

MODELING OF CUSTOMER SATISFACTION IN CALL CENTERS

by

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ABSTRACT

MODELING OF CUSTOMER SATISFACTION IN CALL CENTERS

The customer satisfaction becomes a key element in the service sector in the 21st century. Many companies prefer to contact their customers through call centers in order to give service in a cost effective way and retain satisfied customers. The studies in the literature show that efficiency is important since call centers must provide speed of delivery and operate at a low cost to remain competitive. Therefore, managers concentrate on tangible aspects of performance assessment rather than the customer-centric indicators reflecting their satisfaction levels. However, efficiency doesn't imply the customer satisfaction all the time. Thus, this study proposes to examine a call center performance based on two different perspectives: efficiency and effectiveness. It defends that not only better service response rates, but also increased quality of responses are important for customer satisfaction. Therefore, this study suggests that both delivering high service quality and providing an efficient call center management are a must in order to retain customer satisfaction in a call center.

In the scope of this study, a methodology is proposed in order to measure the service quality and the performance of call centers. In this context, firstly, the satisfaction level of the customers is measured based on the service they get from the call center. SERVQUAL method is used for determining the gap between the customers' expectations and their perceived quality. Secondly, a simulation model is established in order to simulate the call center's operations. Meanwhile, the most important performance measures determined are monitored within the simulation model. Then, alternative scenarios are performed through simulation experiments for increasing the customer satisfaction level and decreasing the

gap between the expectation and perception of service quality of the customers. Results obtained from the simulation experiments are evaluated in order to develop recommendations for the decision makers.

The methodology proposed in this study is implemented for a call center of a private bank in Turkey and the application results indicate that the call center has to revise their strategy for achieving its target performance level and for being able to offer a satisfactory level of service quality to its customers.

ÖZET

ÇAĞRI MERKEZLERİNDE MÜŞTERİ MEMNUNİYETİNİN MODELLENMESİ

Müşteri memnuniyeti, 21. yüzyılda, hizmet sektöründe ön plana çıkan kavramlardan biridir. Birçok şirket, hem müşteri memnuniyetini sağlamak hem de maliyet etkinliği yaratmak için, müşterileriyle çağrı merkezleri aracılığıyla iletişim kurmayı tercih etmektedir. Bu konuda yapılan çalışmalar, çağrı merkezlerinin rekabet ortamında hızlı hizmet vermek ve düşük maliyet ile çalışmak zorunda oldukları için verimliliğin önemli olduğunu ortaya koymuştur. Bu nedenle, yöneticiler, çağrı merkezlerinin performans değerlendirmelerinde müşteri açısından çağrının sonucunu değerlendirmeyip, sadece verimliliği etkileyen somut kriterler üzerinde yoğunlaşmaktadırlar. Ancak, verimlilik her zaman müşteri memnuniyetini sağlayacağı anlamına gelmemektedir. Dolayısıyla, bu çalışma bir çağrı merkezinin performansının iki farklı bakış açısına dayandırılarak değerlendirilmesi gerektiğini önermektedir: etkinlik ve verimlilik. Bu çalışma, sadece verimliliği etkileyen oranların değil, müşteri temsilcisinin müşteriye verdiği yanıtın kalitesinin de müşteri memnuniyetini etkilediğini savunmaktadır. Bu nedenle, bu çalışma çağrı merkezlerinde müşteri memnuniyetini sağlamak için, çağrı merkezini verimli bir şekilde yönetmenin ve yüksek hizmet kalitesi sunmanın zorunlu olduğunu ortaya koymaktadır.

Bu çalışma içerisinde, çağrı merkezleri tarafından verilen hizmetin kalitesini ölçen ve aynı zamanda çağrı merkezinin kendi iç performansını değerlendiren bir yöntem önerilmektedir. Bu kapsamda, öncelikle müşterilerin çağrı merkezinden aldıkları hizmetten ne kadar memnun oldukları ölçülmüştür. Müşterilerin, çağrı merkezinden aldıkları hizmet

kalitesi ile almayı bekledikleri hizmet kalitesi arasındaki farklar SERVQUAL yöntemi kullanılarak ortaya konulmuştur. Daha sonra, bir benzetim modeli aracılığıyla, çağrı merkezinin işleyişi modellenmiştir. Söz konusu benzetim modeli içerisinde, çağrı merkezinin kendi performansını değerlendirirken en çok önem verdiği performans faktörlerinin de değerleri incelenmiştir. Benzetim modeli üzerinde, müşteri memnuniyet seviyesini artırmak ve beklenen ile verilen hizmet arasındaki farkları ortadan kaldırmak amacıyla, benzetim modeli üzerinde farklı senaryolar geliştirilerek uygulanması düşünülmüştür. Senaryolardan elde edilen sonuçlar değerlendirilerek çağrı merkezi yöneticileri için gelişim önerileri oluşturulmuştur.

