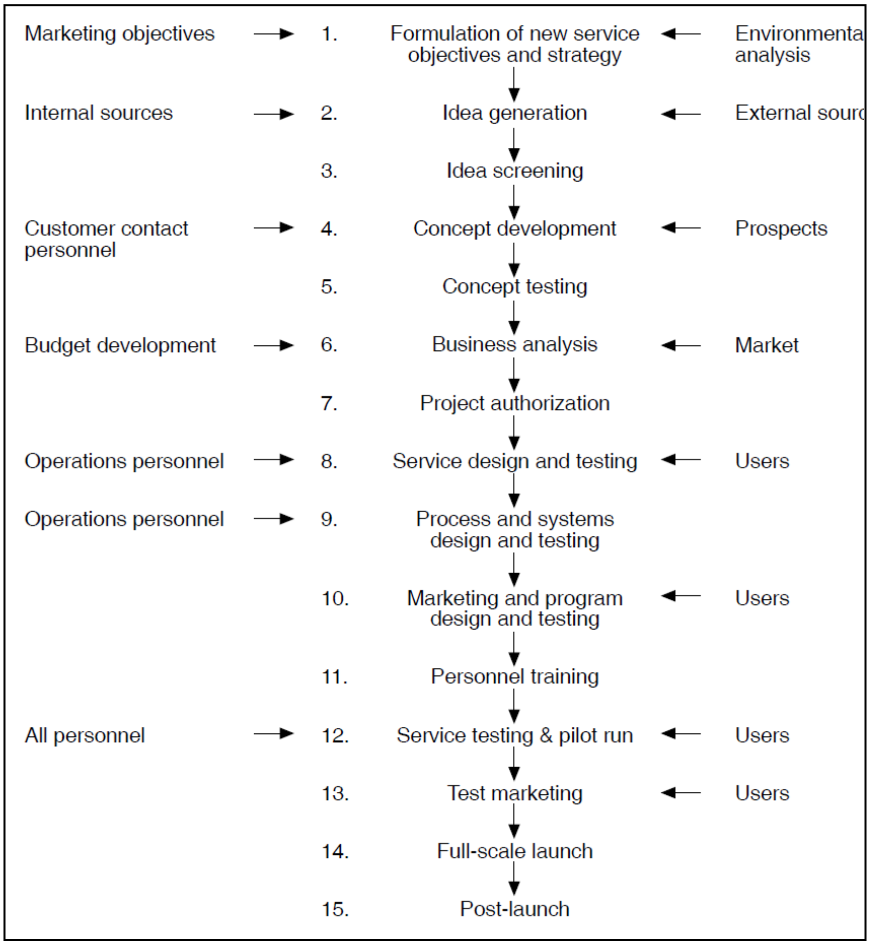


Figure 2.4. Normative Model of New Service Design Process (Johne & Storey, 1998).

Goldstein et al. (2002) made some improvement on the NSD. They proposed a process that employs the service concept as a core element of the design process and as a vital driver of service design decisions. They defined the service concept and described how it can be used to enhance a selection of service design processes. Figure 2.5 shows how this process connects the an organization’s business strategy and delivery of its service products (Goldstein, et al., 2002).

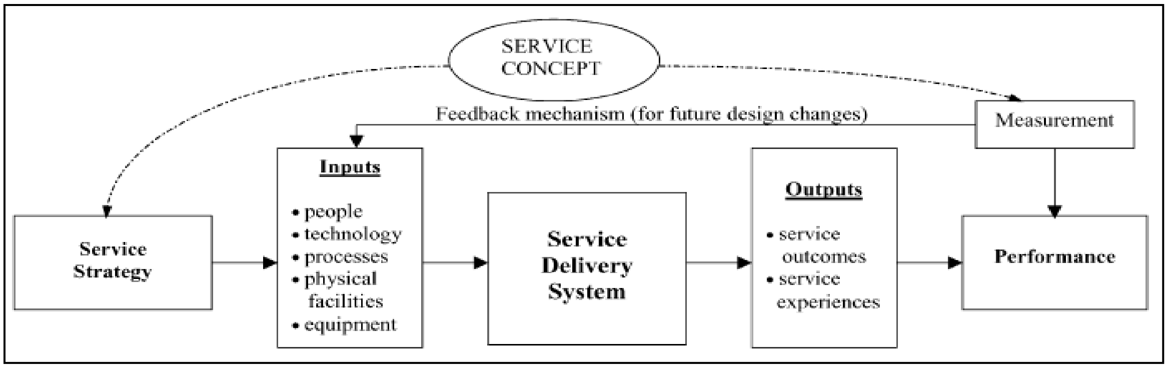


Figure 2.5. Service Design Planning Model (Goldstein et al., 2002).

Jiang (2008) focused on the service interaction that occurs between customers and service providers. He presents a framework for designing service which 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 identifying the customer experience needs, experience design, service system design, experience testing, and new service launch (Jiang, 2008) Figure 2.6 shows the NSD process model for experience.

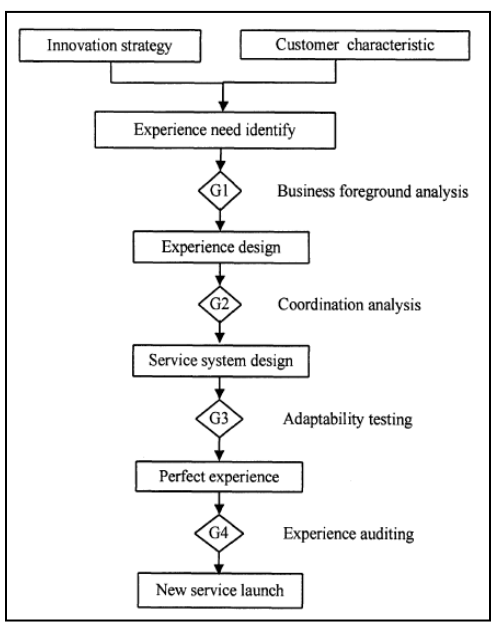


Figure 2.6. SD Process Model for Experience (Jiang, 2008).

Another article by Steen, Koning, and Manschot studies the benefits of co-design (involving users and customers) during the design process in service design (Marc, Menno, & Nicole De, 2011). As a result of their study, recommendations were to identify the desired goals of the service design and identify the intended benefits of their co-designed activities. However, they did not improve the SDP.

Clatworthy (2011) introduces a development process of AT-ONE touch-point cards. These cards have been developed to assist cross-functional teams in the first stages of the NSD process. He identifies seven aspects of touch-point innovation relevant to the performance of cross functional teams at the early stages of the NSD process (Clatworthy, 2011).

From the literature review for the service design/development processes, it has been noticed that all the current new service design/development models have many weaknesses. Stevens (2005) lists some of these weaknesses (Stevens & Dimitriadis, 2005b):

- The sequential development models could lead to excessively bureaucratic processes that slow down the service design timeline.
- The stage descriptions do not integrate with the way that corporations organize the development groups.
- The output of process is a result of co-operation and multi-functional groups. It is not the result of an individual or department even if one of them leads the process.
- The sequential models do not support the output quality of each stage.
- Sequential models do not help to define what must be produced during each stage.

In addition, the interaction among all of these multi-functional groups and stages is not defined properly in the service design/development process. All current models neglect aspects of information management. The new service design/development as a system is a flowing of information about the service concept and elements that includes process, resources, strategies, maps, flowcharts, and diagrams of the following:

1. Service tasks and sub-tasks in sequence
2. Interactions between the service provider and the customer such as customer experience, customer encounter or touchpoints
3. Supporting materials, equipment and facilities used for providing or delivery of the service (Boone & Ganeshan, 2002; Jiang, 2008)

Moreover, experience from multiple observations demonstrated that most of the consultant organizations and individual practitioners don't use any of the previous models mentioned, instead they use their own process. This shows a gap between what is written by scholars or researchers and what the consultant/practitioners adopt in terms of the SDP.

For example, Engine is one of the world's leading service design and innovation consultancies which was founded in 2000. Engine uses its own process for service design that has three general phases: identify, build and measure. The three general phases break down into further steps as shown in Figure 2.7 (http://www.enginegroup.co.uk/service_design/our_process)

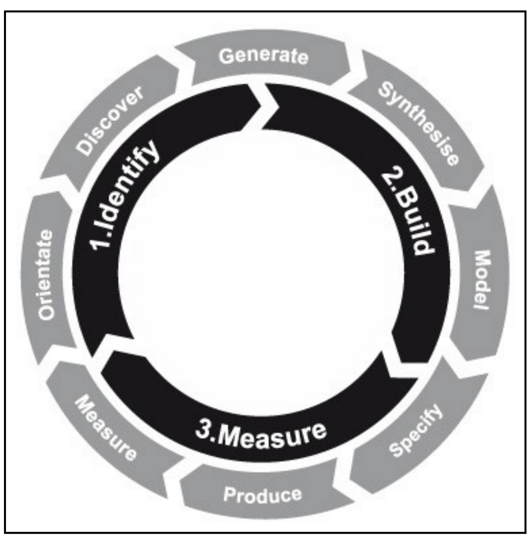


Figure 2.7. Engine Service Design Process (Engine website).

Similarly, the Design Council advocates the "Double Diamond" design process. The model was developed through in-house research at the Design Council in 2005 as a simple graphical way of describing the design process (Figure 2.8)(Design-Council, 2005).

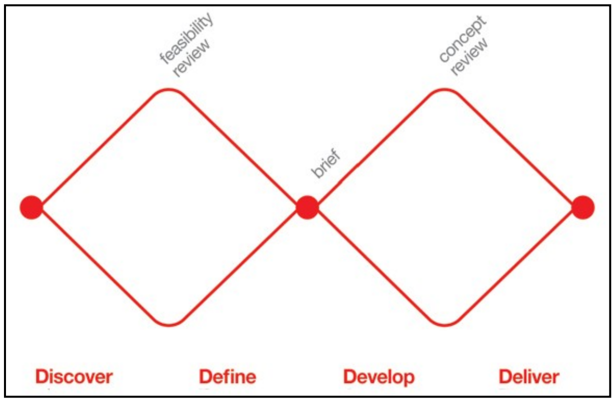


Figure 2.8. Double Diamond Design Process Model (Design Council, 2005).

The model is divided into four phases, Discover, Define, Develop and Deliver. It maps the divergent and convergent stages of the design process, showing the different methods that designers use (Design Council, UK, 2005).

Tabbakh (2011) proposed Integrated Enterprise-Based Service Design Activities (IESDA) framework that provided information-oriented integration model for the service design. 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. Figure 2.9 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) (Tabbakh, 2011).

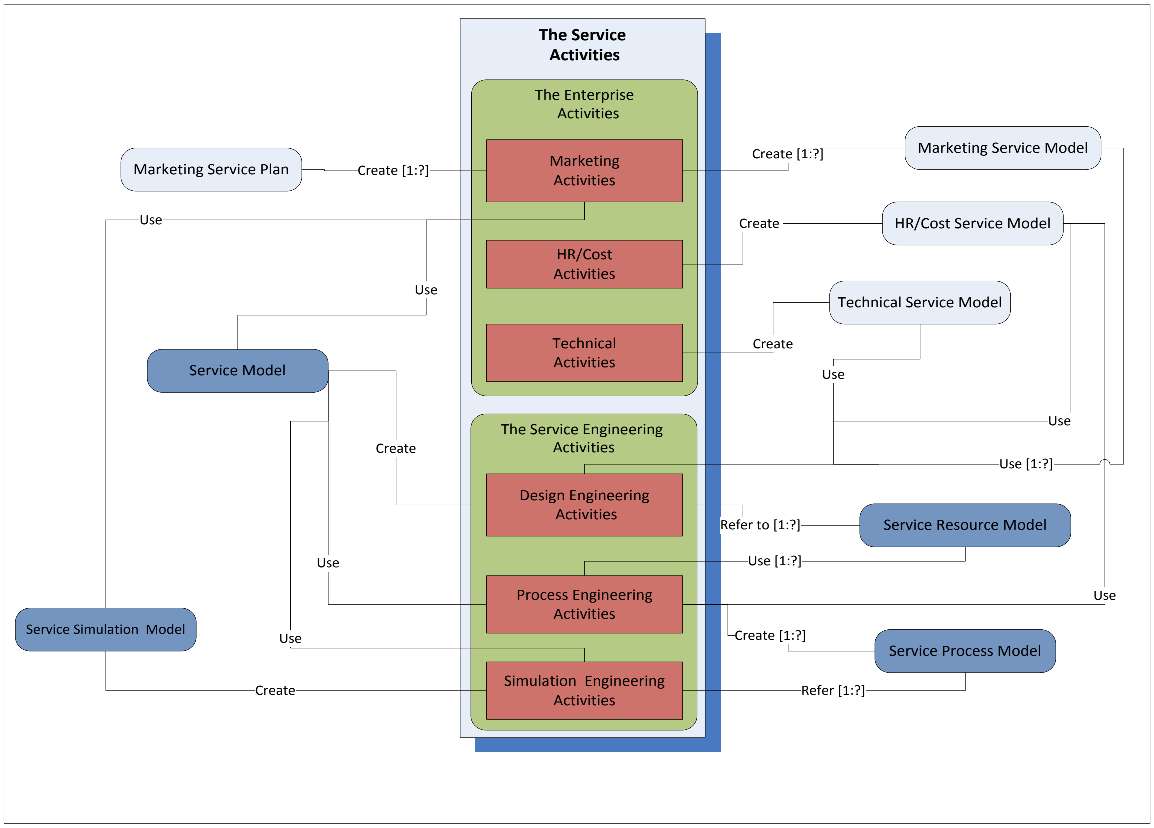


Figure 2.9. Integrated Enterprise Service Design Activities Framework.

The Enterprise Activities (EA): The Enterprise Activities (EA), as envisioned in the IESDA framework, are operational activities related to the service design, and have an 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.

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.
- 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.
- 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.

- 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.
- 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.

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 is shown that the Marketing Service Model, HR/Cost Service Model, Technical Model, Service Model, Process Model and Service Resource Model, and Simulation Model integrate enterprise-based service design activities. For example, if the service resource model is missing, it is impossible to create the service model; consequently, service design cannot be evaluated.

2.1.3. Service Design Process Representation

Currently, the service design process has not been analyzed by any engineering tools. None of the following common tools have been used to give a graphical and mathematical dynamic representation of the service design. Among these are: 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 Model Diagram (Tabbakh, 2011).

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, constraints, mechanisms, resources, output,, and relationships with 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 & Presley, 1993).

UML Activity Diagram is a modern model used to represent the activities of an enterprise, creating a graphical model showing the activities, responsible resources, concurrent and alternate flow board relationships they have to other activities. Figure 2.10 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 classes.

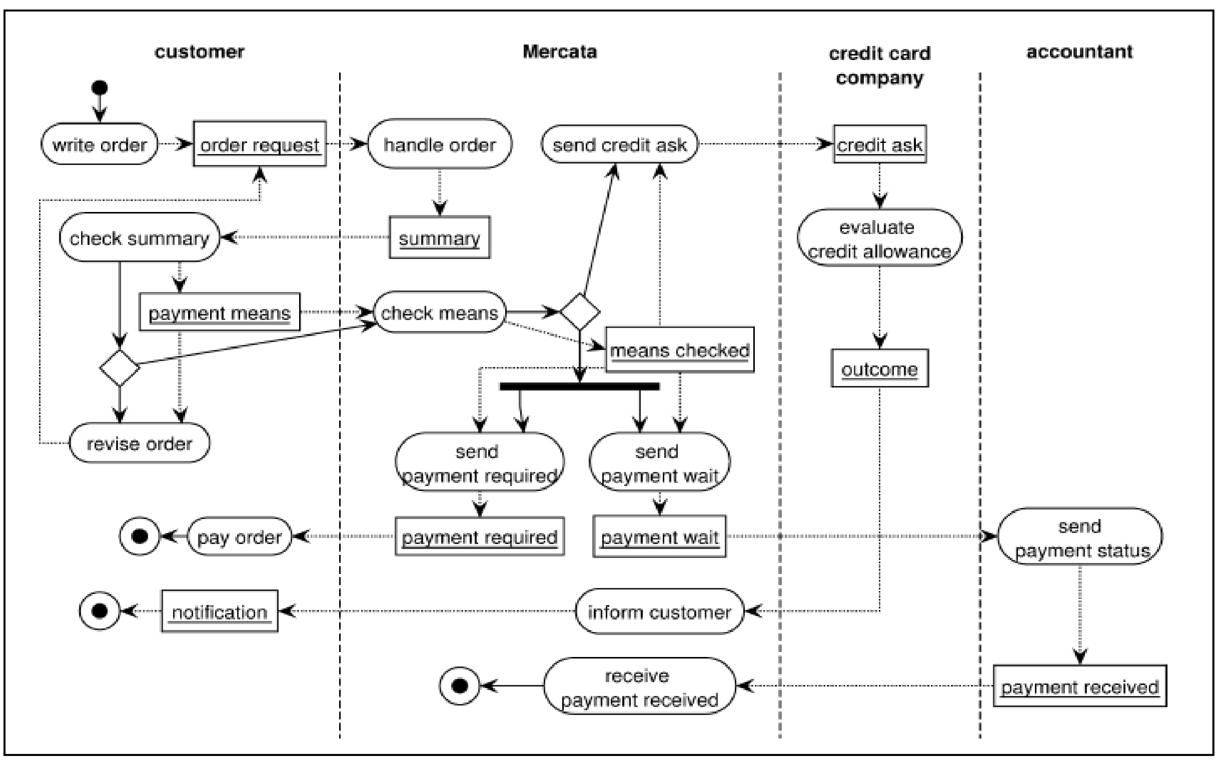


Figure 2.10. UML Activity Diagram (Eshuis, 2006).

Service design is a continual process without a definite end (J. A. Fitzsimmons & Fitzsimmons, 2007). “Cooper and Edgett (1996) argued that the new service development (NSD) is risky because the new service failure rate is almost 50 percent” (Oduori, 2010). Thus, it is essential to implement a robust NSD model that has the capability of creating a successful service design, meeting the aspiration of design practitioners and the market needs. However, one of the contributions of this dissertation will be filling these gaps in improving the service design/development process by using Petri Nets.

2.1.4. Service Design Decision-Making

In designing a new service or improving an existing one, decisions must be made by managers and designers about each component of the service. 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).

2.2. Petri Nets

“Petri Nets” are used in service design and analysis in this research and reviewed here. Petri Nets are an engineering tool that provides a uniform environment for modeling, formal analysis, and the designing of discrete event systems. Petri Nets are a graphical and mathematical representation of processes that help identify behavioral properties and evaluate their performance. Petri Nets application ranges from modeling properties such as process synchronization to asynchronous events and concurrent operations. This makes Petri Nets a promising tool for application to industrial automation (Zurawski & MengChu, 1994). In this dissertation, Petri Nets are implemented for the new service design/development process to design, investigate, and implement the process of NSD.

2.2.1. Petri Nets Fundamentals

The Petri Net model consists of places, transitions, arcs, and tokens (Tan & Sheng-Uei, 2005). Table 2.1 shows all of these elements and illustrates the meaning and the denotation of each one.

Table 2.1

Petri Nets Elements

Element	Description	Denotation
Place	Represents the state of the system and is symbolized with a circle.	○
Transition	Represents the action of the system and is preceded with an output arc and superseded by an input arc. Symbolized with a vertical line.	|
Input arc	Symbolized by an arc ending with an arrowhead leading from a place to a transition.	→
Output arc	Symbolized by an arc ending with an arrowhead leading from a transition to a place.	→
Token	Symbol that denotes the current state of the system. The firing of a transition removes a token from its input place and places a token in its output place.	●

Petri Nets function as an analysis simulation. Thus, Petri Nets are used as a design evaluation process or for pilot tests of a process. These are used in modeling communication protocols, manufacturing environment, Very-Large-Scale Integration (VLSI) etc., (Shapiro, 1991; Zurawski & MengChu, 1994).

The system is managed by a set of firing rules that permits the movement of the process from one state to another. These rules are:

- A transition is permitted when all input places that are connected to it by an input arc have at least one token.
- The firing of a transition removes a token from its input place and places a token in its output place (Tan & Sheng-Uei, 2005).

For example, consider a coffee shop service where coffee is prepared in three steps. Figure 2.11 shows the Petri Nets graphical representation of this process. The circles are considered as places, where place 1 is the cup ready to be used and N2 is the water ready to be used (a), N3 is the result of placing the water in the cup and N4 is the coffee powder ready to be placed (b). The adding step is the first transition T1 in the system. N5 is result of T2 which is adding the coffee powder to the water and N6 is milk ready to be used (c). Finally, N7 is the coffee cup ready for customer (d). Graphically, Petri Nets have three main objects: places, transitions and arrows (Zurawski & MengChu, 1994). The places are denoted by circles and also called as places. Transitions are denoted by rectangular boxes used between two places indicating the transition. Arrows are the connections between the places and transitions. If the places are filled with dots i.e., tokens that show the work at that node is taking place.

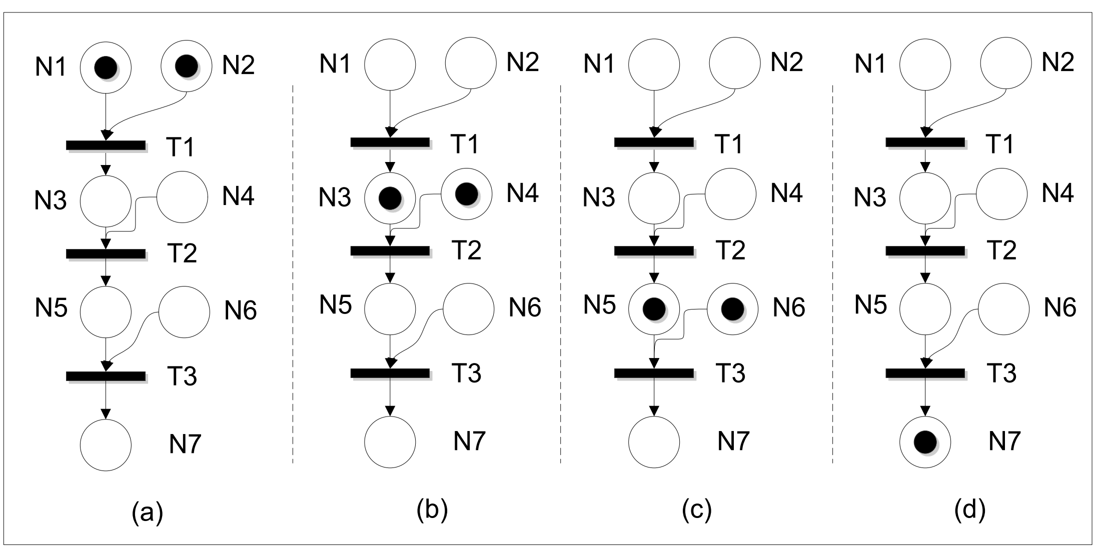


Figure 2.11 . Petri Nets Application in Food Packaging.

2.2.2. Properties of Petri Nets

Petri Nets main strength is their support for analysis of many properties and problems related to concurrent systems (Murata, 1989). The properties of Petri Nets are classified as behavioral and structural. the marking-dependent or behavioral properties depend on the initial marking and structural properties are independent of the initial marking (Murata, 1989). All the behavioral properties rely upon the early state of Petri Nets whereas the structural properties depend on the structure of the process (Tabbakh, Vaizasatya, Wan, Li, & Stanfield, 2012).

The type of properties that are referred to as marking-dependent is behavioral properties. The major behavioral properties of the Petri Nets:

A. *Reachability*: It helps in studying the dynamic properties of the system. Reachability indicates that all the required features, materials or components are available and are able to process the functions. This is denoted by M_0 to $M_n$where marking M_0 is the initial state to M_n that is the reachable state in the process. For example, think about 4 nodes in a process $M_0 = (1,0,0,0,)$ and $M_n = (0,1,0,0)$. So marking M_n is called reachable from a marking M_0if there exists a series of firings that transforms $M_0$to M_n (Murata, 1989). It is what triggers the process and when all of the nodes have to be processed it called "reachability" (Zurawski & MengChu, 1994).

B. *Boundedness and safeness*: Secure and safe the information flow is an important aspect everywhere. Nodes in the Petri net represent buffers or registers for the intermediate data storage in the process. The boundedness and safeness properties safeguard the overflow of information. It is guaranteed that there will be no overflows in the buffers or registers, no matter what firing sequence is taken. Each place can has k number of tokens (K-bounded) but it should be ≤ k and for safe k=1 (1-bounded) (Murata, 1989).

C. *Conservativeness:* The tokens in Petri Nets are considered as resources that are limited and cannot be added or deducted since the resources are constrained (Tabbakh, et al., 2012; Zurawski & MengChu, 1994). This property helps to better optimize and manage the resources by constraining them.

D. *Liveness*: Petri Nets are live when it guarantees deadlock-free operation, no matter what firing series is chosen (Murata, 1989). The liveness property has four conditions, which are as follows:

- Resources are either available or considered for a process.
- Until other resources are requested, the currently available resources can be held for a period of time.
- The resources, once allocated to a process, cannot be removed until the resources passes through that process.
- The process waits until the resources are arranged in a circular pattern (Tabbakh, et al., 2012).

E. *Reversibility and home state*: If an error occurs or at the end of the process, the ability to return to the earlier state is the property of reversibility and home state (Tabbakh, et al., 2012). However, in some applications get back to the initial state is not necessary thus we the reversibility condition need to be relaxed and define a home state (Murata, 1989).

Structural properties are independent of the initial marking M_0 and depend on the topological structures of Petri Nets. They can often be described in terms of the incidence matrix A and its associated homogeneous equations or inequalities (Murata, 1989).

The formal definition of a Petri Nets graphical representation is as followed:

- Petri Nets are a 5-tuple, PN = (P, T, F, W, M_0) where:
- $P = \{p_1, p_2, \dots, p_m\}$ is a finite set of places where m ≥ 0,
- $T = \{t_1, t_2, \dots, t_n\}$ is a finite set of transitions where n ≥ 0,
- $F \in (P \times T) \cup (T \times P)$ is a set of arcs (flow relation which is the connection between the nodes and transitions),
- $W: F \to \{1,2,3, \dots\}$ is a weight function,
- $M_0: P \to \{0,1,2,3 \dots\}$ is the initial marking,
- $P \cap T = \emptyset \; and \; P \cup T \neq \emptyset$.
- Petri Nets structure N = (P, T, F, W) without any specific initial marking is denoted by N.
- Petri Nets with the given initial marking are denoted by (N, M_0) (Murata, 1989) (Achilleos, Kun, Georgalas, & Azmoodech, 2008).

So far, there are not any known applications of Petri Nets in SDP.

2.3. Lens Model

In contrast to the function of Petri Nets, there are models that are used for decisions and judgment analysis, among these is the Lens Model. These decision-making models vary from advanced technological models to complex qualitative models. Technological advancement has led to the development of artificial intelligence based models capable of complex decision-making such as inductive reasoning (Han, Chandler, & Liang, 1996), artificial neural networks

(Efrim Boritz & Kennedy, 1995) and case-based reasoning (Bryant, 1997; Park & Han, 2002; Seong & Nam, 2008). Some decision makers also employ the use of mathematical models as seen in works by Keeny and Raiffa (1976), who makes use of expected utility theory. Klein's (1997) recognition-primed decision-making is an example of a complex qualitative model for experts in their decision-making process with experience, mental libraries, and retrospective accounts as underlying concepts. Signal detection theory, originating from World War II, and statistical theories (Swets, 2001), Lens Model (Bergmann, 1952) and Baye's Theorem are other existing quantitative decision-making models.

The Lens Model is a model for capturing expert judgment policies used in several applications in research. Researchers use this model to describe how experts make judgments about their tasks. Some of these applications are medical judgments, weather forecasting, educational judgments, social judgment, and rapport (Bisantz & Pritchett, 2003). Other applications in cognitive engineering contexts are fault diagnosis, aircraft conflict detection and browsing on the internet (S. Miller & Kirlik, 2006). The Lens Model has also been used in collaboration with signal detection theory in existing studies relating to social workers' decisions on child separation due to parental abuse (Dalgleish, 1988), lie detection tests (Seong & Nam, 2008) and customer creditworthiness for limit increment (Seong & Nam, 2008).

The Lens Model is useful in the capturing of judgment policies in human decision-making. The cues present in the Lens Model are important in meeting this objective. Survey, interviews, document analysis, objective analysis of the ecology, and verbal protocol analysis are some methods outlined by Cooksey (1996) for cue identification. The Lens Model can be designed as a single, double, triple, or n-systems system (Cooksey, 1996). The single system has only one reality, that of the subject, in that the ecological criterion is either not available or not of interest (Cooksey, 1996). The double system design is one which compensates for the missing ecological criterion from the single system design. This system follows the classic Brunswick perspective "where a judge's cognitive system is explicitly compared to a known task or ecology system" (Cooksey, 1996). The third design is the triple system design, which is framed like the double system design, compensating for both the ecology and judge. The distinction however, lies with the presence of two autonomous judges within a common ecology. The final design system is the n-system which Cooksey (1996) describes as an "extension of the Lens Model to social contexts involving many judges". Typically, for social policy formation, this system aims to capture and compare the number of policies of the different judges and has either no access or interest in the ecological criterion. Figure 2.12 shows the Brunswik's Lens Model and explains its parameters.

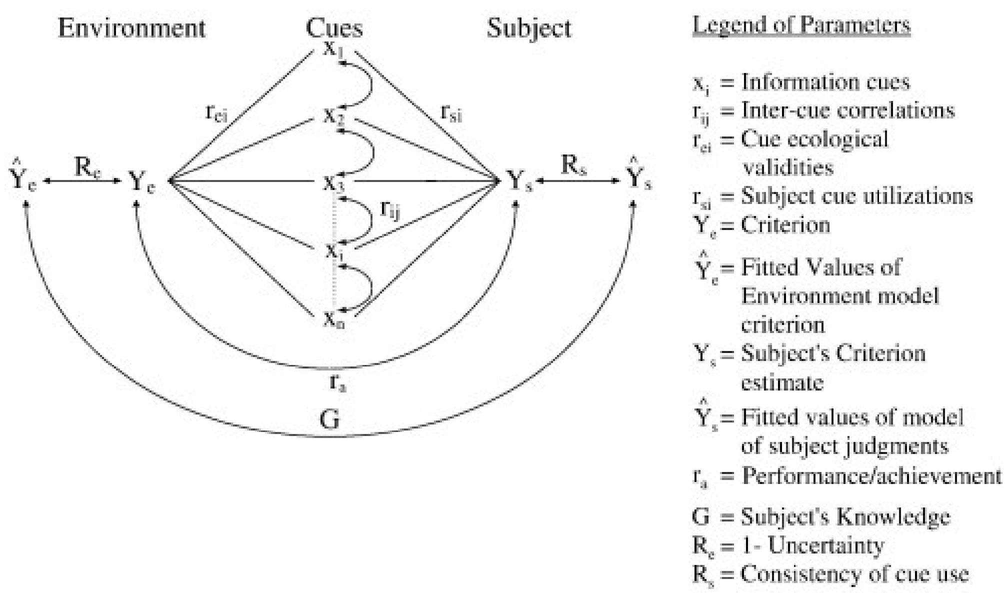


Figure 2.12. Brunswik's Lens Model (Davern, Mantena, & Stohr, 2008).

Linear models, such as the Lens Model, can provide powerful descriptions of human judgment behavior in complex decision-making environments. Many models have been developed based on these linear relationships. These models have proved both successful and reliable (Bisantz et al., 1997). Moreover, Einhorn, Kleinmuntz, and Kleinmuntz (1979) illustrated how linear models can successfully replicate an apparently more cognitive representation, process of tracing models of judgment (Einhorn, Kleinmuntz, & Kleinmuntz, 1979).

The goal of policy capturing using multiple regression procedures is to produce a linear equation that optimally weighs each cue in terms of its predictive contribution to the judgments. This is the liner equation for any subject:

$$Y_s = [b_0 + W_1X_1 + \ W_2X_2 + \cdots + W_kX_k] + e$$

$$Y_s = \hat{Y}_s + e$$

Y_S= Predicted Judgment Model + e

Where: Y_s the actual value of the subject or the right decision

b_0 The regression constant

W_k The regression coefficient for each k cue

e The prediction error

$\hat{Y}_s$ The predicted value

The Lens Model equation (Cooksey, 1996) (Hammond, Stewart, Brehmer, & Steinmann, 1975) describes the relationships among all the previously mentioned parameters:

$$r_a = GR_sR_E + c\sqrt{1 - R_S^2}\sqrt{1 - R_E^2}$$

- Achievement(r_a) is the degree of correlation between human judgment and the actual environmental criterion. It is computed as the correspondence between human judgment and the value of the environmental criterion. This parameter reflects humans' success in making correct judgments. (Bisantz & Pritchett, 2003) (Bisantz, et al., 1997).

- The Knowledge (G) quantifies the similarity of the linear model of the human judgment to the linear model of the environment. It is computed as the correlation between the output of the human model (Y_s) and of the environment model (Y_E) by using the same group of cue values for both models (Bisantz & Pritchett, 2003).
- Cognitive Control (R_S) measures the degree to which the decisions made by humans are predicted by their linear models. It is also referred to as describing how consistent the linear rule is applied in making a judgment (Bisantz, et al., 1997).
- Environmental Predictability (R_E) analyzes the degree to which the judgments made by the environmental criterion are predicted by their linear models. In other words, it reflects how well a linear model predicts the environment (Bisantz & Pritchett, 2003).

These two parameters are the correlations between the actual judgments (R_S) and environmental criterion for (R_E) to the outputs of their respective linear models. Unmodeled Knowledge (C) measures the degree to which the policy models of the human judgment and the environmental criterion share the same nonlinear components. It is calculated as the correlation between the residuals of the human and environmental policy (Bisantz & Pritchett, 2003).

In general, the Lens Model is shown with multiple regressions and correlations as the underpinning analytical techniques. The Lens Model is applicable to complex human-machine systems, complex and dynamic environments and can serve as a valuable tool for designers in that area (Bisantz et al., 2000). This dissertation looks at the application of Brunswik's Lens Model in the service design decision-making. So far, there are no applications for the Brunswik's Lens Model used in service design or in capturing the respective decision-making policy.

2.4. Asset-Based Approach

The word "asset" could have many different interpretations and uses. For finance professionals, it can be used to describe stocks or investment portfolios with the most excellent utilization of these assets being achieved by finding the best combination between the capital security growth and interest rates. For equipment maintainers and software vendors, assets are equipment and software and their task is to maintain these assets and gain greater credibility for their activities with a low budget. For manufacturing, assets are physical plants, infrastructure and its facilities, and the utilization of these assets is finding their best sustained use (Woodhouse, 2007). However, as Woodhouse added, if the scope expands it will include "not just physical assets, but any core, owned elements of significant value to the company (such as good reputation, licenses, workforce capabilities, experience and knowledge, data, intellectual property etc...)." For multiple categories of assets, assets are humans and the people of the community.

Asset-Based Community Development (ABCD) developed from 1970s research and originated in the communities of Chicago (Walker, 2006). It started with sociology scholars who addressed some of the community problems such as poverty, public health, human services and criminal justice (Walker, 2006). Asset-based thinking encourages focusing thoughts on what is currently working and what is on hand rather than what it is missing (Paek, 2008). It focuses on the current strengthening of the system's assets and how these assets should be utilized. Asset-based thinking "is intended to affirm and to build upon, the remarkable work already going on" (Kretzmann, McKnight, Affairs, Research, & Network, 1993). Whiting, et al. stated from different resources some of the ABCD's potential strengths:

- Think positively about the circumstances

- Obtain a common view about what is important
- Maintain easy and entertainment of use for the customer to be involved
- Provide a realistic view about what exists now
- Be inclusive
- Center around effectiveness
- Encourage all parties to realize their ability and talents to contribute
- Become more sustainable
- Empower resources (Whiting, Kendall, & Wills, 2012)

So far, no one has implemented an asset-based approach in service design. All of the service design processes start from finding a problem based on the customers' needs or perspectives (as shown in the previous section). Asset-based thinking insists on looking through an asset "lens" rather than a needs "lens" is instead of looking through a needs Lens, is looking through an assets Lens to find the strengths that can be employed for development (Walker, 2006). In addition, adding the customer as an asset from the asset-based thinking changes the concept of the service design thinking.

A review of service development by Cowell (1988) highlighted that in many services, customers are involved in the service design and development process. In addition, in the current service design thinking, designers work to understand customers' needs and perspectives, but they don't view them as assets. Even though some studies used the term customer as an asset, they did not imply that they were dealing with the customer with an asset-based philosophy. The customer in these studies was a "financial asset that companies and organizations should measure, manage, and maximize just like any other asset" (Persson & Ryals, 2010). "Thus, they integrated aspects of customer relationship management, database marketing, and customer satisfaction within a customer equity framework" (Persson & Ryals, 2010).

Asset-based implementation starts with the step of exploration, which concentrates on the search for assets as Walker described by using an asset lens (Walker, 2006). The second step, which is based on Walker, is to be inclusive by matching each individual's assets and groups of assets. The third step is mapping the assets and identifying their potential in the community by taking a detailed inventory of strengths or just a preliminary scan (Walker, 2006).

Talking about physical assets has two dimensions: asset care, which includes maintenance and risk management, and asset exploitation, which includes the use of the asset to achieve some corporate objective or performance benefit (Woodhouse, 2007). The combination of these two dimensions, exploitation and care, must consider time scopes and be optimized over the whole design cycle.

Stanfield (2012) introduced steps to find the assets in an Asset-Based System (ABS) by using the acronym FIRST. Humans are a key player in the ABS. ABS engineering is the "scientific process to discover and utilize system strengths and resources as a means for sustainable and robust system design and implementation" (Stanfield, 2012). Contrary to other models, the FIRST model is not sequential due to the fact that prior steps are still occurring as each new step is initiated as seen in Figure 2.13.

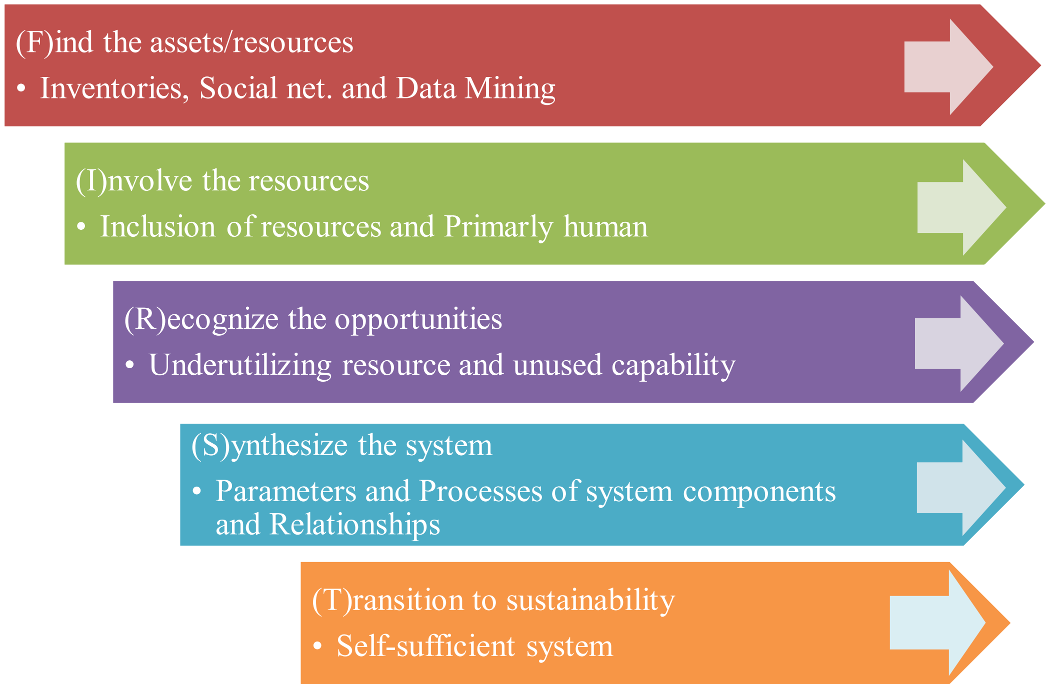


Figure 2.13. FIRST Steps to Find Assets.

For implementing the asset-based approach in the service design process, both the physical and human assets should be considered. This will be the first application of the asset-based approach in the service design. The FIRST framework should have a number of tools available to assist with each step. However, as Stanfield mentioned in the asset-based research, even though these tools exist, there is much that can be done to develop new tools in this research area. (Stanfield, 2012).

2.5. Conclusion

Four topics have been discussed in the literature review chapter. These are the fundamentals of service design, Petri Nets, the Lens Model, and the assets-based approach. In addition, a summary of the important research articles in these four topics has been presented. Petri Nets, the Lens Model and asset-based approach will be used as tools and methods to improve the service process, the conflicts between the different perspectives in the process and the strategic thinking. Based on the literature review, it was shown that since Johnson's NSD model in 2000, there has not been any further model exploration in this topic. Additionally, there are gaps in the research where the opportunity to combine analysis engineering tools with service design has not yet been implemented. There are many critical issues that have yet to be addressed due to the fact that service design is a relatively new science, and this is made evident by gaps in current research. The implications of research included new expansions by using Petri Nets, the Lens Model and asset-based approach in service design.

CHAPTER 3

Research Approach

There is no unified standard model for service design processes. Few efforts have been made to develop an ideal model for the service design. Even so, these models are weak, suffer from the previously mentioned problems and are confined to academic circles, because most practitioners use proprietary models. In the author's previous research, an information frame work that integrated and facilitated activities of service design was proposed. This model is called the Integrated Enterprise Service Design Activities (IESDA).

The approach of this dissertation will build on previous work and will focus on research collected through surveys and engineering tools such as Petri Nets and the Lens Model. As depicted in Figure 3.1, the three directions of this dissertation are the process for service design, the designer-manager conflict in decision-making and an asset-based customer approach for service design. In order to achieve these three goals, the next sections will explain the steps that should be followed for each direction.

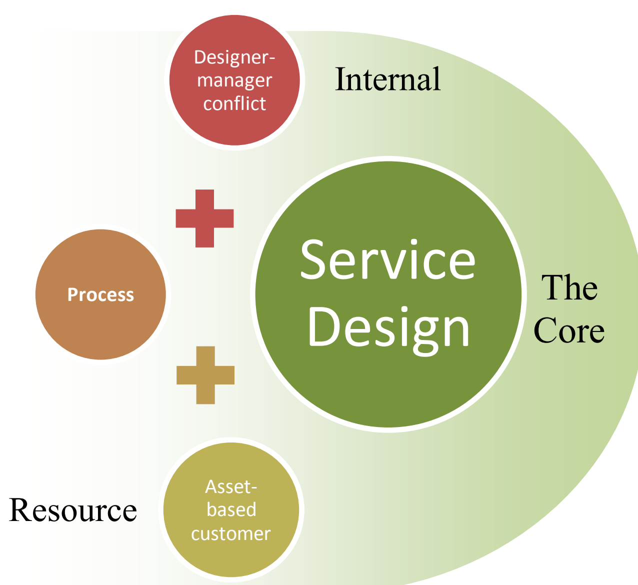


Figure 3.1. Dissertation Directions.

3.1. Integrated Enterprise Service Design Activities (IESDA)

The IESDA model allows functions involved in the service design activities to interact and share information simultaneously in an efficient way, regardless of time, location, and organizational barriers. Figure 3.2 shows the Integrated Enterprise Service Design Activities model (IESDA) (Tabbakh, 2011).

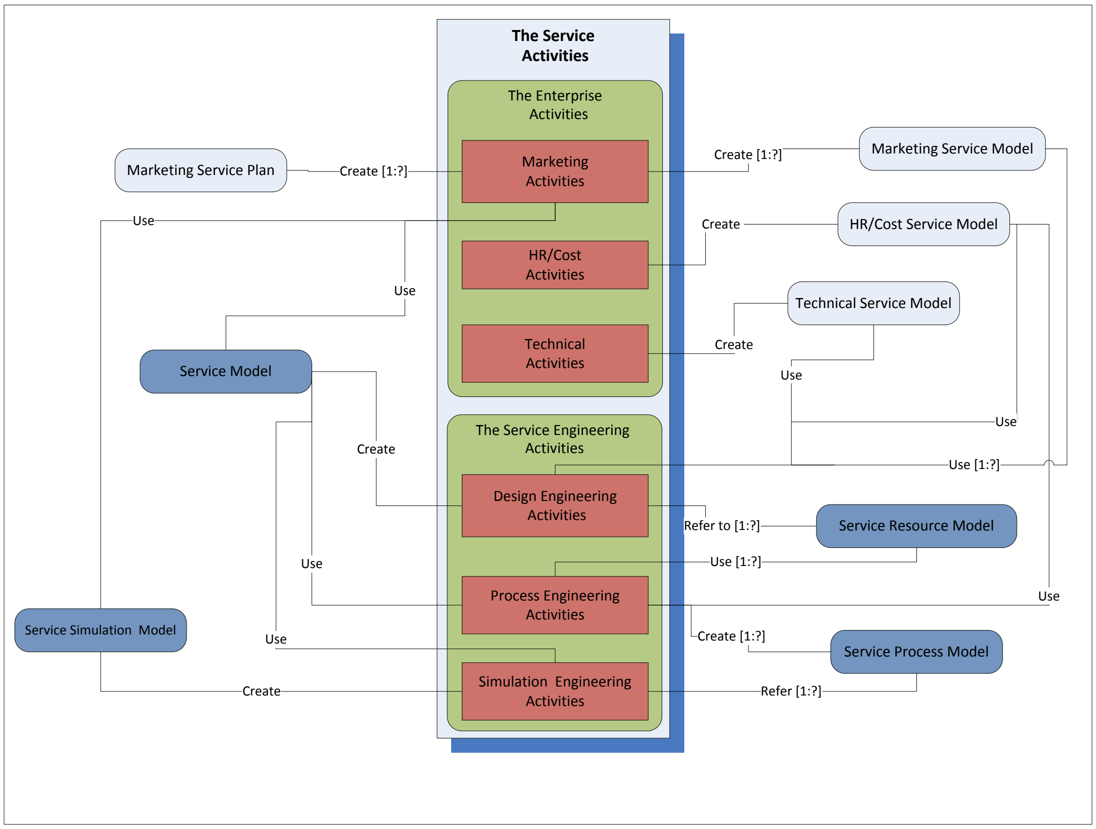


Figure 3.2. Integrated Enterprise Service Design Activities Framework.

Additionally, three of these models were developed and designed with a unique structure. The requirements, representations, database implementations, and examples of the Service Model (SM), Service Resources Model (SRM) and Service Process Model (SPM) are defined.

The Service Model (SM) presents an approach to the service concept through a visualization that combines the service blueprint and layout data. The data based approach removes the need for graphical input and makes a blueprint exchange more efficient. Figure 3.3 shows an example of the service blueprint for a hotel.

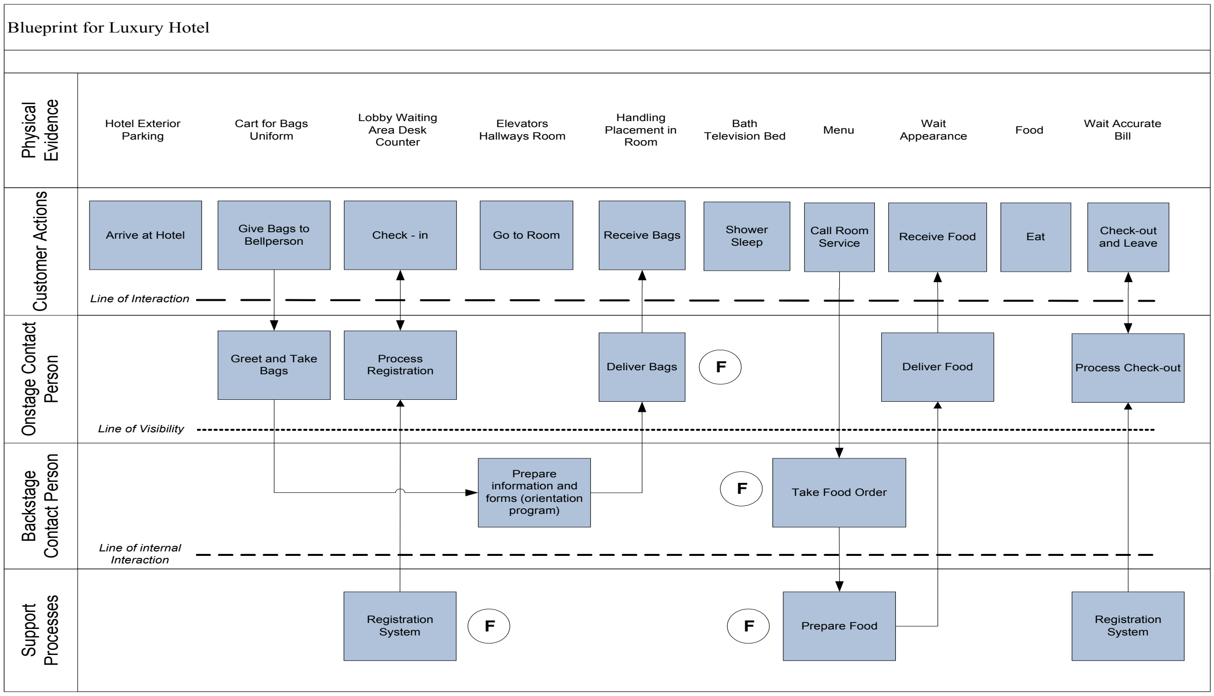


Figure 3.3. Service Blueprint for a Hotel.