Kurgulanan yöntem Türkiye’de hizmet veren özel bir bankanın çağrı merkezinde uygulanmıştır. Uygulanan senaryolar değerlendirilmiş ve hem müşteri memnuniyetini artırabilmek için, hem de kendi performans değerlendirilmelerinde konulmuş olan hedeflere ulaşabilmek için, çağrı merkezinin mevcut düzende uygulamakta olduğu stratejilerinde değişiklikler yapması gerektiği ön görülmüştür.

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LIST OF ABBREVIATIONS

AACW	Average after call work
ACD	Automatic call distributor
AHP	Analytic hierarchy process
AHT	Average handling time
AICV	Average incoming call volume
AP	Agent performance
APT	Average patience time
AQL	Average queue length
ART	Average returning time
ASA	Average speed of answer
ATS_{IVR}	Amount of time spent in IVR
AU	Agent utilization
CCP	Customer capability and persistency
CI	Consistency index
CR	Consistency ratio
CRM	Customer relationship management
IVR	Inter-active voice response

KMO	Kaiser-Meyer-Olkin
KPI	Key performance indicator
NCPA	Number of calls per agent
NRC	Number of retrial calls
PCA	Principal component analysis
PFCR	Percentage of first call resolution
QoS	Quality of service
RA	Rate of abandonment
RI	Random index
RM	Rate of mismatches
SBR	Skill-based routing
SL	Service level
SO	System occupancy
SQ	Servqual score
WSQ	Weighted servqual score

1. INTRODUCTION

The service industry is booming across the world in the 21st century. There has been a major transformation from a manufacturing economy to a service-oriented one. The size of service sectors has recently grown so much and the service sector has been spread on diversified fields such as government, health care, education, financial, tourism, telecommunication services.

As the service sector has become the dominant component of the economy, the studies revealed that quality of service (QoS) is a prerequisite for success and survival in today's competitive environment. Therefore, the interest in service quality has increased noticeably. In addition, the importance of service quality for business performance has been recognized in the literature through the direct effect on customer satisfaction and the indirect effect on customer loyalty. It is generally accepted that QoS is antecedent to customer satisfaction and that customer satisfaction is antecedent to customer loyalty.

Understanding exactly what customers expect is the most crucial step in defining and delivering high-quality service. Therefore, the organizations develop and apply customer-focused strategies for their service delivery. They integrate the customer relationship management (CRM) in their business process. Then, the call centers are the essential component of CRM strategy because call centers have become the common vital channel for companies to communicate with their customers. A customer's experience of a company's telephone service can have serious impact on its bottom line. Because, the customer experience is affected by inconsistent decisions, hand-offs between call center professionals and tedious escalation. Therefore, a company can easily lose a customer due to negative interactions.

For many companies, one of the main ways of establishing a call center's success has been to measure how quickly agents answer calls because (Gilmore, 2001) indicated that managers assess performance by the quantity rather than the quality of the calls. But it is a fact that there is a dichotomy between quantitative and qualitative targets within call centers. Just because there are no calls waiting in the queue and all the agents are on the phone, doesn't mean that customers are happy. Similarly, trying to ensure that all calls are kept to less than two minutes might make the call volumes look good, but what about actually solving the customer's query. Thus, it seems that there are opposing goals within a call center: productivity and QoS. Consequently, the ideal situation is to take a high number of calls while contributing a significant amount of emotional labor being helpful, friendly and empathetic towards customers (Robinson and Morley, 2006).

Despite the increasing importance of the service sector and of the significance of quality as a competitive factor, it is difficult to define and measure service quality since service quality is an elusive and abstract concept. There have been efforts to study service quality, but there has been no general agreement on the measurement of this concept. But, the majority of the work developed to measure service quality has attempted to use the SERVQUAL instrument. In the application of this instrument developed by (Parasuraman, 1988), customers evaluate the QoS by determining whether there is any gap between their expectations and perceptions.

This study establishes an integrated methodology in order to provide a satisfactory level of performance assessment of call centers. In addition to that, this study emphasizes on evaluating a call center performance with managing the contact process and monitoring the quality of an agent's interaction with a customer.

In the scope of this study, a methodology is constructed in order to analyze a call center performance from two different perspectives: efficiency and effectiveness. Efficiency refers to the quantity of calls handled by an agent whilst effectiveness refers to QoS. In order to integrate these two aforementioned perspectives, the proposed

methodology integrates three different tools which are Analytic Hierarchy Process (AHP), SERVQUAL and Simulation. In order to measure the efficiency of a call center, quantitative key performance indicators (KPIs) are identified. Then, in order to evaluate the effectiveness, the quantitative criteria which affect the customer satisfaction in a call center service, are determined and customer service perception is evaluated based on these service quality criteria. Then, the gap between the customers' expectation and their perceived service quality is established. In order to eliminate the gap determined for QoS, different scenarios are developed for creating improvement opportunities. Finally, these scenarios are implemented into a simulation model to observe the results of proposals for improvement.