As seen above, the combination of the service blueprint with its respective layout data provides a new construct that conveys a complete service concept. Three forms of information or service design tools 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 model, its diagram is automatically generated by the system. This method provides greater flexibility of data transfer between the blueprint and the other tools. Given the combination of the service blueprint, layout and site data which represents the core service concept, it is necessary to design the relational database implementation. The comprehensive entity-relationship (ER) diagram is shown in Figure 3.4. 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.

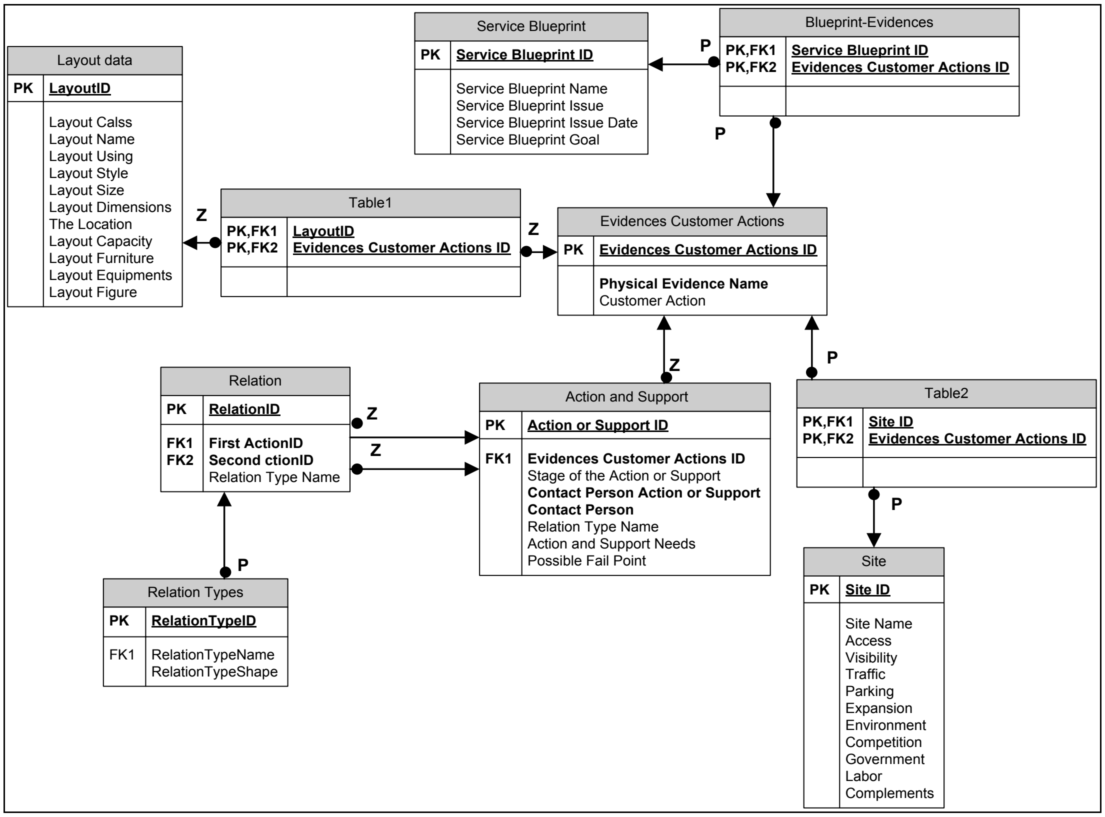


Figure 3.4. ER Diagram of the Service Model.

The contribution of the SM is using a database system to insert data as text and exchanging this data between the service design tools. In addition, the combination of the service blueprint with layout/site data provides a new construct to convey the service concept.

The Service Resource Model (SRM) uses an object representation. An Object-Oriented Modeling (OOM) technique is recommended as the most appropriate method of organizing and specifying data within the SRM. The model represents 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 approach includes a way to represent data across inheritance relationships in a manner which is intuitive to the user. In addition, the approach allows records for abstract objects enabling progressively detailed resource specification. 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 the 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 of class diagram for the hotel application. The class diagram is shown in Figure 3.5.

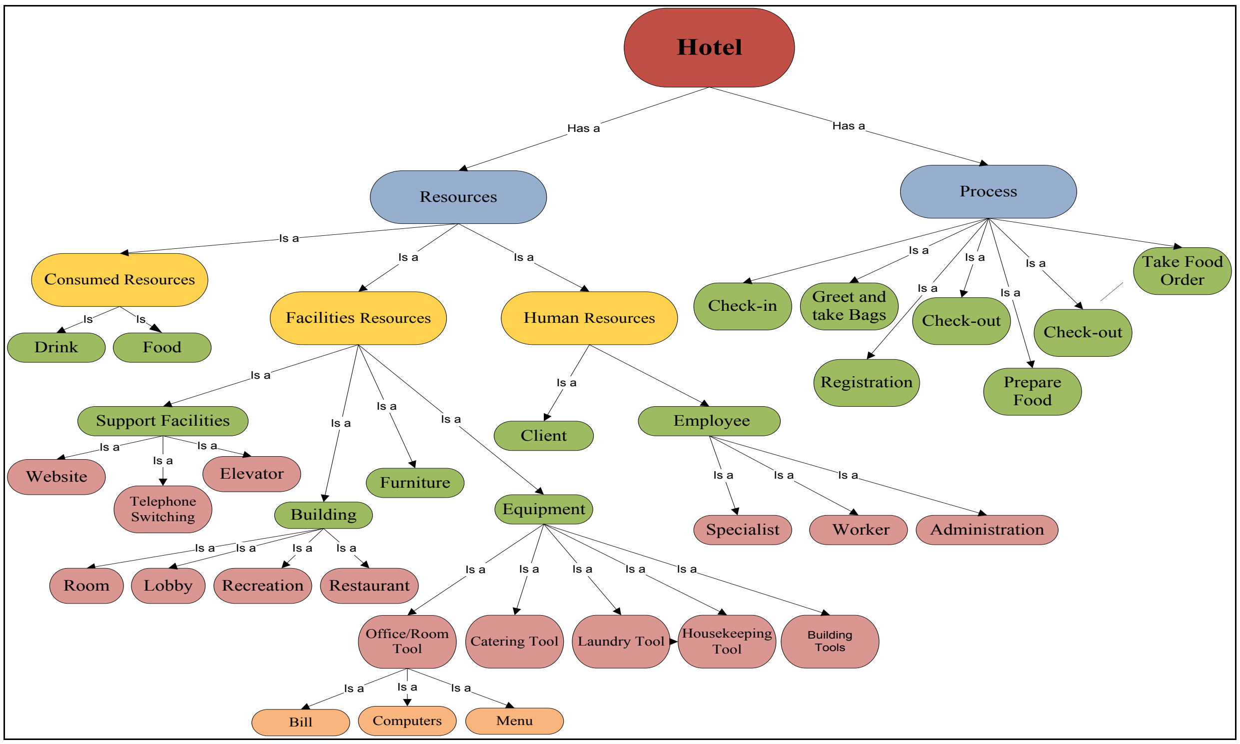


Figure 3.5. Example of Class Diagram of Service Resource Model.

A key contribution is in the portrayal of data to a system user. The database administrator would construct automatically generated queries to enable a data view which integrates 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. Figure 3.6 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.

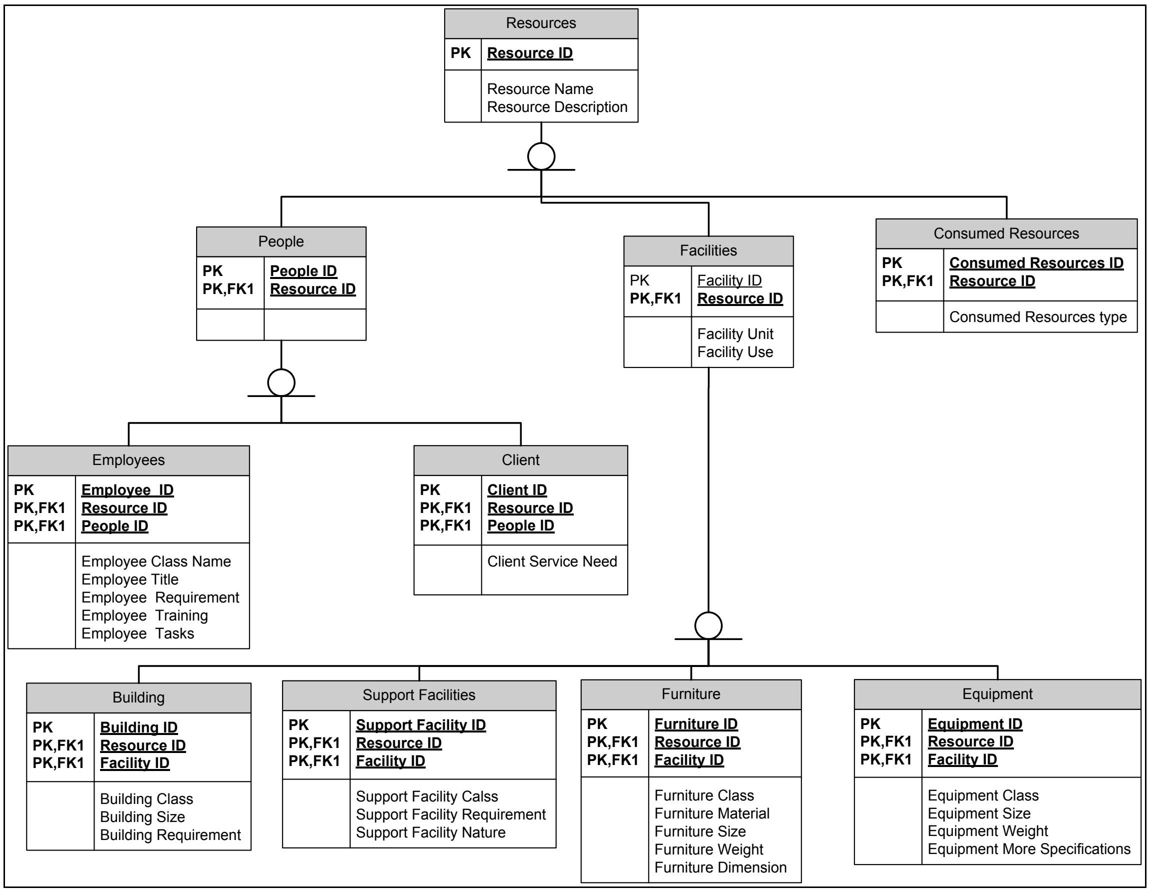


Figure 3.6. Inheritance Structure of Resources Entity on SRM Data.

The primary contribution of the SRM 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. In addition, the approach allows records for abstract objects, enabling progressively detailed resource specification. Finally, the contributions 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. Note that service resources are really the system "assets" available to construct the system.

The Service Process Model (SPM) uses an UML Activity Diagram representation with a database implementation that integrates both the blueprint phase and resource based graphical construction. The UML activity diagram is used as the suggested choice to represent the processes within the SPM. 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. Figure 3.7 shows an example of the UML activity diagrams for check-out classified by the service blueprint stages.

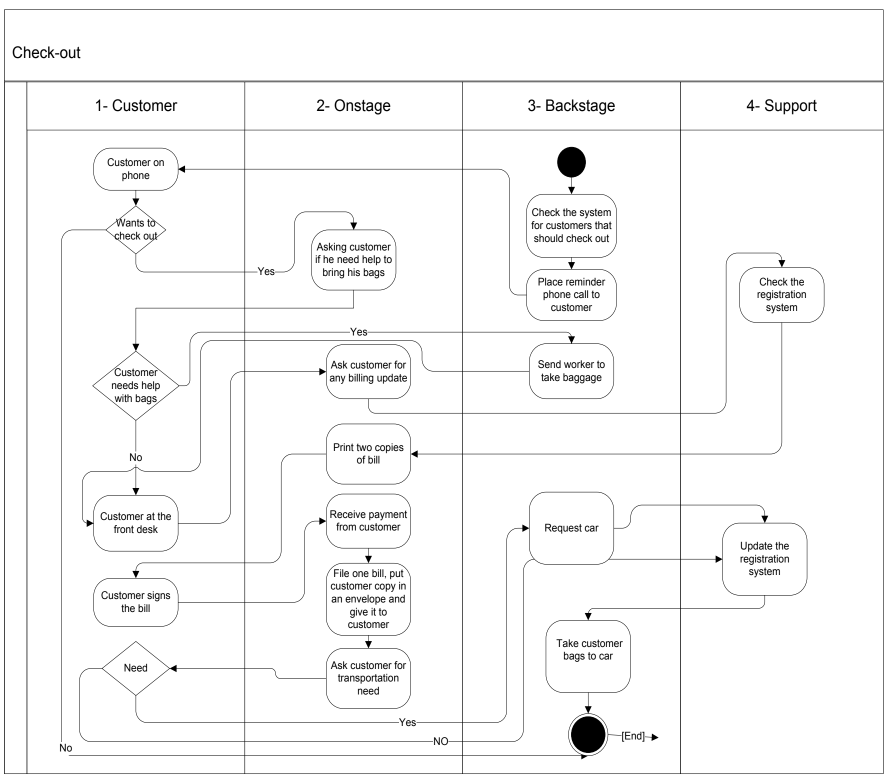


Figure 3.7. UML Activity Diagrams for Checkout.

As a contribution, a new unique method is used to create the UML activities diagrams for SPM. This new method of generating the UML activities diagrams can be in numerous classifications.

Finally, new methods for interaction and integration between the IESDA frameworks have been proposed as well. These methods are results of the special structure of each model used in the IESDA. Specifically, the models enable interaction through the use of a feedback mechanism and data structure. Additionally, the models are integrated by connecting resources in three ways: to their physical elements, to their associated blueprint phase, and finally to their activity diagram. Figure 3.8 shows the SM, SRM, SPM and how they interact and integrate with each other.

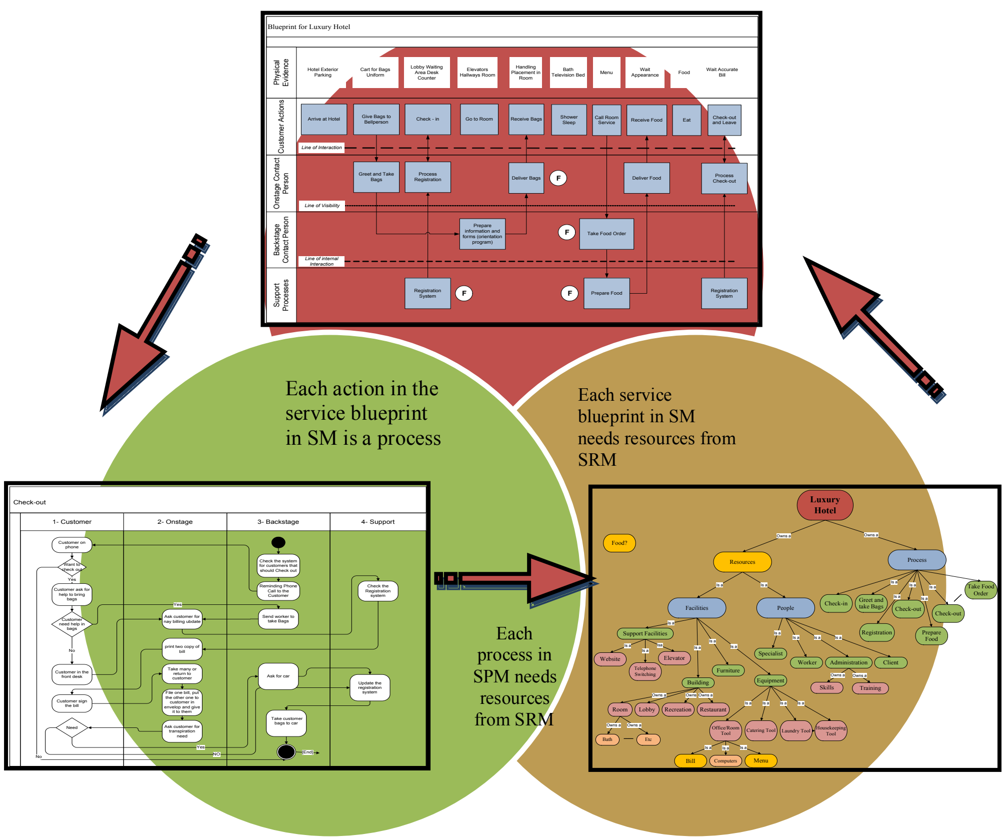


Figure 3.8. Integration Information Framework.

Based on what has already been done in previous research, this dissertation is continuing the improvement of the service design process, which utilizes such models, in three new directions.

3.2. Service Design Development

As shown earlier in Figure 3.1, the three directions of this dissertation cover the process for service design, the designer-manager conflict in decision-making and an asset-based customer approach for service design.

3.2.1. Service Design Process Integration

The first direction of the service design is the process. The academic service design models are not consistent with the practice. Most, if not all, of practitioners don't use a process that has been proposed by scholars. In addition, the current models fail to manage information, consider multidisciplinary integration, incorporate customer contribution and integrate all service design activities. Moreover, these models have a linear process flow that does not apply feedback or concurrent steps. Thereby, it becomes necessary to introduce a new SDP to close these gaps. The new SDP should be designed for easy customization according to each specific service.

The first objective is to create a new service design model that is more inclusive, practical and integrates the service designers both from enterprise and engineering. This goal will be accomplished in four steps:

1. *Definition & Analysis*: During this step, the most current scholarly service design processes will be used and Petri Nets will be used as an analysis tool. The New Service Development (NSD) model is the most recent SD model as proposed by Johnson, Menor, Roth, and Chase. Figure 3.9 shows the diagram of the model.

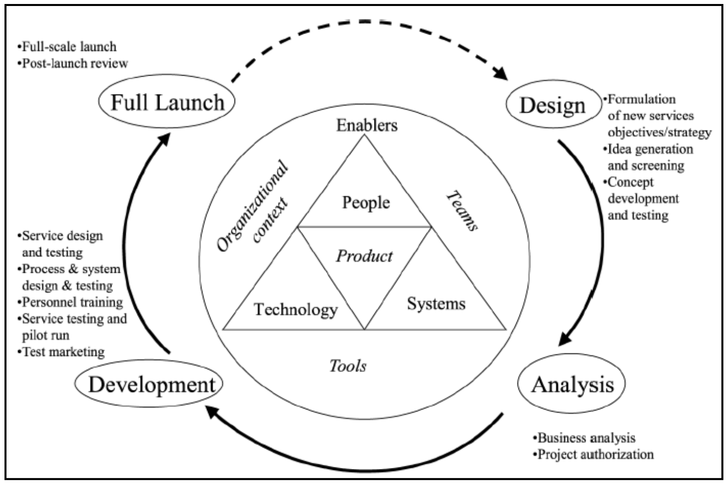


Figure 3.9. New Service Design Model (Stevens & Dimitriadis, 2005).

Moreover, Scheuing and Johnson (1989) use a model based on the NSD that has more details which will be used to generate a system model with an input and output for the service design. Figure 3.10 portrays a combination of these two models. The combination represents the current state of service design from the academic perspective. It shows the intersections between the design activities, the market, and customer and operations personnel. Figure 3.10 is a good point to start analysis for the inputs and the outputs of each step in the SDP.

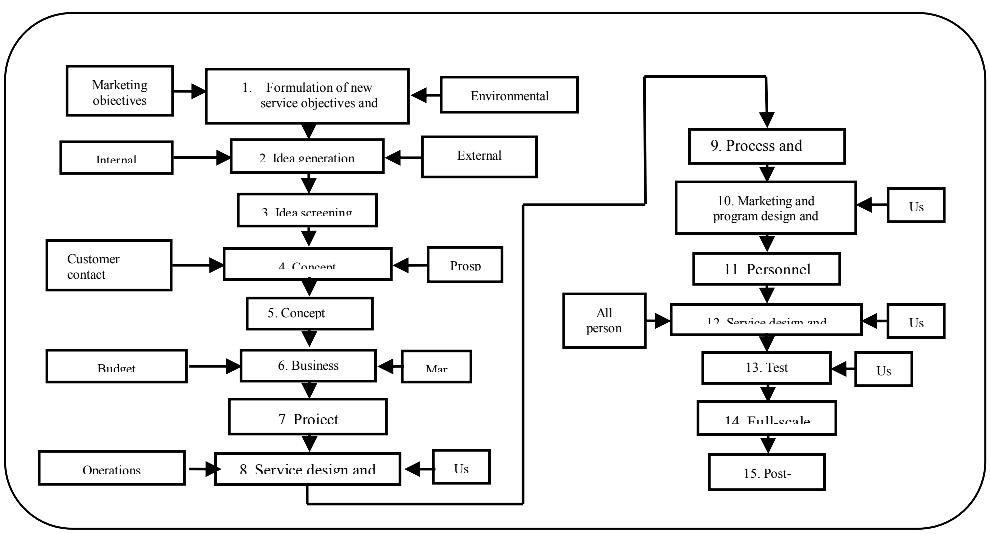


Figure 3.10. Sequence of NSD (Scheuing & Johnson, 1989).

Through an analysis utilizing Petri Nets properties, the current service design processes will be examined. Many process representative tools were considered such as Integrated Definition for Process Description Capture Method (IDEF3), A Language for Process Specification (ALPS), AND/OR directed graph, Process Specification Language (PSL) and Unified Modeling Language (UML) Activity Model Diagram (Tabbakh, 2011), Petri Nets capability in analyzing was the most suitable tool for the service design process. The representative tool needed for this research should be:

- A long-standing tool that has been used previously in similar systems dealing with data management
- Supportive in analyzing the structure and the behavior of the service design process, and not just as the currently used process that represents service design solely as flow chart mapping
- Suitable for complex concurrent systems such as the service design that have higher human interactions and intangible materials
- Supportive of a non-liner process that can provide feedback throughout the service design process
- Supportive of the graphical and mathematical analysis that helps with clear representations of the process and utilization of resources

The output from the previous step will be a diagram for all inputs and outputs for each main step in the process of the service design. Using this result, a Petri Nets graphical representation will be created. The formulation will be used to analyze and understand the most important system behaviors. Figure 3.6 shows the Petri Nets diagram for the first step/stage in Johnson et al. NSD Model. As shown in the diagram, some code colors have been used as places to distinguish between the data, results and resources. This color coding is a new contribution to the Petri Nets diagram in this dissertation. Table 3.1 gives the explanation of these elements from Figure 3.11.

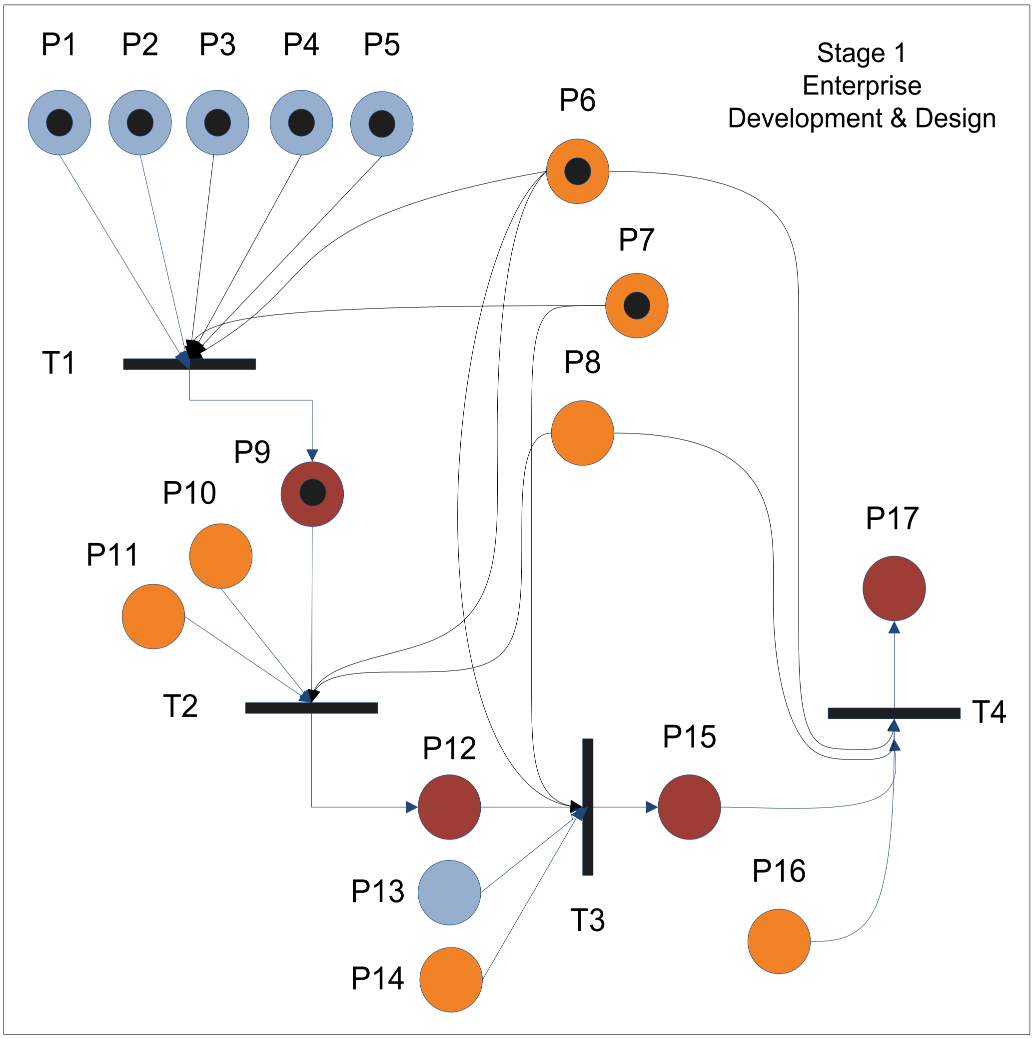


Figure 3.11. Petri Nets Diagram for First Step in NSD.

Table 3.1

Petri Nets Diagram Places

Place Transition	Description
P1	Marketing analysis data
P2	Environment analysis data
P3	Comparative analysis data
P4	Customer analysis data
P5	Current service data
T1	Formulating a new service objective and strategy
P6	Employees (Team work)
P7	Development and design equipment (computers)
P8	Development and design equipment (computers)
P9	New objective and strategy are formulated
P10	Internal source
P11	External source
T2	Generating an idea
P12	Ideas
P13	Prospects vision
P14	Customer contact personnel
T3	Developing concept
P15	Concept is developed
P16	Customer
T4	Testing concept
P17	Concept is tested

2. *Improvement*: Improve the Petri Net representation of NSD. Relocating some resources could be one of the results of this step.

3. *Integration and Development*: Practitioners can use a wide range of service design processes. For this step, this research aims to create a united model that integrates most of the practitioners' models into the newly designed Petri Nets diagram. Some nodes in the Petri Nets diagram will be inserted and others will be removed to give the model flexibility for use in a variety of services and for customizing of specific services. The integration will be based on the most popular practitioners' models such as Double Diamond Design Process Model that is used by the Design Council. Additionally, during this step an interdisciplinary approach will be incorporated into the activities of the service design.

4. *Modeling:* Petri Nets diagram is easy and clear for academics but not for practitioners. In this step, a basic SD model which reflects the improved Petri Nets diagram will be developed for use by practitioners. The SD diagram will address the main steps, sequences and the main service design tools, both enterprise and engineering.

3.2.2. Conflict Reduction in SDP

The second direction addresses the implementation of the SDP. Conflicts can arise between the designer/consultant and the manager/client. This conflict is one of the critical issues that cause inefficiency of time and effort. Both sides of the service design process should know more about each other's perspectives. The Lens Model is one of the best models that could help solve this problem, as has been discussed in Chapter 2. By designing a suitable Lens Model, both sides can understand each other's perspective and their decision policy and thus provide conclusions for diverse decision-making about the service design.

The conflict that exists between that manager and designer could be exploited by using the Lens Model. Lens Model can help to understand the conflict and to find diverse solutions for the service design. It has been used in many applications such as social judgment, medical judgments, weather forecasting, educational judgments and fault diagnosis (Bisantz & Pritchett, 2003; Miller and Kirlik, 2006). Based on the comparison of many factors such as the scope of the study, the intended function, the diversity in subjects, objects and tasks (Cooksey, 1996), it has been found that the Lens Model is suitable tool for this research study comparing it with other judgment and decision approaches.

To design the appropriate Lens Model, the following steps will be followed:

1. *Data collection*: This includes designing the judgment analysis study. The important factors in evaluating a service design from both the manager's and the designer's perspective needs to be investigated. This has been done in two steps:
   - The first step is the creation of a survey that highlights the important factors in the decision-making process about the final service design from both perspectives. These factors represent the cues in the Lens Model.
   - During the second step, different designs will be created for later analysis with designers and managers. By manipulating the values of the selection factors, service designs will be created. Each design has different parameters/factors which will be the cues for the Lens Model. Managers and designers will be asked to prioritize the four designs in order to capture their decision-making policy. Factors that used are customer needs, customer perspective and motivation, cost and revenue, quality easy to deliver (simple service process), creativity, ease of implementation, leading the market, pioneering (new design), reliability, sustainability, accessibility, security and stability. This information will be obtained by running two surveys. The first one is to collect the factors and the second one is for the judgment case profiles.
2. *Lens Models Design*: Single and double Lens systems will be designed for capturing and comparing the decision-making policy of the designer and the manager.
   a. The single Lens system will be designed and used to capture the decision policy for each respective view point. The aim is to identify the relationships between the judge's cognitive system and the task system (design). Figure 3.12 shows the single Lens system design. In this design there is no right answer

(Ecology/Environment). What we need to find are the values $W_{s1}, W_{s2}, \ldots W_{sk}$ to find the weight of each factor or cue.

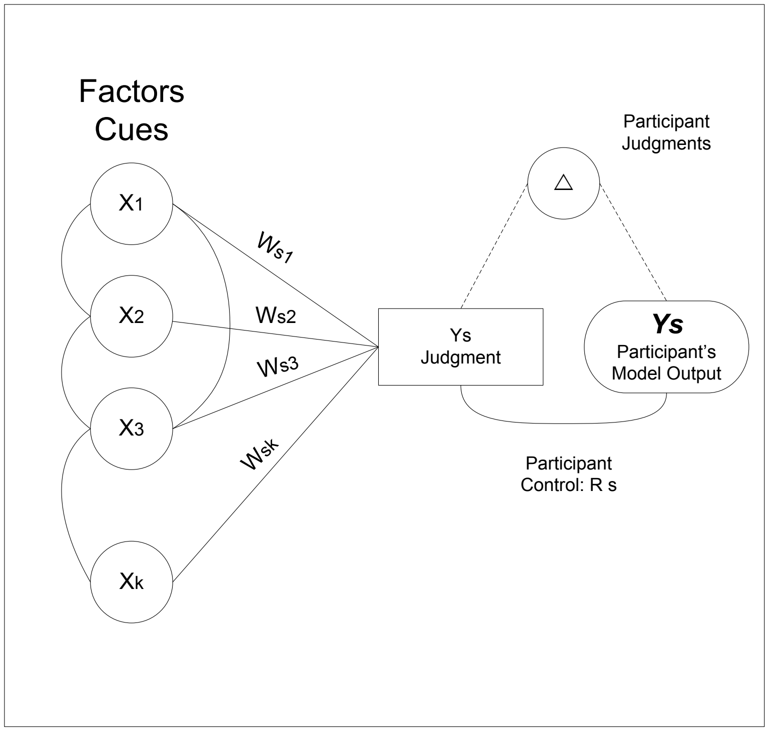


Figure 3.12. Single Lens System

b. The double Lens system will be designed and used to compare between the two decision policies. The double Lens system is shown in Figure 3.13. The Ecology/Environment will be the manager's decision and the weights $(W_{e1}, W_{e2}, \ldots W_{ek})$ are the weight of their cues. At the other side will be the weight of the designer cues$(W_{s1}, W_{s2}, \ldots W_{sk)}$. The closer these weights are to each other, the more the decision will converge. All of the following parameters will be calculated: achievement (*Ra*), knowledge (*G*), cognitive control (*Rs*), predictability (*Re*), and un-modeled knowledge (*C*).

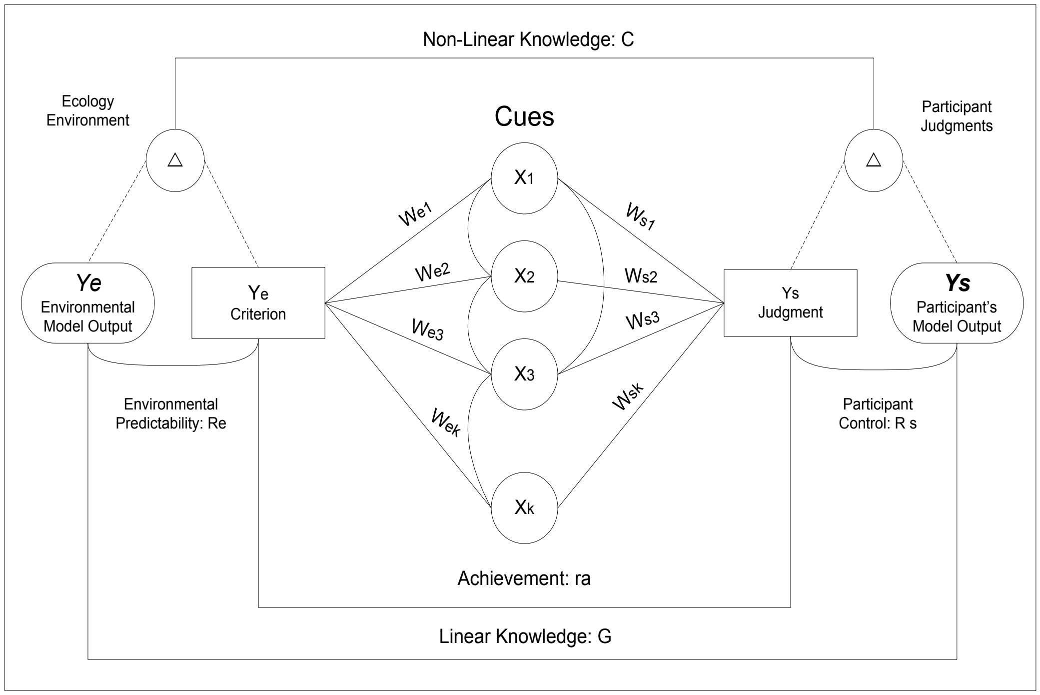


Figure 3.13. Lens Model and its Parameters.

3. *Lens Models Execution and Analysis*: Two single Lens Models, one for manager and the other one for designer will be run. These two models will be run individually by providing the values of the weights($W_{s1}, W_{s2}, \ldots W_{sk}$). Next, the double Lens Model will be performed with designer weights on the right side of the model and the manager weights on the left side of the model. Moreover, analysis of the result will be calculated in this step. In order to carry this out, the Lens Model formula parameters will be used (achievement (*Ra*), knowledge (*G*), control (*Rs*), predictability (*Re*), and un-modeled knowledge (*C*)). The Lens Model equation (Cooksey, 1996) (Hammond, et al., 1975) describes the relationships among all the previously mentioned parameters:

$$r_a = GR_SR_E + C\sqrt{1 - R_S^2}\sqrt{1 - R_E^2}$$

3.2.3. Customer-Integrated Service Design

The third direction relates to the approach that designers use when they create a service. In practice, service design "thinking" is user/customer centered. It should be "experienced through the customer's eyes." However, this dissertation aims to expand this approach. It aims to be asset-based centered with the customer being viewed as a core asset. This view is a significant change in the service design approach. The objective is to create a customer-integrated service design tools that adapt the asset-based approach for the service design and focuses on the customer as a core asset in the system.

The literature review introduced several processes of the service design proposed by scholars and other processes used by practitioners. The logic and strategy behind these processes varies depending on how they deal with the design activities. The scholars' SDP start from stakeholders' guidelines, business strategies, service strategies, or market strategies while the practitioners start their processes from the customer themselves. Practitioners adopt the service design thinking when it consumes the whole process and is based on the customers' perspective as the focal point; while all scholar models make the design just one step in the process and the customer is not the focal point.

Service assets can be divided into general assets that are common in every service and specific assets that are related to certain services. In addition, these assets are a mix of physical material and humans. The steps necessary to find the assets have been mentioned in the second chapter. Walker's approach focuses on humans more than physical assets and is taking the following steps: exploration, inclusion and mapping (Walker, 2006). Stanfield's ABS approach (FIRST) covers all system resources (Stanfield, 2012).

In this dissertation, the steps followed will be a combination of Walker's approach and Stanfield's ABS approach (FIRST). However, Stanfield's ABS approach process (FIRST) could be the most suitable one for finding the assets in the service system because it is the only asset-based model that is launched from the engineering perspective. (Figurer 3.14) (Stanfield, 2012).

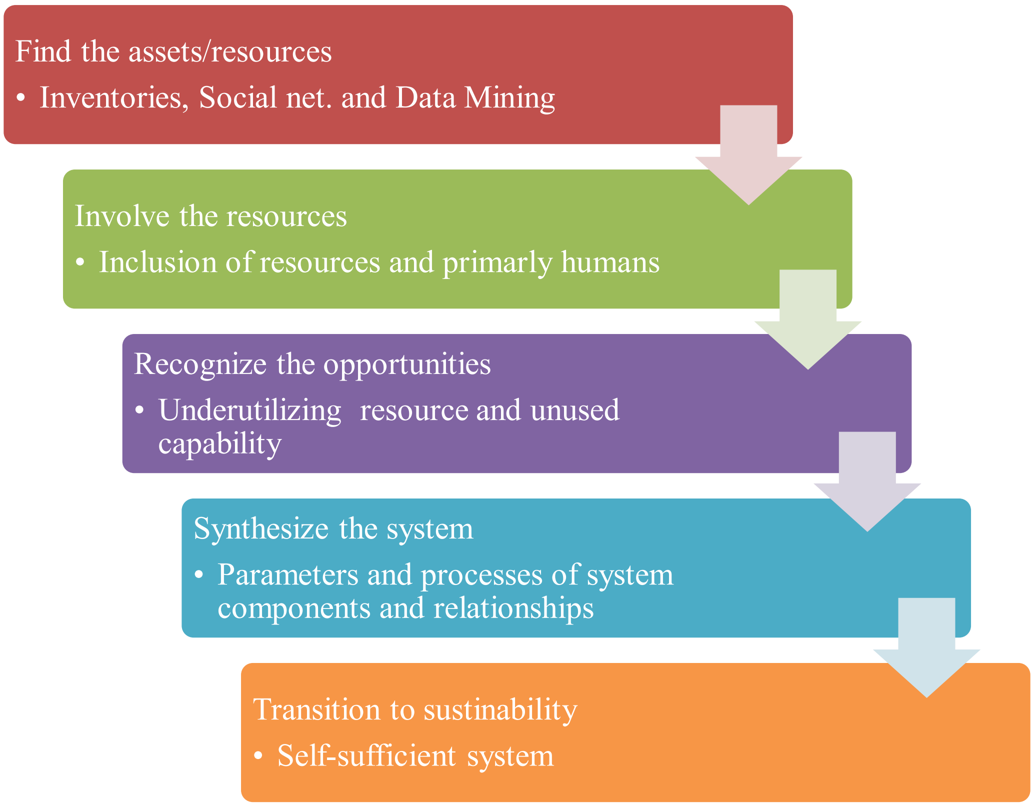


Figure 3.14. ABS Process (FIRST).

Steps that will be followed in this part of the contribution are:

1. *Asset discovery/exploration mechanism and tools:* This step is the implementation of the first step of FIRST by exploring all assets in the system. To start, an inventory of all of the service resources that can be utilized should be created. The addition here is that this step will build on the resource model that has been built in the IESDA model. The resource model is built with an object-oriented representation, with the two main components being processes and resources. The resources are divided into consumer resources, facility

resources and human resources. Figure 3.15 is an example of a class diagram of the service resource model for a hotel.

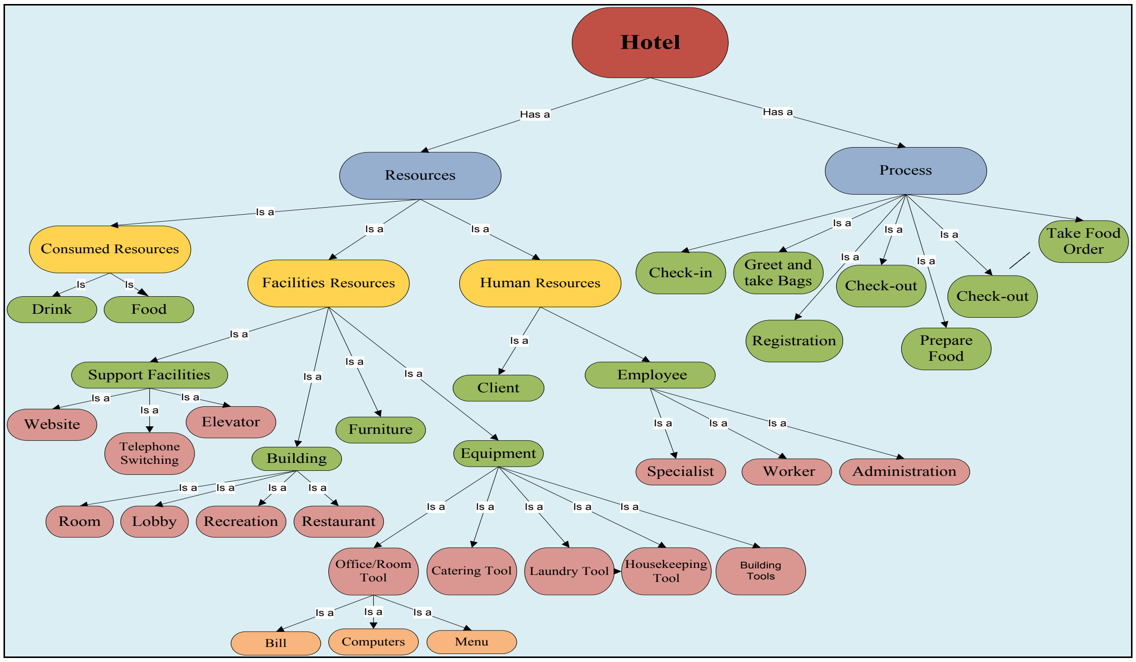


Figure 3.15. Class Diagram of Service Resource Model.

2. *Asset involvement tools:* The customer will be one section on the human resource division but will be utilized differently as a core asset for the system. The customer should be analyzed in order to find their potential strengths. Their strength should be the asset that they contribute within the service system. The customer could contribute their skills, knowledge and capabilities such as using the internet. For example, customers contribute their homes to rent to other customers in the website Airbnb.

   In this step, new tools will be introduced for dealing and involving the customer as a core asset in the system. Tools such as Customer Asset Journey Map and Customer Personas will be introduced.

3. *Recognizing the opportunities tools:* Tools for recognizing the opportunities in each resource including underutilized resources and also potential resources will be introduced.

Inspired by the Failure Mode and Effects Analysis (FMEA) new tools for analyzing the opportunities will introduced. These new tools adapt the asset-based approach by focus on opportunity comparing with FMEA that focus on failure. Some examples of these tools are Asset Mode and Opportunity Analysis (AMOA) and Opportunity Priority Number (OPN).

4. *Building the asset model tools*: This step is a combination of service design thinking and the asset-based approach. The service will be developed by using the service design thinking tools and applying the asset-based approach. Figure 3.16 shows some of the service design tools that could be used in this step (Stickdorn & Schneider, 2011).

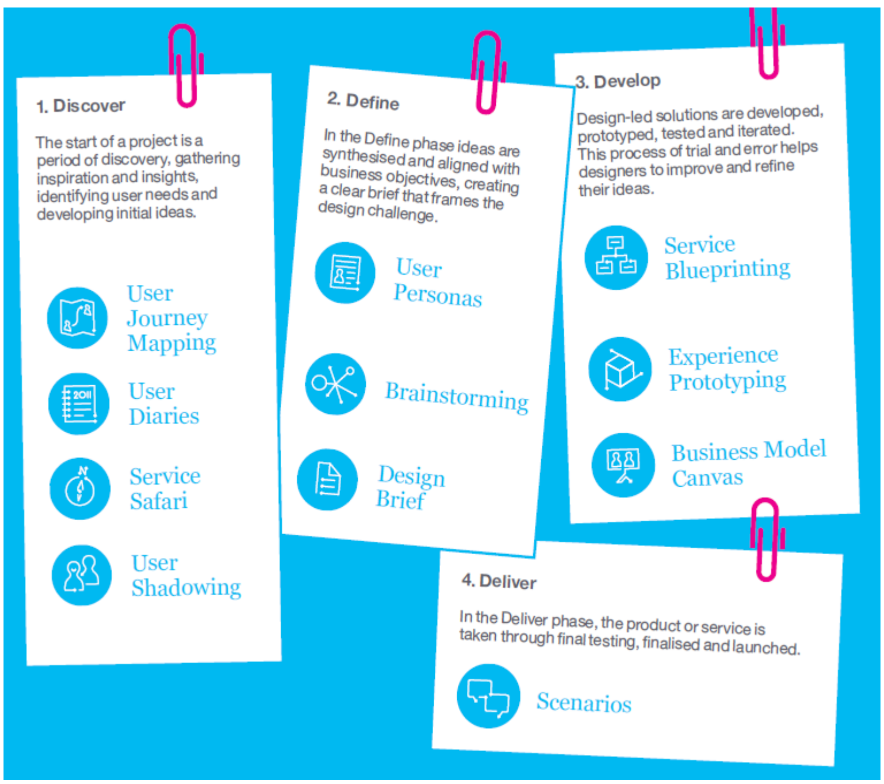


Figure 3.16. Service Design Thinking Tools (Design Council).

This step includes mapping resource model based on the assets. The suitable diagram will be used to illustrate the logical structure for the asset-based diagram. Modification on the well-known service blue print tool will be made to adapt the new approach (AB).

5. *Integration of assets for design:* The results of the previous steps should be integrated with the rest of the SD activities. This step illustrates the next best step for integration and how the process for service design should continue.

3.3. Conclusion

The relevant research articles and studies in this dissertation topic have been discussed and presented in Chapter 2 and the dissertation methodology is covered in Chapter 3. The literature review organized and contributed information based on the following three topics: Petri Nets, the Lens Model and asset-based systems. Figure 3.1 presented the three directions of this dissertation. These directions are the process for service design, the designer-manager conflict in decision-making and an asset-based customer approach for service design. Building on what has been done in the previous research on the IESDA model, steps for the goal of each direction were explained. The next chapters will cover the application of Petri Nets, the asset-based system and the Lens Model in the service design.

CHAPTER 4

Integrating the Service Design Process

The New Service Development (NSD) model is the most widely-researched model among those that have been developed by academics. Since 2000 when Johnson's NSD model was developed, there has not been any substantial academic research dedicated to developing new service design models (Stevens & Dimitriadis, 2005a). Johnson's model is suffering from key weaknesses, including linear process flow, lacking concurrency, lacking the integration of all service design activities and confinement to academic circles. Most practitioners use proprietary models which are not unified and lack integration activities. All service elements could benefit from the NSD process development in the form of reduced cost and time. Petri Nets, which are a graphical and mathematical tool that provides a uniform environment for modeling, formal analysis, and design of discrete event systems (Tabbakh, et al., 2012), could help enhance and reengineer the service design process and integrate its activities. This chapter explains how Petri Nets were used to design, investigate, and improve the process of NSD model. The goal is to develop a new unified service design process that integrates all design activities, enhances the concurrency and feedback by using Petri Nets as an analytical engineering tool.

4.1. Introduction

Petri Nets help in identifying behavioral properties and evaluating performance. Petri Nets application ranges from modeling properties such as process synchronization to asynchronous events and concurrent operations (Tabbakh, et al., 2012). This makes Petri Nets a promising tool for many applications.

Through an analysis utilizing Petri Nets properties, the current service design processes was examined. Among many other process representative tools such as Integrated Definition for

Process Description Capture Method (IDEF3), A Language for Process Specification (ALPS), AND/OR directed graph, Process Specification Language (PSL) and Unified Modeling Language (UML) Activity Model Diagram (Tabbakh, 2011), Petri Nets' capability in analysis was the most suitable tool for the representation of the service design process. Petri Nets are appropriate for this study because they are:

- A long-standing tool that has been used previously in similar systems dealing with data management,
- Supportive in analyzing the structure and the behavior of the service design process better than the currently used process which solely utilizes flow chart mapping,
- A powerful tool assisting in the development process of complex systems (Zurawski & MengChu, 1994),
- Suitable for complex concurrent systems such as service design that have higher human interactions and intangible materials,
- Supportive in multi-direction (a non-liner) processes that can provide feedback throughout the service design process,
- Supportive in graphical and mathematical analysis that helps with clear representations of the process and utilization of resources, and
- Supportive in interactive graphical simulation.

In addition, Petri Nets function as a simulation and is used as a design evaluation process or for pilot tests of a process. The main strength of Petri Nets is their support for analysis of many properties and problems related to concurrent systems (Murata, 1989). Their properties are classified as behavioral and structural such as reachability, boundedness and safeness, conservativeness, liveness, reversibility and home state (Zurawski & MengChu, 1994). Utilizing these properties during the NSD model improvement provides an analytical foundation adds a significant contribution.

The structural and behavioral properties of Petri Nets make this tool a promising tool for many applications in general and particularly for SDP. With the mixture of graphical and mathematical representations, the analysis goes even deeper to utilize and improve the SD process. Thus, in this dissertation, Petri Nets were implemented to the NSD model to design investigate, and improve the NSD process. As has been explained in Chapter 3, the steps to achieve this goal were as follows:

1. Definition and Analysis
2. Process Improvement
3. Integration and Development
4. Modeling

4.2. Definition and Analysis

Understanding the process of new service design/development precedes the improvement procedure. Thus, in this step the process of the service design is defined and analyzed. Johnson's NSD model describes the sequence of the service development in four broad stages and 13 main tasks. These 13 tasks must be performed to launch a new service or to improve an existing service. In addition, they describe the components of the organization that are involved in the process. From this model, the analysis step is launched. The objective from this analysis is to understand the nature of tasks, the resources and the mechanism of the process. Figure 4.1 shows Johnson's NSD model, its stages and steps. In the beginning, the process is defined and then analyzed. Later on, Petri Nets are used for a deeper investigation.

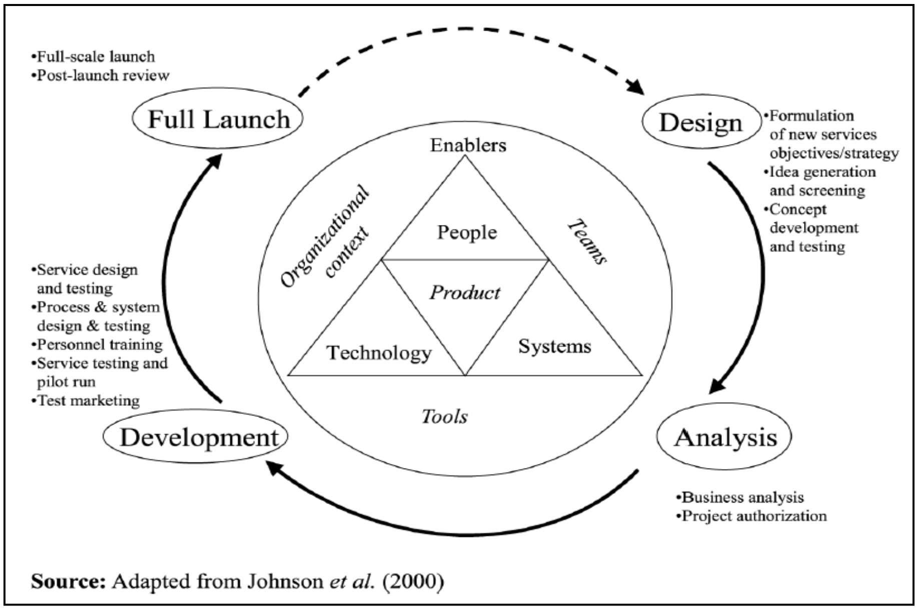


Figure 4.1. Johnson et al. New Service Design Model (Stevens & Dimitriadis, 2005).

4.2.1. Defining the NSD Process

In the NSD model, human resources, design tools and equipment such as computers, software, meeting rooms and a white board are the inputs. The involvement of people is crucial in the NSD process which makes human resources the most important input to the process. In the implementation of the NSD process, there are many types of people who should be involved, managed and incorporated. For example, some of these people are the service development staff (enterprise designers), the customer-contact staff, the expert and specialist staff, engineering designer and the customers themselves. To provide context for the service design process, the input and output diagram was developed as shown in Figure 4.2.

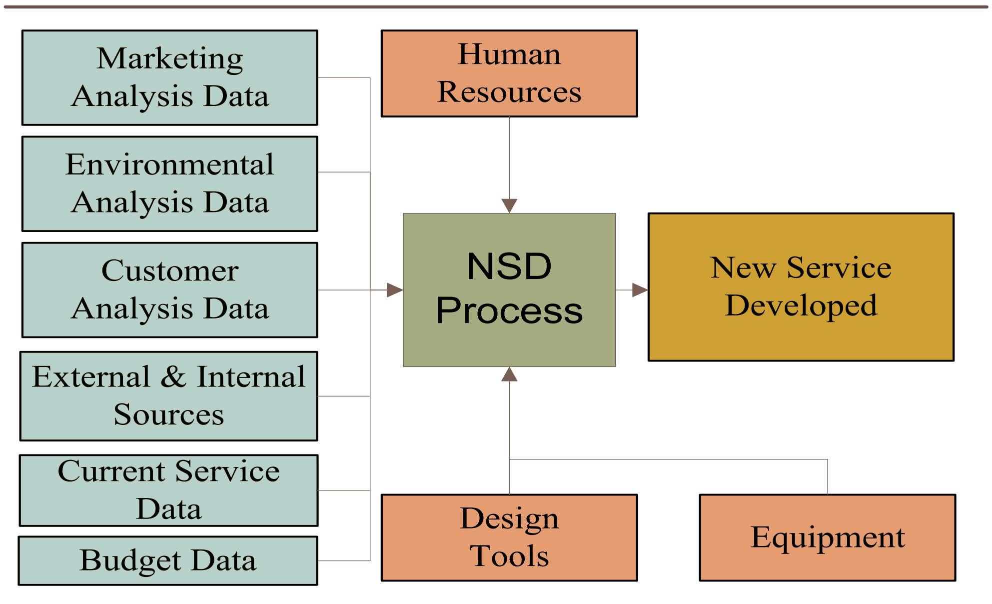


Figure 4.2. Input and Output of NSD System.

This diagram shows the service design process as a system; its core is the NSD process. The main input to the system is data such as marketing analysis figures, environmental analysis data, customer analysis data, budget data, external and internal data and the information of the existing service. This list of data developed is based on the needs for designing the service. The resources are human resources, design tools and equipment. The output is a bundle of information, systems, flowcharts, maps, and diagrams that represent the service concept, structure, process, and the customer experience.

Another model proposed by Scheuing and Johnson, 1989 (Johne & Storey, 1998) (M. J. Fitzsimmons & Fitzsimmons, 1999) adds more details for the fifteen sequential steps such as the internal inputs and outputs of the NSD process shown before in Figure 2.4. From this model, a new input and output NSD model is developed as shown in Figure 4.3. Moreover, the model also shows where customers could be involved in NSD process.

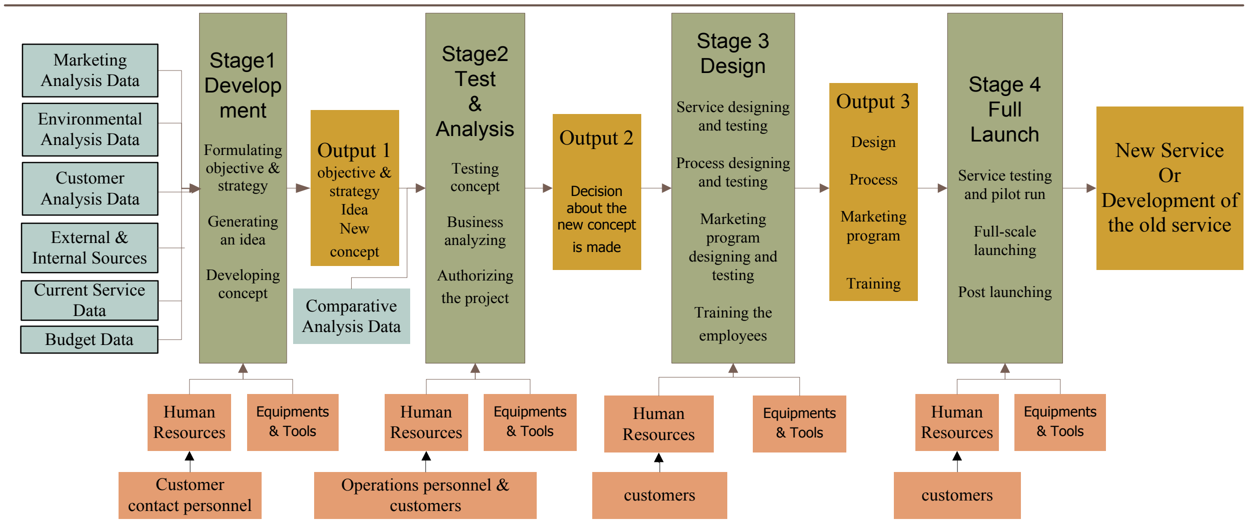


Figure 4.3. Full Input and Output of NSD System.

Each stage has its own inputs, human resources, equipment, tasks and objectives. All the stages and the tasks in sequence are shown in Figure 4.3. The first stage is "development." It focuses on strategically developing the new service concept. This step maps a representation with ideas of the new service design. The market opportunities need to be determined and the potential new service is defined and differentiated from the extant services. The new service concept should be clearly defined and early prototypes, drawings or flowcharts could be used to illustrate and communicate the concept with stakeholders and customers. Communication is essential to obtaining internal, stakeholders and employees, and the external, customers and competitors, feedback. However, this communication is not well-defined in the NSD process. Therefore we use Petri Nets to address this problem.

The next step is the analysis stage. After the new concept is developed, it needs more analysis from the business perspective. Comparative analyses are performed and completed and the budget information needs to be used in this stage as well before the project is authorized. The design stage follows the completion of the comparative analysis. It includes service and process design and testing, for example, defining the overall sequence of steps in the service-delivery process, designing supporting goods and materials and designing the service facilities (front stage and back stage). In addition, a marketing program is designed and tested and training is implemented for all employees. The last stage is full launch which includes service testing, a pilot run, full-scale launching and post launching. This stage involves the real test of the service in a real-world or simulated environment. The evaluation step in the NSD process comes at the end by analyzing the market result of the new service. The NSD process is supposed to enable a continuous improvement procedure.

From scholarly literature review, attending the Service Design Global Conference, and from participating in the Global Service Design Jams in SCAD University and in New York City, it has been found that there are two approaches to the service design. The first approach starts the design activities from the customer perspective and ends with a visualization of the service concept, touchpoints and the delivery process. The second approach starts its activities from the customer perspective as well, with a different perspective, but they end it with full technical and engineering details of the service and design process. Each group uses different tools, with the one commonality between them being the service blueprint. In this study, the two forms of activities have been called “enterprise service design activities” and “engineering service design activities” as shown in Figure 4.4. It is very clear that all of these activities are used but they were not addressed nor integrated in the current academic models. The high level of the service design process shows that the process starts with the enterprise activities, followed by the service concept which should be tested before the engineering activities start. This flow is not a linear process. The enterprise and the engineering design teams should work closely during all of the activities because the practice shows that the design requires team work in all of the steps. During the improvement of the service design model, the integration of these two groups of activities will be implemented.

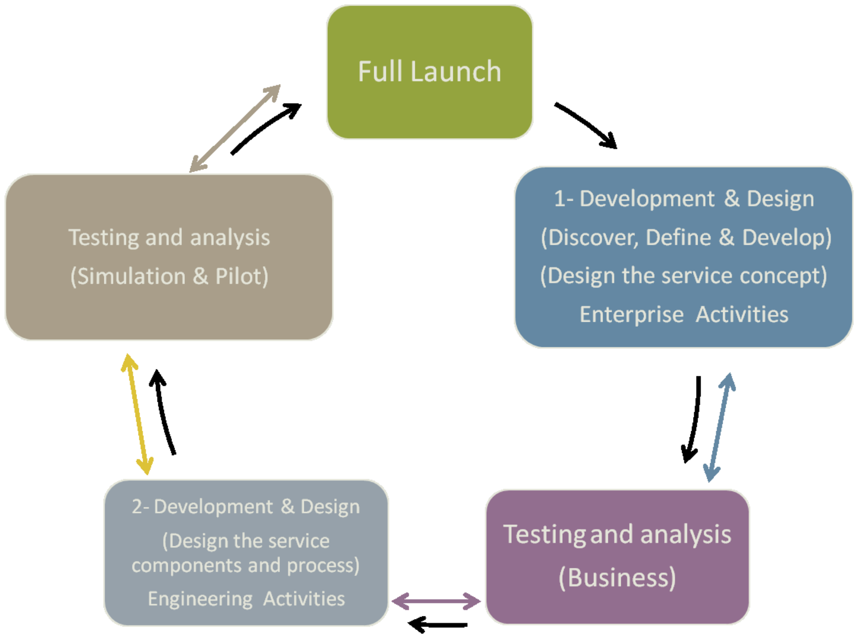


Figure 4.4. High Level of Service Design Process.

4.2.2. Analyzing NSD with Petri Nets

Implementing Petri Nets requires four steps: defining the process/service system, representing it graphically, formulating the representation and executing the process or service (Yoo, Jeong, & Cho, 2010).

Figure 4.3 shows all the components of the system. It demonstrates the inputs and outputs for all the NSD model steps. For analyzing the NSD with Petri Nets, four graphical representations of Petri Nets models have been developed separately to present the sequence of the four broad stages and the thirteen tasks within each broad stage of the NSD. The full input and output NSD process in figure 4.3 was used as a guide for the Petri Nets model structure.

Figure 4.5 shows the Petri Nets diagram for the first stage in Johnson et al. NSD Model and Table 4.1 is the description of the elements. The first stage is the development stage. It focuses on developing the strategy of the new service concept. This stage produces images of the new service and its associated ideas. The market opportunities need to be determined and analyzed. In addition, the potential new service is defined and differentiated from the extant services.

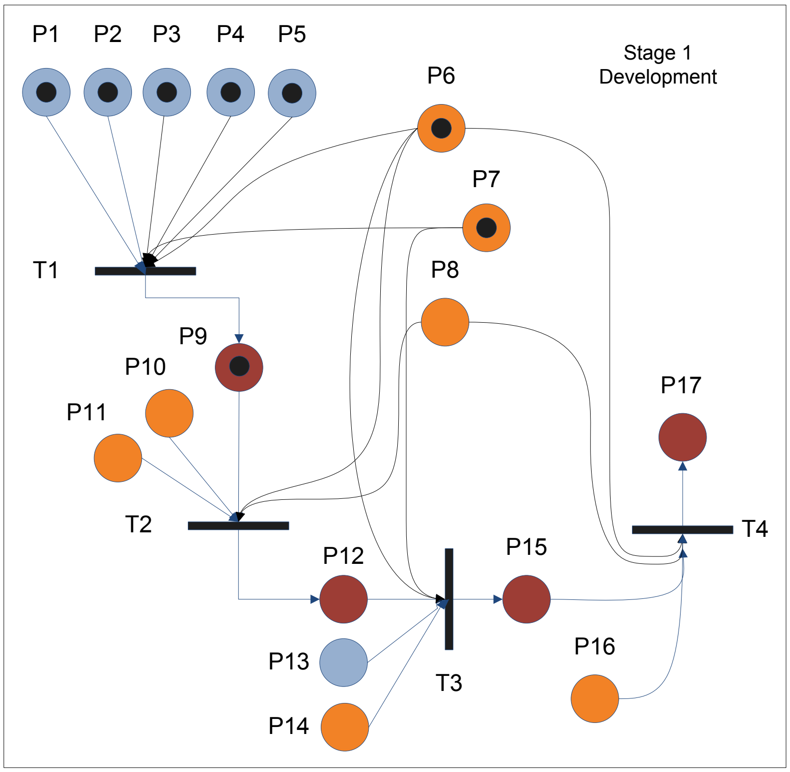


Figure 4.5. Petri Nets Diagram for Development Stage in NSD.

As shown in the diagram, a color code has been used for place to distinguish between the data, results and resources. The place markers help to build a total image of Petri Nets so that the resources can be shared when creating the service design for the entire system. This place marker color code is a new contribution to the Petri Nets diagram in this dissertation. Figure 4.6 shows the Petri Nets color code color that is used for place markers in this study.

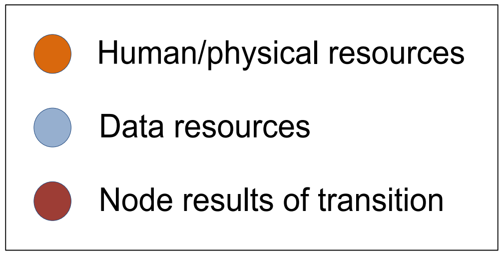


Figure 4.6. Petri Nets Place Color Code.

Table 4.1

Petri Nets Diagram Place for Development Stage

Node/Place Transition	Description
P1	Marketing analysis data
P2	Environment analysis data
P3	Comparative Analysis Data
P4	Customer analysis data
P5	Current Service Data
T1	Formulating a new service objective and strategy
P6	Employees (Team work)
P7	Development and design equipment (computers)
P8	Development and design equipment (computers)
P9	New objective and strategy are formulated
P10	Internal source
P11	External source
T2	Generating an idea
P12	Ideas
P13	Prospects vision
P14	Customer contact personnel
T3	Developing concept
P15	Concept is developed
P16	Customer
T4	Testing concept
P17	Concept is tested

The first step in the NSD processes can be understood by viewing Figure 4.5 and Table 4.1. For instance, in stage 1, the initial stage (T1) is formulating a new service objective and strategy by using (P1) marketing analysis data, (P2) environment analysis data (P3) comparative analysis data, (P4) customer analysis data and (P5) current service data. Similarly, Figure 4.7 and Table 4.2 represent the Petri Nets model diagram for the second stage (Analysis Stage).

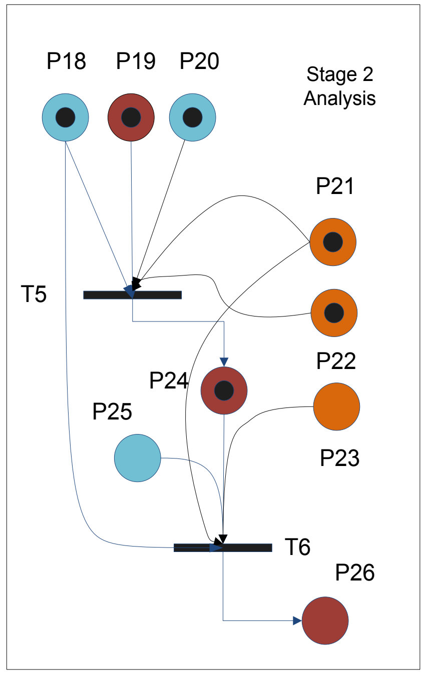


Figure 4.7. Petri Nets Diagram for Analysis Stage.

Table 4.2

Petri Nets Diagram Place for Analysis Stage

Node/Place Transition	Description
P18	Budget information
P19	New service concept, objective, strategy and ideas
P20	Marketing information
P21	Employees (team)
P22	Equipment (computers)
P23	Equipment (computers)
T5	Business analyzing
P24	Business is analyzed
P25	Comparative analysis data
T6	Authorizing the project
P26	Project is authorized

Figure 4.8 and Table 4.3 represent the Petri Nets model diagram for the third stage (Design).

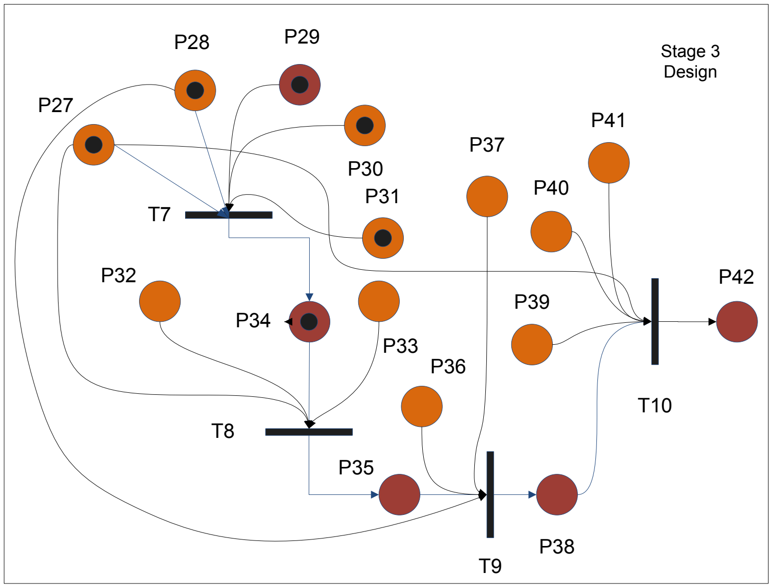


Figure 4.8. Petri Nets Diagram for Design Stage.

Table 4.3

Petri Nets Diagram Place for Design Stage

Node/Place Transition	Description
P27	Operations personnel
P28	User/customer
P29	Decision of the new concept is made (prototype of new
P30	Service designers employees (team)
P31	Equipment (Designing equipment and tools)
T7	Service designing and testing
P32	Service process employees (team)
P33	Equipment (Process equipment and tools)
P34	Service is designed
T8	Process designing and testing
P35	Service process is structured
P36	Marketing employees (team)
P37	Marketing equipment and tools
T9	Marketing program is designing and testing
P38	Service marketing program is designed and tested
P39	All employees/ personnel
P40	Training employees
P41	Training equipment and tools
T10	Training the employees
P42	Training is done

Finally, Figure 4.9 and Table 4.4 represent the Petri Nets model diagram for the fourth stage (Full Launch).

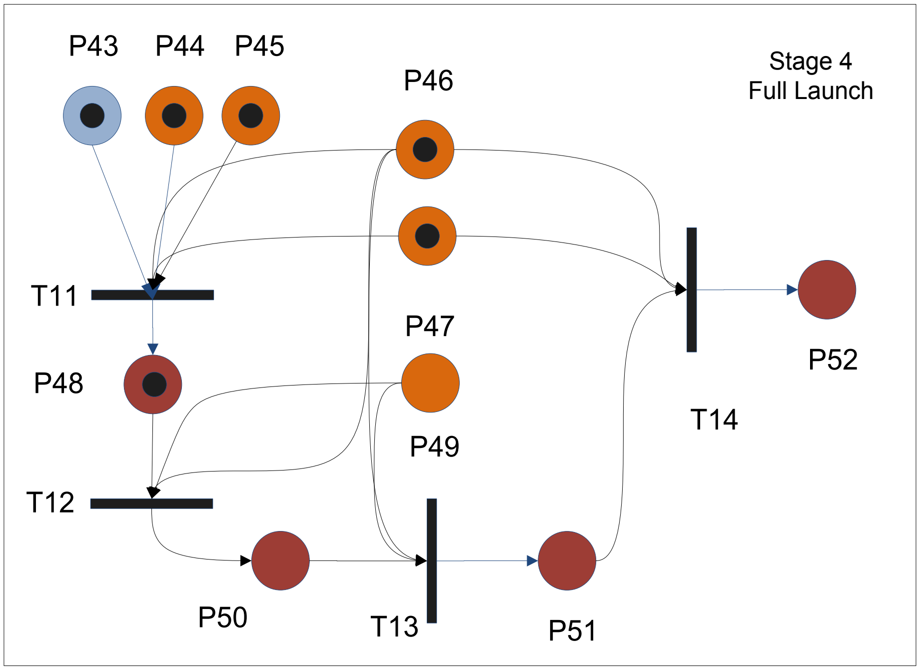


Figure 4.9. Petri Nets Diagram for Full Launch Stage.

Table 4.4

Petri Nets Diagram Place for Full Launch Stage

Node/Place Transition	Description
P43	New service information
P44	All employees/personnel
P45	User/ customer
T11	Service testing and pilot run
P46	Marketing employees (Team)
P47	Marketing equipment and tools
P48	Service is tested and pilot ran
P49	Marketing equipment and tools
T12	Test marketing
P50	Market tested
T13	Full-scale launching
P51	Service full-scale is launched
T14	Post is launching
P52	Service post is launched
P43	New service information

Figure 4.10 shows all of these four stages in one Petri Net model. Inter-stage arcs and common nodes between the different stages show the transition of the project from one phase to the next. For instance, an output of stage 2, an event occurring at P26, is input to stage 3 as a constraint to trigger P29. Similarly, P17 of stage 1 is fed forward to trigger P19 of stage 2.

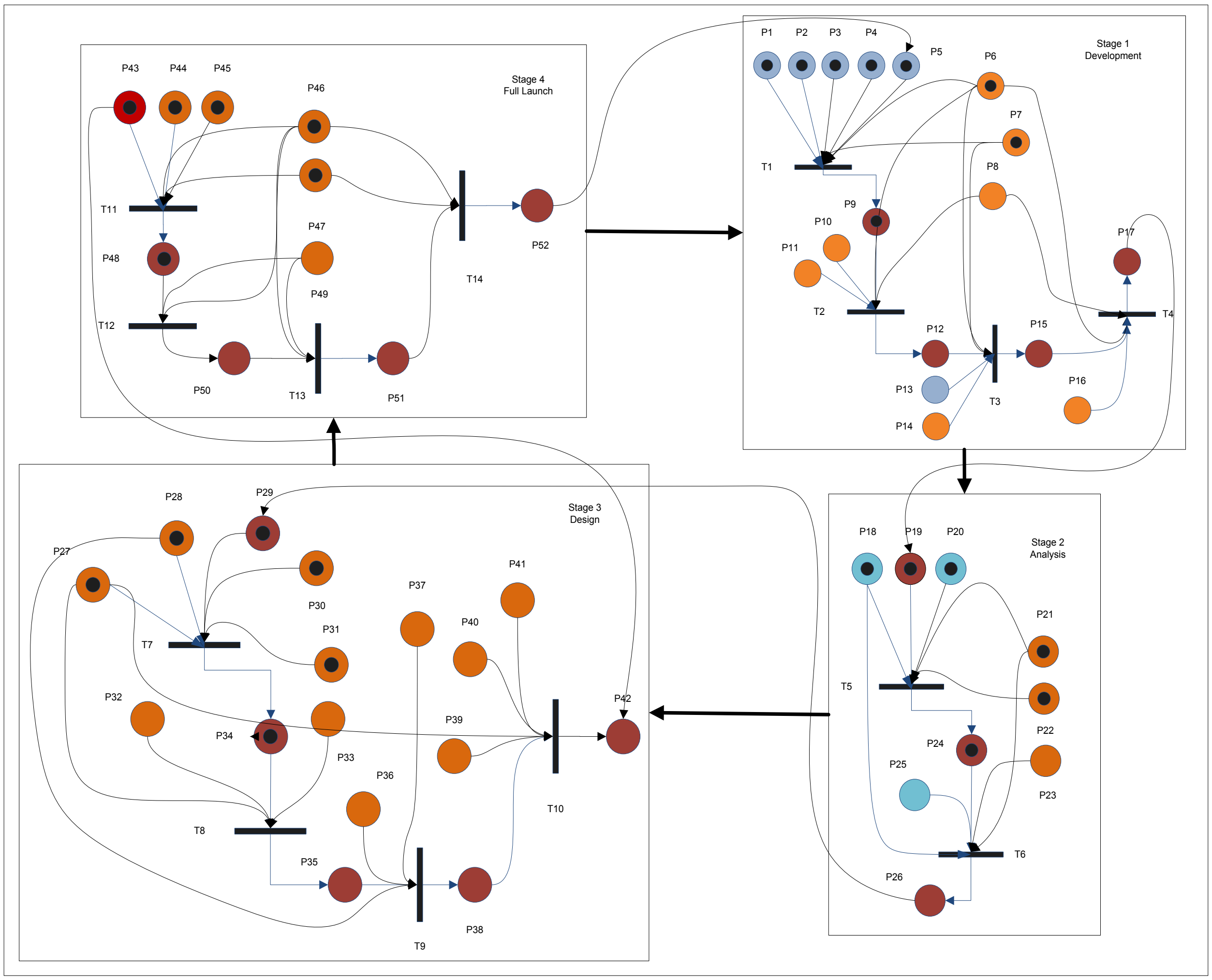


Figure 4.10. Petri Nets Diagram for NSD.

The Petri Nets model for NSD gives more details about the sequence of the main four stages and the 13 steps of the original NSD model. It clarifies the needed resources for each step and the outcome of each step as well. The place colors help to distinguish between the data, results of each step and the resources.

The activities represented in these diagrams are flexible and can be carried out by either one employee or by teams of employees. By nature, service design is team work and it is completed through human communication. In addition, the diagrams allow for the placement of multiple pieces of equipment at one place; however, it is assumed that the pieces of equipment are minimized to two in each stage. Usually the amount of equipment and tools depend on the organization size. Moreover, it is assumed that each stage has its own resources, equipment, tasks and objectives when they are represented separately. All the stages and the tasks in the sequence have been shown in the Petri Nets diagrams matching the NSD model. However, in the real practice of the NSD model investigation shows that:

- The process stages are not processed separately as is shown in the model diagram.
- Many interactions occur between the NSD stages.
- Resources are not used separately as shown in Figure 4.10; rather, they are shared and thus they should be utilized accordingly.

To achieve the above qualities of Petri Nets analysis, the boundaries among the NSD stages should be removed and the system should be tested as one cycle that is sharing the resources and the goal. For this purpose, a well-developed open source Petri net tool called Platform Independent Petri Net Editor (PIPE) was used.

4.2.3. Modeling with Platform Independent Petri Net Editor (PIPE)

There are many tools available for modeling Petri Nets, all of which provide a graphical user interface and a collection of tools to perform analysis on Petri Nets. However, many of them are difficult to use and have unintuitive interfaces (Bloom et al., March 2003). PIPE is an application that creates a Petri net fast and provides substantial analysis tools.

PIPE is a Java based tool for creating, saving, loading, editing, animating, analyzing and executing Petri Nets (Bloom, et al., March 2003). It "comes with a full suite of analysis modules producing performance statistics, correctness properties and new features such as Petri net comparison and classification" (Bloom, et al., March 2003). PIPE is logically divided into three main components Graphical user interface (GUI), Layer managing the interactions between the GUI and the modules (DataLayer) and Analysis modules (Liu, Zeng, & He, 2011).

Using PIPE is useful for allowing insight about the sequences of the service design process and their relationship with their resources. In addition, it helps determine which steps could be combined without having an adverse effect on the process flow.

Petri Nets for each stage of the NSD have been created. The associated PIPE diagrams use a color code system for tokens so the previous color code for places is not implemented. Additionally, for analysis purposes in each stage, the cycle is closed with one extra transition to update the data and start the cycle again. One place is assigned for resources, which includes data and human resources, and another place for equipment and tools. These two places are shared during all of the activities within each stage.

Table 4.5 shows the colors of the tokens and Figures 4.11 shows the PIPE diagrams for the development stage in the NSD model while Table 4.6 shows the description of the places and transitions. Additionally, the Figures 4.12, 4.13 and 4.14 show the PIPE diagrams for the rest of the NSD stages. Petri Nets combined with computer tools allows for dynamic graphical simulation of Petri Nets, which can be a powerful tool for engineers developing complex systems (Zurawski & MengChu, 1994).

Table 4.5

Token Colors for NSD PIPE Diagram

Token	Color	Token	Color
Default		Internal and external sources	
Budget information		Marketing analysis	
Comparative analysis		Marketing employees	
Comparative analysis data		Marketing information	
Customer		Operations personnel	
Customer analysis		Prospects vision	
Customer contact personnel		Service	
Employees (Designer)		Service design Eng	
Environment analysis		Service process Eng	
Equipments and tools		Training employees	

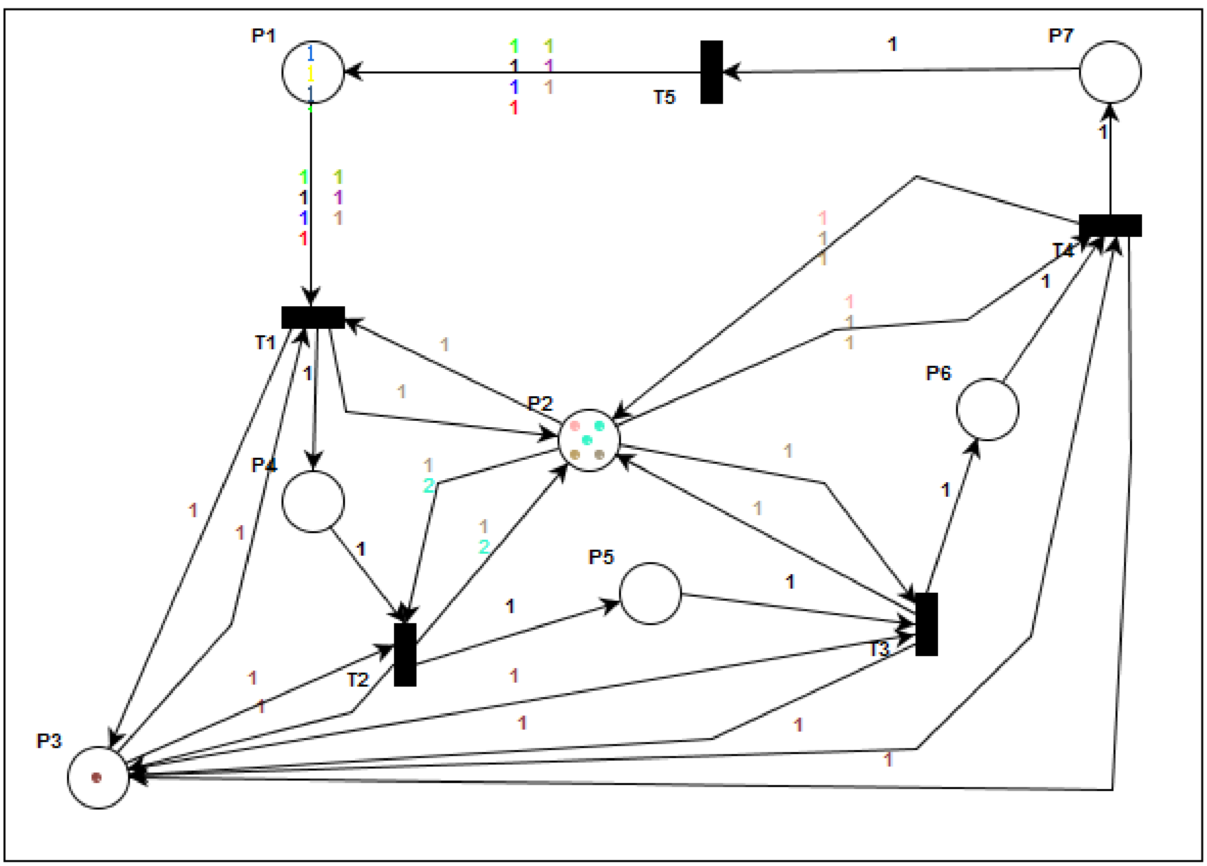


Figure 4.11. PIPE Diagram for Development Stage in NSD.

Table 4.6

PIPE Diagram of Development Stage

Node/Place Transition	Description
P1	Data
P2	Resources
P3	Equipment and tools
T1	Formulating a new service objective and strategy
P4	New objective and strategy are formulated
T2	Generating and screening ideas
P5	New ideas
T3	Developing concept
P6	Concept is developed
T4	Testing concept
P7	Concept is tested
T5	Update data

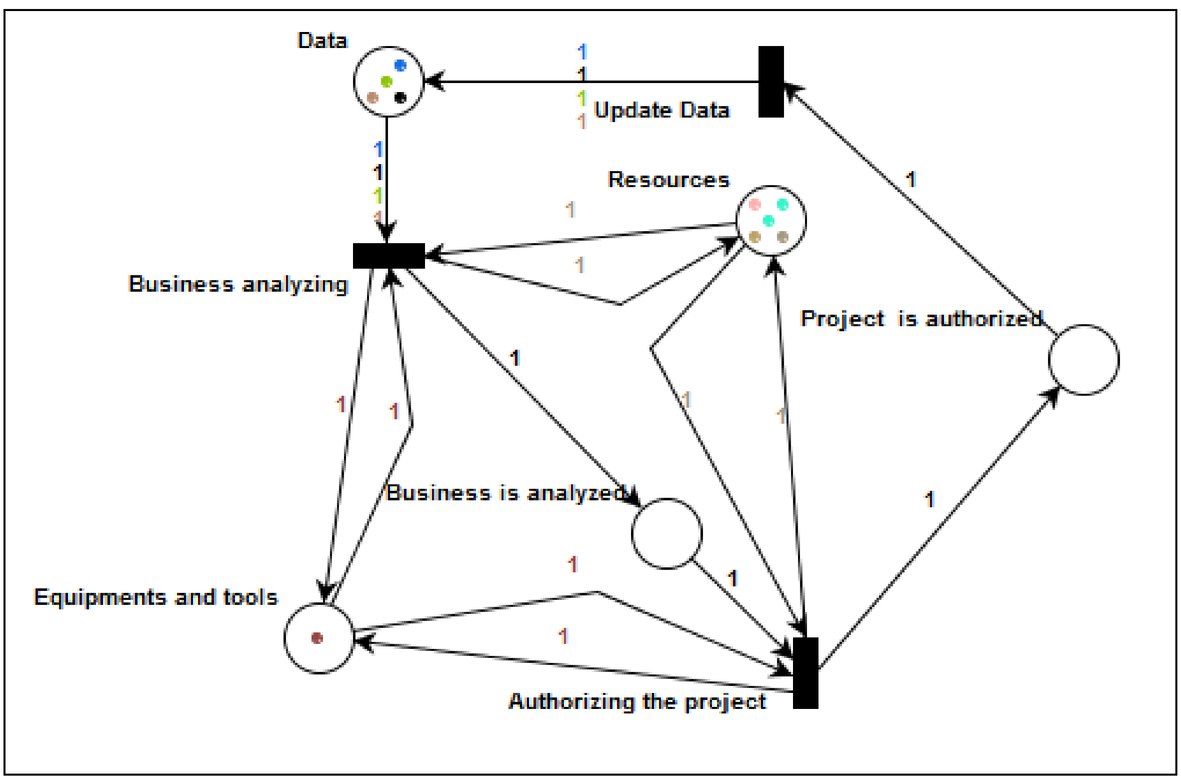


Figure 4.12. PIPE Diagram for Analysis Stage.

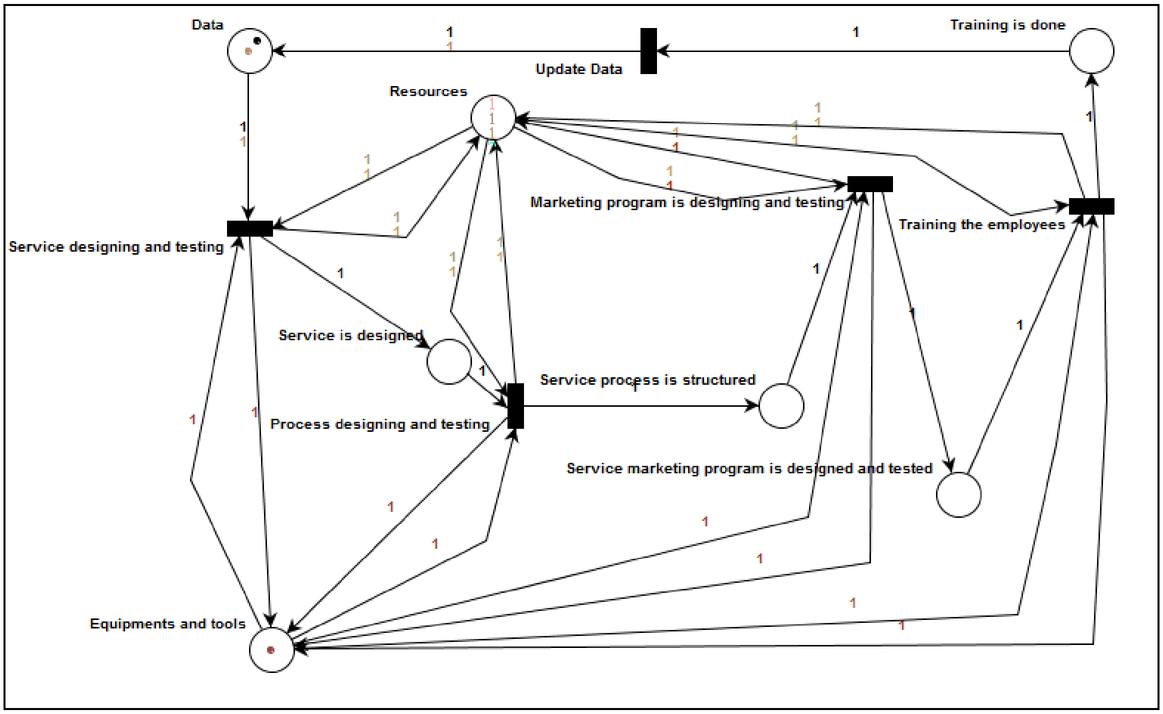


Figure 4.13. PIPE Diagram for Design Stage.

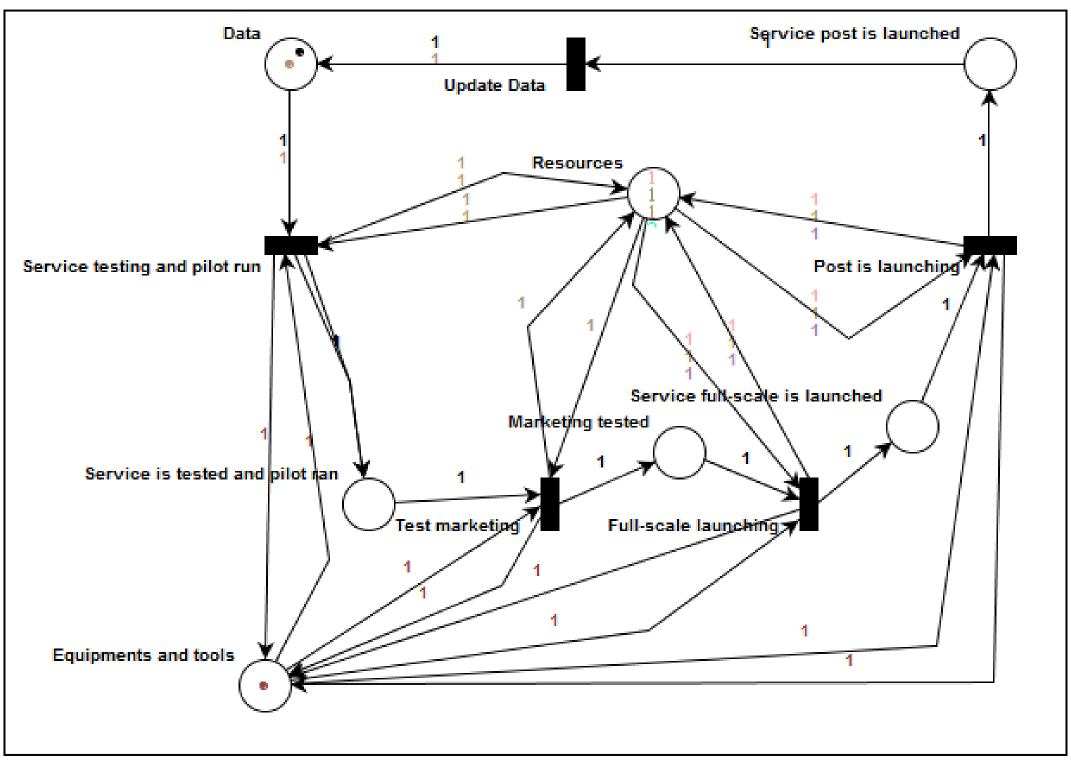


Figure 4.14. PIPE Diagram for Full Launch Stage.

Finally, all boundaries are removed and the SDN process is represented as one cycle for all steps. Figure 4.15 shows the PIPE diagram for the full SDN process and Table 4.6 is the descriptions of the Petri Nets elements. The resources are shared in the whole process, thus the diagram assigns one place for data, one place for HR, one place for tools and one place for the customer. These places are located in the middle of the diagram. This structure allows shifting roles based on the resources. The last transition in the process is for updating the data to start the cycle again. It has been assumed that HR resources and tools are ready to use when they are needed and immediately returned to be ready to use again after any transition. Some of the common resources are kept with serial transitions.

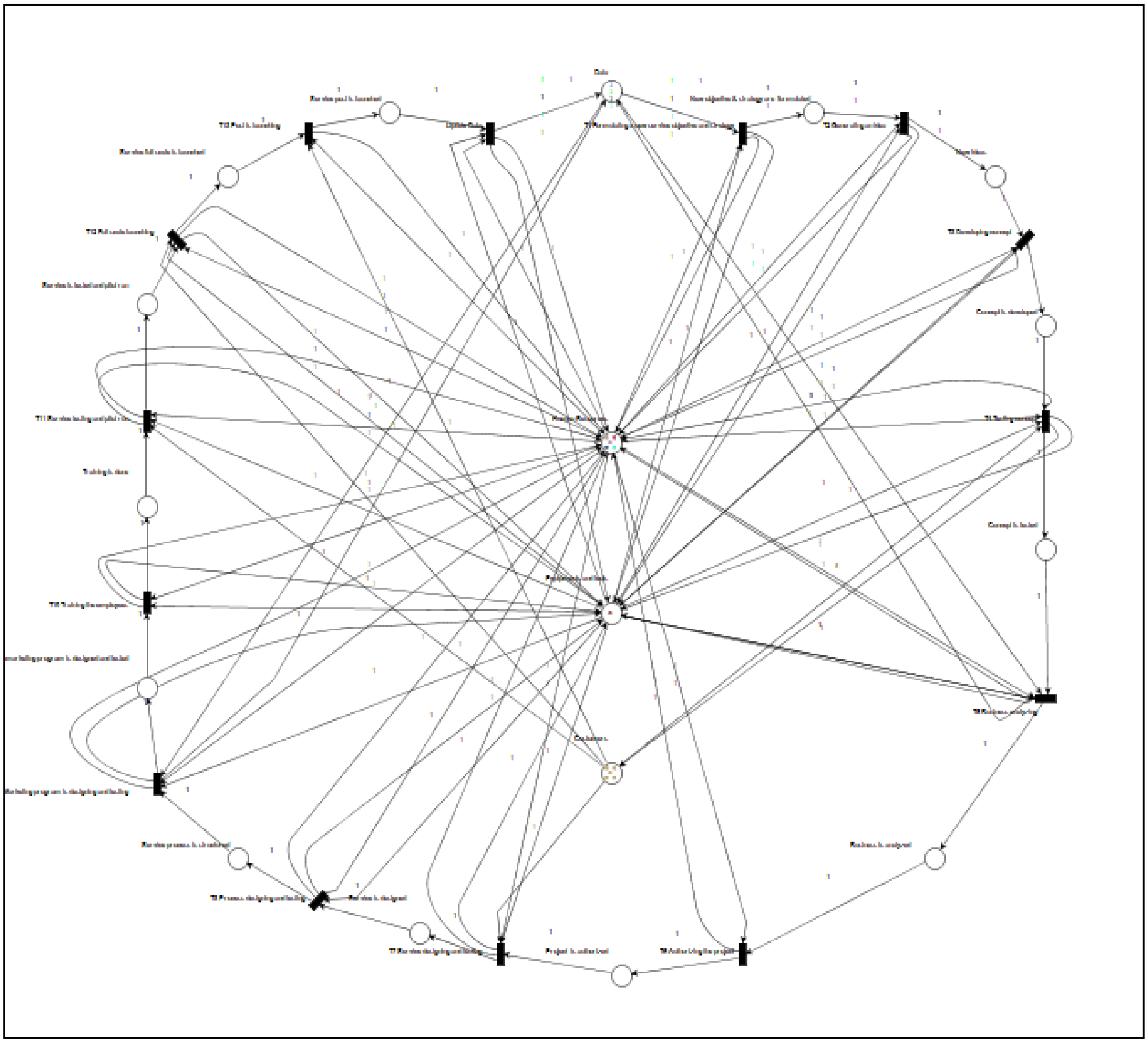


Figure 4.15. PIPE Diagram for NSD.

Table 4.7

PIPE Diagram of All NSD

Node/Place Transition	Description
P1	Data
P2	Human Resources
P3	Equipment and tools
P4	Customers
T1	Formulating a new service objective and strategy
P5	New objective and strategy are formulated
T2	T2 Generating an idea
P6	New ideas
T3	T3 Developing concept
P7	Concept is developed
T4	T4 Testing concept
P8	Concept is tested
T5	T5 Business analyzing
P9	Business is analyzed
T6	T6 Authorizing the project
P10	Project is authorized
T7	T7 Service designing and testing
P11	Service is designed
T8	T8 Process designing and testing
P12	Service process is structured
T9	T9 Marketing program is designing and testing
P13	Service marketing program is designed and tested
T10	T10 Training the employees
P14	Training is done
T11	T11 Service testing and pilot run
P15	Service is tested and pilot ran
T12	T12 Full-scale launching
P16	Service full-scale is launched
T13	T13 Post is launching
P17	Service post is launched
T14	T14 Update Data

The previous diagram and table outline the Petri Nets graphic representation of the NSD without making any improvements in the system itself. The resources are connected to each step of the service design to represent shared resources. This diagram is used for implementing the

PIPE analysis tools to better understand the behavior of the NSD process. Additionally, it serves as an experimental platform with which all future developments are checked and verified to meet the end goal of integrated service design process. Any development steps such as combining activities, adding feedback loops, and adding or removing steps will be verified by the PIPE platform to see if it improves the overall Petri Nets diagram. Improving this representation will be analyzed and explored in future work using PIPE.

4.2.4. Petri Nets Formulation Analysis

The previous diagrams are the graphical representation of the Petri Nets. They show the flow of the NSD process, its 13 tasks and the moving of its process during the design mission. To get the benefit from the Petri Nets as an analysis tool, the mathematical representation is used as well. This supplementary section is a brief description and explanation of the Petri Nets formulation analysis that is used in this research.

The formal definition of a Petri Net graphical representation or structure is as follows:

- A Petri net is a 5-tuple, PN = (P, T, F, W, M_0) where:
- $P = \{p_1, p_2, \ldots, p_n\}$ is a finite set of places where n ≥ 0,
- $T = \{t_1, t_2, \ldots, t_m\}$ is a finite set of transitions where m ≥ 0,
- $A\ or\ F \subseteq (P \times T) \cup (T \times P)$ is a set of arcs which is the connection between the places and transitions (arc from P to T with form (p_i, t_j) and arc from T to P with form (t_j, p_i))
- $W: F \rightarrow \{1,2,3, \ldots\}$ is a weight function,
- $M_0: P \rightarrow \{0,1,2,3 \ldots\}$ is the initial marking. The X could be used as well as a marking of the set of places,
- $P \cap T = \emptyset\ and\ P \cup T \neq \emptyset$.

- A Petri net structure N = (P, T, F, W) without any specific marking is denoted by N. A Petri net with the given initial marking is denoted by (N, M_0) (Murata, 1989) (Achilleos, et al., 2008) (Cassandras & Lafortune, 2008).

This 5-tuple term is used to describe the behavior of systems in terms of system states and their changes. In addition, to simulate the dynamic behavior of systems, a marking in a Petri Nets is changed according to enabling rule and firing rules (Murata, 1989). Moreover, $I(t_j)$is used to represent the set of input places to transition t_j and $O(t_j)$ is used to represent the set of output places from transitiont_j. $w(p_i, t_j) = k$ means there are k arcs from p_i to t_j or, equivalently, a single arc accompanied by its weight k and vice versa (Cassandras & Lafortune, 2008). For example, the PIPE for the first stage (development) in the NSD was shown in the Figure 4.11 and a description of its places and transitions were in the table 4.6. This diagram could be defined by the Petri net graph as follow:

$$P = \{p_1, p_2, p_3, p_4, p_5, p_6, p_7\} \qquad T = \{t_1, t_2, t_3, t_4, t_5\}$$

$$A = \begin{matrix} \{(p_1, t_1), (p_2, t_1), (p_2, t_2), (p_2, t_3), (p_2, t_4), (p_3, t_1), (p_3, t_2), (p_3, t_3), (p_3, t_4), \\ (p_4, t_2), (p_5, t_3), (p_6, t_4), (p_7, t_5), (t_1, p_2), (t_1, p_3), (t_1, p_4), (t_2, p_2), (t_2, p_3), (t_2, p_5), \\ (t_3, p_2), (t_3, p_3), (t_3, p_6), (t_4, p_2), (t_4, p_3), (t_4, p_7), (t_5, p_1)\} \end{matrix}$$

$$\begin{matrix} w(p_1, t_1) = 7 & w(p_2, t_1) = 1 & w(p_2, t_2) = 3 & w(p_2, t_3) = 1 & w(p_2, t_4) = 3 \\ w(p_3, t_1) = 1 & w(p_3, t_2) = 1 & w(p_3, t_3) = 1 & w(p_3, t_4) = 1 & w(p_4, t_2) = 1 \\ w(p_5, t_3) = 1 & w(p_6, t_4) = 1 & w(p_7, t_5) = 1 & w(t_1, p_2) = 1 & w(t_1, p_3) = 1 \\ w(t_1, p_4) = 1 & w(t_2, p_2) = 3 & w(t_2, p_3) = 1 & w(t_2, p_5) = 1 & w(t_3, p_2) = 1 \\ w(t_3, p_3) = 1 & w(t_3, p_6) = 1 & w(t_4, p_2) = 3 & w(t_4, p_3) = 1 & w(t_4, p_7) = 1 \\ & & w(t_5, p_1) = 7 & & \end{matrix}$$

To clarify the mechanism of the Petri net that is based on assigning or putting tokens to places, a marking is defined. Marking *x* of a Petri net graph (*P, T, A, w*) is a function x: P → N = {0, 1, 2...}. Thereby, the five-tuple (*P, T, A, w, x*) is the marked Petri net, where (*P, T, A, w*) is a Petri net graph and *x* is a marking of the set of places $P; X = [x(p_1), x(p_2), \ldots. x(p_n)] \in N^n$ is the row vector associated with *x* where *n* is the number of places in the Petri net (Cassandras & Lafortune, 2008). For example, consider the Petri net of the development stage in Figure 4.11 with more than one token as shown in Table 4.5, the marking corresponds to X= [P6_Default, P3_Equipments and tools, P2_Employees (Designer), P5_Default, P4_Default, P1_Customer analysis_Default_Environment analysis_Marketing analysis_Marketing information_Prospects vision_Service, P2_Employees (Designer) Internal and external sources, P7_Default, P2_Customer contact personnel_Employees (Designer) Customer].

The possible markings, namely the row vectors: $x_1 = [0,1,1,0,0,1,2,0,1]$, $x_2 = [0,1,1,0,1,0,2,0,1]$, $x_3 = [0,1,1,1,0,0,2,0,1]$, $x_4 = [1,1,1,0,0,0,2,0,1]$ and $x_5 = [0,1,1,0,0,0,2,1,1]$.

These markings could be represented in a tree form as well where nodes are Petri net states and the arcs represent transitions. For the above example, Figure 4.16 shows the reachability tree for the development stage in NSD. Figure 4.16 is developed from the Petri net diagram in Figure 4.5. Note the reachability tree shows the linear and sequential nature of NSD.

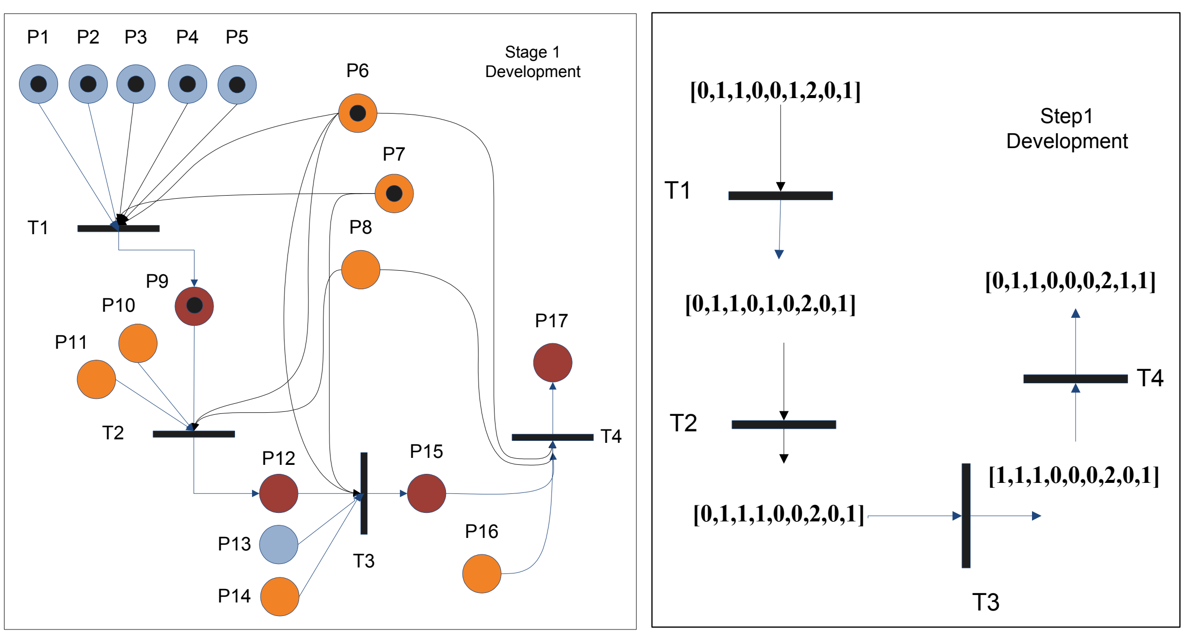


Figure 4.16. Petri Net Diagram and Reachability Tree.

The PIPE software can generate the reachability graph tree and coverability graph results. The concept of state coverability is a generalization of the concept of state reachability. It is also related to the concept of eventually being able to fire a particular transition (Cassandras & Lafortune, 2008). Figure 4.17 shows the PIPE reachability graph of only one stage for the PIPE diagram of the development stage in NSD as is shown in Figure 4.11. This has been done intentionally to show a smaller portion of the process before adding any improvements that could complicate the diagram. By hovering the cursor over any state or node, PIPE gives all the information about this node as shown in the Figure 4.17.

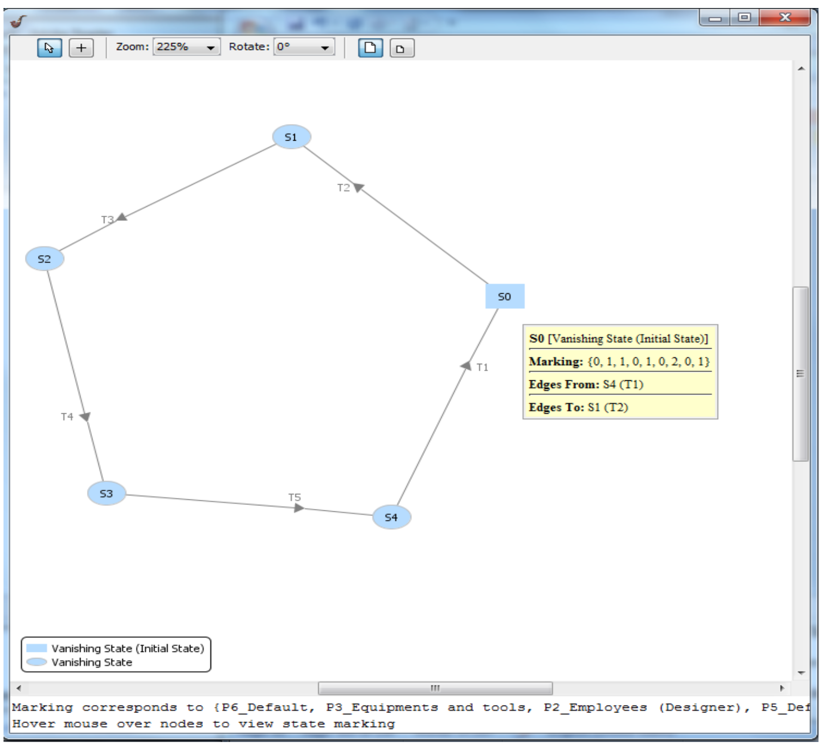


Figure 4.17. Reachability/Coverability Graph Results from PIPE for Development Stage.

The reachability and coverability diagrams show how the process of service design can be simplified using the PIPE software. It illustrates how there is only one direction for the sequence in addition to showing the status of resources before and after each transition. For example, the first step which is formulating a new service objective and strategy; $x_1 = [0,1,1,0,0,1,2,0,1]$ tell us what resources we need as shown in Table 4.8.

Table 4.8

Set of Places for the First Step's Marking

X	***X(P)***
0	P6_Default
1	P3_Equipments and tools
1	P2_Employees (Designer)
0	P5_Default
0	P4_Default
1	P1_Customer analysis_Default_Environment analysis_Marketing analysis_Marketing information_Prospects vision_Service
2	P2_Employees (Designer) Internal and external sources
0	P7_Default
1	P2_Customer contact personnel_Employees (Designer) Customer

In addition, PIPE software can provide all of the incidence matrixes of a Petri net. These matrixes illustrate more about the behavior of the system such as when the transition is enabled, state transition function and the vector state equation. These equations and matrixes help to configure the resources needed for each transition and the changes happening to the system after each transition. To give a brief example, more formulas need to be introduced. The first one is about enabling. The transition $t_j \in T$ a Petri net system is said to be enabled if

$$x(p_i) \geq w(p_i, t_j) \; \forall \; p_i \in I(t_j)$$

This means that the firing of t_j is enabled when the number of tokens in p_i is at least as large as the weight of the arc connecting to t_j from p_i and these for all places p_i that are input to transition t_j. The second formula is about the state transition function. If the transition is enabled based on the previous formula and$f(x, t_j)$, then the $(x) = \acute{f}(x, t_j)$, where

$$\acute{x}(p_i) = x(p_i) - w(p_i, t_j) + w(t_j, p_i) for \; i = 1,2, \dots, n$$

From these two formulas the vector state equation can be written as:

$$\acute{x} = x + uA$$

The u is the firing vector and A is incidence matrix of a Petri net. The formula describes the state transition process as a result of an "input" u, that is, a particular transition firing (Cassandras & Lafortune, 2008; Murata, 1989) (Murata, 1989). "The state equation provides a convenient algebraic tool and an alternative to purely graphical means for describing the process of firing transitions and changing the state of a Petri net" (Cassandras & Lafortune, 2008).

For an example from the Petri net of development stage, if the marking is $x_1 = [0,1,1,0,0,1,2,0,1]$ and we need to fire t_1 the matrixes of the state equation will be as follows:

$$\begin{bmatrix}0\\1\\1\\0\\1\\0\\2\\0\\1\end{bmatrix} = \begin{bmatrix}0\\1\\1\\0\\0\\1\\2\\0\\1\end{bmatrix} + \begin{bmatrix}1 & 0 & 0 & -1 & 0\\0 & 0 & 0 & 0 & 0\\0 & 0 & 0 & 0 & 0\\-1 & 0 & 1 & 0 & 0\\0 & 1 & -1 & 0 & 0\\0 & -1 & 0 & 0 & 1\\0 & 0 & 0 & 0 & 0\\0 & 0 & 0 & 1 & -1\\0 & 0 & 0 & 0 & 0\end{bmatrix}\begin{bmatrix}1\\0\\0\\0\\0\end{bmatrix}$$

The result is the next marking $x_2 = [0,1,1,0,1,0,2,0,1]$. The A matrix calculated by PIPE software which could help to find the A for more complicated system such as NSD model. The above mathematical introduction is essential because the Petri Nets analysis is based on the algebraic equations and not on the graphical representation. These equations were illustrated in the first stage, development, of the NSD model.

Another analysis could be done by PIPE which is the T–Invariants and P–Invariants. The "T-invariant may represent a set of fired transitions in the firing sequence that takes the model back to the initial marking. It shows the possibility of regeneration of a certain marking of the model." (YuanLin & MuDer, 2005). It is very useful in such applications of testing and proofing of cyclical operation such as reversibility, home state, liveness, and avoidance of deadlocks. This analysis is even more valued for the cases of intangibility such as with services. The P–Invariants function as conservation laws that ensure the number of the tokens invariant under the firing of transitions within the Petri Nets system. It has applications in finding finite-state automata, decomposition and proofing of correctness.

For the first stage in the NSD model, the Petri net invariant analysis results of T-Invariants is shown in Table 4.9 from the PIPE software. It means that the Petri Nets need to fire each transition one time to get back to the initial marking. In addition, it shows that there is just one sequence of firing to achieve this goal. In this research case study, it means that to get back to the initial state or first step (formulating a new service objective and strategy) in the "development" stage, each step should occur only one time. In addition, it means that all resources are still in the system and ready to use after each step occurs one time.

Table 4.9

T-Invariants for Development Stage

T3	**T1**	**T2**	**T4**	**T5**
1	1	1	1	1

The P-Invariants as shown in Table 4.10 are generated by the PIPE software. It shows all the values of the tokens' movement in each place. The P–Invariants show that the number of the resources (tokens) is invariant under the occurring of steps within the first stage "development". The PIPE software creates formulas for the resources (tokens) movement that shown in Table 4.10.

Table 4.10

P-Invariants for Development Stage

P6_Default	P3_Equipments and tools	P2_Employees (Designer)	P5_Default	P4_Default	P1_Customer analysis_Default_Environment analysis_Marketing analysis_Marketing information_Prospects vision_Service	P2_Employees (Designer)_Internal and external sources	P7_Default	P2_Customer contact personnel_Employees (Designer)_Customer
0	1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
1	0	0	1	1	1	0	1	0
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	1

The formulas for the resources movement are:

M(Equipments and tools_Equipments and tools) = 1

M(Resources_Employees (Designer)) = 1

M(Concept is developed_Default) + M(New ideas_Default) + M(New objective & strategy are formulated_Default) + M(Data_Customer analysis_Default_Environment analysis_Marketing analysis_Marketing information_Prospects vision_Service) + M(Concept is tested_Default) = 1

M(Resources_Employees (Designer)_Internal and external sources) = 2

M(Resources_Customer contact personnel_Employees (Designer)_Customer) = 1

The P-Invariant equations above control the flow of the resources through the process. In the event that you want to change the number of resources you should satisfy these equations. Additionally, if you want to assign more than one design task at a time, you need to change the number of resources and use these equations to control the change.

The previous examples of the PIPE application are for the first stage (development) of the NSD model provides a snapshot of what will be done for the NSD model as a whole. The next step will be implementing all these analyses from the PIPE software and using them for the NSD system as a whole with the following goals:

- Understand the resources' usability and utilization.
- Find out the best location for the feedback points in the process that do not affect the resource allocation and utilization.
- Find out the best opportunities for combination that could share the same resources and feedback cycles.
- Create the new integrated process for the service design.

4.3. Current NSD Process Improvement

Improvement of the NSD process took place over five stages of the merging scenario as shown in Figure 4.18 :

1- Developing Petri Nets for the current NSD model: This stage started with the revised NSD that illustrated all the input and output in the design system, developed segmented Petri Nets for the NSD and developed integrated Petri Nets for the NSD. Before the next stage, some modifications on the current NSD's Petri Net model needed to be completed. These modifications were done with the support of the PIPE through trial and error analysis. The Petri Nets analysis tools help to improve the representation of the NSD process and prepare the model for integration with other practitioners' models.

2- Developing the new Petri Nets with feedback and integrated activities: This stage was achieved by combining the high level of the NSD diagram with the Feedback Petri Nets in one diagram.

3- Developing a unified service design model: This step was achieved by combining the previous diagram in step 2 to the practitioner models.

4- Improving the unified model: This stage was completed by adding the concurrency concept to the unified model.

5- Translating the model: This step was accomplished by developing an easy model to be used by practitioners that emphasizes the integration and the concurrency concepts.

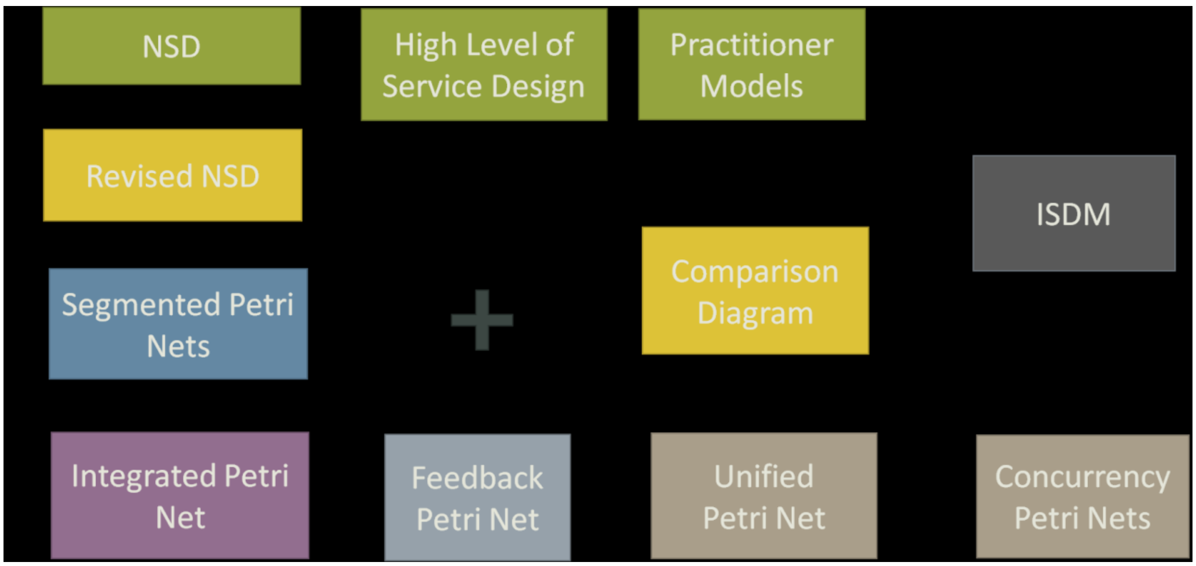


Figure 4.18. Improvement Merging Scenario.

The first stage has been done in the previous section, the next two stages are explained in this section of the chapter, stage four is explained in section 4.4 and stage five explained in section 4.5. Some suggested improvements have been submitted by Tabbakh, et al. in previous research. These recommendations as stated for improvements in the NSD are (Tabbakh, et al., 2012): the reduction of the process time by performing tasks concurrently instead of sequentially and the addition of four new transitions between the four stages (TA1, TA2, TA3 and TA4) as shown in Figure 4.19. These new transitions for auditing are for getting feedback from the stakeholders and to check the output quality of the stages. It will enhance the exploration of possible solutions and help the team to select the most efficient combinations.

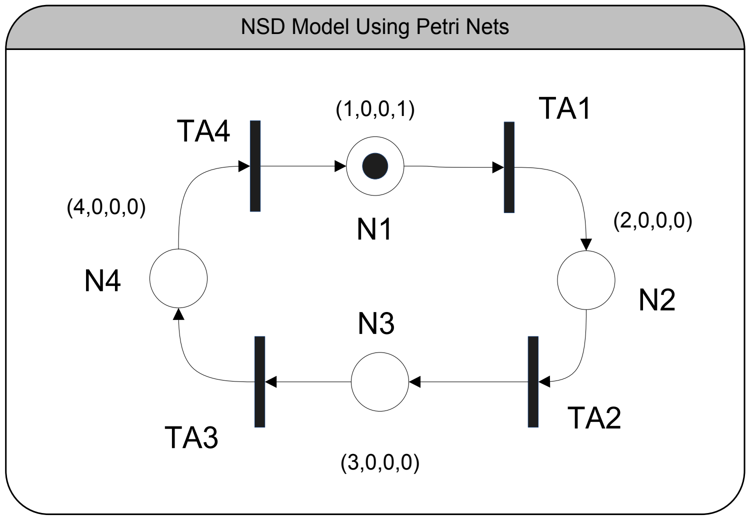


Figure 4.19. NSD Model Using Petri Nets after Improvement (Tabbakh, et al., 2012).

In previous research, Petri Nets have been used to structure the New Service Design (NSD) process. Adding the transitions between the four stages of NSD as a test point could improve the quality of the service and allow stakeholders' feedback. However, the goal of this dissertation is to benefit from insight gained from employing the properties and formulations of the Petri Nets. This insight could provide a good methodology to design the new service design process. PIPE was used as an analysis tool for Petri Nets. The improvement takes two paths. First, there was relocation and rearrangement of resources to find the best setting that reduces the cycle of the process to get back to the initial marking. Secondly, the best point for adding feedback points was found in order to provide loops that need to reuse the resources. The best model will be determined by the criteria mentioned in the next section.

4.3.1. Rearrangement of Resources

Adding the feedback process transitions before relocating the resources creates a long and complicated process. The T-Invariants analysis results show that the number of firing steps to complete the process doubled from 16 to 32 with the addition of a feedback loop. In practice, this means that the resources do not go back to their initial status until each step is executed sixteen times, and this number doubles when we add the feedback. This observation is recognized after adding the feedback points and running the PIPE analysis. Thus, the model needs to be improved by relocation and rearrangement of resources.

The improvement steps start from the first PIPE diagram in Figure 4.15 for the full SDN process. Table 4.6 showed the descriptions of the Petri Nets elements. The Petri net invariant analysis results of the T-Invariants for the PIPE diagram in Figure 4.15 and is shown in the Table 4.11. This result is before any improvement and it shows that the resource allocation setup needs 16 cycles to get back to the initial marking.

Table 4.11

PIPE Diagram before Improvement

T10	T11	T12	T13	T14	T1	T2	T3	T4	T5	T6	T7	T8	T9
16	16	16	16	16	16	16	16	16	16	16	16	16	16

After relocating the resources, the analysis result of the T-Invariants improved. The best result that could be achieved is one fire for each transition to get the model back to the initial marking. The rearrangement was made to the customer place. The old setting was connecting and preparing the customer once, for all the transitions, before the test concept transition. The new setting is connecting and preparing the customer just in the transition that they need to be involved. In the same manner all the common resources are allocated to be ready when they are needed and get back to their place and available for the next transition. In a real system, this means that the data of the new service, the employees and the tools used in the design that are involved in specific steps do not move directly forward to the next step until they go back to the holding place and are ready to move either forward or backward. Table 4.12 shows the Petri Net invariant analysis results of the T-Invariants for the PIPE diagram in Figure 4.15 after the first improvement.

Table 4.12

PIPE Diagram after the First Improvement

T10	T11	T12	T13	T14	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 4.13 shows the Petri Net invariant analysis results of the P-Invariants. It has been assured that the net is covered by positive T-Invariants therefore it might be bounded and live. In addition, it has been assured that the net is covered by positive P-Invariants. The P–Invariants shows that the number of the resources (tokens) is invariant under the entire system and therefore, it is bounded. As the analysis results shows, there is only one way to get the model back to the initial marking. This would be changed when the feedback points are added.

4.3.2.Development of Unified Service Design Model

The next step is adding the feedback processes. These processes are the transitions that allow the designer to go back to previous design points. These transitions are analysis and decision points. Based on the feedback of the designer or the manager, they need to decide to either continue and move to the next step in the process or go back to the previous step. These feedback transitions should work as a sequence that allows the process to go back in the opposite direction to the first step. In addition, the resource should be ready to use whenever the designer decides to go back and start over and transition again and again. In order to do that, many points for feedback are suggested and tested in the PIPE analyses to find out the suitable combination for the system. For illustration, Figure 4.20 shows the feedback map that shows the resources for each step of the NSD.

Table 4.13

Petri Net Invariant Analysis Results of the P-Invariants for NSD

P3_Equipments and tools	P2_Employees (Designer)_Service personnel_Training employees_Operations	P14_Default	P13_Default	P15_Default	P4_Customer	P2_Employees (Designer)_Service personnel_Operations personnel	P16_Default	P17_Default	P2_Employees (Designer)	P1_Customer analysis_Default_Internal and external sources_Marketing and	P5_Default_Prospects vision	P6_Default_Prospects vision	P2_Employees (Designer)_Internal and external sources	P7_Default	P2_Service personnel_Employees (Designer)	P8_Default	P9_Default	P1_Budget information_Marketing and Environment	P10_Default	P2_Employees (Designer)_Manager	P11_Default	P12_Default	P1_Marketing and Environment
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	1	0	0	1	1	0	1	1	1	0	1	0	1	1	0	1	0	1	1	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

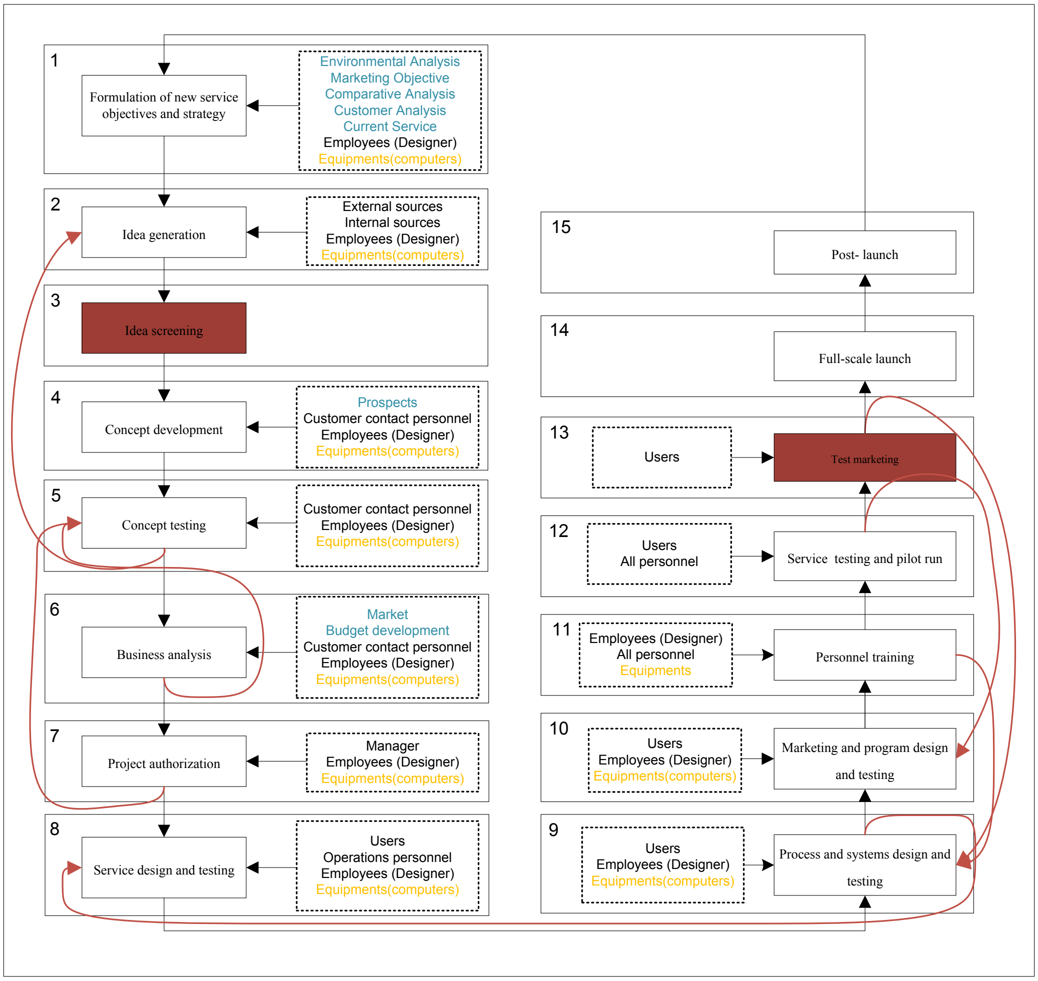


Figure 4.20. Feedback Map.

The feedback loop could be between any steps that involve decisions. In other words, after every decision, feedback is valuable.

The final locations that are selected were based on the following criteria:

1. Availability of combining resources: This means that the group of transitions uses same resources which make the input resources for these combinations the same.
2. Transitions that results in decisions: Some bounded and live transitions are just preparing or researching activities and no decisions are made within them. The nature of these activities helps to make decisions, but they are not necessarily decision-making transitions that need feedback.

3. The PIPE analysis: The results reveal the shortest cycle to get the model to flow back in both directions to the initial marking that has been selected.
4. P-Invariants and T- Invariants analysis: If the net is covered by positive T-Invariants and P-Invariants, it is bounded and live.

The result of adding the feedback points is shown in Figure 4.21. It shows that based on the above criteria, six feedback transitions have been added to the PIPE diagram of the NSD model. The new feedback points are new transitions that keep the process bound and live wherever the direction goes. Table 4.14 explains the meaning of these feedback transitions.

Table 4.14

Meaning of the Feedback Transitions

Transtion	Meaning	Explanation
FB1	Redeveloping concept	After the concept is developed and tested, designers need to know if that should go forward or go back to change the concept.
FB2	Concept doesn't work	After analyzing the business based on the development concept decision that needs to be made, the decision is determined on whether or not this concept works based on the business analysis.
FB3	Not authorized	This is an administrative decision that is taken by the manager. If the design is authorized, the next step of the process will be taken; otherwise the designer needs to go back to the concept point.
FB4	Need change	The design needs to be changed.
FB5	Need change	The service process needs to be changed.
FB6	Need change	Something needs be changed, either the process or the design. This feedback comes before the full service launch. It is the result of testing the service and running the pilot of the service.

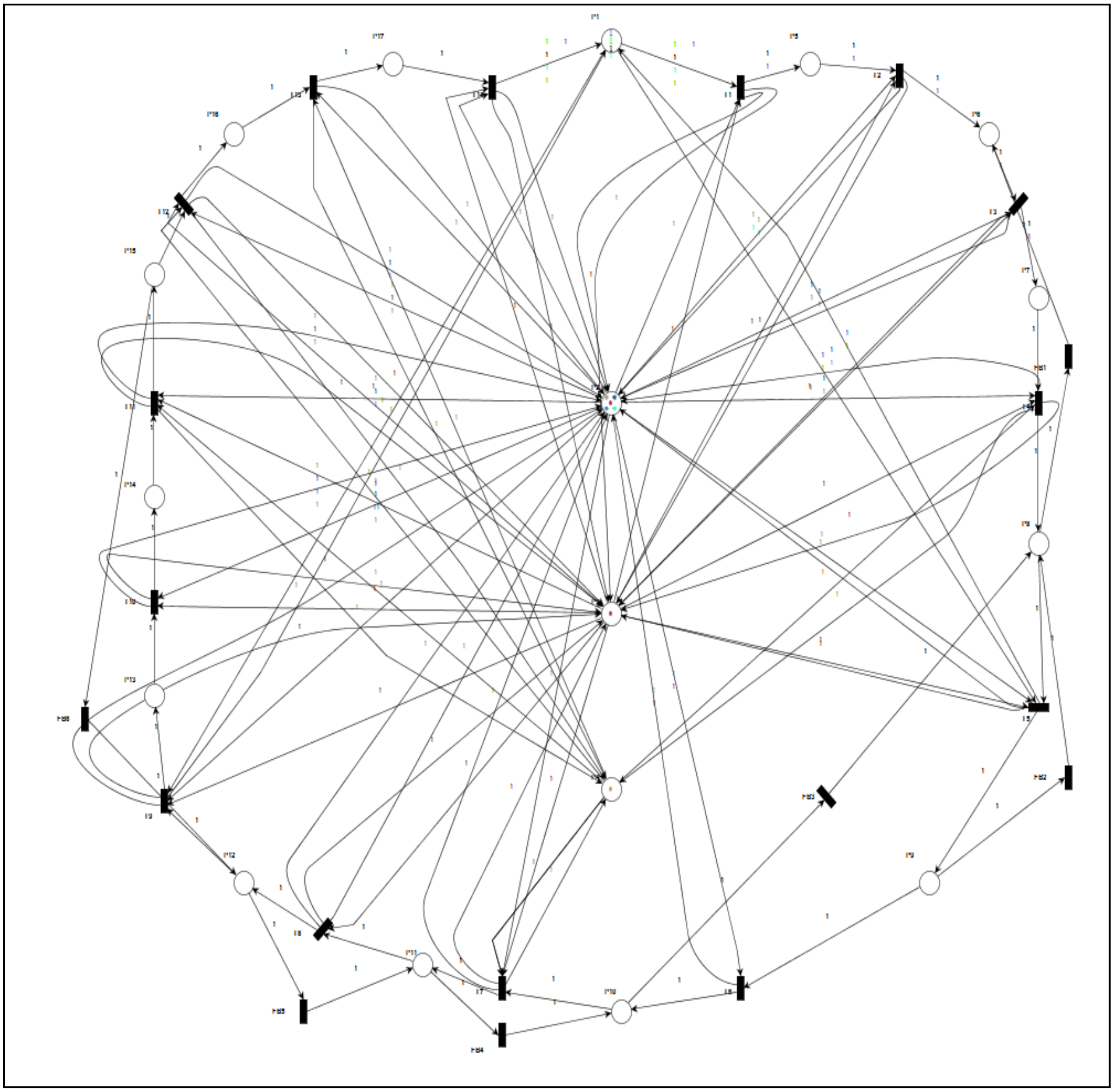


Figure 4.21. PIPE for NSD with Feedback Transitions.

The Petri net invariant analysis results for the T-Invariants are shown in Table 4.15. The table shows that we have more than one path to return to the first initial marking and more than one loop to run during the process of service design. For example, the last row shows the path of the process if none of the feedback loops are used. If any step of the feedback loop is used, it takes value "1" and the transitions associated with it takes value "1" as well such as FB1, T3 and T4 (T3 is developing concept, T4 is testing concept, FB1 is the feedback transition if the concept needs to be developed again). Additionally, with the P-Invariants analysis, the results show that the net is covered by positive T-Invariants and therefore it is bounded and live.

Table 4.15

T-Invariants for NSD with Feedback Transitions

FB2	FB4	FB5	FB6	FB3	FB1	T10	T11	T12	T13	T14	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Figure 4.22 is a comparison between the Reachability/Coverability graph which shows results from PIPE of the NSD model before and after the feedback transitions.

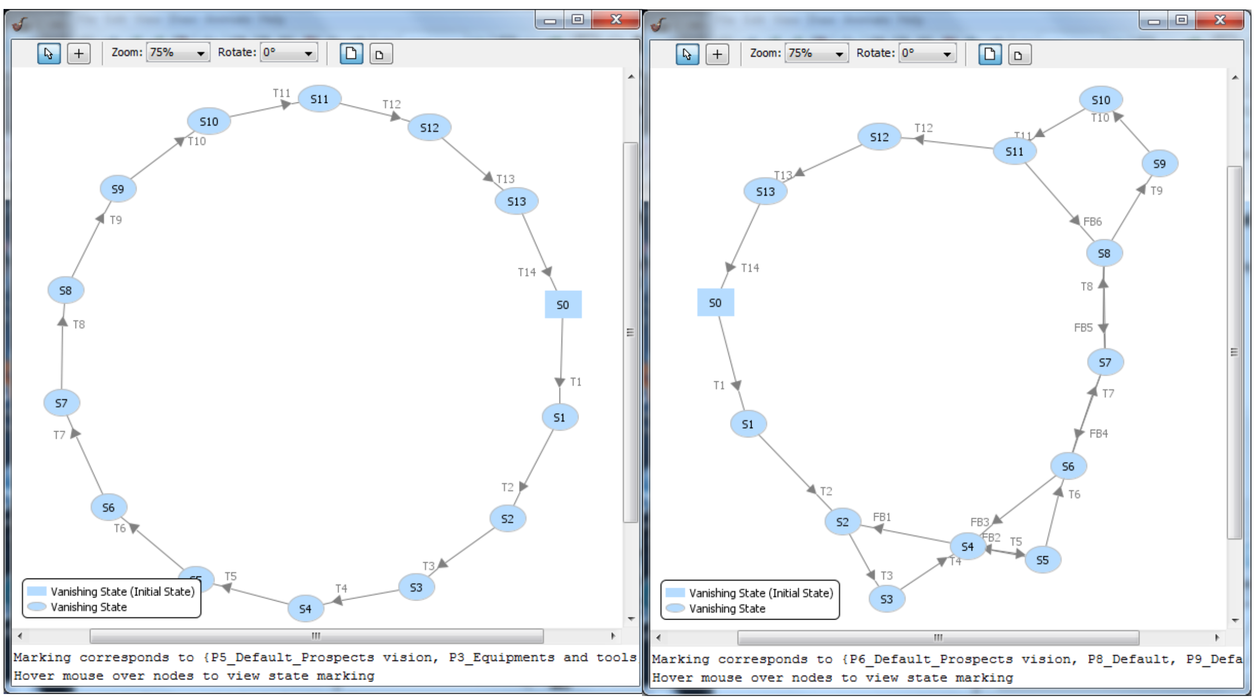


Figure 4.22. Comparison of Reachability/Coverability Graph of the NSD.

In Figure 4.22, the right diagram is for the NSD model without feedback transitions and the left diagram is with the feedback transitions. The comparison shows the new alternatives paths for the service design process. These new alternatives are the result of adding the six feedback transitions to the system. This new process now has feedback loops which make it multi-directional. For example, after creating the concept, the process can either go to the next step or enter the feedback loop to build a revised process. In the event that the feedback loop is utilized, the resources that are needed should be available including any updated data related to that concept. The next step is using this improved mode of the NSD to integrate it with other well-known practitioner models.

4.4. Integration and Development

Practitioners use a wide range of service design processes. The integration of these processes with the NSD model is the goal of this step. The Petri Nets of the NSD model that have been developed in the previous section are integrated with the practitioners' processes. The step aims to create a universal model that integrates all of the practitioners' SDP models into the newly designed Petri Nets diagram. Some nodes in the Petri Nets diagram were inserted and others were combined to give the model flexibility to use in a variety of services and for the customization of specific services. The integration was based on the most popular practitioner models such as the Double Diamond Design Process model that is used by the Design Council, the Engine Corporation process and the Minds & Makers process. Additionally, during this step an interdisciplinary approach was incorporated into the activities of the service design.

A quick review of the most popular service design models shows that each model focuses on different activities, although there is some overlap. The Double Diamond Design Process model and the Minds & Makers model end at delivering the service, which leaves visualizing the service concept and design to be implemented by the client. The Engine process is similar, but works with the client to ensure its implementation and measures the results for future improvement. However, the design activities are not completed by visualizing the service concept and design. The end of the service design process is the beginning of the engineering design activities. Examples of these activities, elements and tools are listed in Table 4.16 (J. A. Fitzsimmons & Fitzsimmons, 2007). All of these activities are designed but they are missing from the previous practitioners' models.

Table 4.16

Engineering SD Elements and Tools (J. A. Fitzsimmons & Fitzsimmons, 2007)

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

Figure 4.23 is a comparison diagram among these models and the NSD model. The diagram shows three practitioners' models side by side with the NSD model. Each model has its own name or term for each step; however, the output of the steps beside each other is the same. In addition, some steps are at an intersection between steps as the diagram shows.

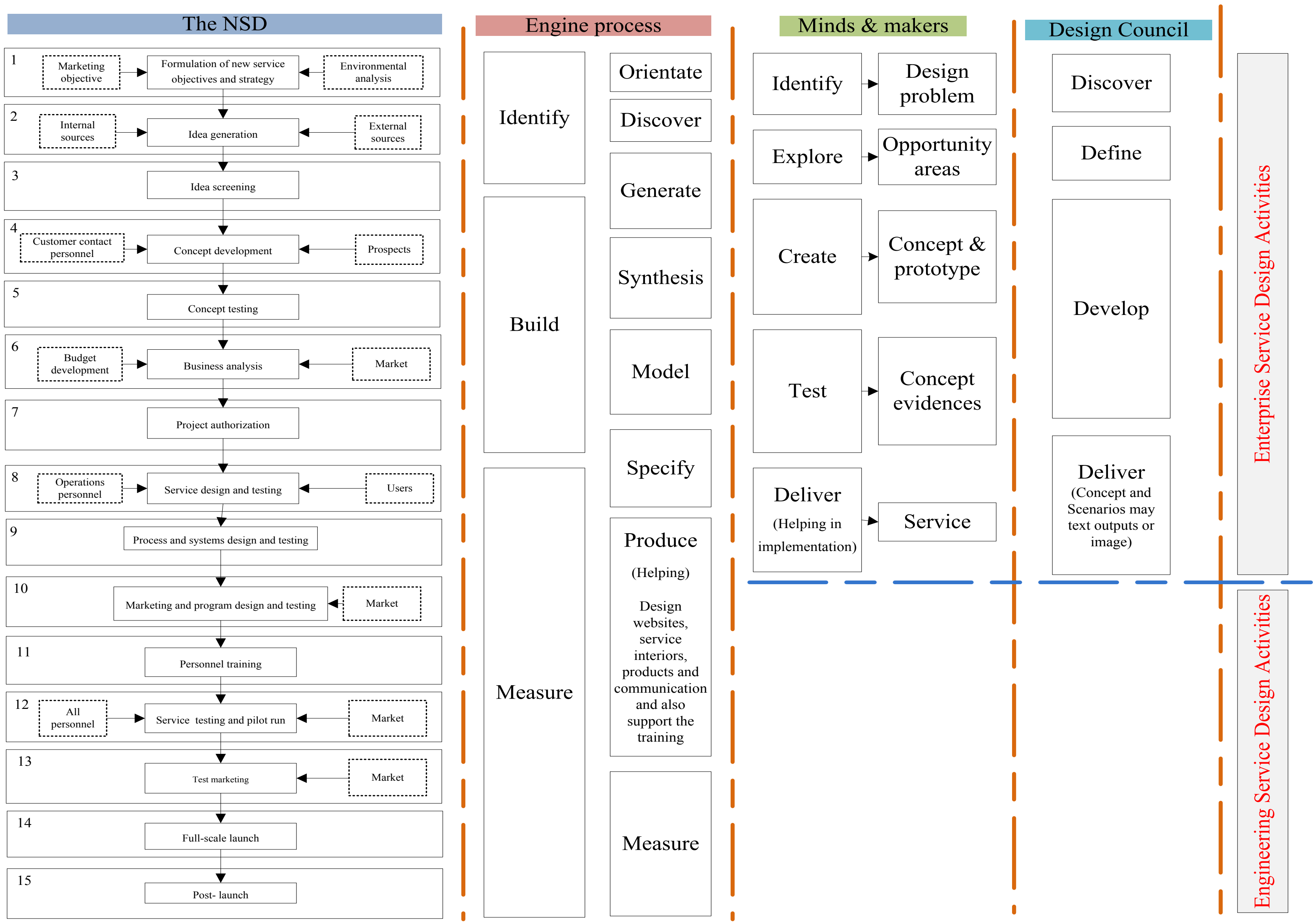


Figure 4.23. Comparison Diagram among Service Design models.

The result of this comparison and applying the PIPE analysis through iterative trial and error was combining the steps of the NSD model in the following eight major areas:

1. Discovery and analysis
2. Idea generation and concept development
3. Engineering service design and process
4. Simulation
5. Marketing program preparation and testing
6. Training
7. Implementation
8. Full-scale launch and measurement

These steps integrate all of the design activities of the service design. They include the enterprise and the engineering activities in addition to implementation engineering tools such as simulation. This integration was based on three criteria. First, involvement of all of the activities is essential which includes combining some functions and making multiple criteria with the same name as one activity. Second, assuring that both the practitioners and scholars approaches are included is essential in the integration of the activities. Third, the steps that are combined must be sharing the same resources and running in an efficient way based on the Petri Nets analysis tools. Petri Nets is essential in this development and improvement because you must know the resources necessary for each step before combining them and adding feedback loops. For example, to execute the analyzing step, the NSD model of the current service information should be available. This information is needed as well to execute the discovery step in the Design Council model. Thus, to execute the *"Discovery and Analysis"* step, this one single resource should be accessible for use.

Moreover, in the practitioner's model, the first step is customer discovery. In the scholar's model, the first step is business analysis. Combining these together in one step gives the opposite perspective of each approach. To do that, the resources should be ready for activation and ready to be recycled into the feedback loop to repeat the step. This simulation is an added value to the process that enhances the visualization by providing dynamic analysis. In addition, feedback steps are added to the process. The new process is developed in the PIPE software and is tested to be sure that it is live, bounded and short. Then, all the resources such as tools, equipment, human resources and customers are located in one place in the middle of the diagram. The last transition is for updating the system data. Figure 4.24 shows the PIPE diagram of the new service design model. It is called Integrated Service Design Model ISDM. One final improvement has been made as well. It has been noticed that these three steps are using different resources and could be processed in the same time. These steps are Marketing Program Preparation and Test, Training and Implementation. Thus, ISDM is improved to perform that. The result is shown in Figure 4.25. Table 4.17 shows description of the places and transitions and Table 4.18 shows the colors of the tokens of the ISDM.

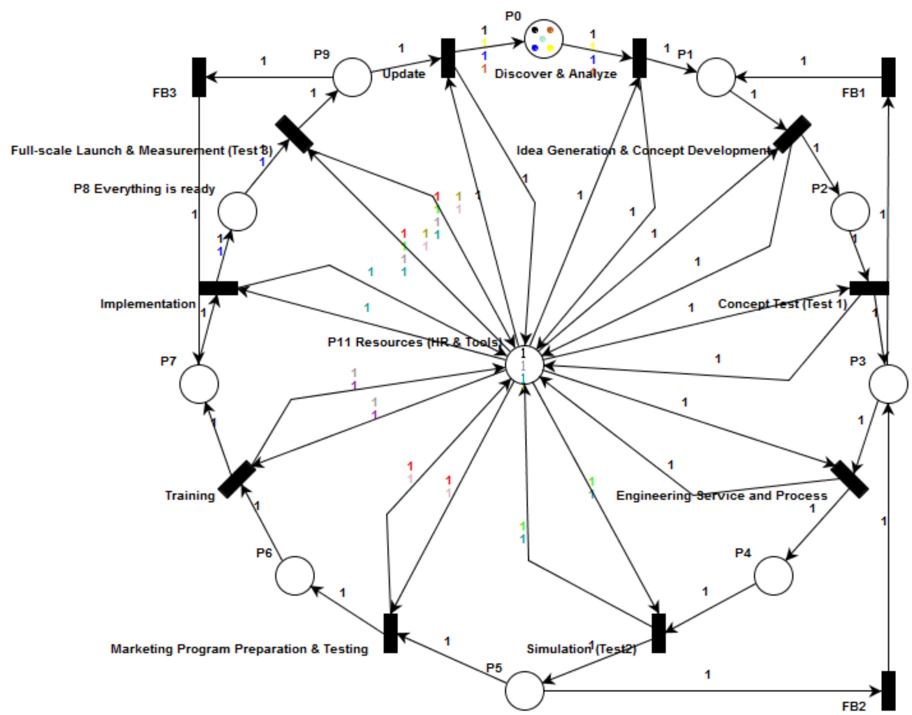


Figure 4.24. Enterprise and Engineering Service Design Model ISD Model.

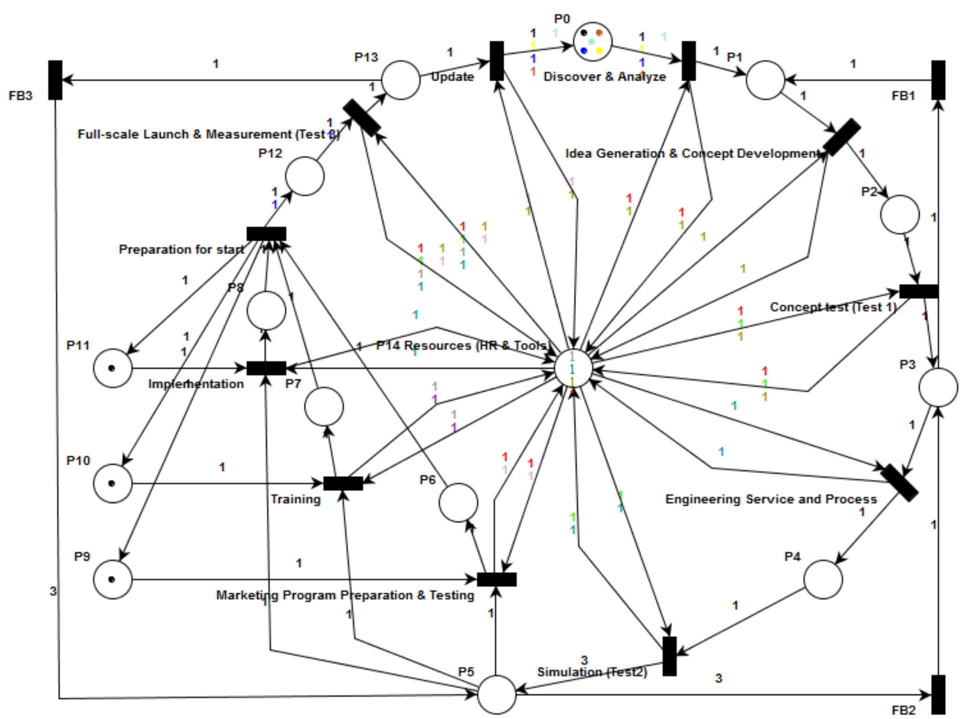


Figure 4.25. ISDM Improved Model.

Table 4.17

Description of the Petri Nets Diagram Place for ISD Model

Place Transition	Description	Place Transition	Description
P0	Data	**P6**	Marketing program is prepared and tested
T1	Discover and Analyze	**T7**	Training
P1	Customer defined and Market analyzed	**P7**	Training is done
T2	Idea Generation and Concept Development	**T8**	Implementation
P2	New ideas and Concept is developed	**P8**	Implementation is done
T3	Concept test (Test 1)	**P9, P10, P11**	Safety places for parallel steps
P3	Concept tested	**T9**	Preparation for start
FB1	Feedback loop (1)	**P12**	Service is ready to start
T4	Engineering Service and Process	**T10**	Full-scale Launch and Measurement (Test 3)
P4	Service and process designed	**P13**	Service is launched
T5	Simulation (Test2)	**FB3**	Feedback loop (3)
P5	The design accepted	**T11**	Update Data
FB2	Feedback loop (2)	**P14**	Resources (HR and Tools)
T6	Marketing Program Preparation and Testing		

Table 4.18

Token Colors for ISD Model

Token	**Color**	**Token**	**Color**
Budget information		Marketing personnel	
Customer		Operations personnel	
Customer Info		Service	
Default		Service design Eng.	
Manager		Service design Ente.	
Marketing and Environment		Training personnel	

Depending on the type of project and size of the organization, some of the token names could be different. For example, if they have a different staffing or management, this would be specifically reflected in these flexible token categories.

4.5. Modeling

The Petri Net analysis is straight forward for scholars and engineers, but not clear for practitioners. There is a need for an equivalent process representation to be used by practitioners. The diagram of Integrated Service Design Model (ISDM) addresses the main steps, sequences and feedback loops for both enterprise and engineering as shown in Figure 4.26.

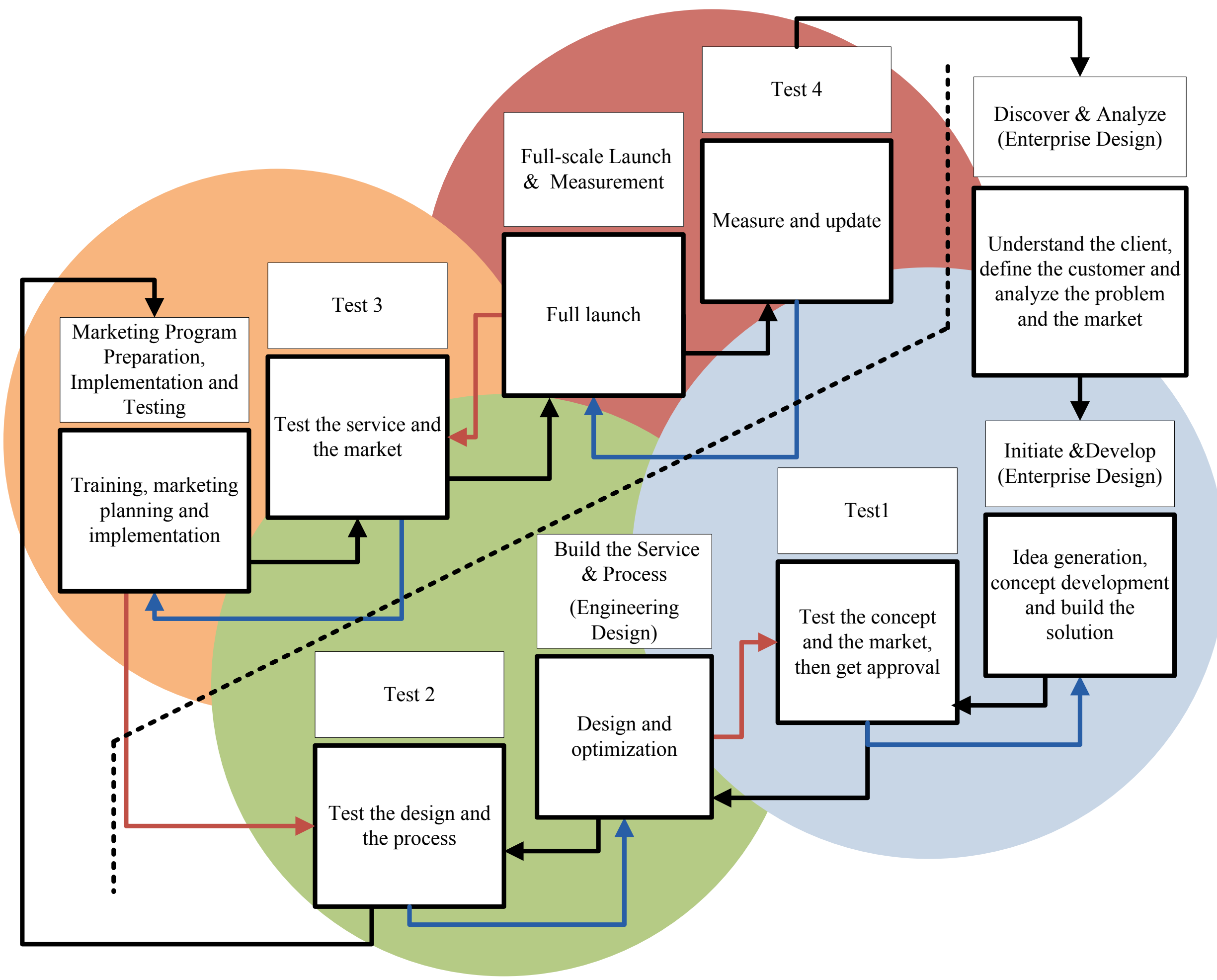


Figure 4.26. New ISDM for Practitioners

The ISDM is a result from the ISDM Petri Nets. There are three kinds of arrows in the above diagram. The black arrows show the normal sequence of the process. The blue arrows show the feedback loop of each main step, and as you can see above there are four feedback loops represented with a different colored circle. This feedback is the preferred action in the process because it is a short cycle for improvement within one stage. The red arrows are the less preferred feedback action where the designer needs to go back to the previous main step of the feedback loop. For example, the first blue loop has two steps: develop and test 1. Moving between these two steps, forward with the black arrow or backward with the blue arrow is within the circle and these are preferred actions. The designer can move as much he likes to be sure about the quality of the idea and the concept before moving to the next circle. If he moves to the next circle, he could go back but this action is not preferred because it involves repeating more than one step. The dotted line represents the boundary between the pure enterprise and engineering design activities and the other enterprise activities such as marketing and implementing the design. Table 4.19 is a comparison between the NSD model ISD Model.

Table 4.19

Comparison between NSD Model and the ISDM Model

Criteria	NSD	ISDM
Quality	No feedback loops	More than one feedback loop to evaluate the design and to ensure quality
Concurrency	Linear process	Concurrency to shorten design process
Integration	Segmented process	Completely unified and integrated to improve process management (ex. enterprise, engineering and implementation)
Utilization	No information or resource utilization.	Information and resources utilization to enhance efficiency

Moreover, Table 4.20 is a comprehensive table that shows all of the steps and their resources, data, tools and feedback for ISDM. This table can be used as guide for various designers' enterprise or engineering.

Table 4.20

ISDM Comprehensive Table

Step	Resources needed	Data needed	Tools needed	Feedback needed
Discovery and analysis	Team, computers and printers	Current service data	Marketing research, analysis software, user journey mapping, user diaries, service safari, user shadowing and user personas	The current implementation
Idea generation and concept development	Team, computers and printers	User data and market data	Brainstorming, design briefing, service blueprinting, experience prototyping, business model canvas, scenarios.	Test the concept or engineering design.
Engineering service design and process	Team, computers and printers	Developed concept data (enterprise)	Service blueprint, service capes, architecture software, layout software (AutoCAD), site selection software (GIS), queuing models methods, quality methods (SERVQUAL, HOQ, Six-sigma), encounter triad and supply chain methods	Simulation results or marketing test.
Simulation	Team, computers and printers.	New service data (enterprise and eng.)	Software simulation (ServiceModel)	Marketing test
Marketing preparation and testing	Team, computers and printers.	New service data (enterprise and engineering)	Marketing tools	Implementation
Training	Team, computers, training facility	New service data (enterprise and engineering)	Training tools	No
Implementation	Implementation team	New service data (enterprise and engineering)	Implementation tools	Full-scale launch
Full-scale launch and measurement	Team, computers and service facility	New service data (enterprise and engineering)	Launching and measurement tools	Test the Full-scale launch

4.6. Efficiency of New Model

Analyzing the ISDM model shows that all the SD activities are integrated, the long process cycle is reduced and the resources were utilized more effectively. The result of running the simulation analysis in the PIPE is shown in Table 4.21. The simulation parameters were set to make 50 firings and 5 replications. The simulation was run for all the alternative transitions that are listed in the Petri Net invariant analysis results of T-Invariants in Table 4.22. In addition, Figure 4.26 shows the reachability/coverability graph results that illustrated all the directions of the process. The result shows a better average number of tokens in each place which reflects better resource utilization. In addition, the results show that the 95% confidence interval is higher than in all the places where it was 0% for all places in the old NSD model. The net is covered by positive T-Invariants and P-Invariants therefore it is bounded and live. Note that this network is not timed.

Table 4.21

Petri Net Simulation Results for ISD Model

Place	Average number of tokens	95% confidence interval (+/-)
P0	0.03922	0.02431
P1	0.13725	0.04482
P2	0.13725	0.04482
P3	0.15686	0.05648
P4	0.03922	0.03074
P5	0.52941	0.10312
P6	0.13725	0.06612
P7	0.17647	0.03765
P8	0.15686	0.07913
P9	0	0
P10	0	0
P11	0	0
P12	0	0
P13	0.07843	0.01883
P14	0	0

Table 4.22

Petri Net Invariant Analysis Results of T-Invariants for ISD Model

T3	T1	T4	FB1	FB2	FB3	T10	T2	T8	T6	T9	T5	T7	T11
1	1	1	0	0	0	1	1	1	1	1	1	1	1
1	0	0	1	0	0	0	1	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0	1	0	0
0	0	0	0	0	1	1	0	1	1	1	0	1	0

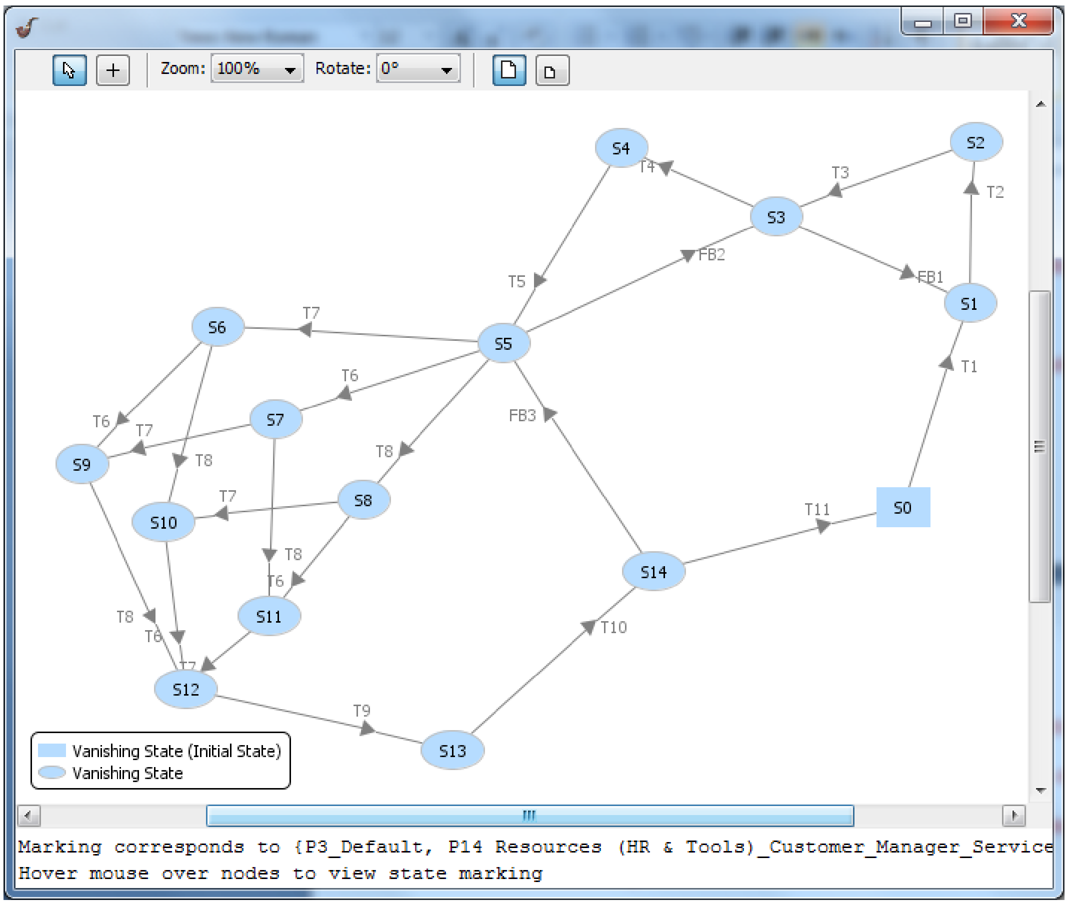


Figure 4.27. Reachability/Coverability Graph Results of the ISD Model.

The reachability/coverability graph (Figure 4.27) shows that the ISDM process is working in a multi-directional manner and now it appears more complicated than the previous graphical representations. For this reason, Petri Nets was used as an analysis tool. PIPE has been used to calculate all the functions and parameters and to ensure that the process will not become locked in a certain step without the required resources.

Table 4.23 shows and illustrates the five stages of the improvement process with their outcome improvement.

Table 4.23

Outcome Improvement of the Process

Stage	Outcome Improvement
Developing Petri Nets for the current NSD model	Developed Petri Net representation for the NSD and its improvements
Developing new Petri Nets with the feedbacks and integrated activities	Developed integrated Petri Net for the NSD with the feedback
Developing unified service design model	Integrated diagram in step 2 to the practitioner models
Improving the unified model	Added the concurrency concept to the unified model
Modeling	Developed an easy model to be used by practitioners that emphasizes the integration and the concurrency concept.

Moreover, the ISDM new model has many advantages in comparison with the old NSD model and the practitioners' models. These are as follow:

1. Feedback loops: Three feedback loops allow the designer to go back and change the design based on the feedback related to the step. Additionally, the ISD model tests transitions as they are associated with each loop. For the first feedback loop, the concept is tested; in the second feedback loop, the service design and process are tested by using a simulation; and in the third feedback loop, the entire service after implementation is tested. These three feedback loops cover the major decisions in the process and allow the designer to go back to the first step in the service design process.

2. Integration: The model situates all the service design activities in both enterprise and engineering in one process as shown in Figure 4.26. In addition, it integrates both strategies of the scholars and the practitioners. This result is attained by mixing the market analysis with customer discovery in the first step of the process.
3. Multi-directional processes: The NSD model was lacking the multi-dimensional approach. This problem has been solved in the ISD model through the multi-dimensional arrows among the process steps.
4. Concurrent activities: There were no parallel activities in all the previous models both for scholars and for practitioners. Using Petri Nets help to better utilize resources and help to make this decision. The parallel activities for sure will cut down the cycle time and save money.
5. Simulation step: The enterprise designers focus on visualizing the output of their activities. In the same manner, the engineering designers should simulate their service design. This step should be one of the major parts of the design process. It gives the process the strength it needs to test the whole service system and support the decision-making. The simulation was not in any processes, neither scholar nor practitioner models. It has been added as a new idea to test the service design that is intangible and as an extension to the previous work in the IESDA model.

4.7. Conclusion

In this chapter, Petri Nets are used to analyze and investigate the New Service Design (NSD) process. The properties and formulations of the Petri Nets provided a good methodology and analytical foundation to design the complexity needed for service design process. These properties have been used in the research to construct a new model for service design. The significant contributing improvements of the new service design are illustrated by the Petri Nets model and by using its analysis tools. The main contributions in this chapter are:

- Integration of SDP between scholars and practitioners
- Analytical foundation to improve the SDP
- Feedback loops to ensure quality
- Concurrency to shorten design process
- Process management improvement by unification and integration
- Information and resource utilization to enhance efficiency
- New comprehensive ISDM that is ready to use by scholars and practitioners

The utilization of resources is improved to work more efficiently in terms of the feedback loops. Adding the transition feedback improved the quality of the service, helped to get feedback from the stake holder and supported the decision-making. The new service design Integrated Service Design Model (ISDM) model that is proposed is a result of applying the Petri Nets as an analytical foundation tool and integrating the practitioners' service design process. The ISDM integrates both the enterprise and engineering design activities and tools in one model that is ready for use by scholars and practitioners.

CHAPTER 5

Conflict Reduction and Diversity Exploiting in Decision-Making

Both researchers and practitioners have recognized that design decision paradigms and priorities of the service designer are different than those of the service manager (Boland Jr & Collopy, 2004). The designers and the managers have their own judgment policies regarding the design. These differences often create a conflict between the designers and the managers during the service design process. Both of them should learn more about each other's perspective and decision-making policy. Engineering analysis tools that provide numerical explanation and interpretation could be useful to use in this case. The Lens Model has been used to capture "expert" judgment policies in several research applications. The Lens Model "may be taken to represent the basic unit of psychological functioning" (Brunswik, 1955). This chapter explains how the Lens Model is used to characterize decision-making policy in service design. Using the Lens Model to capture the judgment policy of both the manager and the designer and comparing between them leads to an improved decision-making process, better design and implementation.

5.1. Introduction

It has been mentioned in the literature review that the Lens Model is an effective model for capturing judgment policies in the human decision-making process. The Lens Model has been used in several research applications. Researchers use this model to describe how experts make judgments about their cases or tasks. The judgment or decision is usually based on key factors (criteria). These factors are not equal from a single judge's perspective and they have different weights that vary from across judges. In the Lens Model, these factors are represented by "cues".

The Lens Model with its extensions (Brunswik, 1955; Cooksey, 1996; Hammond, et al., 1975) is an application of linear models to the description of judgment behavior. The model provides dual, symmetric models of both the human judgment and the environment. This allows the judgments and the environmental criterion to be judged and to be described as linear combinations of environmental cues. Thus, the judgment policy and the environmental structure are captured in terms of cue-criterion relationships (Bisantz, et al., 1997). This allows assessment of the extent to which a human's judgment policy reflects and adapts to the structure of the environment (Bisantz, et al., 1997). Moreover, the Lens Model enables studying the complex interaction between the human and the environment by creating dual symmetrical models (S. Miller & Kirlik, 2006).

In this study, the Lens Model is used to analyze, capture and characterize the decision-making policies in service design. The objective is to create a model to capture decision making policies of the designers and managers during the service design process to reduce conflict, exploit diversity and encourage understanding of each other's perspective. The Lens Model systems used in this research follow the Brunswick approach, his formula and its parameters: achievement, knowledge, control, predictability, and un-modeled knowledge. Using the Lens Model to capture the judgment policy of both managers and designers and to compare them leads to a better design and process implementation. These steps, as they explained in the methodology, are shown in Figure 5.1. The objective is to create a model for analyzing and capturing the judgment of the designer's and manager's decisions during the service design process.

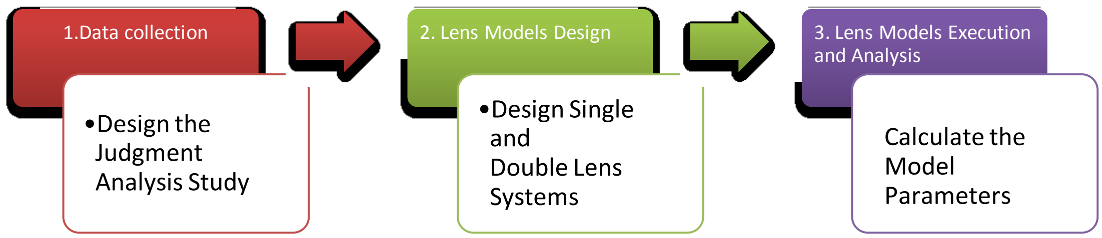


Figure 5.1. Framework for Lens Model Analysis.

For this research, the Lens Model describes the relationships between the design and the decision as a judgment behavior of both the designer and the manager. The relationships are interpreted as weights of the cues and correlations between them corresponding to the decision.

The "cues" present in the model are important to meeting this objective. Surveys, interviews, document analysis, objective analysis of the ecology and verbal protocol cue identification analysis are some methods outlined by Cooksey (1996). In this dissertation, surveys and interviews for designers and managers were used to identify the "cues". Based on the cues, single and double Lens Model systems have been designed and analyzed.

The Lens Model is the most appropriate judgment and decision approach for analyzing the decision in the service design for several reasons. It is suitable to be used when there are different opinions and perspectives that need to be compared. In addition, it is suitable for analyses and intuitive decisions and it adapts procedures from multiple regressions, that approach combines elements into a single framework. Moreover, a comparison among the judgment and decision approaches based on fourteen criteria shows that the criteria of this research are suitable for the Lens Model.

Based on the study of the tools used in the service design and the survey that has been done in this dissertation, the decision-making nature in the service design could be described as a combination of analysis and intuition. The more the design process becomes closer to the engineering service design tools, the decision becomes more analytical and objective. On the other side when the design process gets closer to the enterprise service design approaches, the decision becomes more intuitive and subjective. Most of the decisions in the enterprise service design activity, where this study is focusing, are based on intuition. Table 5.1 describes the characteristic of each decision nature as adapted from Cooksey (1996).

Table 5.1

Comparison between Analytical and Intuitive Decisions

Analysis- Engineering Level (objective)	**Intuition- Enterprise Level (subjective)**
Slow information processing	Rapidity information processing
Sequential nature	Simultaneous (snapshot) nature
Judgment process retraceable	Judgment process not retraceable
Consistency	Inconsistency
Propensity to produce few errors	Propensity to create conflict due to being non-retraceable
Reliance on pictorial/nonverbal	Reliance on quantitative cues
Emphasizes right brain	Emphasizes left brain
Leads to resolvable conflict	Leads to interpersonal conflict

The comparison among 14 judgment and decision approaches shows that the Lens Model is suitable for the objective of this research study. Cooksey, 1996 in the book *Judgment Analysis: Theory, Methods, and Applications* provides a comparison among 14 theoretical perspectives in decision research. The comparison is based on 14 criteria including the scope, the study that is being examined, the intended function of the decision perspective, the intended uses of research, loci uncertainty and diversity in subjects and tasks (Cooksey, 1996). The nature of the objective of this part of the dissertation study matches with the Lens Model judgment approach as shown in Table 5.2. Therefore, a Lens Model approach is appropriate for use in this study.

Table 5.2

Study Criterion

Criteria	Explanation	Study Criteria
Scope	The scope could just consider the judgment process or could be considered a comparison of judgment. This is characterized by system concepts (single, double, triple and n-system).	Single and double systems need to be used.
Intended function	The decision perspective intention could be prescription (correct), description, explanation (the way) or prediction.	Description: How are the judgments made? Prediction: What will the judge say in future?
Intended uses of research	It is the intention of translating the methodological concepts into procedure that can be used in the real world	Feedback, decision support and conflict resolution.
Loci uncertainty	The focus of the conceptualization theory could be environmental process, peripheral process, or central process feedback process.	Peripheral process: The interface between people and the environment, and also among the people themselves.
Diversity in subjects and objects	The number of subjects and objects that are used in the study.	The number of subjects and objects in this study are small.

5.2. Design the Judgment Analysis Study (Data collection)

To conduct the judgment analysis study, certain data needs to be collected and prepared. This data could include surveys, interviews, document analysis, objective analysis of the ecology, and verbal protocol analysis. The goal is to identify the cues, build cue profiles and judgment cases. Collection data needs to be well planned to get useful data for the suitability of usage. In this dissertation, two surveys were conducted. The first survey collected information about the cues that are used in the study. The second survey was for the judgment tasks.

Designing the judgment analysis study included defining the judgment context, the Lens Model system and the size of the research study.

5.2.1. Judgment Context

Two dimensions are determined by the judgment context: the familiarity of the tasks and the nature of the task information. The familiarity with the tasks is related to the judges. If the judge has made these sorts of judgments before in real life, then he/she is familiar with it and vice versa. The task information could be concrete or abstract. Concrete means that the task information is represented and/or obtained in original units of measurement encountered in the ecology. Abstract means that the task information is represented and/or obtained using abstract conceptual variables. Table 5.3 illustrates the intersection between these two dimensions. The judgment context of this dissertation is the B square where the judge is familiar with the task and the task information is abstract.

Table 5.3

Judgment Context (Cooksey, 1996)

	Concrete	**Abstract**
Familiar	A	B
Unfamiliar	C	D

The two surveys target specific populations who are familiar with service design. For the first survey, the participants are either involved in design activities, management within a design organization/consulting firm or a manager in a service-based industry who makes decisions about the service design. For this last instance, the manager intended in this survey is the authorized manager that makes decisions about the design (such as approvals or changes).

In the first survey, the most important factors in making a decision about service design from both the manager's and the designer's perspective have been investigated. The survey highlights some other issues such as the role of the participant in the organization regarding service design and the nature of the decision-making process. The survey also suggested some factors that are important for decision-making. Factors that used are customer needs, customer perspective and motivation, cost and revenue, quality easy to deliver (simple service process), creativity, ease of implementation, the market leadership, pioneering (new design), reliability, sustainability, accessibility, security and stability. These factors are developed in consultations with academics, practitioners and managers in the service design field. This information was obtained by running two surveys.

The result of the first survey that was completed supports the conclusion that the Lens Model is appropriate for this objective of this research. Figure 5.2 shows that around 86% of the survey participants are making their decisions based on their experiences and around 63% based on their intuition. Additionally, it shows that the size of the sample was 25 designers and 10 managers (Figure 5.3).

Some of these factors were selected for the second survey. The selection process was based on the contributions and the insight that these selected factors could bring to the study. Factors that could help the designer and manager to better understand each other were selected. More explanation was given in the second survey. These factors were used as cues in the judgment profiles of the second survey and in the Lens Model.

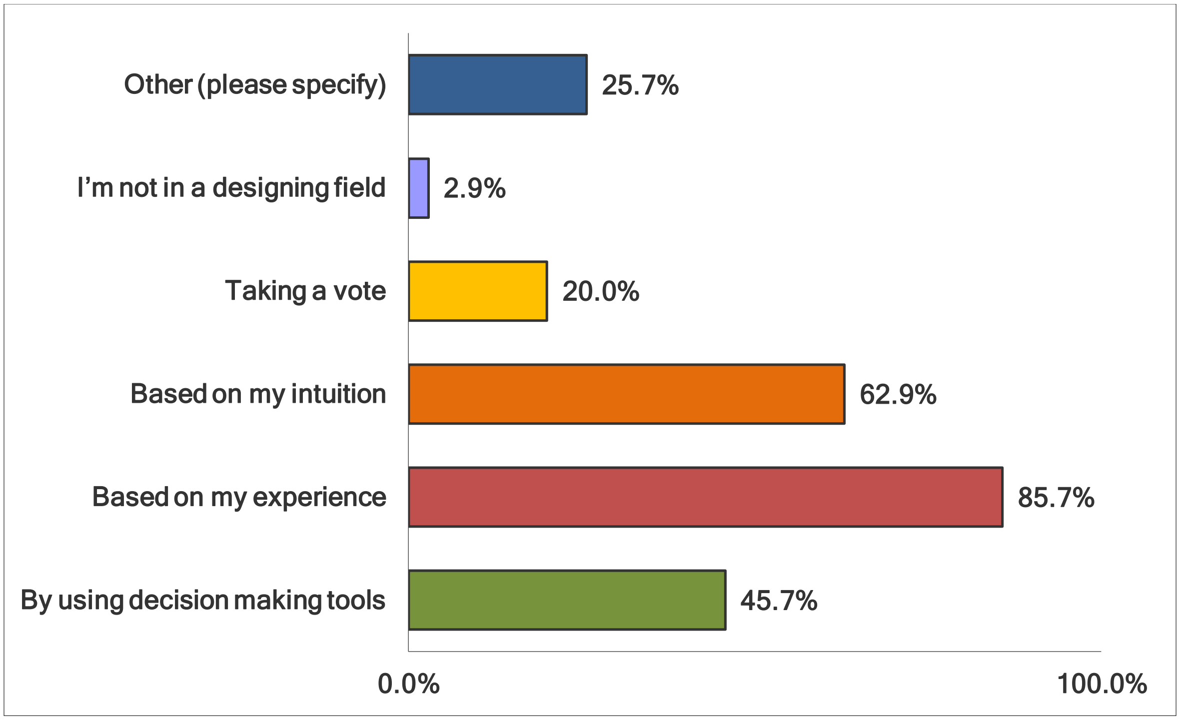


Figure 5.2. Decision-Making Nature in Service Design.

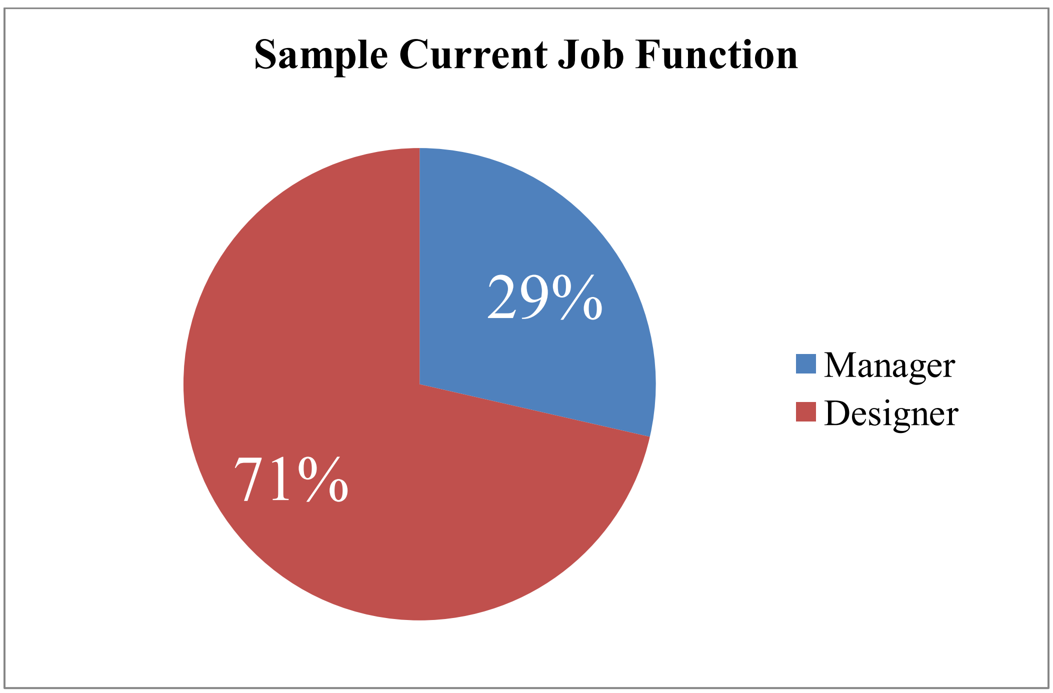


Figure 5.3. Sample Current Job Function.

For the second survey, the participants should be experts and familiar with the service design task. That means the judge (participant) has made these sorts of judgments before. Thus, in this study the judges were a service design professional and managing expert in the service design field. The task information is represented in abstract conceptual variables. For example, the design scenarios that the judges were asked to evaluate are the tasks in this study. Each task has different factor values which are the cue values. Each design was described as a scenario and the blueprint as a graphical map was represented. The scales used were a simple numerical scale from one to five, where one is very low and five is very high. Thus, cue profiles were created as judgment cases for the designer and manager. These simulated cue profiles are created by manipulating the combination of each cue.

5.2.2. Lens Model System Design

The Lens Model can be designed as a single, double, triple, or n-systems system (Cooksey, 1996). The focal intent of the study is the comparison between the two decision-making policies. The study is designed for individual judgments to compare them. Two Lens Model system designs were used, a single and a double system. A single Lens Model is designed to capture the service designer's decision policy and the service manager's decision policy as well. In addition, a double Lens Model system is used to compare between these two opposing perspectives.

The planned output from the Lens Model system design is as follows:

- Task information (TI): "How the cues relate to an ecological criterion measurement and how predictable that measure is from knowledge of all the cues" (Cooksey, 1996). In other words, this means how the factors are related to the manager criterion measurement and how predictable that measurement is for knowledge of all the factors.

- Cognitive information (CI): It is judgmentally-related information that gives the judge cognitive feedback when there is no available ecological criterion. Basically, it gives the judge (manager and designer) cognitive feedback when there is no available service design criterion or when there are other criterion that are not used to affect the judgments.
- Functional validity information (FVI): It links the task and cognition to each other. This informs how decision-making and cognition are linked to each other and whether or not this is valid.

5.2.3. Number of Cues

It is important to use correlated cues in the judgment case and to select the appropriate number of cues. The study is planned to investigate the traditional linear function forms, thus four cue numbers is an effective number for this sort of study (Cooksey, 1996). The results of the first survey show the most important factors that designers or managers consider when they make their decisions about the service design components and about the final design. Some of these factors are used as cues in the Lens Model. In addition, the first survey was not just designed to tell us the most important cues but also to tell us their order of importance or rank for both the designer and the manager.

Table 5.1 shows all the factors of consideration for designers and managers ranked in the order of importance based on the results of the first survey. There is an agreement between both the designers and the managers about the five most important factors; however, the order was different between them.

Table 5.4

Result of Factor Ranking for Managers and Designers

	Designer Order	Manager Order
1	Customer needs	Customer needs
2	Customer perspective and motivation	Cost and revenue
3	Cost and revenue	Customer perspective and motivation
4	Quality	Creativity
5	Easy to deliver (Simple service process)	Easy to implement
6	Creativity	Leading the market, pioneering (New Design)
7	Easy to implement	Easy to deliver (Simple service process)
8	Leading the market, pioneering (New Design)	Quality
9	Reliability	Sustainability
10	Sustainability	Security
11	Accessibility	Accessibility
12	Security	Reliability
13	Stability	Stability

A quick look at the results in Table 5.4 shows that managers and designers agree about the ranking for just three factors and disagree about all the other ten factors. For example, it is clear that the importance of quality is much more important for the designer than the manager, while leading the market is slightly more important to the manager than the designers. However, it is also clear that they concur that customer needs are the most important factor in service design.

With this being said, it is not always necessary to further explore the most important factors such as customers' needs for many reasons. The purpose of using the Lens Model is to help both the designers and the managers understand each other's perspective and understand the difference between their respective decision policies. The factors that are the highest ranking were not selected because they are most likely to be explicitly recognized during design collaboration. For example, it is clear to both the manager and the designer that customer satisfaction is essential. On the other hand, the factors that often have the most ambiguity associated with their selection are the factors that are the lowest ranking. The goal is to exploit these differences and perspectives in the decision-making of these lowest ranking and ambiguous factors. Investigation in these factors will give the designers and the managers more insight and explain the hidden conflicts. These are the factors that will be analyzed more closely in the second survey.

The factors that were chosen for the second survey are stability, reliability, security and sustainability. They were chosen because of the implied ambiguity. It is hard to make their selection process clear in the enterprise service design step where most of decisions are based on intuition and experience. This lack of clarity in selection could lead to disagreement and poor interpretation. Providing the designers and the managers more information about the importance of these factors will help them to clearly define these attributes and pay closer attention to these during the design process and it will also prepare them to understand the diverse perspectives as well.

The next step is using these factors or “cues” to create service designs or “cue profiles” to be judged by designers and managers in the second survey.

5.2.4. Number of Cue Profiles

The number of cues and the number of cue profiles is one of the most important decisions that should be made in designing the judgment study. Many factors need to be considered in such a decision, among these is the number of cues available for making the judgment. For a multiple regression, a five case to every cue utilized ratio is considered the minimum (Cooksey, 1996). However, this ratio is connected to the level of the anticipation regression model and the cue inter-correlations. In this study, cues have a high connection with the task and the inter-correlations are low to zero.

By using four factors, twenty different designs are created for the second survey. Each design has different parameter/factor values which provide the cues values for the Lens Model.

5.2.5. Construction of Judgment Measures

Each cue gives a level from one to five. One is the lowest level and five is the highest level of the cue. In order to capture the manager's and designer's decision-making policy, they were asked to give a score form one to five for each cue from their perspective. In addition, they were asked to give a score form one to ten for each design as a whole from their perspective. Ten is the best ranking design and one is the worst.

In order to do that, each cue was decomposed to contributing characteristics. Each item gives a point. For example, Table 5.5 illustrates how the security level was determined. (The complete list of cues can be found in Appendix A)

Table 5.5

Security Levels

Item	Point
The elevator functions without the magnetic card key (Available or not)	1
Magnetic cards for room access and other hotel facilities (Available or not)	1
Security personnel (24/7 or not)	1
SAFE in each room (Available or not)	1
Cameras (just in the lobby or cover all the hallways and corridors)	1

The levels of the cues are manipulated in each design to create different judgment profiles. Each design was submitted with a scenario and blueprint which manipulates the levels of the four cues that have been selected. The service that is used as an application for this survey is a hotel. Table 5.6 shows the levels of the factors (cues) for each scenario. The second survey is given to a few experts in service management and service design fields. Some expert designers are consulted in advance regarding the factors to develop the survey. Both surveys are approved by an Institutional Review Board (IRB). Copies of both surveys are included Appendix B.

Table 5.6

Levels of the Factors/Cues

Service Design #	Service Design Scenario Code	Stability	Security	Sustainability	Reliability	Design Level
1.	A1	5	2	5	4	
2.	A2	5	4	3	3	
3.	A3	5	5	2	4	
4.	A4	5	5	5	2	
5.	B1	2	5	5	2	
6.	B2	2	2	5	2	
7.	B3	3	5	5	4	
8.	B4	3	5	2	4	
9.	C1	3	5	5	3	
10.	C2	4	5	2	3	
11.	C3	4	1	4	4	
12.	C4	4	1	4	4	
13.	D1	4	5	5	5	
14.	D2	4	5	5	1	
15.	D3	4	1	5	5	
16.	D4	4	1	5	1	
17.	E1	5	3	5	1	
18.	E2	5	3	5	5	
19.	E3	5	3	2	5	
20.	E4	5	3	2	2	

5.3. Lens Models Design

A single Lens system is designed and used to capture the decision policy for each respective view-point. The aim is to identify the relationships between the judge's cognitive system and the judgment/task system (design of the service). Figure 5.4 shows the single Lens system design with the four cues. In this design, there is no right answer (Ecology/Environment). Values for W_{s1}, W_{s2}, W_{s3} *and* W_{s4} weights of each factor or cue from the judge's perspective are determined. These values are different from one judge to another. The judges are the designers and the managers.

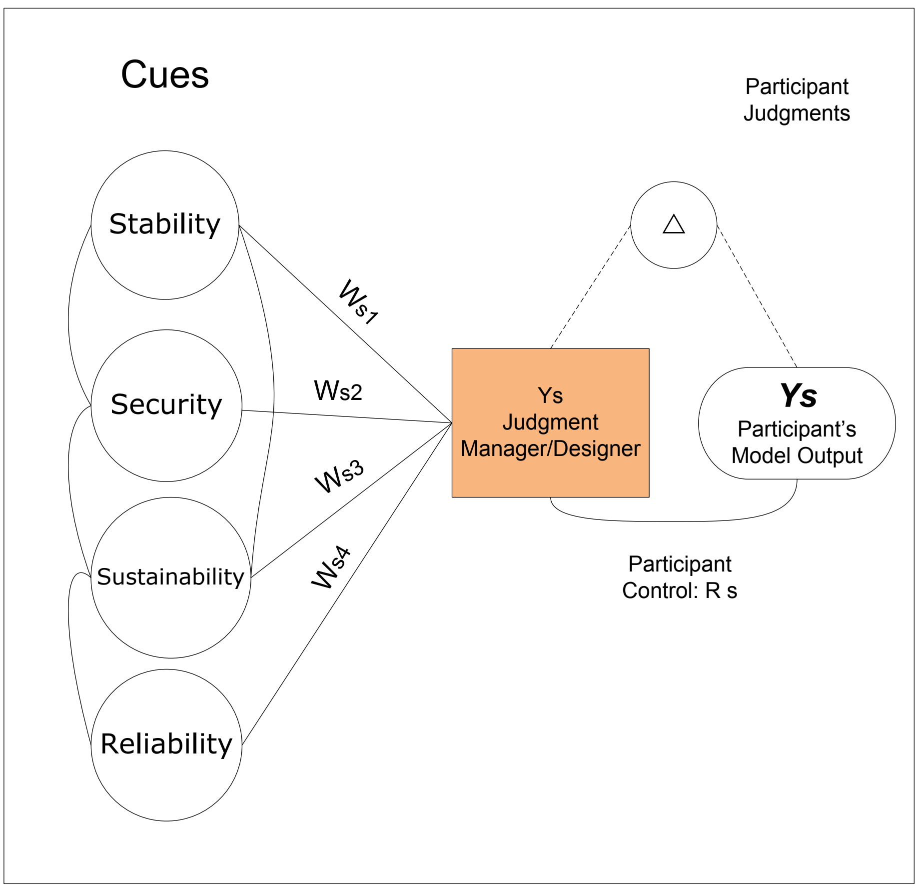


Figure 5.4. Single Lens System.

The double Lens system is designed and used to compare the two decision policies that have been captured separately for the designer and manager. The double Lens system is shown in

Figure 5.5. The double Lens system is designed to use the manager's decision perspective as an ecology/environment. The weights for cues from the manager's decision perspective are W_{e1}, W_{e2}, W_{e3} and W_{e4}. On the other side are the weights of cues from the designer perspective W_{s1}, W_{s2}, W_{s3} and W_{s4}. The closer these weights are to each other, the more the decisions converge and the conflicts are reduced.

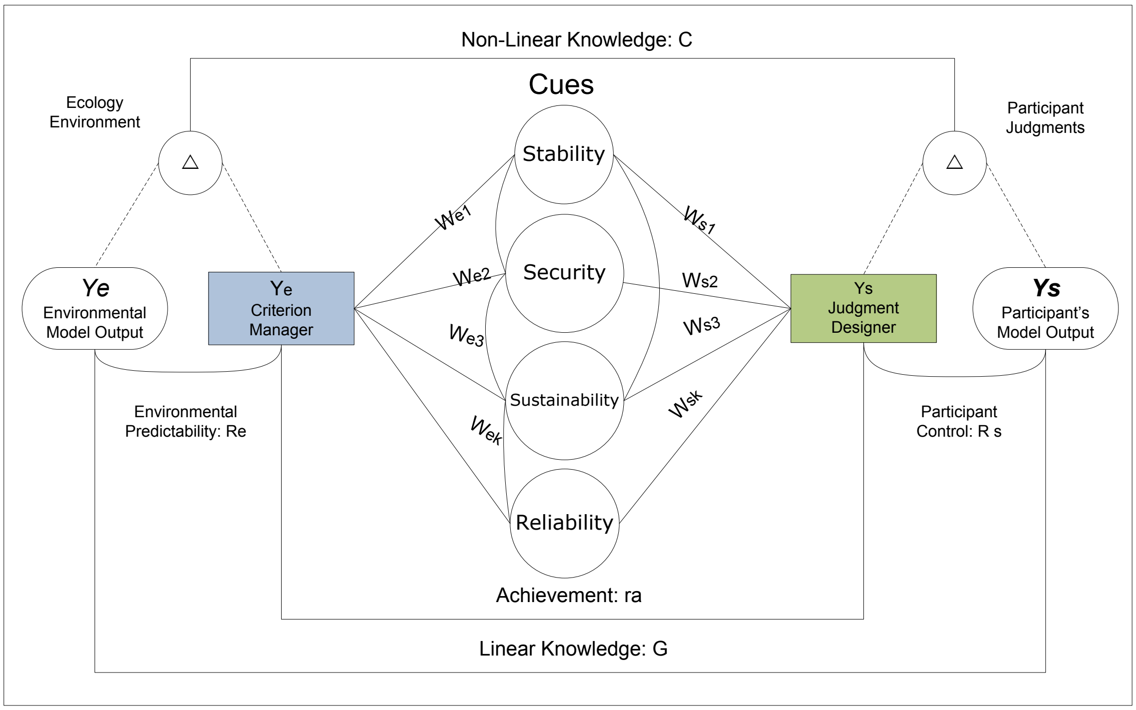


Figure 5.5. Double Lens System.

5.4. Lens Models Execution and Analysis

After the survey results were collected, the models are built, and the model analyses run. The analyses of the two single system Lens Models, one for the manager and the other for the designer, are run. The analysis provided the values of the weights ($W_{s1}, W_{s2}, \dots W_{sk}$).

Analysis ToolPak in Microsoft Excel was used for data analysis and for calculating all the Lens Models' parameters and correlations. The data tools analyses that have been used included:

- Multiple Regression Analysis
- Correlation Analysis
- Descriptive Statistics

The variables that are used for these analyses are shown in the following Table 5.7.

Table 5.7

Variables for the Analyses

Independent Variables With level from 1 to 5	**Dependent variable With level from 1 to 10**
Stability, Security, Sustainability and Reliability	Overall design evaluated

The goal of running the multiple regression procedures is to produce a linear equation that optimally weights each cue in terms of its predictive contribution to the judgments. This is the form of the linear equation for any subject:

$$Y_s = [b_0 + W_1 X_1 + W_2 X_2 + \cdots + W_k X_k] + e$$

$$Y_s = \hat{Y}_s + e$$

$$Y_S = \text{Predicted Judgment Model} + e$$

Where: Y_s the actual value of the subject or the right decision

b_0 The regression constant W_k Regression coefficient for each *k* cue (*b-weights*)

e The prediction error $\hat{Y}_s$ The predicted value

The correlation between the actual judgments and the predicted judgments of *(i)* profile is represented as $corr(Y_s, \hat{Y}_s) = r_{Y_s \hat{Y}_s}$ and it is termed R_s. The R_s^2 yields the proportion of the variance in judgments from liner model of the judge. In addition to the above analysis, the scores of each cue are converted to standard scores or *Z*-scores which always have a mean of 0 and standard deviation of 1.0 to remove the typical measurement between the cues. This transformation in the weights removes the measurement scale influences, and supports the relative comparisons among the cues (Cooksey, 1996). Thus a different form of the policy equation emerges.

$$Z_{Y_s} = \left[\beta_1 Z_{X_1} + \beta_2 Z_{X_2} + \cdots + \beta_k Z_{X_k}\right] + e,$$

$$\text{where } \beta_i = b_i \frac{sd_{X_i}}{sd_{Y_s}}.$$

More relative weights were calculated as well. These weights are: rw_i, $rw_{U_i} and\ rw_{\beta_i}$. The weights are meant to index the independent contribution of each cue to the prediction of judgments to me more connecting to the study content. These weights introduced by Hoffman (1960) (Cooksey, 1996). The following is the formulas for these weights:

$$\text{Relative weight for the } i_{th} \text{ cue is } rw_i = \frac{\beta_k r_{Y_S.X_i}}{R^2_{Y_S X_{1,2,..k}}}.$$

$$\text{Beta weight is } rw_{\beta_i} = \frac{|\beta_i|}{\sum_{i=1}^{k}|\beta_i|}.$$

Usefulness coefficent from the simultaneous regression policy model is

$$rw_{U_i} = \frac{sr_i^2}{\sum_{i=1}^{k} sr_i^2},$$

where: $r_i^2 + \sum_{i=2}^{k} sr_i^2 = R^2_{Y_s X_{1,2,..k}}$ and

$$sr_i^2 = \frac{t_i^2}{m-k-1}\left(1 - R^2_{Y_s X_{1,2,..k}}\right).$$

$R^2_{Y_s X_{1,2,..k}}$ Is the full model considering all the available cue yields

$R^2_{Y_s X_{1,2,(i)..k}}$ Is the full model consider all the cues expect the one cue (i)

(R) is correlation and *(k)* is the number of cues and (*i)* is the number of cue profiles

Table 5.8 shows the summary of the analysis results of the second survey for the first designer. The result shows a high correlation (*R Square* = 0.9699) between the level of the service design (DES) and the cues which means that there is a high relationship between the decisions and the factor's combination. In other words, decisions were made based on the values of the combination of the factors by 96%. The validity coefficient (*r*) for security is the lowest one which means the influence of the security level in the decision had the lowest impact in comparison with the other factors.

Table 5.8

Results of the Second Survey (Designer1)

Weighting Scheme	DES	CUES Stability	Security	Sustainability	Reliability
Validity Coefficient (r)		0.6997	0.2302	0.6831	0.6970
b-weight		0.5541	0.3886	0.3842	0.6930
SE(b)		0.0928	0.0570	0.0456	0.0675
R Square	0.9699	0.7796	0.8057	0.8486	0.9189
Cue Standard Deviation	1.3717	0.7678	1.2085	1.4464	1.1286
t-test		5.9696	6.8200	8.4178	10.2660
Usefulness (sr^2)		0.0716	0.0934	0.1423	0.2116
β-weight		0.3101	0.3424	0.4051	0.5701
SE(β)		0.0954	0.1017	0.1151	0.1573
t-test		5.96958	6.819994921	8.417805501	10.266045
p-value		2.6E-05	5.79304E-06	4.5747E-07	3.533E-08
Hoffman rw_i		0.2237	0.0813	0.2853	0.4097
Usefulness rw_{u_i}		0.1379	0.1800	0.2742	0.4079
Beta rw_{β_i}		0.1905	0.2103	0.2489	0.3503

More analyses in Table 5.9 show the correlations among the cues and the mean, median and mode for each cue for the first designer. In general, the correlations among all the cues are less than (0.5). The analyses of the cues' mean shows that all the ranks are above (3.250) with a low standard deviation. This means that the differences in the designs were small at least from the first designer's point of view.

Table 5.9

Correlations among the Cues (Designer1)

Cue Correlations	*DES*	*Stability*	*Security*	*Sustainability*	*Reliability*
Rank/DES	1	0.6997	0.2302	0.6831	0.6970
Stability	0.6997	1	0.1134	0.2844	0.4130
Security	0.2302	0.1134	1	0.0979	-0.3280
Sustainability	0.6831	0.2844	0.0979	1	0.2741
Reliability	0.6970	0.4130	-0.3280	0.2741	1

Descriptive Statistics	*DES*	*Stability*	*Security*	*Sustainability*	*Reliability*
Mean	7.250	4.200	3.750	3.250	3.300
Median	7.000	4.000	4.000	3.000	3.000
Mode	7.000	4.000	5.000	3.000	3.000
Cue Standard Deviation	1.3717	0.7678	1.2085	1.4464	1.1286

The above analysis and calculations are done for two more designers and one manager as well. Table 5.10 shows the analysis results of the second survey for the manager. The result shows a very high correlation (0.9994) between the level of the service design (DES) and the cues. The highest validity coefficient was (0.9327) for the sustainability which is ranked ninth (the first one among the four factors that were used) in the most important factors in the design decisions for the managers.

Table 5.10

Results of the Second Survey (Manager)

	CUES				
Weighting Scheme	DES	Stability	Security	Sustainability	Reliability
Validity Coefficient (r)		-0.1008	0.5831	0.9327	0.6227
b-weight		0.5232	0.5240	0.4900	0.5104
SE(b)		0.0280	0.0188	0.0049	0.0123
R Square	0.9994	0.9634	0.9847	0.9988	0.9935
Cue Standard Deviation	0.9438	0.2351	0.3670	1.4409	0.5821
t-test		18.6651	27.9138	99.7415	41.3488
Usefulness (sr^2)		0.0150	0.0337	0.4297	0.0739
β-weight		0.1303	0.2038	0.7481	0.3147
SE(β)		0.0344	0.0531	0.1933	0.0816
t-test		18.6651	27.9138	99.7415	41.3488
p-value		8.56312E-12	2.40777E-14	1.37907E-22	7.13882E-17
Hoffman rw_i		-0.0131	0.1189	0.6981	0.1961
Usefulness rw_{u_i}		0.0272	0.0609	0.7781	0.1337
Beta rw_{β_i}		0.0933	0.1459	0.5355	0.2253

The results seen above are taken from running the single Lens Models for three designers and one manager. It shows a very high correlation (*R Square*) between the level of the service design (DES) and the cues for all the Lens Models. In addition, it shows different levels of cues' weight for all the participants. The results are used in the double Lens Model for deep investigation about these differences.

The analysis for the double Lens Model are performed with the comparison between the designer's cue weights on the right side of the model and the manager's cue weights on the left side of the model.

Achievement (Ra) is calculated as follows. It is the degree of correlation between the designer's judgment and the manager's judgment as an actual design criterion. This parameter reflects the match between the designer judgment and the manager judgment. The larger the r_a, the closer the decisions of both the designer and the manager.

The Lens Model equation (Cooksey, 1996) (Hammond, et al., 1975) describes the relationships among all of the previously mentioned parameters:

$$r_a = GR_SR_E + C\sqrt{1 - R_S^2}\sqrt{1 - R_E^2}$$

The following parameters are calculated as well:

The Knowledge (G) quantifies the similarity of the linear model of the designer judgment to the linear model of the manager judgment. It is computed as the correlation between the output of the human model (Y_s) and of the environment model (Y_E) by using the same group of cue values for both models (Bisantz & Pritchett, 2003).

Cognitive Control (R_S) measures the degree to which the decisions made by designer or manager are predicted by their linear models. It is also referred to as describing how consistent the linear rule is applied in making a judgment (Bisantz, et al., 1997).

Environmental Predictability (R_E) analyzes the degree to which the judgments made by the manager criterion are predicted by their linear models. In other words, it reflects how well a linear model predicts the ideal manager decision.

Un-modeled Knowledge (*C*) measures the degree to which the policy models of the designer judgments and the manager judgments share the same nonlinear components. *C* is calculated as the correlation between the residuals of the designer and manager policy. Table 5.11 is the comparison summary for all the above parameters between the three designers analysis results and manager analysis result.

Table 5.11

Lens Model Analysis Comparison Summary

Parameters	D1	D2	D3	M	D1-M	D2-M	D3-m
Achievement (ra)	-	-	-		0.3097	0.5691	0.5368
The Knowledge (G)	-	-	-	-	0.1166	0.6231	0.4735
Cognitive Control (Rs)	0.8323	0.9848	0.9367	-	-	-	-
Environmental Predictability (Re)	-	-	-	0.9997	-	-	-
Unmodeled Knowledge (C)	-	-	-	-	0.1393	0.1633	0.0398

The predicted level of the manager's model is very high (*Re* = 0.997). The *Re* is the multiple correlations coefficient between the predicted judgments and the actual judgments made, by the manager, across all judgment profiles. This correlation represents the subject's cognitive control and the consistency of the execution of the manager's judgment policy. In addition, it represents the optimal predictability of the manager's decision given the set of cues that were used. If the model is perfect the *Re* is = 1.0.

The best predicted model among the designers is the second designer which has the highest (*Rs* = 0.9848). The *Rs* is the multiple correlations coefficient between the predicted judgments and the actual judgments made, by designers, across all judged profiles. This correlation represents the subject's cognitive control and the consistency over the execution of the designers' judgment policy. If the model is perfect the *Rs* is = 1.0 and as much as the *Rs* is higher the better the model.

The second designer has the highest knowledge level as well (*G* coefficient = 0.6231). That means the second designer policy is the closest policy to the manager's policy and the degree of the knowledge matching is (62.3 %) as shown in Figure 5.6.

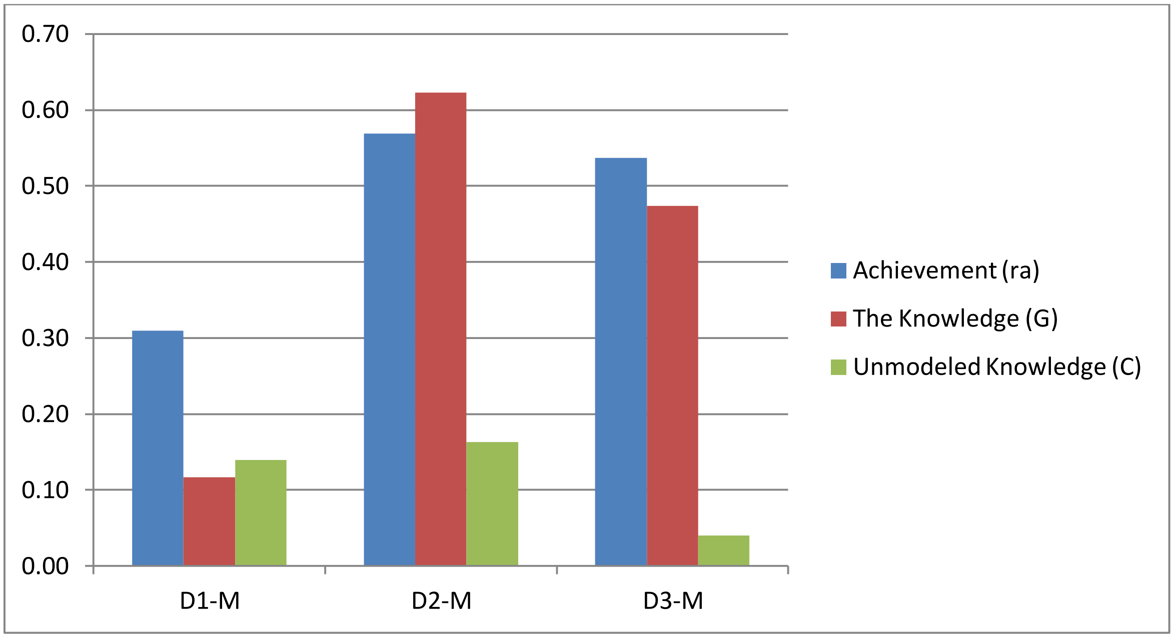


Figure 5.6. Comparison Summary of ra, G and C Coefficient.

While *Rs* and *Re* are very high the *Ra* and the *G* coefficients are low, it indicates that the designed Lens Model, for capturing the designers' and managers' judgment policy, has a very high level of prediction, but the agreement between the designers and the manager is low. The model allows the designer to find out the degree of the agreement for his/her decision with his/her manager's decision based on the (*ra*) value.

More analysis of the cue weights helps to better understand the decision policy. The result of the comparison among the b-weights is illustrated in Figure 5.7. It shows that the second designer is the closest b-weights level to the manager and the third designer is the distant one. Moreover, the manager's b-weight values are almost equal which means that the factors have been treated equally in the decision-making.

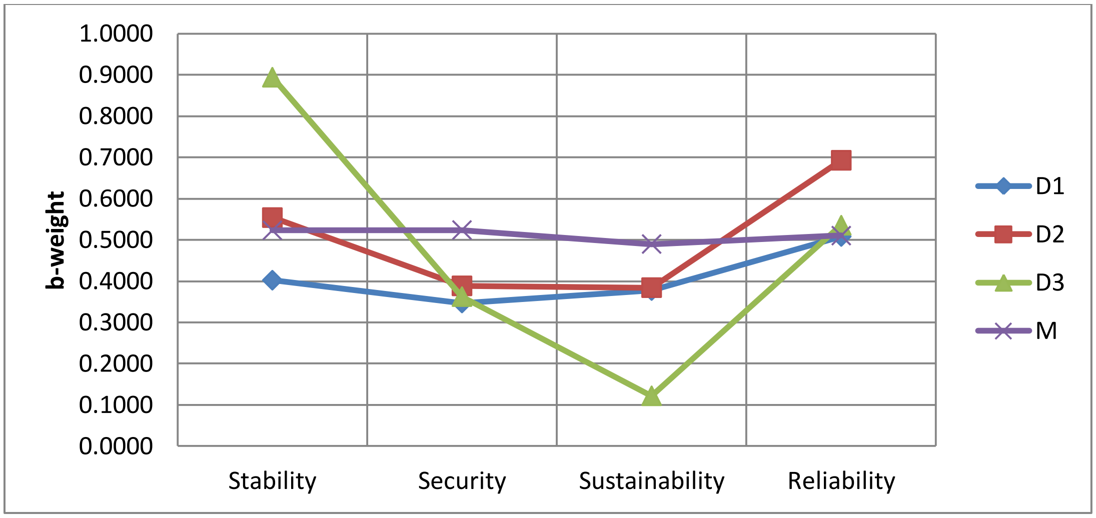


Figure 5.7. b-weights Comparison.

β-weight is more connected to the study content because it is interpreted as the expected change in the standardized judgment prediction for a unit increment in the i^{th} standardized cue score. The β-weight shows that level for sustainability is higher than all the designers' levels by a very significant amount (Figure 5.8). While the stability level for the manager is lower than the designers' levels by a significant amount.

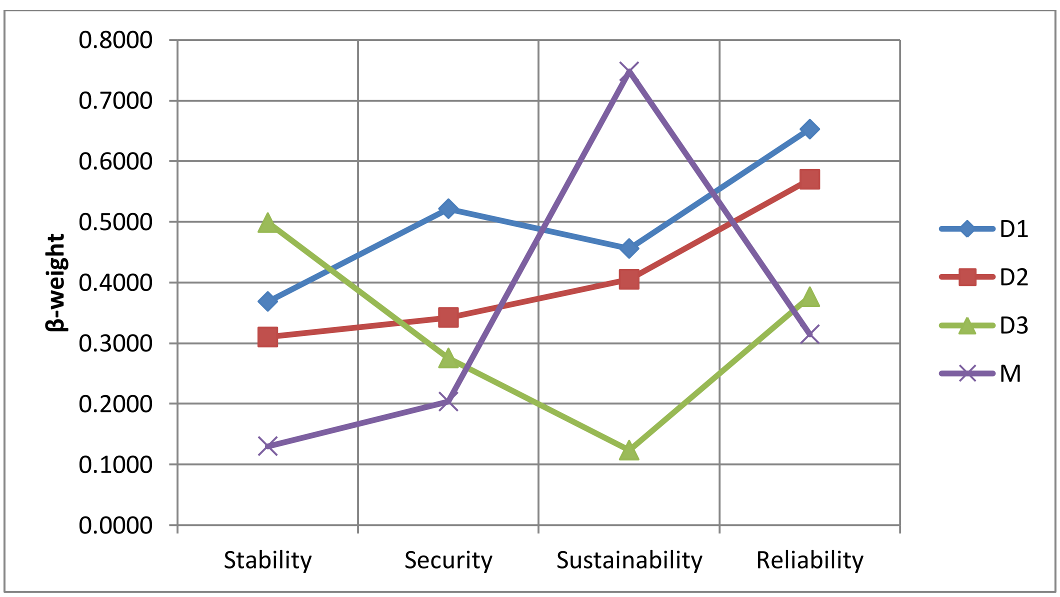


Figure 5.8. β-weights Comparison.

These two factors need more attention for both managers and designers during the service design decision-making. They need to work together to determine the difference in dealing with these two factors and agree upon the best “weight” they should follow. The other weights such as rw_i , rw_{U_i} and rw_{β_i} could be used as well in this matter.

One more measure can be used, which is the *Euclidean distance* measure of dissimilarity. It computes between any two cue weights profiles (i and j) for k number of cues:

$$d_{ij}^2 = \sum_{h=1}^{k} (w_{ih} - w_{jh})^2$$

The d_{ij}^2 compiles all the important sources of the information that could be neglected due to the standardization cue weight profiles. While the correlation of two cue weight profiles shows that they are exactly parallel or monotonically identical in direction to movement, the d_{ij}^2represents the true dissimilarity or similarity between these two cue weight profile in every detail. Figure 5.9 show Euclidean distance measures of dissimilarity comparison for all the cue weight measurements. It illustrates a low value of d_{ij}^2 between the manager and the second designer in all cue weight profiles except b-weight.

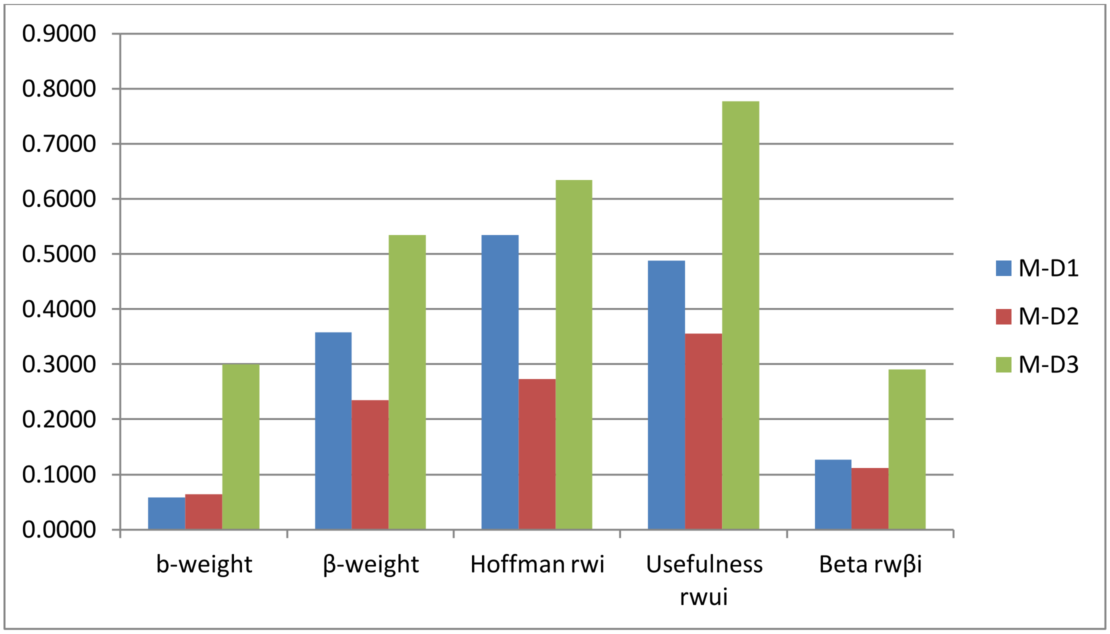


Figure 5.9. Euclidean Distance Measure of Dissimilarity Comparison.

The result of using the Lens Model analysis provides deeper rationale for design preference and indicates likely areas of conflict. Note that conflict is helpful in generating a diversity of designs assessed by a diversity of cues. This analysis assists in working toward consensus in final design. Knowing more about the cues helps both the designers and managers to come up with new designs by manipulating the values of the factors' weights.

5.5. Conclusion

The designer and the manager are typically faced with the daunting task of making decisions for appropriate service design components and elements. The Lens Model is used in capturing and comparing the decision-making policies of the designers and managers. Single Lens Model systems are designed to capture the decision policy for the service designer and service manager viewpoint. A double Lens Model system is used to compare the perspectives. These systems follow the Brunswick approach, his formula and its parameters will be used: achievement, knowledge, control, predictability, and un-modeled knowledge. The results of the

Lens Model application provide support for the decision-making process by helping both the designer and manager to recognize each other's perspectives. The Lens Model is a judgment analysis technique that can be applied to solve real problems or conflicts such as a conflict in the service design. This application includes resolving the conflict, reducing it or coming up with new solution.

Furthermore, the Lens Model as a judgment analysis technique can be developed to investigate different cues or to capture customer perspectives .As a contribution, besides being the first use of the Lens Model in the service design field, this model helps to develop a design that was based on understanding multiple perspectives and unifying them to find the final solution. The model could be used between the main steps or in the final step. Using the Lens Model to capture the judgment policy of both the managers and the designers and comparing them may lead to a new design and implementation. The strength of multiple perspectives and sharing these makes for a stronger service design.

CHAPTER 6

Customer-Integrated Service Design

Service design involves designing a service to make it useful, enjoyable and cost-efficient for the customer. Though still relatively new, the field of service design has been a rapidly growing field, in both research and in practice. A key growth area is creating service design in which the customer is central to the design process. Such "customer-centered" approaches give significant attention to the consumers' needs, desires, and limitations. Yet, these approaches view customers as a burden, often viewed as data input points to the service design process. These approaches leave room for a more comprehensive consideration of customer system contribution or supplementary benefits. Asset-based System Engineering (ABSE) is a recently introduced concept that attempts to synthesize systems around their key assets and strengths. This dissertation proposes an ABSE approach for service design that views customers as a primary asset. Customer integration in the design process is achieved through an Asset Capabilities/Capacity/Motivation Assessment based on a traditional FMECA process. Ramifications to the service design tools are suggested in this chapter. A number of new tools that adopt the asset-based approach for the service design and focus on the customer as a core asset in the system are introduced along with a developed example in the tourism industry. Note that research activities in chapters 4 and 5 were more analytical in nature. This chapter provides a more conceptual approach.

6.1. Introduction

The asset-based approach focuses on what is currently working and what is inside the system rather than what it is external (Paek, 2008). Furthermore, "Asset-based approaches are approaches of engagement, which aim to identify the resources and capabilities that exist across communities, groups or individuals" (Lynch, 2008).

Asset-based thinking "is intended to affirm and to build upon, the remarkable work already going on" (Kretzmann, et al., 1993). ABSE focuses on the development of the system's assets and how these assets could be utilized. In the literature review, several process models of service design proposed by scholars or used by practitioners are introduced. The logic and strategies behind these approaches are different. The scholars' service design process begins from defining the business strategies, service strategies, or marketing strategies with stakeholders' guidelines while the practitioners start their service design process from the customer itself. Practitioners adopt the service design thinking approach where the process is based on the customer's perspective. The scholars' models do not make the customer the focal point. Figure 6.1 illustrates the strategies of these two approaches and compares them with the newly designed ABSE approach that is proposed in this dissertation.

Both of the old approaches view customers as data sources and fail to fully consider their possible contribution or supplementary benefits in the service system. These approaches focus on problems and deficiencies in the system. They are built on creating new service by bringing in external resources or elements from outside the system which could be expensive. Finally, old models consider customers as a burden on the system.

The proposed approach, which follows the FIRST model, suggests that assets should be the focal point for the process and that customers are perhaps the most important asset. In other words, a user-centered design is elevated to an asset approach. This change forms a fundamental difference in the service design approach that could change the current thinking, processes, methods and tools used by practitioners.

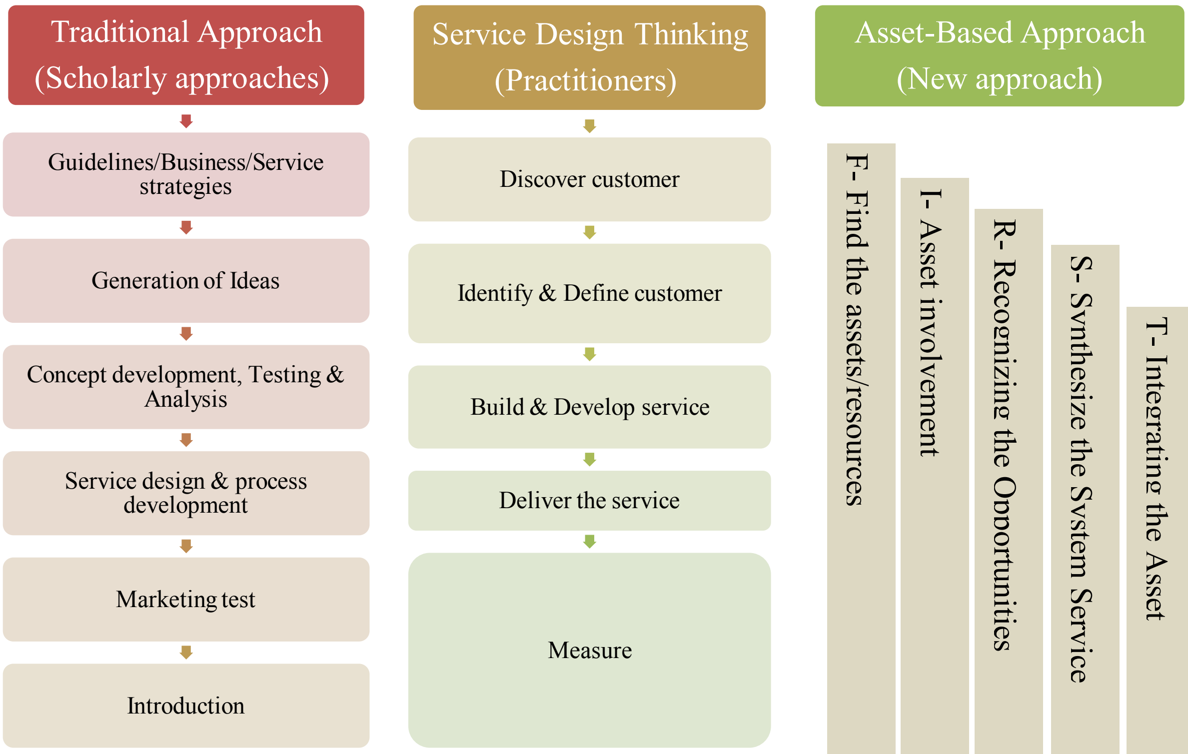


Figure 6.1. SDP Summaries and Comparisons.

The most challenging part is formulating and dealing with the customer as an asset. The objective of this chapter is to create customer-integrated service design tools that adapt the asset-based approach to service design and focus on the customer as a core system asset.

6.2. Asset-Based Approach Advantage

The asset-based approach has proved its efficiency in the social sciences in the area of community development and could be exploited to improve the service design as well. Whiting, et al. stated from different resources some of the ABCD's potential strengths that could be applicable in the service design. Some of these points are (Whiting, et al., 2012):

- Engenders positive thinking by focusing on strength instead of focusing on problems,
- Obtains common view for the working team about what is important,
- Creates an easy and fun way for customers to be involved and share ideas,
- Provides a realistic view about what exists now,

- Allows for inclusiveness,
- Centers around effectiveness and sustainability,
- Encourages all parties to realize their ability and talents to contribute, and
- Empowers resources,

Additionally, the asset-based approach is simple and cost effective because it starts with resources that are already in the system and have been used rather than starting from scratch. It inherently encourages resource utilization.

Some similar existing applications utilize customers in the service system, but do not emphasize the asset-based view. One example is asking customers to use a kiosk in the airport or making customers complete their check-in online and print a boarding pass at home. Here, new tools that are asset-based are proposed for service design which can be adopted as a design approach for the whole service. In this new approach, customers will be the core asset of the process. Table 6.1 shows a brief comparison between the asset-based approach and the other current approaches in the service design that have been discussed.

Table 6.1

Comparison between the Asset-based Approach and Traditional Approaches

Criteria	Traditional Approach	Asset-based Approach
Basis	Customer needs	System assets
Goal	Create new service by bringing new components which are mostly outside of the system	Utilize what is in system
Focus	Solve problems	Build on strengths
Customer Role	Consumer, Client	Partner, Producer, Owner
Relationship with Customer	Burden	Helper

Scholars' models usually start from the business point of view and practitioners approach models starting from the customers' point of view. The new approach provides the capability to combine the strengths of the existing service design models and the customer as an asset. This could be represented as an extension of a mixture between the scholars' and the practitioners' approach as shown in Figure 6.2.

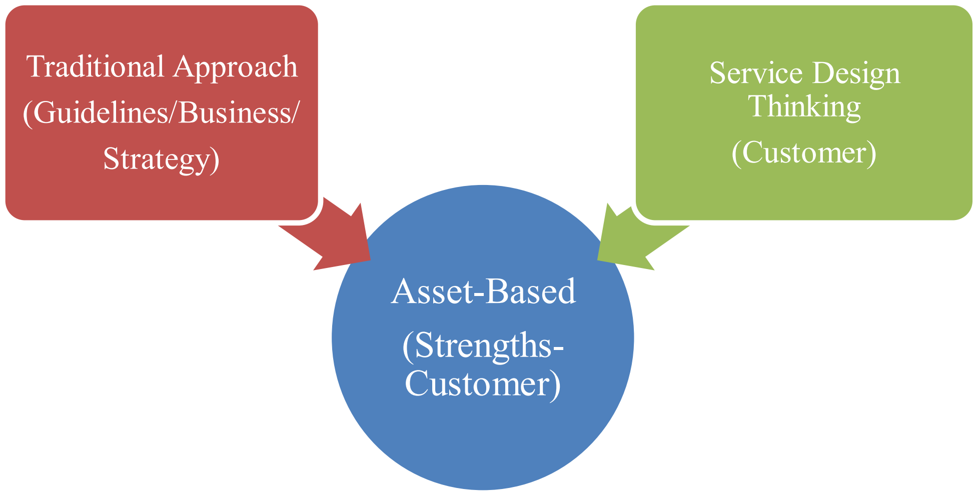


Figure 6.2. New Approach Mixture

Adapting the asset-based approach to service design allows the customer to be utilized as a positive component. In asset-based system design, customers have strengths and limitations that should be considered and leveraged. Customers should be involved in the service process not as a consumer but as a contributor in the service delivery and the whole experience. The FIRST model that was introduced by Stanfield (2012) is followed as a process guide to create the new asset-based tools (Figure 2.13). Contrary to traditional models, the FIRST model is not sequential due to the fact that early steps continue as each new step is initiated as seen in Figure 2.13.

In order to achieve the goal of this chapter, the following steps are suggested as seen in Figure 6.3. These steps are similar to the FIRST model except the last step. The last step aims to integrate the results of the first four steps into the rest of service design process.

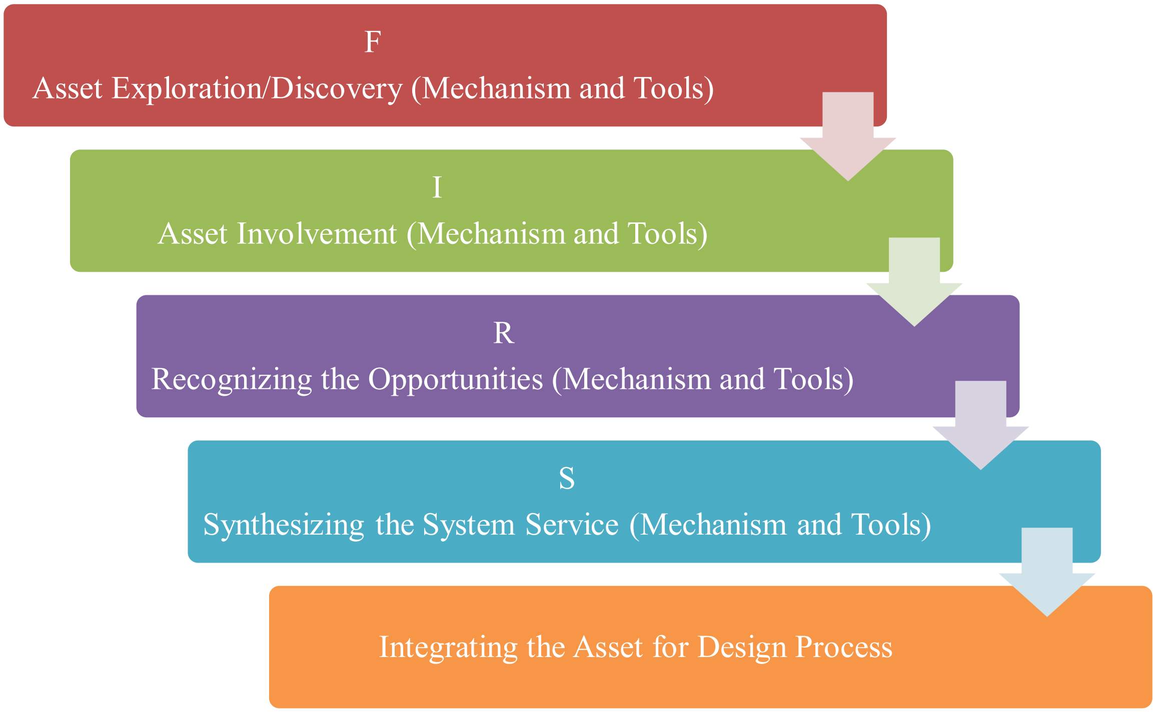


Figure 6.3. Asset-Based Service Design Approach.

6.3. Asset Exploration/Discovery

Exploration and discovery of the service assets should be built and connected in a logical relationship. They could be divided into two groups: general assets that are common in every service and specific assets that are related to certain types of services. For example, a building is a general asset that all or most of the corporate services have while healthcare services have some specific assets that are not used in other service businesses. In addition, assets move from being general to being more specific as we specify the business. For example, a building is general and the storage unit is more specific. Moreover, these assets are a mixture of physical materials and humans.

Asset discovery/exploration is the first step in the asset-based system. It is the same as the first step in Walker's model or the FIRST model. It seeks to explore all the current assets available to the service system. To start this step, an inventory of all of the service resources that are used by the existing service should be created. In the IESDA model, a unique structure has been used for the service resources which enables the inventory of the assets and representation of inheritance and composition relationships. The resource model is built with an object-oriented representation, with the two main components being processes and resources. The resources are divided into consumed resources, facility resources and human resources. The customer is one of the human resources. Figure 6.4 is an example of a class diagram of the service resource model for a hotel. The resource model is general in the first two levels and it changes to be more customized in the next levels.

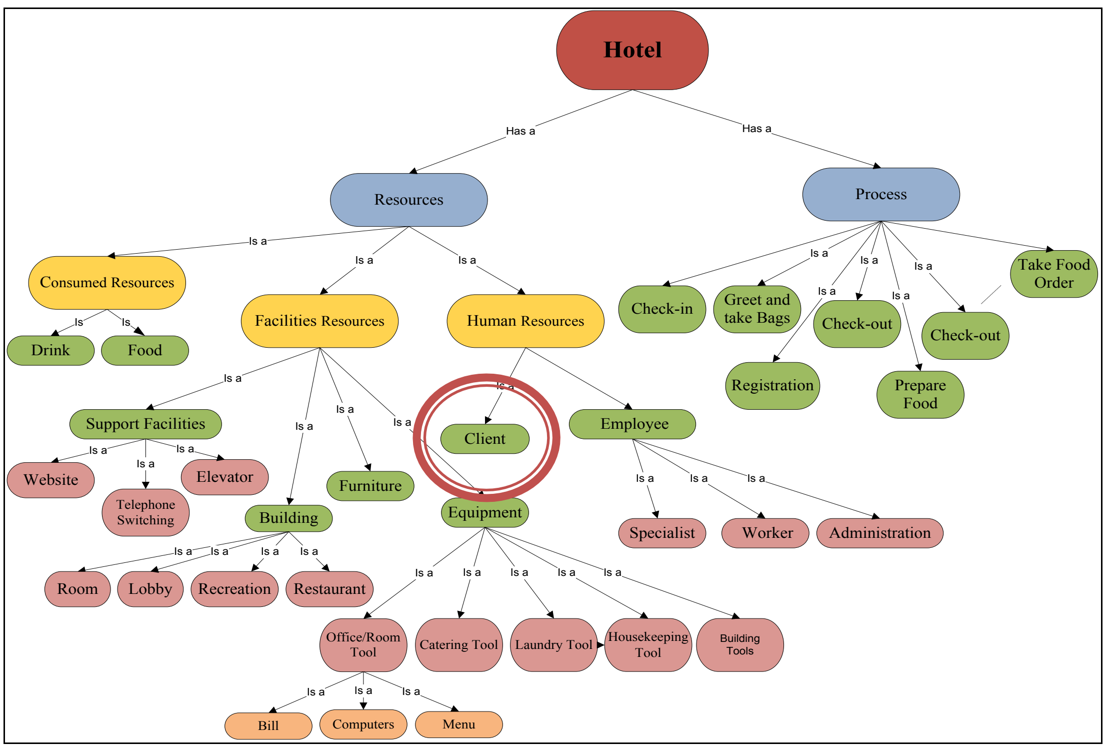


Figure 6.4. Class Diagram of Service Resource Model (SRM).

In the IESDA model, the resource model is built with an object-oriented representation, with the two main components being processes and resources. The resources are divided into consumer resources, facility resources and human resources. Figure 6.4 is an example of a class diagram of the service resource model for a hotel. The service resource representation shows the objects as the resources, which come from the service components. The service components 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 the IESDA model the service components are considered to be resources and processes. 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 are established to characterize the object-oriented paradigm in a relational database. These two relationship types are inheritance ("Is a") and composition ("Has a") enabling groups. Table 6.2 shows descriptions and examples of these two relationships (Kulvatunyou & Wysk, 2000).

Table 6.2

Descriptions of the Two Object-Oriented *Relationships*

Relationship	**Description**	**Example**
"Has a"	Indicates possession between objects, and their attributes that could be inherited.	An object that has another object receives all attributes. E.g. “Hotel has a resource”
“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.”

The database structure itself is directly created from the object diagram. Although 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 could be unique and customized to a specific service system. The database construction would reflect this customization. This structure helps to understand and utilize the assets in the service design and is adapted in this dissertation as well.

The discovery/exploration step includes asking some essential questions such as: what is the current resource role in the existing service system and what group of resources goes together in the system? What could be done with all the other resources? Finally, what are some tools that could be used such as data mining and others mentioned by Stanfield (2012).

In addition to building on the resource model of the IESDA, a new tool is introduced in this dissertation. This new tool is called Asset-Relationship Map (ARM). It establishes six types of relationships among assets (group and individual) and associated modes and needs. A mode is any form of contribution to the service system. Table 6.3 documents the relationships. The ARM establishes these relationships as part of the inventory process.

Table 6.3

Relationships within the Assets Relationship Map

Relationship	Between	Meaning/Description
G-A	Group of assets and asset	This asset is part of a group of assets
A-N	Assets and need	This asset has a connection with this need
N-M	Need and mode	This need has a connection with this mode
M-A	Mode and asset	This mode is connected to this asset
G-N	Group of asset and need	This group has a connection with this need
M-G	Mode and group of asset	This mode is connected to this group

Between asset relationships are represented in the Assets Relationship Map in Figure 6.5. The ARM diagram shows that the assets have been divided into three categories. The first category is for assets outside the service system. The second category is for assets inside the system but are controlled by external systems. The third category is assets inside the system that are controlled by the system.

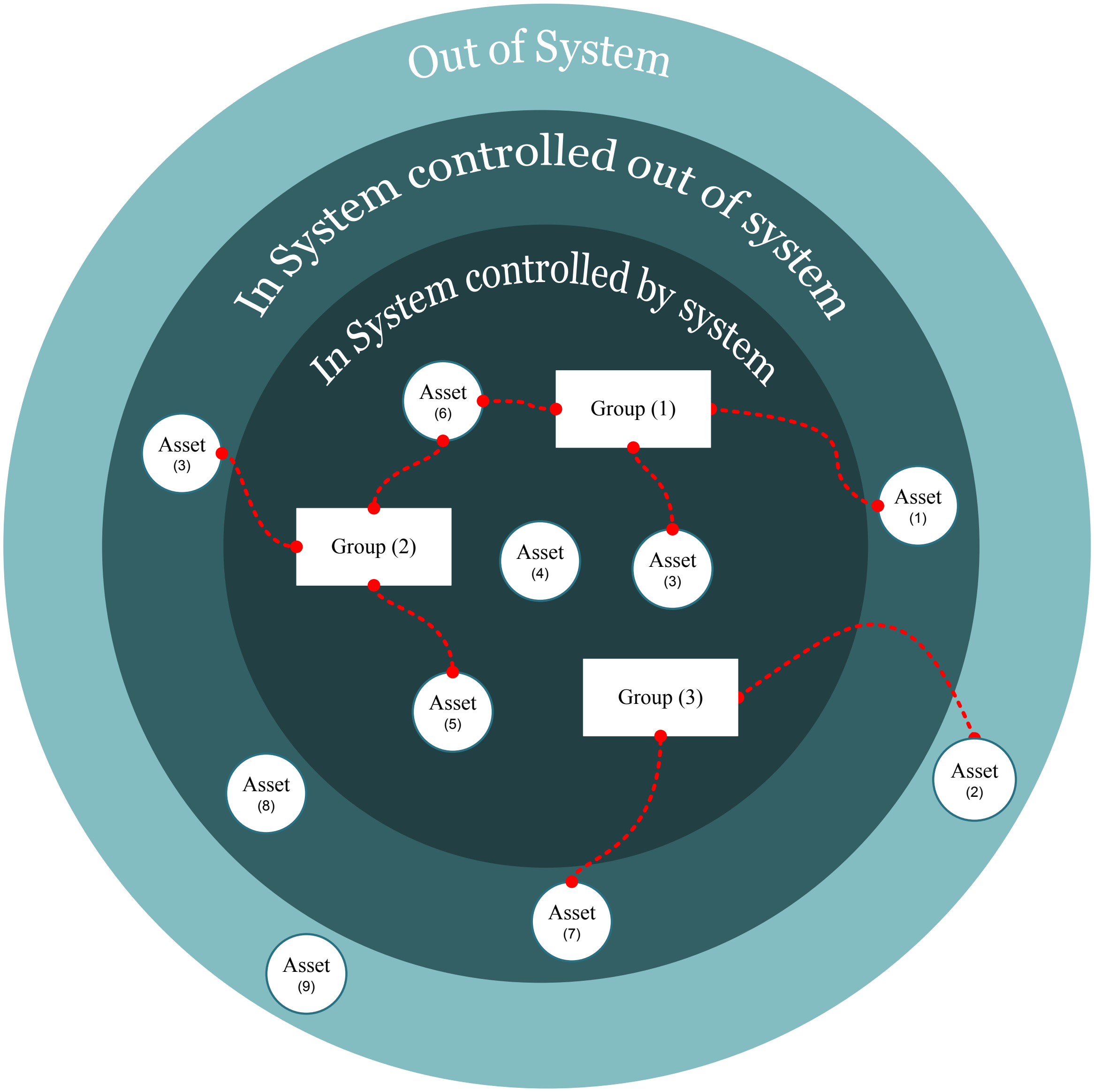


Figure 6.5. Assets Relationship Map (ARM).

These relationships might be indicated and in some cases quantified to provide a basis for future systems design research. Thus, *(l), (k)*, *(j)* and *(i)* variables used in the ARM parameters and their relationships are explained and summarized in Table 6.4.

Table 6.4

ARM Parameters and Relationships

Abbreviation	Parameters/ Relationship	Description
G_l	Group of assets	*l*: index for groups of assets (l =1 ,2, …l different groups)
A_k	Asset	*k*: index for assets (K =1 ,2, …*k* different assets)
$G_l - A_k$	Relationship	GR_{kl} orG R_{lk}The connection between group *l* and asset *k*
N_i	Need	*i*: index for needs (I = 1, 2, … *i* different needs)
$A_k - N_i$	Relationship	R_{ki} or R_{ik} The connection between asset *k* and need *i*
M_j	Mode	*j*: index for modes (J = 1, 2, ….*j* different modes)
$N_i - M_j$	Relationship	R_{ij} or R_{ji}The connection between need *i* and mode *j* in asset *k*
$M_j - A_k$	Relationship	R_{kj} or R_{jk}The connection between asset *k* and mode *j*
$G_l - N_i$	Relationship	GR_{li} or GR_{il}The connection between group *l* and need *i*
$M_j - G_l$	Relationship	GR_{ji} or GR_{ij}The connection between group *l* and mode *j*

The customer is one instance of the human resource class in the resource model of the IESDA and it is an asset in the ARM. However, customers are a focal point of the ABS in the service design process and need to be utilized in a different way as an asset. Customers should be analyzed in order to find their potential strengths and how these strengths could bring value to the service system. Initially, the customer contribution could potentially divide into many modes including the following:

- Potential strengths
- Skills (such as using the internet)
- Knowledge of the topic, services or competitors
- Experience in the service and their feedback
- Properties (Example is Airbnb website that uses the customer's home to rent to another customer)
- Social networking

- Position at work or in the society/community

Searching for assets and connecting them to needs in the system requires creativity and design thinking. Thus the five principles of service design thinking which are user-centered, co-creative, sequenced, using evidence and holistic are encouraged to adapt throughout all of the ABS process for the service design. In the involvement step, more tools are created based on this asset-based approach and integrated with the service design thinking approach. An example of the asset-need-mode relationships diagram for having the customer as an asset in the hotel service system is illustrated in Figure 6.6. It shows that not all modes have a relationship with all needs such as "drive his car" doesn't meet any of the needs for this customer.

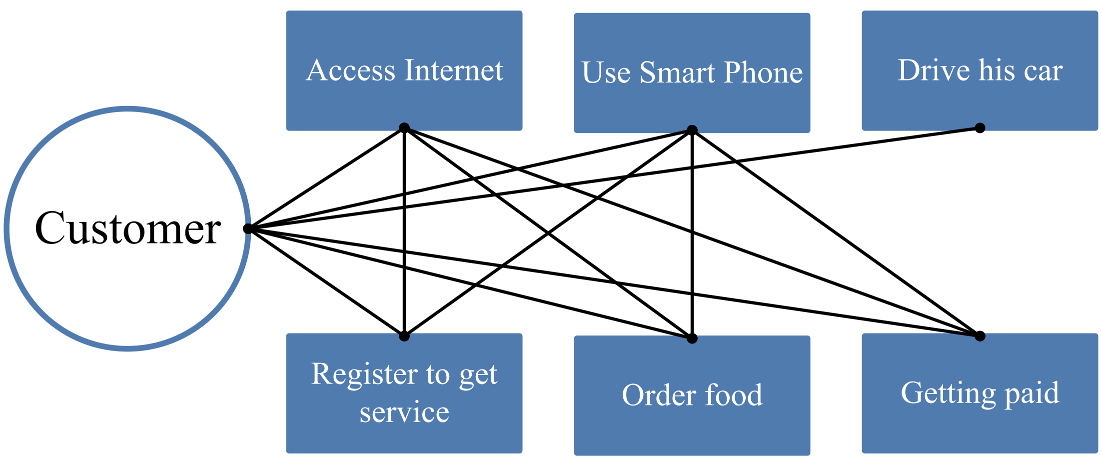


Figure 6.6. Example of Asset-Need-Mode Relationships.

Another example in Figure 6.7 illustrates the case when the relationships are between different customers' needs and modes. The example shows that customer A's needs are met by customer B's modes and vice versa.

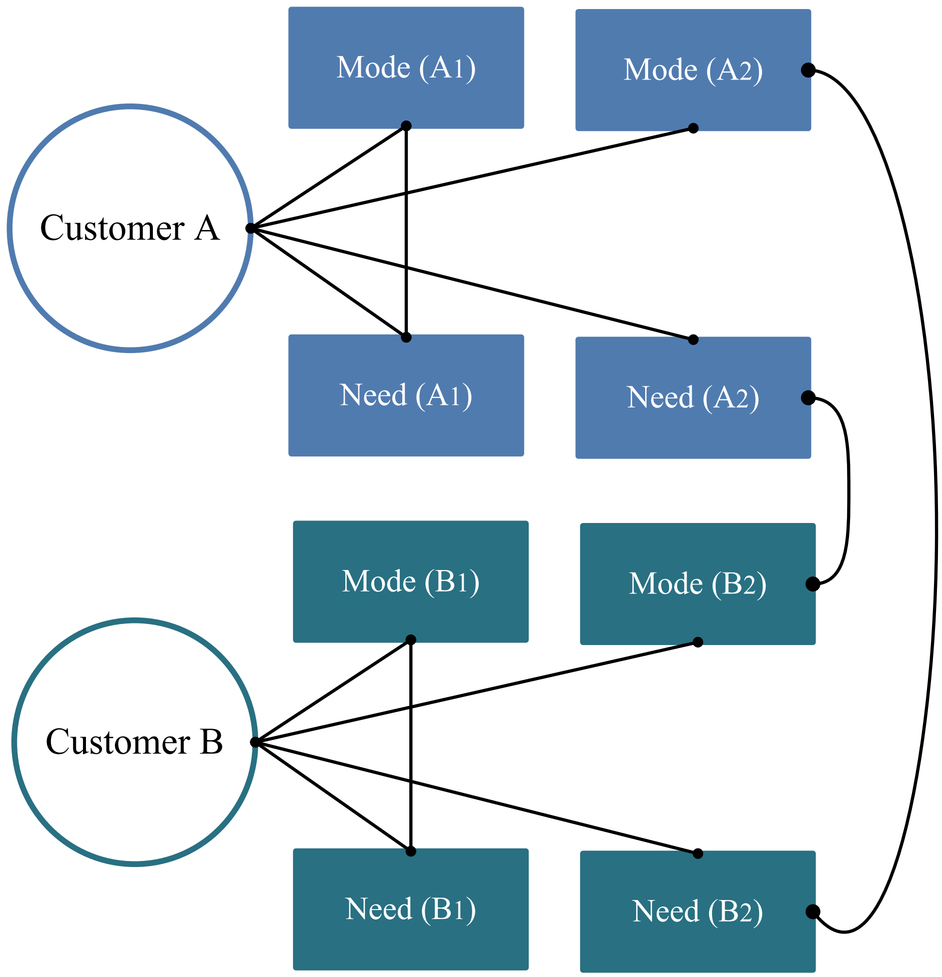


Figure 6.7. Example of Asset-Need-Mode Relationships between Two Customers.

6.4. Asset Involvement

This step was accomplished through the combination of service design thinking and the asset-based approach. The concept of the service will be developed by using the service design thinking tools and applying the asset-based approach to them. The outcome of the asset involvement step should result in involving customers and their perspectives with utilization and incorporating the customer asset's mode. Figure 6.8 shows some of the service design tools that could be developed and used in this step.

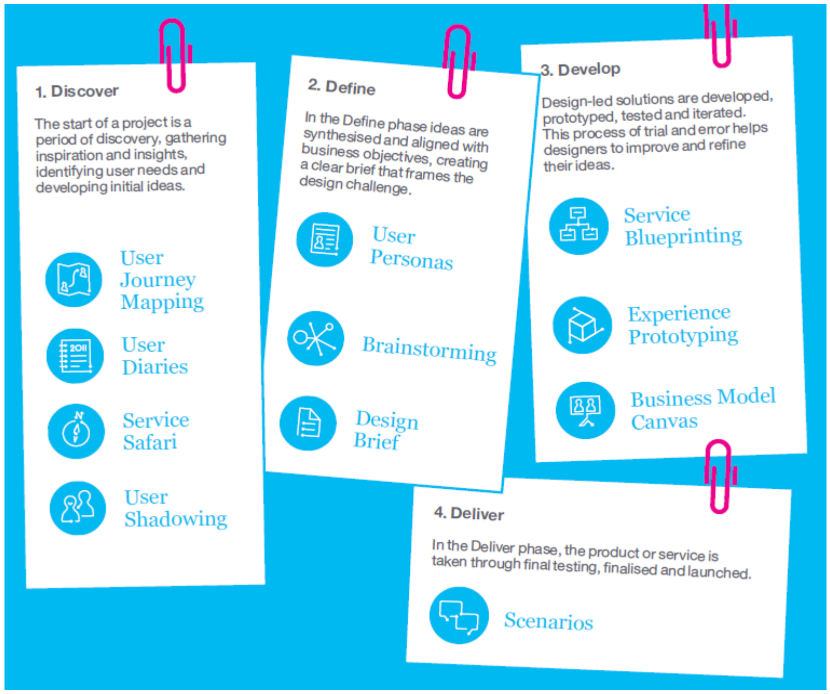


Figure 6.8. Service Design Thinking Tools (Design Council).

Two service design thinking tools are used after slight modifications to adopt the asset-based approach: These tools are the User Persona and User Journey Map

A User Persona provides information about similar people to create a single characteristic that represents the group. Personas are normally created as a set, showing different types of users with different needs (Design Council). A Persona can cover information such as imaginary name, age, occupation, where they live, family, hobbies and interests, likes and dislikes, values, and needs. In the application of the ABS in the service design, the customer asset modes are added to the information of the User Persona. For example, he could use a mobile phone for selecting the seat in the plane. It tells us what needs the customers could meet by participating in the service delivery process. Persona should be made as rounded as possible; it is archetypal, not stereotypical. Adding the modes to the User Persona tells us how the customers could be involved and helps us to maintain focus and deliver value through them.

A User Journey Map is a visual representation of a customer's journey through a service, showing all the different interactions. This tool tells what parts of the service work for the customer and what parts need improving. A User Journey Map takes the customer's point of view and explains their actual experience of the service.

The Customer Asset Journey Map (CAJM) is an extension of the User Journey Map to include ABSE. The CAJM focuses on where the customer might contribute to the system. The CAJM reflects real experiences rather than notional system function. The map includes service stages from the beginning (when the customers first become aware of the service) to when they leave. The map tells the current customers' activities in the service process and the potential customer interactions or contributions to include how and where these asset modes occur. The Customer Asset Journey Map links the individual touch points with customer asset modes in each stage of the service. Figure 6.9 shows an example of the Customer Asset Journey Map.

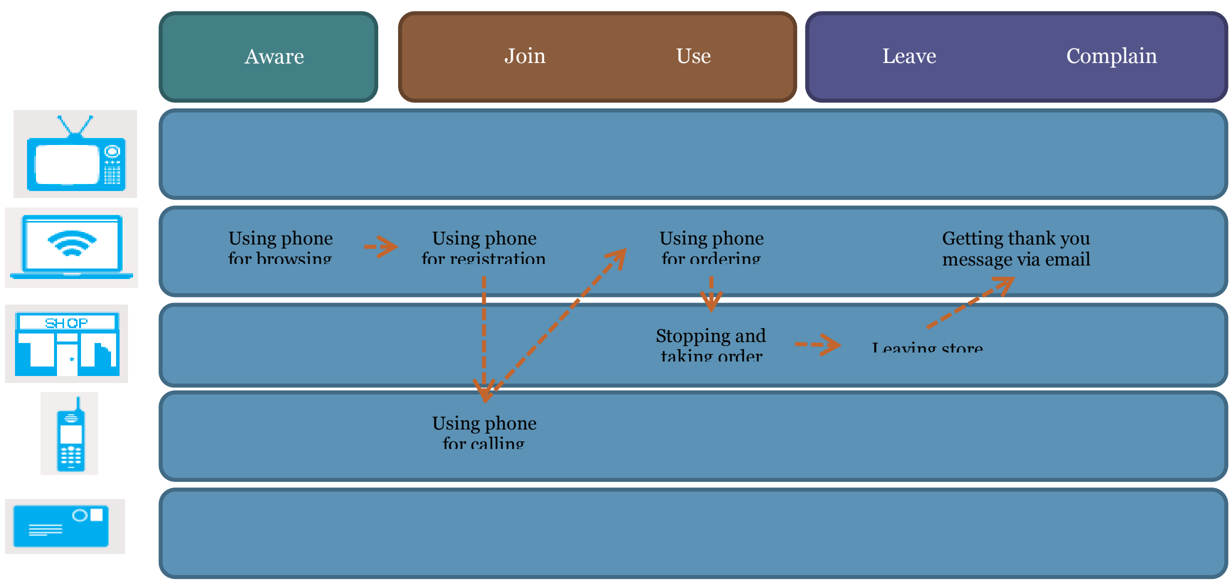


Figure 6.9. Customer Asset Journey Map.

It is recommended to go back and update the Assets Relationship Map (ARM) as the process continues; because subsequent steps help the designer to know more about the customer needs and asset modes.

6.5. Opportunity Recognition

Recognizing the opportunities in each asset's modes and prioritizing them is the next step. In addition, groups of assets might create new modes. This could create new opportunities that should be considered as well. To begin this step, the inventory of all assets, assets' modes and current assets' role in the existing service system should be defined and known. The ARM is the best tool to build on in this step.

To evaluate the opportunities associated with each asset mode, the Asset-Based Opportunity and Priority Analysis (ABOPA) is used. ABOPA is composed of two separate analyses; the Opportunity Analysis (OA) and Opportunity Priority Analysis (OPA) are proposed. These two analysis tools are inspired by Failure Mode, Effects and Criticality Analysis (FMECA). FMECA is composed of two separate analyses, the Failure Mode and Effects Analysis (FMEA) and the Criticality Analysis (CA). The FMEA analyzes different failure modes and their effects on the system while the CA classifies or prioritizes their level of importance based on the failure rate and severity of the effect of failure (*Technical Manual "Failure Modes, Effects and Criticality Analyses (FMECA) for Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Facilities"*, 2006). However, the asset-based approach emphasizes strengths and opportunities in the asset. Table 6.5 illustrates three comparison differences between the FMECA and ABOPA approaches.

Table 6.5

Comparison between FMECA and ABOPA

Dimension	FMECA	ABOPA
Searching for	Failure in the system	Opportunity in the system
Focusing on	Weakness of the system	Strength of the system
Preparing to	Minimize risk	Maximize opportunity

The basic items for the OA and OPA are shown in the ABOPA worksheet in Table 6.6. Item definitions are as follows:

- Asset name: The name of the asset itself.
- Asset description: Details about the asset such as size, color or location.
- Asset mode: The way that the asset or group of assets will contribute to the service system.
- Need: The need that the asset's mode will satisfy or serve
- Asset's mode opportunity: The opportunity that is recognized and utilized in a service system and subsystem by the asset's mode. Opportunity should be reflected in the service system and used for improvement in the current service design.
- Asset's mode opportunity contributions: The level or degree that the potential opportunity contributes in the current service system.
- OA: The level that the asset's mode opportunity contributes to the service system.
- Mode capability description: The description of the capability of each asset mode's involvement in the service. It is the actual capability of the customer that is related to the contribution in the service. It answers the question: What can they do for the service system?)

- Mode capacity description: The description of the extent to which the asset mode participates. It includes the efficiency and the availability of the mode (It also answers the questions: How good are they and how long is their sustainability?)
- Mode motivation description: The explanation of the motivation behind the asset's mode contribution. It is about their needs. (It answers the question: Why do they do it?)
- OPA: The level of the asset's mode opportunity and priority in the service system.

Table 6.6

Asset-based Opportunity and Priority Analysis (ABOPA) worksheet

Asset Name	**Asset Description**	**Asset Mode**	**The Need**	**The Asset's Mode Opportunity**	**Asset's Mode Opportunity Contributions**	**OA**	**Mode Capability**	**Mode Capacity**	**Mode Motivation**	**OPA**
Customer		Using technology or smart phone	Save time	Easy and available	Save money	6	8	5	8	320
Customer		Parking	Select the best spot	More convenience	Save money	7	7	4	8	224

6.5.1. Opportunity Analysis (OA)

The OA methodology is designed to analyze different asset's mode opportunity and their potential contributions and enhancements to the system. In other words, it tells us the degree of the contributions and enhancements that the asset's mode might be able to bring to the system. The OPA prioritizes the asset mode level of importance based on its capability, capacity and motivation rate. The ranking process of the OA can be accomplished by utilizing existing opportunity data or by a subjective ranking procedure conducted by a team of service design experts, service persons and the customer.

OA and OPA should be initiated as soon as preliminary asset information is available. They are beneficial when used during the design phase but also during the sustainment service itself for feedback improvement.

The asset's mode opportunity is the way that an opportunity is recognized and utilized in service systems and subsystems. Opportunity of the asset's modes is dependent on the specific asset, service systems, environment and past history of opportunity in similar systems. All probable independent opportunity modes for each item should be identified.

To assure that a complete analysis will be performed, each asset's mode opportunity should be examined for the following benefit on the service system:

- Reduction of time or cost
- Creating flexibility
- Improving accessibility
- Improving reliability
- Creating new output services
- Solving existing problems
- Increasing customers
- Enhancing the customer experience or the service delivery process
- Enhancing and applying technology

In order to perform an accurate OA and OPA, the design team must have some basic resources to get started, such as:

1. Assets inventory with short descriptions
2. Assets Relationship Map (ARM)

3. The process of the conceptual or existing service (It could be represented by a flow chart or blueprint of the service system. The most important part is that the diagram should graphically show the operation and interrelationships between components and assets of the service system defined in the schematics.)
4. Knowledge of the role of assets in the existing system
5. Understanding of the assets, subsystem, and systems operations

Once the team has all of these items and information available to them, the analysis can proceed.

After all asset's mode opportunities are listed, their contributions in the service system and the other previous items have been documented in the ABOPA worksheet, the design team needs to provide a level/ranking for potential "enhancement" or role in the service design for each asset mode which is the OA. Prior to doing these levels/rankings, all prior columns of the ABOPA should be filled in. This will help the designer analyze to assign the right level/rank to each opportunity's enhancement in the system.

Each asset's mode opportunity is evaluated in terms of the best potential contributions upon the system which may be a result of opportunity utilization. An enhancement classification must be assigned to each system level where contributions are made. A lower ranking indicates less contribution opportunity and a higher ranking indicates more contribution opportunity. Contribution classifications provide a qualitative measure of the best potential enhancement resulting from asset's modes opportunity in three main items in the service. The three main service divisions are (Figure 6.10):

- Service support system: Includes all service processes that are behind the scenes operations or not within the customer's visibility.

- Delivery process system: Includes all service delivery processes that are in the front lines or within the customer's visibility.
- Customer experience: Includes all service activities that create the customer experience.

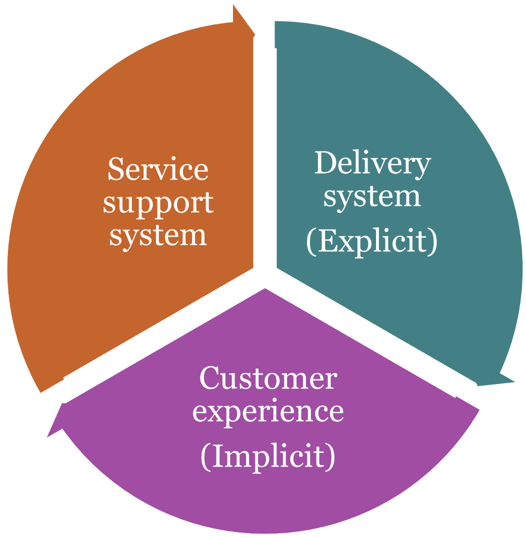


Figure 6.5. Main Service Divisions Opportunity.

A contribution classification is assigned to each identified asset's mode opportunity and the service systems will be analyzed in accordance with the categories in Table 6.7. Each service division has three levels: 1 for low, 2 for medium and 3 for high. This ranking classification is designed to cover the supply chain portion, behind the scenes activities, the front-line activities, the delivery portion and the customer experience portion. This division is appropriate to use for any service system. All of these parts are covered by the service blueprint which makes it straight forward for the team to estimate the contribution ranking for each asset's mode opportunity.

Table 6.7

Contribution Enhancement Ranking Table

Enhancement	Service support system	Delivery process	Customer experience	Rank The Total
Very Low	1	1	1	3
	1	1	2	
Low	1	2	1	4
	2	1	1	
	1	1	3	
	1	2	2	
	1	3	1	
Medium	2	1	2	5
	2	2	1	
	3	1	1	
	1	2	3	
	1	3	2	
	2	1	3	
High Medium	2	2	2	6
	2	3	1	
	3	1	2	
	3	2	1	
	1	3	3	
	2	2	3	
	2	3	2	
High	3	1	3	7
	3	2	2	
	3	3	1	
	2	3	3	
Very High	3	2	3	8
	3	3	2	
Extremely High	3	3	3	9

The design team should review the information on the Asset-Based Opportunity Prioritization Analysis (ABOPA) worksheet to determine if any changes should be made. Once all of the information has been entered into the ABOPA worksheet, the foundation for the OPA has been established.

6.5.2. Opportunity Priority Analysis (OPA)

The previous ABOPA worksheet can be used in a qualitative analysis without data or in a quantitative analysis with data. With the ABOPA as a reference, new calculations for Opportunity Priority Analysis (OPA) will be stated, which use some of the information from the ABOPA worksheet. Through this analysis, OPA is a method to evaluate the priority for utilizing each opportunity associated with each incorporated asset's mode.

The OPA provides relative measures of importance for the enhancement of an asset's mode opportunity, as well as the significance of an entire asset on the service. In essence, it is a tool that ranks the importance of each opportunity for each asset's mode in the service system's design based on the utilization of the asset's mode. This tool will be used to prioritize and maximize the utilization and contribution of the asset opportunity in the service design.

OPA can be performed using either a quantitative or a qualitative approach based on the data availability. Availability of the asset utilization rate and the asset contribution rate data will determine the analysis approach. The designers should determine which approach they will use for the OPA. The OPA is calculated by obtaining the product of the four ratings:

$$OPA = Cb \times Cp \times M$$

Where: Cb is Capability, Cp is Capacity and M is Motivation

Table 6.8

OPA Four Ratings

Rating	Description
Cb	Capability level for each asset's mode opportunity.
Cp	Capacity level for each asset's mode opportunity.
M	Motivation level for each asset's mode opportunity.

Each one of the OPA elements is evaluated based on components that have three levels: low, medium and high. The capability has seven ratings and evaluations based on two components: the potential and actual capability as shown in Table 6.9. The capacity has five ratings and evaluations based on two components: efficiency (speed) and availability as shown in Table 6.10. The last element in the OPA formula is the motivation which has five ratings and evaluations based on two components: level of the customer needs and level of the asset control as shown in Table 6.11.

Table 6.9

Capability Levels

Capability	Potential	Actual
1	Low	Low
2	Medium	Low
3	Low	Medium
4	Medium	Medium
5	High	Medium
6	Medium	High
7	High	High

Table 6.10

Capacity Levels

Capacity	Efficiency	Availability
1	Low	Low
2	Medium	Low
3	Medium	Medium
4	Medium	High
5	High	High

Table 6.11

Motivation Levels

Motivation	**Needs**	**In/Out**
1	Low	Out of the system / control out of the system
2	Medium	Out of the system control from in the system
3	Medium	In the system control out of the system
4	Medium	In the system control in the system
5	High	In the system control in the system

The value of the OPA will complete the ABOPA worksheet. However, ABOPA helps to recognize and prioritize the assets' mode but it does not consider any constraints that could exist.

6.6. Building the Asset-Based Service

The process of the ABS in the service design is the focus on the asset; thus, all of the service structures and processes should be built on assets. In this step, the first image of the service structure is created. The most common tool used in this step is the Service Blueprint. The

Service Blueprint is a detailed visual representation of the whole service over time that shows the customer's journey, all touch points and channels, the front line service activities as well as behind the scenes activities. However, modifications have been made to the regular service blueprint to suit the ABS for service design. Inspired by the Service Blueprint, the Asset Opportunity Blueprint is a new tool that represents the service based on the assets and the asset's mode. Figure 6.11 shows the structure of the Asset Blueprint with an example of a hotel.

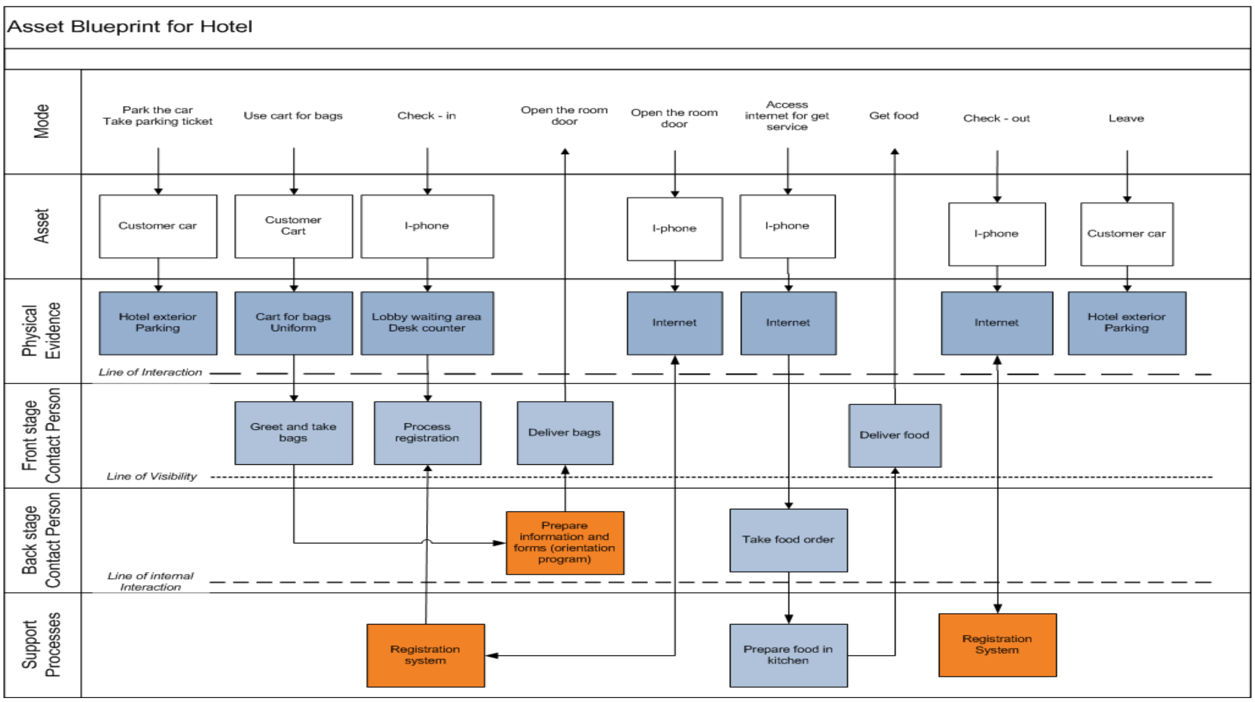


Figure 6.6. Asset Opportunity Blueprint

The process of the Asset Opportunity Blueprint starts with the mode which is the customer contribution to the service. The next step is writing the asset name. After that, the physical evidence and the other blueprint elements is added.

6.7. Integration

The result of using the asset-based service design tools should be integrated with the other steps of the service design. These results should be the base of building the service concept. Later on, this concept should be tested and the process could go forward or backward for more improvement. If the developed concept that was based on the asset-based approach was tested and the results were satisfied, the engineering design activities should be started and the other SD activities could be implemented. This design should be tested and implemented based on the asset-based approach.

6.8. Conclusion

This chapter contributes a new application of the Asset-based approach in the service design field. Asset-based System Engineering (ABSE) is a recently introduced concept that attempts to synthesize systems around their key assets and strengths. This chapter proposed tools based on the asset-based approach to the service design. These tools are designed to give the emphasis of the asset-based systems that have been developed. Additionally, these tools view customers as a primary asset for the service system. Customer integration in the service design process is achieved through an Asset Capabilities/Capacity/Motivation Assessment based on a traditional FMECA process. The assets and the asset mode are mapped to be ready to integrate with the other SD process activities. Still, more tools need be developed for the ABS which makes it a fertile research area for future work.

CHAPTER 7

Conclusion

Service design is the science of creating a quality customer centered experience using a package of tools (Stickdorn & Schneider, 2011). Service design is relatively new and it has been rapidly expanding in research and practice. Most researchers have focused on the usefulness of the service, cost-efficiency, meeting clients' needs, and service strategy. This research has focused on improving different aspects of the service design process. These aspects include functional integration, redesigning of all the service design processes, improving the decision-making process and tools and a fundamental rethinking about the service design approach. Building on previous research, function integrating information models have been developed (IESDA models). As an extension of this dissertation, three solutions were introduced to improve the service design process and mechanization. These are integrating the service design process, conflict reduction in decision-making and customer-integrated service design.

7.1. Research Contributions

All service elements can benefit from improving the service design process. Current service design processes are suffering from key weaknesses and not connected to practitioners' needs. Petri Nets as a graphical and mathematical tool introduced a uniform environment for modeling, formal analysis, and design of the service design systems. The goal was to develop a new service design process that integrates the design activities, enhances the multidisciplinary approach and meets the practitioners' ambitions.

Petri Nets models were constructed, analyzed and improved. The significant contributions to new service design have been illustrated by the Petri Nets model and by using its analysis tools. The utilization of resources was improved to work more efficiently in terms of budget, time and feedback. In addition, adding the transition feedback also improves the quality of the service, helps to get feedback from the stake holders and supports the decision-making. The new service design Integrated Service Design Model (ISDM) model is proposed and described. The ISDM distinguished and integrated both the enterprise and engineering design activities and tools in one model that was ready for use by scholars and practitioners. The summary of the main contributions is below:

- Integration of SDP between scholars and practitioners
- Feedback loops to ensure quality and concurrency to shorten design process
- Process management improvement by unification and integration
- Information and resource utilization to enhance efficiency
- New comprehensive ISDM that is ready to use by scholars and practitioners

Additionally, the decision-making process, which can be lengthy and costly, is explored. Research shows that there is a conflict between the designer and the manager in the service design decision-making which seems like a perfect case for the Lens Model implementation. The Lens Model is used to characterize the decision-making policy in service design. Single Lens Model systems are designed to capture the decision policies and a double Lens Model system is used to compare between the designers and the managers perspectives. These systems follow the Brunswick approach, his formula and its parameters have been used. Using the Lens Model to capture the judgment policy of both the managers and the designers and compare them may lead to a better design and implementation at a lower cost.

This is the first usage of the Lens Model in the service design field. This model helps to develop a design that reflects many perspectives for a lower cost and shorter time. The model could be used between the main steps or within the main steps. Using the Lens Model to capture the judgment policy of both the managers and the designers and comparing them may lead to a better design and implementation at a lower cost. Furthermore, the Lens Model could be developed to capture the customer perspective. The summary of the contributions is found in the bullets points below:

- Introduces a supportive decision-making model for service design
- Creates a new scientific approach to exploit the conflicts in decision-making between the manager and the designer to help understanding of each other's perspective and create diverse solutions
- Allows for a new application of the Lens Model in service design

Finally, Asset-based System Engineering (ABSE) is a recently introduced concept that attempts to synthesize systems around their key assets and strengths. With extreme global competition, ABSE has proposed as an ambitious approach that considers customers as a primary asset. Customer integration in the design process is achieved through this contribution that is categorized by asset capabilities, capacity and motivation assessment loosely based on a traditional FMECA process. Ramifications to the service design process are suggested, and an example in the tourism industry was developed to illustrate these suggestions.

The implementation contributes a new application of the Asset-based approach in the service design field. New tools based on the asset-based approach to the service design have been proposed. These tools view customers as a primary asset. The assets and the assets mode are mapped to be ready to integrate with the other SD process activities. The summary of the main contributions is:

- Introducing a new approach for service design based on assets
- Applying a new application of the Asset-based theory in the service design

- Utilizing the customer as a core asset in the Asset-based service design process
- Creating new customer-integrated service design tools such as Assets Relationship Map (ARM), Customer Asset Journey Map (CAJM) and Asset Blueprint
- Creating a new engineering method to estimate the potential asset such as AMOA and OPN

7.2. Future Research

Each of the research areas provides opportunities for future research. There are many others areas that can be explored as an extension of this study. First of all, the implementation of the Petri Nets in the service design process was without employing time as a factor. Time can change many components involved with the research and practice of service design. This could be a new research area for service engineers. In addition, using the Petri Nets as an analytical engineering tool to develop a new process for the service design could open the door for other tools to be used.

Additionally, the Lens Model has the potential to be used with other factors as cues. These could include factors that are used in the first survey which are those that the researcher would like to bring. Moreover, the user or customer decision-making policy could be captured in the same manner, which could present a new potential area for research.

For future work in the ABS, more asset-based tools in other service design steps could be created. The relationship in the ARM could be a good case for mathematical or optimization solutions as well. All of the above areas could provide even more insight into the world of service design and the infusion of engineering tools that strengthen service processes

References

Achilleos, A., Kun, Y., Georgalas, N., & Azmoodech, M. (2008, 6-8 Aug. 2008). *Pervasive Service Creation using a Model Driven Petri Net Based Approach.* Paper presented at the Wireless Communications and Mobile Computing Conference, 2008. IWCMC '08. International.

Bergmann, G. (1952). Review of "The conceptual framework of psychology". *Psychological Bulletin, 49*(6), 654-656.

Birgit, M., & Tung-Jung David, S. (2011). Special Issue Editorial: Designing for Services. *International Journal of Design, 5*(2), n/a.

Bisantz, A. M., Gay, P., Phipps, D. A., Walker, N., Kirlik, A., & Fisk, A. D. (1997, 12-15 Oct 1997). *Specifying training needs in dynamic judgment tasks using a lens model approach.* Paper presented at the Systems, Man, and Cybernetics, 1997. Computational Cybernetics and Simulation., 1997 IEEE International Conference on.

Bisantz, A. M., Kirlik, A., Gay, P., Phipps, D. A., Walker, N., & Fisk, A. D. (2000). Modeling and analysis of a dynamic judgment task using a lens model approach. *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on, 30*(6), 605-616.

Bisantz, A. M., & Pritchett, A. R. (2003). Measuring the fit between human judgments and automated alerting algorithms: a study of collision detection. *Human Factors*(45.2), 266-280.

Bloom, J., Clark, C., Clifford, C., Duncan, A., Khan, H., & Papantoniou, M. (March 2003). *Platform Independent Petri-net Editor: Final Report*. London.

Boland Jr, R., & Collopy, F. (2004). *Managing as Designing* (1 ed.): Stanford Business Books.

Boone, T., & Ganeshan, R. (2002). *New Directions in Supply-Chain Management: Technology, Strategy, and Implementation*. New York: AMACOM.

Brunswik, E. (1955). Representative design and probabilistic theory in a functional psychology. *Psychological Review, 62*(3), 193-217.

Bryant, S. M. (1997). A Case-Based Reasoning Approach to Bankruptcy Prediction Modeling. [Article]. *International Journal of Intelligent Systems in Accounting Finance & Management, 6*(3), 195-214.

Cassandras, C. G., & Lafortune, S. (2008). Petri Nets. In C. Cassandras & S. Lafortune (Eds.), *Introduction to Discrete Event Systems* (pp. 223-267): Springer US.

Clatworthy, S. (2011). Service Innovation Through Touch-points: Development of an Innovation Toolkit for the First Stages of New Service Development. *International Journal of Design, 5*(2), n/a-n/a.

Cook, L. S., Bowen, D. E., Chase, R. B., Dasu, S., Stewart, D. M., & Tansik, D. A. (2002). Human issues in service design. *Journal of Operations Management, 20*(2), 159-174.

Cooksey, R. W. (1996). *Judgment Analysis: Theory, Methods, and Applications*: Acad. Press.

Dalgleish, L. I. (1988). Decision-making in child abuse cases: Applications of social judgment theory and signal detection theory. In B. Brehmer & C. R. B. Joyce (Eds.), *Human Judgment: The Sjt View* (illustrated ed., pp. 520): Elsevier.

Davern, M. J., Mantena, R., & Stohr, E. A. (2008). Diagnosing decision quality. *Decision Support Systems, 45*(1), 123-139.

Design-Council. (2005). Design Council Process. Retrieved January, 2, 2013, from http://www.designcouncil.org.uk/

Efrim Boritz, J., & Kennedy, D. B. (1995). Effectiveness of neural network types for prediction of business failure. *Expert Systems with Applications, 9*(4), 503-512.

Einhorn, H. J., Kleinmuntz, D. N., & Kleinmuntz, B. (1979). Linear regression and process-tracing models of judgment. *Psychological Review, 86*(5), 465-485.

Engine. (2013). Engine Service Design Process. from http://www.enginegroup.co.uk/service_design/our_process

Eshuis, R. (2006). Symbolic model checking of UML activity diagrams. *ACM Trans. Softw. Eng. Methodol., 15*(1), 1-38.

Fitzsimmons, J. A., & Fitzsimmons, M. J. (2007). *Service Management: Operations, Strategy, Information Technology*. New York: McGraw-Hill Irwin.

Fitzsimmons, M. J., & Fitzsimmons, J. (1999). *New Service Development: Creating Memorable Experiences*: SAGE Publications.

Forlano, L. (2010). What is Service Design? Urban Omnibus. Retrieved October 27th, 2010, from http://urbanomnibus.net/2010/10/what-is-service-design/#comments

Goldstein, S. M., Johnston, R., Duffy, J., & Rao, J. (2002). The service concept: the missing link in service design research? *Journal of Operations Management, 20*(2), 121-134.

Hammond, K. R., Stewart, T. R., Brehmer, B., & Steinmann, D. O. (1975). Social Judgment Theory. In M. F. Kaplan & S. Schwartz (Eds.), *Human Judgment and Decision Processes* (pp. 325). New York: Academic Press.

Han, I., Chandler, J. S., & Liang, T.-P. (1996). The impact of measurement scale and correlation structure on classification performance of inductive learning and statistical methods. *Expert Systems with Applications, 10*(2), 209-221.

Huertas-García, R., & Consolación-Segura, C. (2009). A framework for designing new products and services. [Article]. *International Journal of Market Research, 51*(6), 819-840.

Jiang, K. (2008, 12-15 Oct. 2008). *New service development for interactive experience.* Paper presented at the Service Operations and Logistics, and Informatics, 2008. IEEE/SOLI 2008. IEEE International Conference on.

Johne, A., & Storey, C. (1998). New service development: a review of the literature and annotated bibliography. *European Journal of Marketing, 32*(3/4), 184-251.

Joyce, C. R. B., & Stewart, T. R. (1994). Applied research in judgment: What should happen. *Acta Psychologica, 87*(2–3), 217-227.

Kahneman, D., Slovic, P., & Tversky, A. (1982). *Judgment Under Uncertainty: Heuristics and Biases*: Cambridge University Press.

Kretzmann, J. P., McKnight, J. L., Affairs, N. U. C. f. U., Research, P., & Network, N. I. (1993). *Building communities from the inside out: a path toward finding and mobilizing a community's assets*: Center for Urban Affairs and Policy Research, Northwestern University.

Krueger, J. I. (2008). *Rationality and Social Responsibility: Essays in Honor of Robyn Mason Dawes*: Taylor & Francis.

Kulvatunyou, B., & Wysk, R. A. (2000). A functional approach to enterprise-based engineering integration. *Journal of Manufacturing Systems, 19*(3), 156-171.

Liu, S., Zeng, R., & He, X. (2011). PIPE+ - A Modeling Tool for High Level Petri Nets *SEKE* (pp. 115-121).

Lynch, H. (2008). Lifelong Learning, Policy and Desire. *British Journal of Sociology of Education, 29*(6), 677-689.

Mager, B., & Sung, T.-J. D. (2011). *Special Issue Editorial: Designing for Services*.

Marc, S., Menno, M., & Nicole De, K. (2011). Benefits of Co-design in Service Design Projects. *International Journal of Design, 5*(2), n/a-n/a.

Miller, J. (2012 May 21, 2012). Expanding Trade through Services. Retrieved May 21, 2012, 2012, from http://blog.trade.gov/2012/05/21/expanding-trade-through-services/

Miller, S., & Kirlik, A. (2006). Modeling the Task Environment: Act-R and the Lens Model. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 50*(11), 1127-1131.

Murata, T. (1989). Petri nets: Properties, analysis and applications. *Proceedings of the IEEE, 77*(4), 541-580.

Nixon, N. W. (2010). *A study of the experiential service design process at a luxury hotel.* University of Westminster, London, UK.

Oduori, F. N. (2010). *New service development: strategy and process in the hospitality sector in Kenya*. Soreze, France.

Paek, P. L. (2008). *Asset-based instruction: Boston Public Schools*. Austin, TX: Charles A. Dana Center at The University of Texas at Austin.

Palmer, D. (2012, September 20, 2012). U.S. says WTO at "crossroads," urges services talks. *Thomson Reuters*, from http://thomsonreuters.com/

Park, C.-S., & Han, I. (2002). A case-based reasoning with the feature weights derived by analytic hierarchy process for bankruptcy prediction. *Expert Systems with Applications, 23*(3), 255-264.

Paulson, L. D. (2006). Services Science: A New Field for Today's Economy. *Computer, 39*(8), 18-21.

Persson, A., & Ryals, L. (2010). Customer assets and customer equity: Management and measurement issues. *Marketing Theory, 10*(4), 417-436.

SCAD.edu. (2013). Service Design. from http://www.scad.edu/academics/programs/service-design

Scheuing, E. E., & Johnson, E. M. (1989). A Proposed Model For New Service Development. *The Journal of Services Marketing, 3*(2), 25-25.

Seong, Y., & Nam, C. S. (2008). Capturing judgment policy on customers' creditworthiness: A lens model and SDT approach. *International Journal of Industrial Ergonomics, 38*(7–8), 593-600.

Shapiro, R. M. (1991). Validation of a VLSI Chip Using Hierarchical Colored Petri Nets. In K. Jensen & G. Rozenberg (Eds.), *High-level Petri Nets* (pp. 667-687): Springer Berlin Heidelberg.

Shekar, A. (2007). An Innovative Model of Service Development: A process guide for service managers. *The Innovation Journal, 12*(1), 18.

Stanfield, P. (2012). The case for asset-based solutions. [Article]. *Industrial Engineer: IE, 44*(10), 43-47.

Stevens, E., & Dimitriadis, S. (2005a). Managing the new service development process: towards a systemic model. *European Journal of Marketing, 39*(1/2), 175-198.

Stevens, E., & Dimitriadis, S. (2005b). Managing the New Service Development Process: Towards a Systemic Model. *European Journal of Marketing, 39*(1/2), 175 - 198.

Stickdorn, M., & Schneider, J. (2011). *This Is Service Design Thinking: Basics - Tools - Cases*: Consortium Book Sales & Dist.

Swets, J. A. (2001). Signal Detection Theory, History of. In J. S. Editors-in-Chief: Neil & B. B. Paul (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 14078-14082). Oxford: Pergamon.

Tabbakh, S. (2011). *A Functional Approach to Enterprise-Based Service Design Integration.* North Carolina A&T State University, Greensboro.

Tabbakh, S., Vaizasatya, A., Wan, S., Li, Z., & Stanfield, P. (2012). *Petri Nets Application and Implementation on New Service Development*. Paper presented at the 2012 Industrial and Systems Engineering Research Conference.

Tan, R., & Sheng-Uei, G. (2005). A dynamic Petri net model for iterative and interactive distributed multimedia presentation. *Multimedia, IEEE Transactions on, 7*(5), 869-879.

. *Technical Manual "Failure Modes, Effects and Criticality Analyses (FMECA) for Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Facilities"*. (2006).

Walker, J. E. (2006). Building from strength: asset-based community development. *Communities and Banking, 2006*(Win), 25-27.

Waltman, W. D., & Presley, A. (1993). *Reading and Critiquing an IDEF0 Model*. Fort Worth,Texas: Enterprise Integration Framework Group Automation & Robotics Research Institute.

Whiting, L., Kendall, S., & Wills, W. (2012). An asset-based approach: an alternative health promotion strategy? *Community Practitioner, 85*(1), 25-28.

Woodhouse, J. (2007). Asset Management:Joining up the jigsaw puzzle-PAS 55 standards for the integrated management of assets. *Maintenance & Engineering Magazine*(Sept-07), 12-16.

Yoo, T., Jeong, B., & Cho, H. (2010). A Petri Nets based functional validation for services composition. *Expert Systems with Applications, 37*(5), 3768-3776.

YuanLin, W., & MuDer, J. (2005, 19-22 March 2005). *Diagnosability analysis based on T-invariants of Petri nets.* Paper presented at the Networking, Sensing and Control, 2005. Proceedings. 2005 IEEE.

Zurawski, R., & MengChu, Z. (1994). Petri nets and industrial applications: A tutorial. *Industrial Electronics, IEEE Transactions on, 41*(6), 567-583.

Appendix A

Stability Levels

Item	Point
Reservation and payment are available online or in person. (In person available or not)	1
Website contains basic information and allows the customer to make the reservation. (Available or not)	1
Customers turn in his/her bags to the bell person with tags (Barcode reader). (Available or not)	1
The receptionist assists with the registration, checks the customer ID and credit card, assigns the room and gives the customer the key (Available or not)	1
All other services such as food requests and check out are provided in the normal hotel service manner.	1

Sustainability Levels

Item	Point
The hotel utilizes a basic technology. (Very good technology)	2
Employees receive training to remain up to date onthe service processes.No) (training	2
Processes are clear and well designed. (Not well design)	1

Reliability Levels

Item	Point
The hotel has a backup battery/generator system in case they lose power.	1
All services could be provided without computer support.	1
Enough employees are available during all shifts and ready to help customers.	1
Ordering the food by TV or smart phone applications helps avoid any misunderstandings which could happen during food ordering services.	1
Service quality indicators are being used.	1

Appendix B

A Copy of the First Survey

Introduction

You have been asked to participate as a subject in a research study about the conflicts in decision-making between designers and managers in the service design. The purpose of this research is to propose a decision-making support model that helps designers and managers understand each other's perspective during the service design process. You have been asked because you are either involved in design activities, management within a design organization/consulting firm or a manager in service-based industry who is in charge of making decisions about the design of your service. For this last instance, the manager intended in this survey is the authorized manager that makes decisions about the design such as approvals, changes or rejections.

You will be asked to answer the following survey questions which are part of a PhD dissertation in Industrial and Systems Engineering at NC A&T State University USA that discusses decision-making during the service design process or in the final decision about the service design. In addition, the result of this survey will be used for publication of scientific papers. The total number of the questions is 18 questions and the expectation time is 10 minutes to complete this survey.

There are no direct benefits to participants in this research. Data will be collected anonymously. Your participation is voluntary, and you may end your participation at any time.

If you have any questions about your involvement in this project, you may contact Sameer Tabbakh at 336-392-8643 or by email at sgtabbak@gmail.com. If you have any study-related concerns or any questions about your rights as a research study participant, you may contact the Office of Research Compliance and Ethics at North Carolina A&T State University at 336-334-7995.

During the process of the service design, both the designer and manager are making many decisions about how the service will be shaped. They choose among many options to end up with the final image of the service. To make these decisions, some people employ decision-making tools, some will hold a vote, while others may simply follow their intuition from previous experiences. Regarding this issue, answer the following survey questions please:

Questions about Decisions:

1. How often do you make decisions about design in your daily work?
   - Never
   - Sometimes
   - Always
   - If other, please specify : ___________________

2. As a designer or manager in a designing field, what do you design (what is your specialist area)? Choose all that apply.
   - Customer experience
   - Human Interaction
   - Web design
   - Graphic design
   - Service touch-point
   - Interior design
   - Facilities layout
   - Product design
   - Interaction design
   - Strategic design
   - Visual analytics/visual organizing systems design
   - Not in design field
   - If other, please specify : ___________________

3. How do you make your decisions about the design during the service design process? Choose all that apply.
   - By using decision-making tools
   - Based on my experience
   - Based on my intuition
   - Taking a vote
   - I'm not in a design field
   - If other, please specify : __________________

Questions about Decision Conflict

4. Taking into consideration previous projects that you completed, did the client implement your proposed service design exactly as it was originally created?
   - Yes exactly as it was
   - Yes with some changes
   - No they changed a lot
   - No, they just took it as starting point

5. As a designer, does your manager agree with you about your design's components, choices and decisions?
   - Always
   - Sometimes
   - Never
   - I'm not designer

6. Do you think there is a conflict between the designer and the manager about the final design?
   - Always
   - Sometimes
   - Never
   - If other, please specify : __________________

7. Think back to when there has been a disagreement on a particular design. Did it often take a long time (comparing to the entire project time) to resolve this disagreement?
   - Always

- Sometimes
- Never
- If other, please specify : __________________

<u>Questions for Designer Only:</u>

8. As a designer, what are the most important factors you will consider in decisions about design components? (What will your decision be based on).

Please rank all the items using the values 1 (most valuable) to 13 (least valuable), using each value only once.

If you're not a designer, leave answers blank and proceed to the next question

- Cost and revenue
- Creativity
- Customer needs
- Customer perspective and motivation
- Leading the market, pioneering (New Design)
- Easy to implement
- Easy to deliver (Simple service process)
- Quality
- Reliability
- Sustainability
- Stability
- Security
- Accessibility

9. If other, please specify here: ___________________

<u>Questions for Manager Only:</u>

10. As a manager, if you have more than one design that you are selecting as the final design, what are the most important factors you will consider in this final decision? (What will your decision be based on?)

Please rank all the items using the values 1 (most valuable) to 13 (least valuable), using each value only once.
If you're not a manager, leave answers blank and proceed to the next question

- Cost and revenue
- Creativity
- Customer needs
- Customer perspective and motivation
- Leading the market, pioneering (New Design)
- Easy to implement
- Easy to deliver (Simple service process)
- Quality
- Reliability
- Sustainability
- Stability
- Security
- Accessibility

11. If other, please specify here: ____________________

Questions for Biographical

12. Please indicate your gender
    - Female
    - Male

13. Which range includes your age?

    - 18-24
    - 25-30
    - 30-35
    - 40- Above

14. What is your job industry?
    - Business/consultancy
    - Non-Profit
    - Marketing
    - Education
    - Government
    - Still student

15. What is your current job function or area of work in the organization or school?
    - Manager
    - Designer

16. How do you describe yourself? (Chose the closest one)
    - Manager with designing experience
    - Manager of a design organization or department
    - New Designer/Student in designing
    - Professional Designer
    - Business manager
    - Professor/Associate Professor

17. What is your experience?

	Less than 1 year (New)	1 year to 3 years	3 years to 5 years	5 years or more
As a designer				
As a manager				

18. What is your higher education degree and level achieved? Choose all that apply.

Degrees	In progress	BS	MS	PhD
Service design				
Engineering design				
Marketing/Business				
Engineering				
Industrial design/Product design				
Architecture design				
Interface designing				
Interior design				
Web design				
Graphic design				
Interaction deign				
Design Management				
Other ………				

A Copy of the Second Survey

Introduction

You have been asked to participate as a subject in a research study about the conflicts in decision-making between designers and managers in the service design. The purpose of this research is to propose a decision-making support model that helps designers and managers understand each other's perspective during the service design process. You have been asked because you are either involved in design activities, management within a design organization/consulting firms or a manager in service-based industry who is in charge in making decisions about the design of your service. For this last instance, the manager intended in this survey is the authorized manager that makes decisions about the design such as approvals, changes or rejections.

You will be asked to answer the following survey questions which are part of a PhD dissertation, in Industrial and Systems Engineering at NC A&T State University USA that discusses decision-making during the service design process or in the final decision about the design of service. In addition, the result of this survey will be used for publication of scientific papers. The expectation time is 30 minutes to complete this interview survey.

There are no direct benefits to participants in this research. Data will be collected anonymously. Your participation is voluntary, and you may end your participation at any time.

If you have any questions about your involvement in this project, you may contact Sameer Tabbakh at 336-392-8643 or by email at sgtabbak@gmail.com. If you have any study-related concerns or any questions about your rights as a research study participant, you may contact the Office of Research Compliance and Ethics at North Carolina A&T State University at 336-334-7995.

What you will be asked for is to rank these service design scenarios based on your experience. Blueprint and scenarios for these service designs will be provided to do that.

Statement of Consent

I have read the above information and have received answers to any questions I had. I am at least 18 years of age or older and voluntarily consent to take part in this research study.

☐ I agree ☐ I disagree

Name:…………………………. Signature:……………………..

In the following papers, you will find five service blueprints for hotel (A, B, C, D and E). Each service blueprint has four different scenarios. The total will be 20 different design scenarios for hotel service. All these service design scenarios are virtual and fictional but mimic the reality.

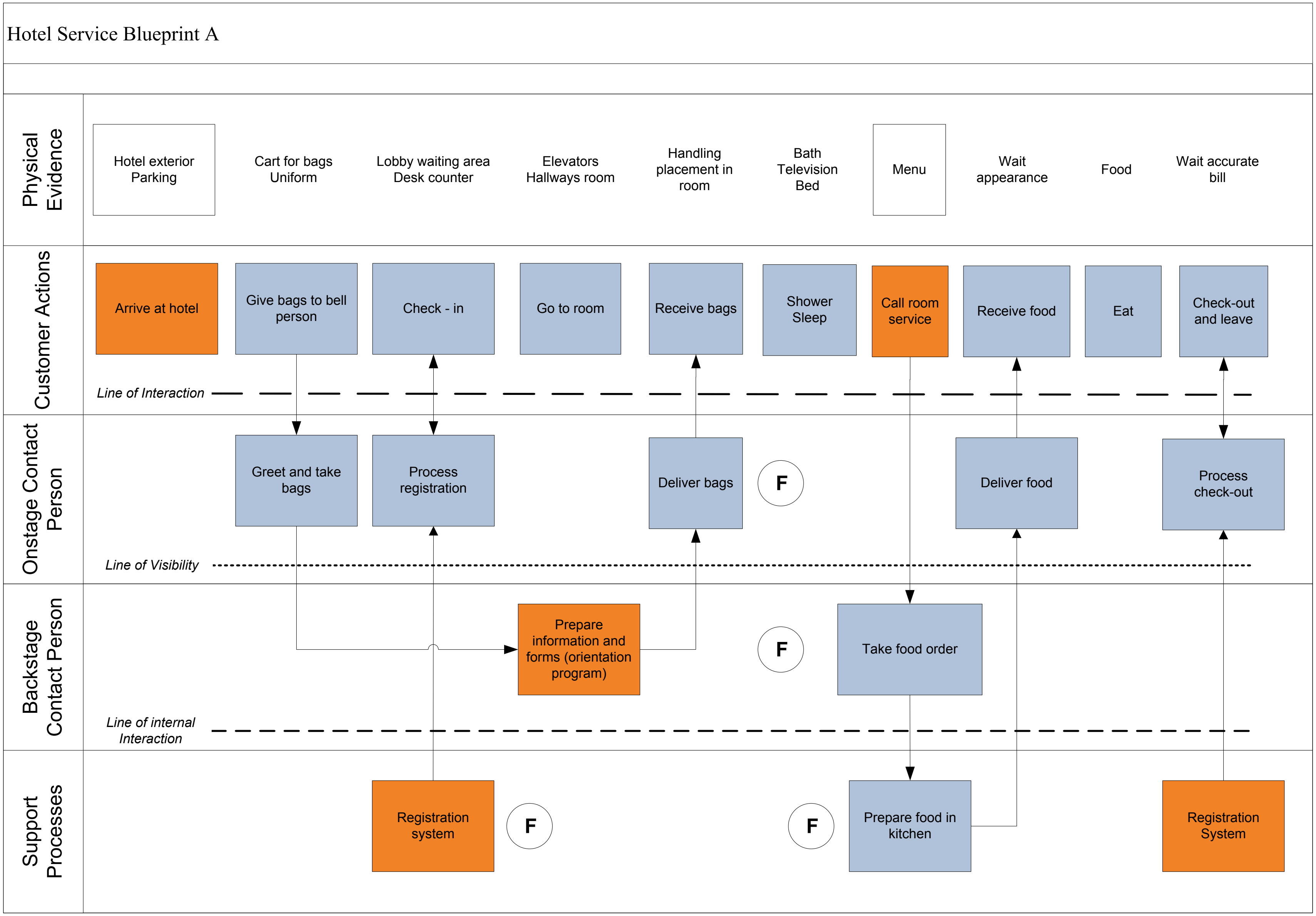
The differences among these design scenarios are based on the manipulation of four design factors. These factors are stability, security, sustainability and reliability. Each one of these factors has a different level (1 being the lowest to 5 being the highest) in each design.

We would like your participation in the three following items:

1. Read and understand these designs.
2. Give a level of each factor in each design scenario.

3. Give a number for each design scenario from 1 to 10 (10 is the most favorite one and 1 is the last)
4. Fill the table 1 on the last page.

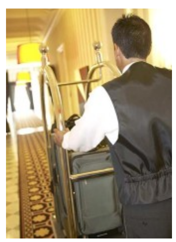
Service Blueprint for Design A



Service Scenario A1 classic Hotel

Stability level

Customers can make the reservation and the payment online or in person. The website is a normal one that gives the customers basic information and allows them to make the reservation. The next touch point after the website is the hotel exterior and the parking.



Customers will hand his/her bags to the bell person and wait in the front desk to start his check in process. The receptionist completes the registration, checks the customer ID and credit card, assigns the room and gives the customer the key. All other services such as food requests and check out are provided in the normal hotel service manner as shown in the hotel service blueprint A. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers. The hotel uses magnetic cards for room access and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel work each shift. The cleaning service personnel use a master magnetic card key and the elevator functions without the magnetic card key. In addition, there is no SAFE in each room. The hotel is equipped with cameras just in the lobby and they do not cover all the hallways and corridors.

Sustainability level

The hotel uses very basic technology and the processes are clear and well designed. In addition, training is planned for all employees.

Reliability level

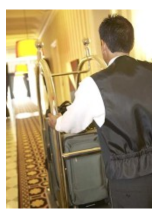
It uses a very basic technology and has backup procedures as well. In addition, it prints a hard copy for each service. All services could be provided without computer support. Enough employees are available during each duty and ready to help customers. The room service staff work 24 hours a day. Hotel service has quality standards. However, misunderstandings could happen during food order services.

Old fashion customers like how the service is provided. It is easy and not complicated for them. They prefer human interaction during the check in, food ordering and check out process. However, the new generation likes to use technology and does not like the waiting time for check in and check out.

Service Scenario A2 classic Hotel

Stability level

Customer can make the reservation and the payment online or in person. The website is a normal one that gives the customers basic information and allows them to make the reservation. The next touch point after the website is the hotel exterior and the parking. Customers will hand his/her bags to the bell person and wait in the front desk to start his check in process. The receptionist goes through the registration, checks the customer ID and credit card, assigns the room and give the customer the key. All other services such as food requests and check out are provided in the normal hotel service manner as shown in the hotel service blueprint A. The letter "F" shows where the failure point in the process could happen.



Security level

All of the customer information will be saved in computers. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each duty. The elevator is working with the magnetic card key. In addition there is a safety box in each room. However, the cleaning service personnel use a master magnetic card key.

Sustainability level

The hotel uses a very basic technology. However, the design of the service process is not clear and there is an on training program for new recruitment.

Reliability level

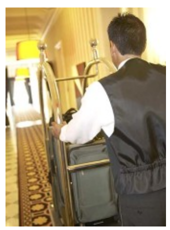
The hotel uses very basic technology and print copies for each service. All services could be provided without the computer support. Enough employees are available during the day time shifts and ready to help customers. However, only one desk personnel works the night duty and the room service closes at 5pm. In addition, misunderstandings could happen during food order because it handles by many employees.

Old fashion customers like how the service is provided. It is easy and not complicated for them. They prefer human interaction during the check in, food ordering and check out process. However, the new generation likes to use technology and does not like the waiting time for check in and check out. In addition, they complain about the misunderstandings during food order service. These misunderstandings are a result of the long process that involves many employees.

Service Scenario A3 classic Hotel

Stability level

Customers can make the reservation and the payment online or in person. The website is a normal one that gives the customers basic information and allows them to make the reservation. The next touch point after the website is the hotel exterior and the parking. Customers will hand his/her bags to the bell person and wait in the front desk to start his check in process. The front desk receptionist goes through the registration, checks the customer ID and credit card, assigns the room and gives the customer the key. All other services such as food request and check out are provided in the normal hotel service manner as shown in the hotel service blueprint A. The letter “F” shows where the failure point in the process could happen.



Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each duty. The elevator is working with the magnetic card key. In addition there is a safety box in each room. However, if the cleaning service personnel want to use the master magnetic card key he/she should inform the front desk. The hotel is equipped with cameras that cover all the halls and corridors.

Sustainability level

The hotel uses very basic technology. However, the design of the service processes is not clear and there is no training program for new recruitment.

Reliability level

The hotel uses a very basic technology and prints a hard copy for each service. All services could be provided without computer support. Enough employees are available during each duty and ready to help customers. The room service works 24 hours a day. It has quality standards. However, misunderstandings could happen during food order service.

Old fashion customers like how the service is provided. It is easy and not complicated for them. They prefer human interaction during the check in, food ordering and check out processes. However, the new generation likes to use technology and does not like the waiting time for check in and check out. To solve this problem the hotel uses a numbering system and offers beverages while customers are waiting.

Service Scenario A4 classic Hotel

Stability level

Customers can make the reservation and the payment online or in person. The website is a normal one that gives the customer basic information and allows them to make the reservation. The next touch point after the website is the hotel exterior and the parking. Customers will hand his/her bags to the bell person and wait at the front desk to start his check in process. The receptionist goes through the registration, checks the customer ID and credit card, assigns the room and gives the customer the key. All other services such as food requests and check out are provided in the normal hotel service manner as shown in the hotel service blueprint A. The letter “F” shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each duty. The elevator is working with the magnetic card key.

In addition, there is a safety box in each room. However, if the cleaning service personnel want to use the master magnetic card key he/she should inform the front desk. The hotel is equipped with cameras that cover all the halls and corridors.

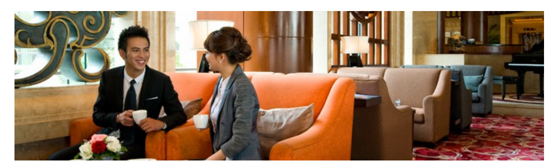
Sustainability level

The hotel uses a very basic technology and the processes are clear and well designed. In addition, training is planned for all employees.

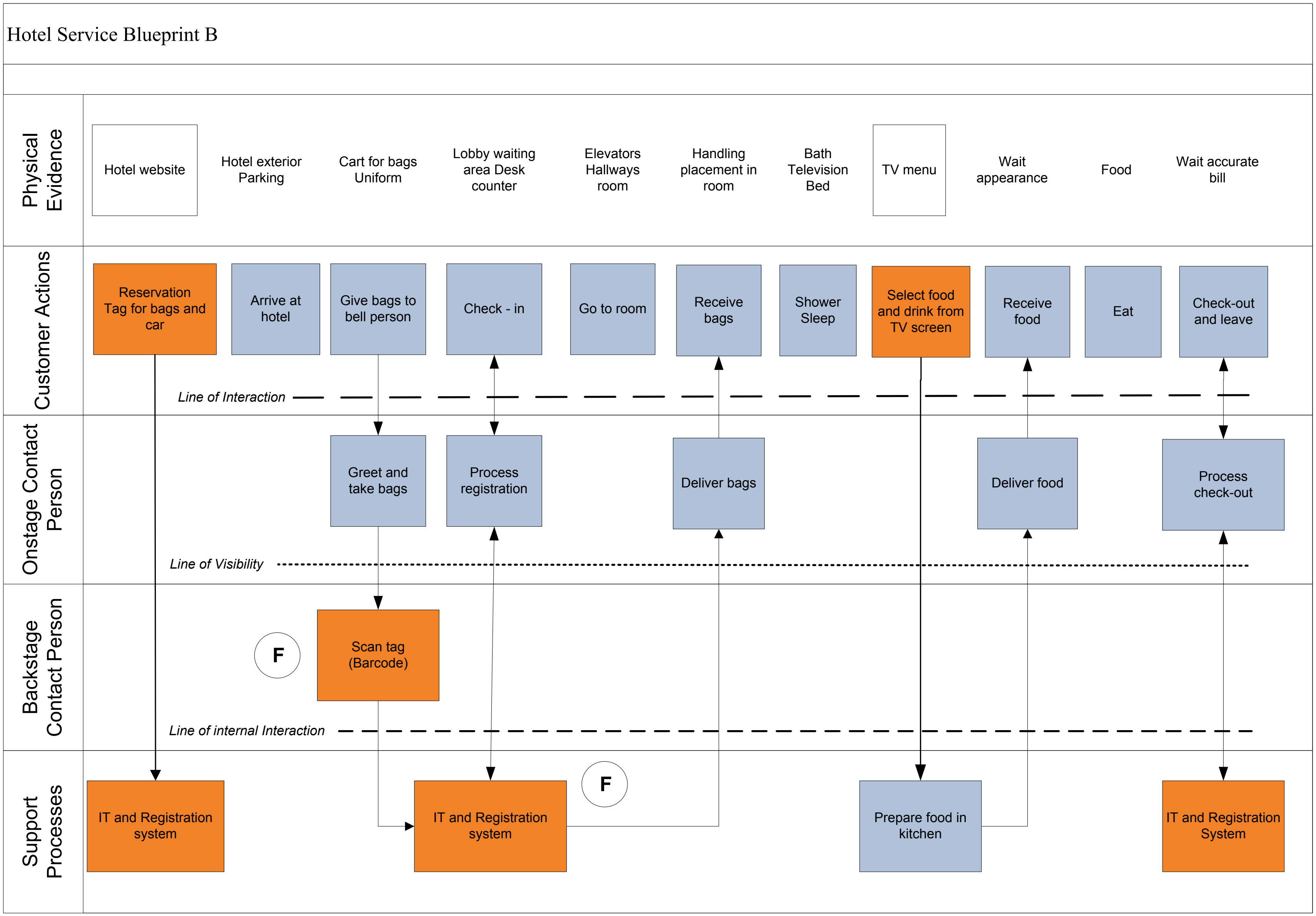
Reliability level

It uses a very basic technology and doesn’t make any backup. All services could be provided without the computer support. Enough employees are available during the day shift and ready to help customers. However, only one desk personnel works the night duty and the room service closes at 5pm. No quality indicator is being used. In addition, misunderstandings could happen during food order service.

Old fashion customers like how the service is provided. It is easy and not complicated for them. They prefer human interaction during the check in, food ordering and check out processes. However, the new generation likes to use technology and does not like the waiting time for check in and check out. To solve this problem the hotel uses a numbering system and offers beverages while the customers are waiting.



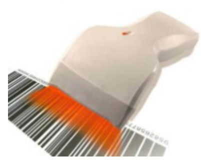
Service Blueprint for Design B



Service Scenario B1 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service in advance. The next touch point after the website is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will use a barcode reader to identify bags. The front desk person uses the barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key. Customers can use the TV for ordering food. However, not all customers get benefit from all these services which makes employees not rely on them. For example, sometimes customers forget to print the barcode or the barcode reader loses charge and doesn't function. The hotel service blueprint B shows this design. The letter "F" shows where the failure point in the process could happen.



Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions with the magnetic card key. In addition, there is a safety box in each room. However, if the cleaning service personnel want to use the master magnetic card key he/she should inform the front desk. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a good basic technology and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

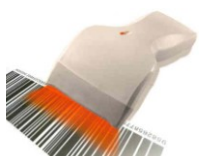
Because the hotel doesn't utilize the technology that it has and doesn't make any backup. All services could be provided without the computer support. Enough employees are available during the day shift and ready to help customers. Ordering the food by TV helps to avoid any misunderstandings could happen during food order service. However, only one desk personnel works in the night duty and the room service closes at 5pm. No quality indicator is being used.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping.

Service Scenario B2 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service in advance. The next touch point after the website is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will use a barcode reader to identify bags. The front desk person uses the



barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key. Customers can use the TV for ordering food. However, not all customers get benefit from all these services which makes employees not rely on them. For example, sometimes customers forget to print the barcode or the barcode reader loses charge and doesn't function. The hotel service blueprint B shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions without the magnetic card key. In addition, there is a safety box in each room. However, the cleaning service personnel usually use the master magnetic card key.

Sustainability level

The hotel uses a very good technology and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

The hotel doesn't utilize the technology that it has and doesn't make any backup. All services could be provided without the computer support. Enough employees are available during the day shift and ready to help customers. Ordering the food by TV helps to avoid any misunderstandings could happen during food order service. However, only one desk personnel works in the night duty and the room service closes at 5pm. No quality indicator is being used.

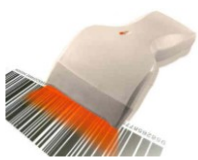
Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping. In addition, customers who coming late night doesn't like the long waiting time.

Service Scenario B3 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service

in advance. The next touch point after the website is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a barcode reader to identify bags. The front desk person uses the barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key.



Customers can use the TV for ordering food. However, not all customers get benefit from all these services which makes employees not rely on them. For example, sometimes customers forget to print the barcode or the barcode reader loses charge and doesn't function. The hotel service blueprint B shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions with the magnetic card key. In addition, there is a safety box in each

room. However, if the cleaning service personnel want to use the master magnetic card key he/she should inform the front desk. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a very good technology and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

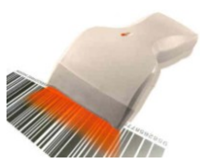
The hotel doesn't utilize the technology that it has. However, hotel system makes backup. All services could be provided without the computer support. Enough employees are available during the each shift and ready to help customers. Ordering the food by TV helps to avoid any misunderstandings could happen during food order service. The room service staff work 24 hours a day. Hotel service has quality standards.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping.

Service Scenario B4 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service in advance. The next touch point after the website is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a barcode reader to identify bags. The front desk person uses the barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key. Customers can use the TV for ordering food. However, not all customers get benefit from all these services which makes employees not rely on them. For example, sometimes customers forget to print the barcode or the barcode reader loses charge and doesn't function. The hotel service blueprint B shows this design. The letter "F" shows where the failure point in the process could happen.



Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions with the magnetic card key. In addition, there is not a SAFE in each room. However, if the cleaning service personnel want to use the master magnetic card key he/she should inform the front desk. The hotel is equipped with cameras just in the entrance and they do not cover all the hallways and corridors.

Sustainability level

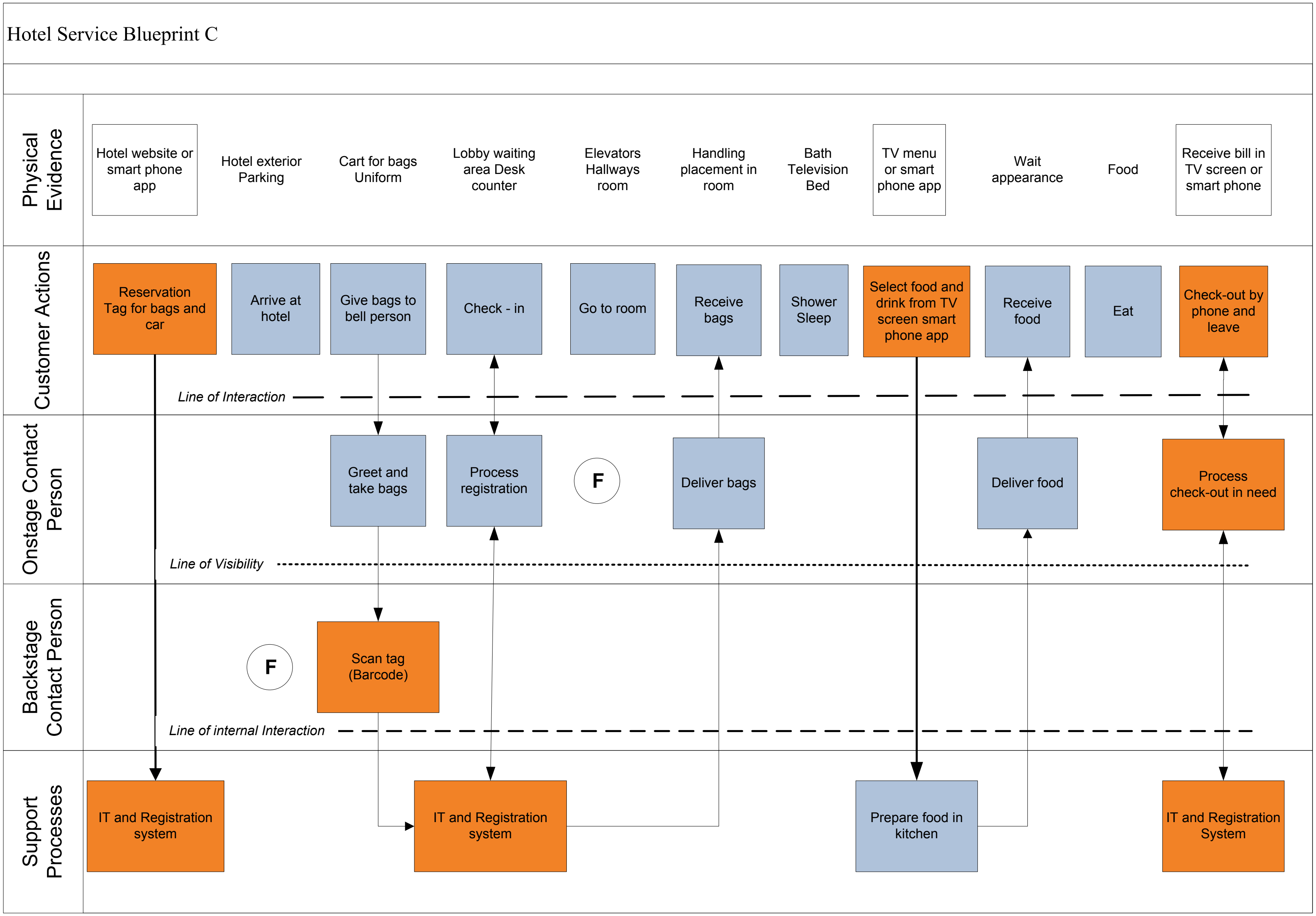
The hotel uses a very good technology but the processes are not clear and not well designed. In addition, employee training is ignored and not planned.

Reliability level

The hotel doesn't utilize the technology that it has. However, hotel system makes backup. All services could be provided without the computer support. Enough employees are available during the each shift and ready to help customers. Ordering the food by TV helps to avoid any misunderstandings could happen during food order service. The room service staff work 24 hours a day. Hotel service has quality standards.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping.

Service Blueprint for Design C

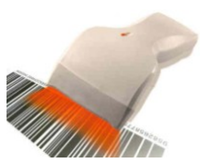


Service Scenario C1 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service in advance. In addition, customer could do

these operations by using the hotel smart phone app where they can get a barcode in their phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a barcode reader to identify bags. The front desk receptionist uses the



barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key. Customers can use the TV or their smart phone app for ordering food. In addition, customer can use their smart phone app to check out and the TV screens help them to review their bill. However, not all customers get benefit from all these services which makes employees not rely on them. Sometimes customers forget to print the barcode or the barcode reader gets lost or is not charged. The hotel service blueprint C shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions with the magnetic card key. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to use the master magnetic card

key, he/she should inform the front desk. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a good basic technology and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

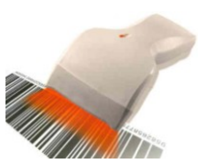
This design has a low level of reliability. It doesn't utilize the technology that it has and doesn't have any backup. All services could be provided without the computer support. Enough employees are available during the day shift and ready to help customers. Ordering the food by TV or Phone app helps to avoid any misunderstandings which could happen during food order service. However, only one desk personnel works the night duty and the room service closes at 5pm. No service quality indicator is being used.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode on smart phone app. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping.

Service Scenario C2 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service in advance. In addition, customer could do these operations by using the hotel smart phone app where they can get a barcode in their phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a barcode reader to identify bags. The front desk receptionist uses the barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key. Customers can use the TV or their smart phone app for ordering food. In addition, customer can use their smart phone app to check out and the TV screens help them to review their bill. However, not all customers get benefit from all these services which makes employees not rely on them. The hotel service blueprint C shows this design. The letter "F" shows where the failure point in the process could happen.



Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions with the magnetic card key. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to use the master magnetic card key, he/she should inform the front desk. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a very good technology but the processes are not clear and not well designed. In addition, employee training is ignored and not planned.

Reliability level

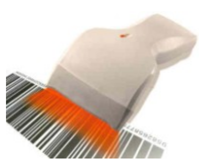
This design has a low level of reliability. It doesn't utilize the technology that it has and doesn't have any backup. All services could be provided without the computer support. Enough employees are available during the day shift and ready to help customers. Ordering the food by TV or Phone app helps to avoid any misunderstandings which could happen during food order service. However, only one desk personnel works the night duty and the room service closes at 5pm. No service quality indicator is being used.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode on smart phone app. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping.

Service Scenario C3 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service in advance. In addition, customer could do these operations by using the hotel smart phone app where they can get a barcode in their phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a barcode reader to identify bags. The front desk receptionist uses the barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key.



Customers can use the TV or their smart phone app for ordering food. In addition, customer can use their smart phone app to check out and the TV screens help them to review their bill. However, not all customers get benefit from all these services which makes employees not rely on them. The hotel service blueprint C shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions without the magnetic card key. In addition, there is not a SAFE in each room. The cleaning service personnel can use the master magnetic card key any time without inform the front desk. The hotel is equipped with cameras but do not cover all the hallways and corridors.

Sustainability level

This design has a low level of sustainability. The hotel uses a very good technology but the processes are not clear and not well designed. In addition, employee training is ignored and not planned.

Reliability level

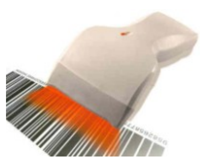
Although the hotel doesn't utilize the technology that it has it has a backup. All services could be provided without the computer support. Enough employees are available during all shifts and ready to help customers. Ordering the food by TV or Phone app helps to avoid any misunderstandings which could happen during food order service. In addition, service quality indicator is being used.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode on smart phone app. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping.

Service Scenario C4 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a barcode and asking for room service in advance. In addition, customer could do these operations by using the hotel smart phone app where they can get a barcode in their phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a barcode reader to identify bags. The front desk receptionist uses the barcode reader for registration, checks the customer ID and credit card, assigns the room and gives the customer the key. Customers can use the TV or their smart phone app for ordering food. In addition, customer can use their smart phone app to check out and the TV screens help them to review their bill. However, not all customers get benefit from all these services which makes employees not rely on them. The hotel service blueprint C shows this design. The letter “F” shows where the failure point in the process could happen.



Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions without the magnetic card key. In addition, there is not SAFE in each room. The cleaning service personnel can use the master magnetic card key any time without inform the front desk. The hotel is equipped with cameras just in the entrance and they do not cover all the hallways and corridors.

Sustainability level

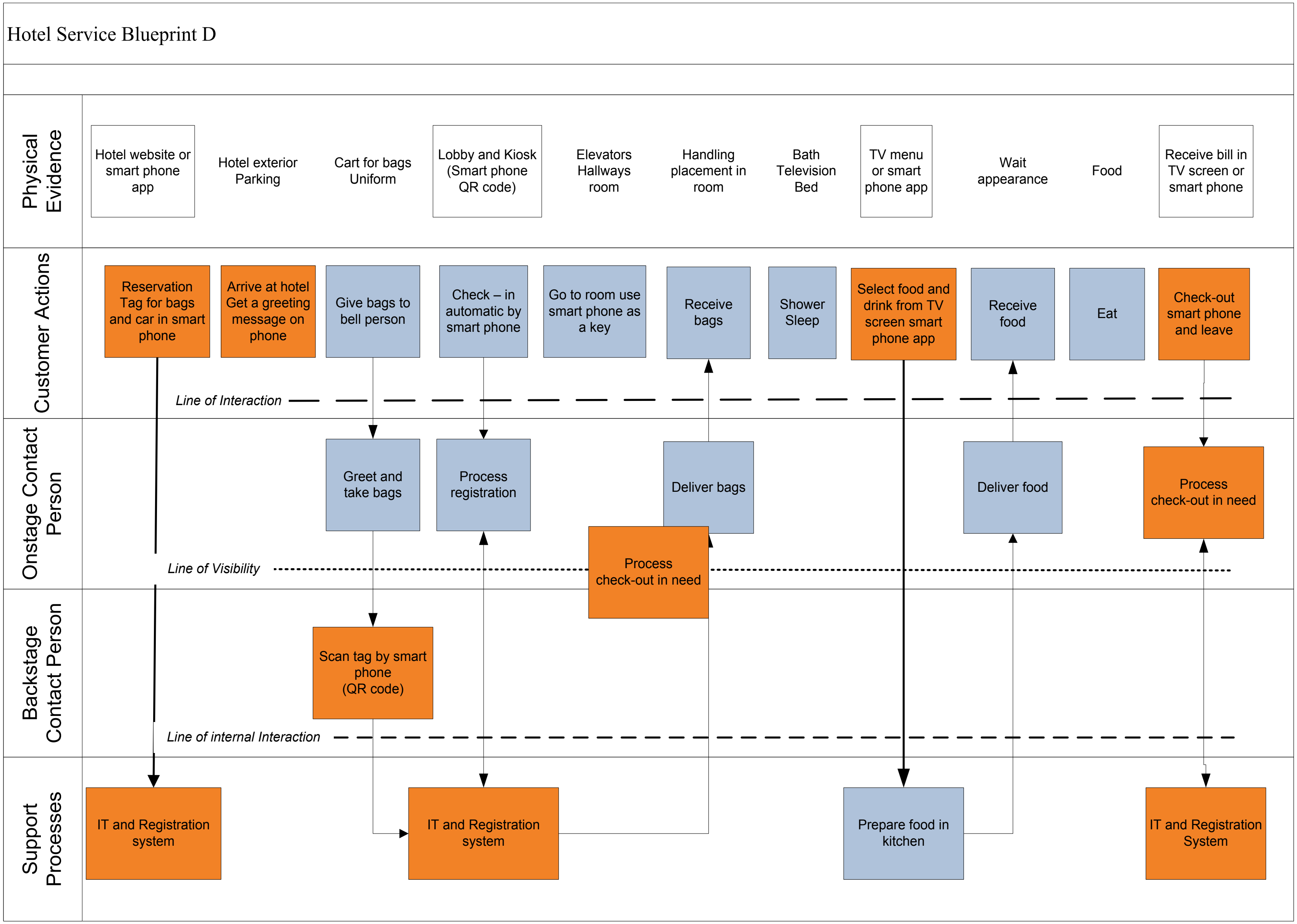
The hotel uses a very good technology but the processes are not clear and not well designed. In addition, employee training is ignored and not planned.

Reliability level

Although the hotel doesn’t utilize the technology that it has it has a backup. All services could be provided without the computer support. Enough employees are available during all shifts and ready to help customers. Ordering the food by TV or Phone app helps to avoid any misunderstandings which could happen during food order service. In addition, service quality indicator is being used.

Old fashion customers don’t like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a barcode on smart phone app. It reduces the waiting time for check-in. However, it will be disappointing for them if it will not be used as they are hoping. Sometimes customers forget to print the barcode and the hotel does not provide assistance with this issue.

Service Blueprint for Design D



Service Scenario D1 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation,

such as printing a parking pass, printing baggage tags with a QR code and asking for room service in advance. In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their

phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on

the bag and use a QR code reader or their smart phone to identify bags. The check in happens as soon as the customer arrives at the hotel (it is a feature in the app) and the customer gets a greeting message on phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and TV screens help them to review their bill. The hotel provides QR code printers for printing the QR code for customer. The front desk receptionist uses the barcode reader for registration, checks the customer ID and credit card and assigns the room. The hotel service blueprint D shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic lockers that read the QR code. Two security personnel are working in each shift. The elevator functions with the QR code. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to clean, they use a specific QR code. The hotel is equipped with cameras that cover all the hallways and corridors. In addition, the IT system tracks all the uses of the QR codes.

Sustainability level

T The hotel his design has a very high level of sustainability. It uses a new and sustainable system and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

The hotel utilizes the technology that it has, and its system makes backup. However, it is so hard to provide services without the computer support so the hotel provide a backup battery system in case of losing power. Enough employees are available and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff works 24 hours a day. The hotel service has quality standards.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as a QR code on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Service Scenario D2 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation,

such as printing a parking pass, printing baggage tags with a QR code and asking for room service in advance. In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their phone.

The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a QR code reader or their smart phone to identify bags.

The check in happens as soon as the customer arrives at the hotel (it is a feature in the app) and the customer gets a greeting message on phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and TV screens help them to review their bill. The hotel provides QR code printers for printing the QR code for customer. The front desk receptionist uses the barcode reader for registration, checks the customer ID and credit card and assigns the room. The hotel service blueprint D shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic lockers that read QR codes. Two security personnel are working in each shift. The elevator functions with the QR code. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to clean, they use a specific QR code. The hotel is equipped with cameras that cover all the hallways and corridors. In addition, the IT system tracks all the usage of the QR codes.

Sustainability level

The hotel uses a new and sustainable system and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

The hotel utilizes the technology that it has, and the system makes backup. However, it is so hard to provide services without the computer support. One employee is available in the night shift and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff work until 5 PM. Hotel service has quality standards.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as QR codes on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Service Scenario D3 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing

baggage tags with a QR code and asking for room service in advance. In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their phone. The next touch point

is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will

put a label on the bag and use a QR code reader or their smart phone to identify bags. The check in happens as soon as the customer arrives at the hotel (it is a feature in the app) and the customer gets a greeting message on phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and TV screens help them to review their bill. The hotel provides QR code printers for printing the QR code for customer. The front desk receptionist uses the barcode reader for registration, checks the customer ID and credit card and assigns the room. The hotel service blueprint D shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions without any key. In addition, there is not a SAFE in each room. The cleaning service personnel can use the master magnetic card key any time without inform the front desk. The hotel is equipped with cameras but do not cover all the hallways and corridors.

Sustainability level

The hotel uses a new and sustainable system and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

The hotel utilizes the technology that it has, and its system makes backup. However, it is so hard to provide services without the computer support so the hotel provide a backup battery system in case of losing power. Enough employees are available and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff works 24 hours a day. The hotel service has quality standards. Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as QR codes on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Service Scenario D4 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking

pass, printing baggage tags with a QR code and asking for room service in advance. In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their phone. The next touch point is the hotel exterior and the

parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use

a QR code reader or their smart phone to identify bags. The check in happens as soon as the customer arrives at the hotel (it is a feature in the app) and the customer gets a greeting message on phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and TV screens help them to review their bill. The hotel provides QR code printers for printing the QR code for customer. The front desk receptionist uses the barcode reader for registration, checks the customer ID and credit card and assigns the room. The hotel service blueprint D shows this design. The letter “F” shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic cards for accessing rooms and other hotel facilities. If the customer loses his/her magnetic card, a new one will be assigned to him after deleting the old one. Two security personnel are working in each shift. The elevator functions without any key. In addition, there is not a SAFE in each room. The cleaning service personnel can use the master magnetic card key any time without inform the front desk. The hotel is equipped with cameras but do not cover all the hallways and corridors.

Sustainability level

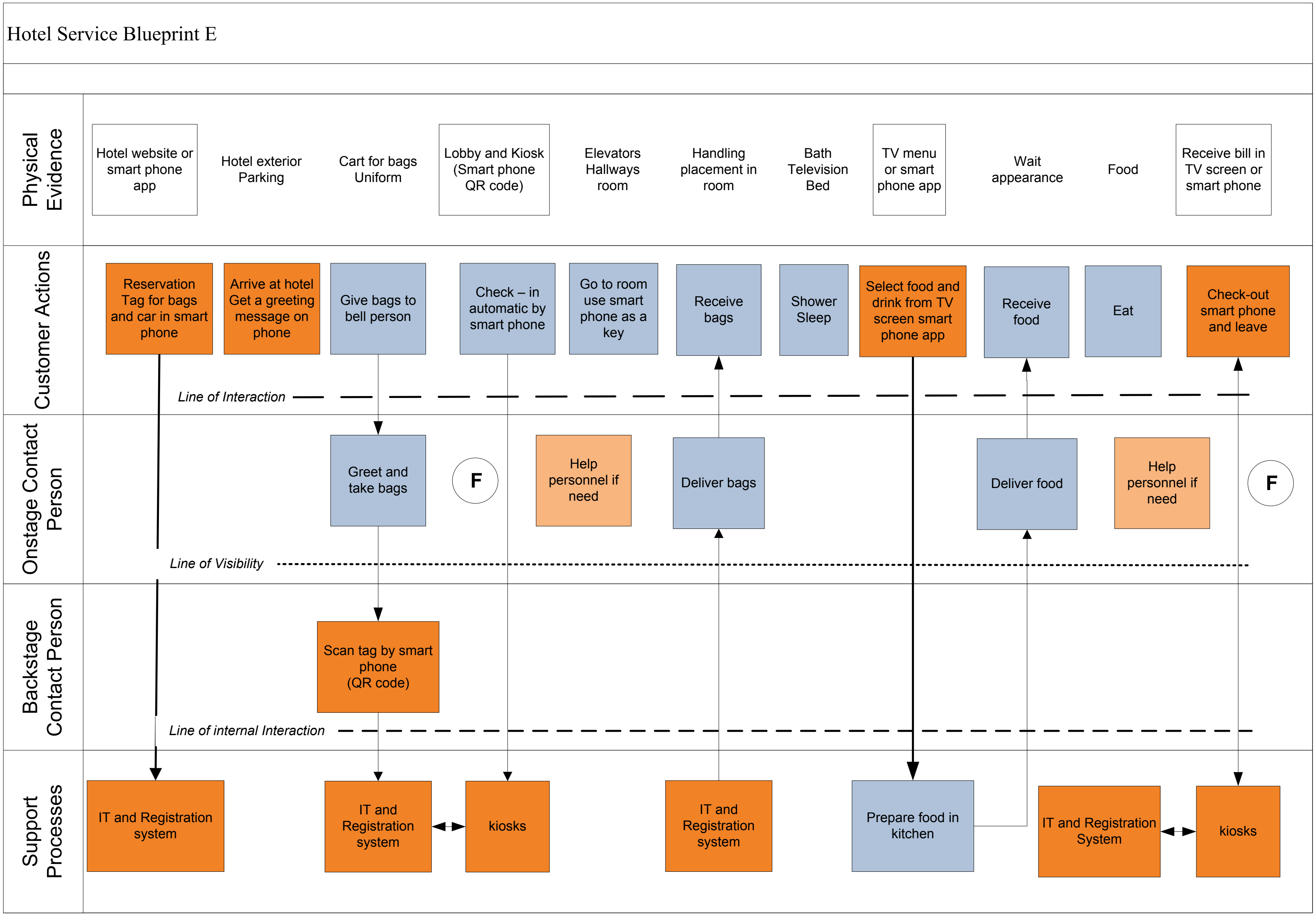
The hotel uses a new and sustainable system and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

The hotel utilizes the technology that it has, and the system makes backup. However, it is so hard to provide services without the computer support. One employee is available in the night and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff work until 5 PM. Hotel service has quality standards.

Old fashion customers don’t like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as QR codes on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Service Blueprint for Design E



Service Scenario E1classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a QR code and asking for room service in advance. In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a QR code reader or their smart phone to identify bags. The check in happens as soon as customer gets to the hotel (it is a feature in the app) and the customer gets a greeting message on their phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and the TV screens help them to review their bill. In addition, the hotels provide kiosks to print their QR code for customers. The hotel service blueprint E shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic lockers that read QR codes. No security personnel are working for hotel. The elevator functions with the QR code. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to clean, they use a specific QR code. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a new and sustainable system and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

The hotel utilizes the technology that it has, and the system makes backup. However, it is so hard to provide services without the computer support. One employee is available in each shift and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff work until 5 PM. Hotel service has quality standards.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as QR codes on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Service Scenario E2 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass,

printing baggage tags with a QR code and asking for room service in advance. In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their phone. The next touch point is the hotel exterior and the parking. Customers will

hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a QR code reader or

their smart phone to identify bags. The check in happens as soon as customer gets to the hotel (it is a feature in the app) and the customer gets a greeting message on their phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and the TV screens help them to review their bill. In addition, the hotels provide kiosks to print their QR code for customers. The hotel service blueprint E shows this design. The letter “F” shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic lockers that read QR codes. No security personnel are working for hotel. The elevator functions with the QR code. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to clean, they use a specific QR code. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a new and sustainable system and the processes are clear and well designed. In addition, all employees get training to follow the service processes.

Reliability level

The hotel utilizes the technology that it has, and its system makes backup. However, it is so hard to provide services without the computer support so the hotel provide a backup battery system in case of losing power. Enough employees are available and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff works 24 hours a day. The hotel service has quality standards.

Old fashion customers don’t like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as QR codes on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Service Scenario E3 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a QR code and asking for room service in advance. In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a QR code reader or their smart phone to identify bags. The check in happens as soon as customer gets to the hotel (it is a feature in the app) and the customer gets a greeting message on their phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and the TV screens help them to review their bill. In addition, the hotels provide kiosks to print their QR code for customers. The hotel service blueprint E shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic lockers that read QR codes. No security personnel are working for hotel. The elevator functions with the QR code. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to clean, they use a specific QR code. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a very good technology but the processes are not clear and not well designed. In addition, employee training is ignored and not planned.

Reliability level

The hotel utilizes the technology that it has, and its system makes backup. However, it is so hard to provide services without the computer support so the hotel provide a backup battery system in case of losing power. Enough employees are available and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff works 24 hours a day. The hotel service has quality standards.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as QR codes on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Service Scenario E4 classic Hotel

Stability level

The service design of the hotel encourages customers to make the reservation and the payment online and provides a rich website that allows them to get many services besides making the reservation, such as printing a parking pass, printing baggage tags with a QR code and asking for room service in advance.

In addition, customers could do these operations by using the hotel smart phone app where they can get a QR code in their phone. The next touch point is the hotel exterior and the parking. Customers will hand his/her bags to the bell person with tags. The bell person will put a label on the bag and use a QR code reader or their smart phone to identify bags. The check in happens as soon as customer gets to the hotel (it is a feature in the app) and the customer gets a greeting message on their phone with his/her room number. Customers can use the TV or their smart phone app for ordering food. In addition, customers can use their smart phone app to check out and the TV screens help them to review their bill. In addition, the hotels provide kiosks to print their QR code for customers. The hotel service blueprint E shows this design. The letter "F" shows where the failure point in the process could happen.

Security level

All the customer information will be saved in computers that are locked with a password for every user. The hotel uses magnetic lockers that read QR codes. No security personnel are working for hotel. The elevator functions with the QR code. In addition, there is a SAFE in each room. However, if the cleaning service personnel want to clean, they use a specific QR code. The hotel is equipped with cameras that cover all the hallways and corridors.

Sustainability level

The hotel uses a very good technology but the processes are not clear and not well designed. In addition, employee training is ignored and not planned

Reliability level

The hotel utilizes the technology that it has, and its system makes backup. However, it is so hard to provide services without the computer support so the hotel provide a backup battery system in case of losing power. One employee is available in each shift and ready to help customers. Ordering the food by TV or smart phone app helps to avoid any misunderstandings that could happen during food order service. The room service staff work until 5 PM. Hotel service has quality standards.

Old fashion customers don't like to use technology. It is easy for them to interact with humans during check in, food ordering and check out processes. However, the new generations like to use new technology such as QR codes on the smart phone app. It reduces the waiting time for check-in, getting a key and checking out.

Table 1. Summary of the Service Design Scenarios

Service Scenario	Stability	Security	Sustainability	Reliability	Overall number
A1					
A2					
A3					
A4					
B1					
B2					
B3					
B4					
C1					
C2					
C3					
C4					
D1					
D2					
D3					
D4					
E1					
E2					
E3					
E4					

Biographical

1. What is your job industry?

    a. Business/consultancy
    b. Non-Profit
    c. Marketing
    d. Education
    e. Government
    f. Still student

2. What is your current job function or area of work in the organization or school?

    a. Manager
    b. Designer

3. What is your experience?

	Less than 1 year (New)	1 year to 3 years	3 years to 5 years	5 years or more
As a designer				
As a manager				

4. What is your higher education degree and level achieved?

Answer Options	In progress	BS	M.S	PhD
Service design				
Engineering design				
Marketing/Business				
Engineering				
Industrial design/Product design				
Architecture design				
Interface designing				
Interior design				
Web design				
Graphic design				
Interaction deign				
Design Management				
Other (please specify)				