This methodology is implemented to a call center of a private bank in Turkey. Based on the data analysis of this call center system, certain recommendations are developed for the decision makers at the end of the study.

2. LITERATURE SURVEY

The literature that inspired this study can be categorized into two groups: the ones providing the conceptual background about call centers workflow management and the ones providing the technical background about service quality measurement. The first group focuses on how a call center is managed in daily life, and the second group includes conceptual service quality gap model. Finally, this section reviews the publications related to call center management and related to service quality scale SERVQUAL aiming to providing a valuable background for this research.

2.1. Call Center Management

The growth of the call center industry is witnessed world-wide, fueled by advances in information technologies and the decline in the costs of voice and data transmission over the last two decades. As part of this global industry, call centers have experienced spectacular growth in the last years.

Evidence of the growth in importance and ubiquitousness of call centers can be seen directly from the growth of the number of call centers in every country around the world. It is estimated by the Center for Customer Driven Quality at Purdue University that there are 115.000 call centers in USA and 10.000+ call centers across Europe (Dean,2007).

The development of the call center industry in Turkey started in late 1996. Until 1996, only those companies whose operations required possessing a call center were running call centers. Nevertheless, during the past years the growth of the call center industry has been significant. This is largely attributable to the increased awareness on

customer retention and its impact on profitability. Banks and GSM companies have largely pioneered the developments and contributed substantial investments. Today there are more than 300 call centers by the end of 2007 in Turkey where approximately 30.000 people are employed. Banks cover about 34 per cent of the market, and the share of the telecommunication sector is about 30 per cent (Pekkan, 2008).

2.1.1. Key Concepts in Call Center Management

In recent years, call centers have grown rapidly in volume and popularity throughout the world. They are relatively a new approach and employees in call centers perform a crucial role in the delivery of front-line services, which is fundamental to the CRM activities (Frenkel et al., 1998).

Historically, the call centers employed by companies have handled routine customer transactions such as address changes, membership or subscription renewals, product orders inspired by catalogs and complaint collection. These tasks required nothing but the simplest training, often with a focus more on attitude than expertise. But, nowadays, call centers are quickly becoming many organizations' main customer interface channel (Robinson and Morley, 2006). Furthermore, over the past few years, the call center has emerged as the essential component of the CRM strategy now widespread among companies. Because, call centers allow a company to build, maintain, and manage customer relationships by conducting transactions, giving information, answering questions, solving problems and resolving complaints quickly, and less expensively than face to face contact (Feinberg et al., 2002).

Retaining existing customers rather than spending to acquire new ones is a key motivation in effective call center management. It is clear that call centers can create and sustain customer satisfaction because if a customer's problem is solved by a telephone contact, she/he will be simply satisfied. Then, a satisfied customer is more likely to

repurchase, or promote positive word of mouth (Feinberg et al., 2002). Thus, the performance of call centers will be critical to the image of the organization (Gilmore, 2001)

Before evaluating the means of establishing a call center's success, it is necessary to explore what the call center is. A call center is a set of resources such as communication equipment, employees and computers which enable the delivery of services via the telephone. Operations are managed by a group of people who spend most of their time doing business by telephone, usually working in a computer-automated environment. Employees in blended call centers may receive inbound or make outbound telephone calls. Inbound calls are those initiated by customers calling into the center to obtain information, report a malfunction, or ask for help and outbound calls are initiated by agents calling customers for selling a product. Those calls are processed and controlled either by an automatic call distributor (ACD) or predictive dialling system (Taylor and Bain, 1999). An ACD technology is a specialized switch designed to route each call to an individual agent; if no qualified agent is available, then the call is placed in a queue. A predictive dialer tries to anticipate the number of free agents at the time customers are reached. More recently, call centers have had an additional technology, the inter-active voice response (IVR). The latest generation of speech-recognition technology allows IVRs to interpret complex user commands, so customers may be able to "self-serve", i.e. complete the service interaction at the IVR.

In a multi-skill call center, various call types (or skills) are distinguished, and agents are grouped by their skill group, defined as the subset of call types they can handle. Skill-based routing (SBR) refers to rules, programmed in the ACD, that control in real time the agent-to-call and call-to-agent assignments.

In inbound call process, a customer can be blocked, i.e., receive a busy signal, if all of the center's phone lines are busy at the time he/she calls. If a customer succeeds to enter to the call center, at first, calls may be connected to an IVR unit. Otherwise, calls are

passed from the IVR to ADC. ADC technology places inbound calls in a queue and allocate them to the first free call center agent. A queued customer may abandon without receiving service. Sometimes, a mismatch occurs whenever a customer connects to an irrelevant agent and then he/she has to be transferred to the relevant agent. The detailed inbound call process is displayed in Figure 2.1.

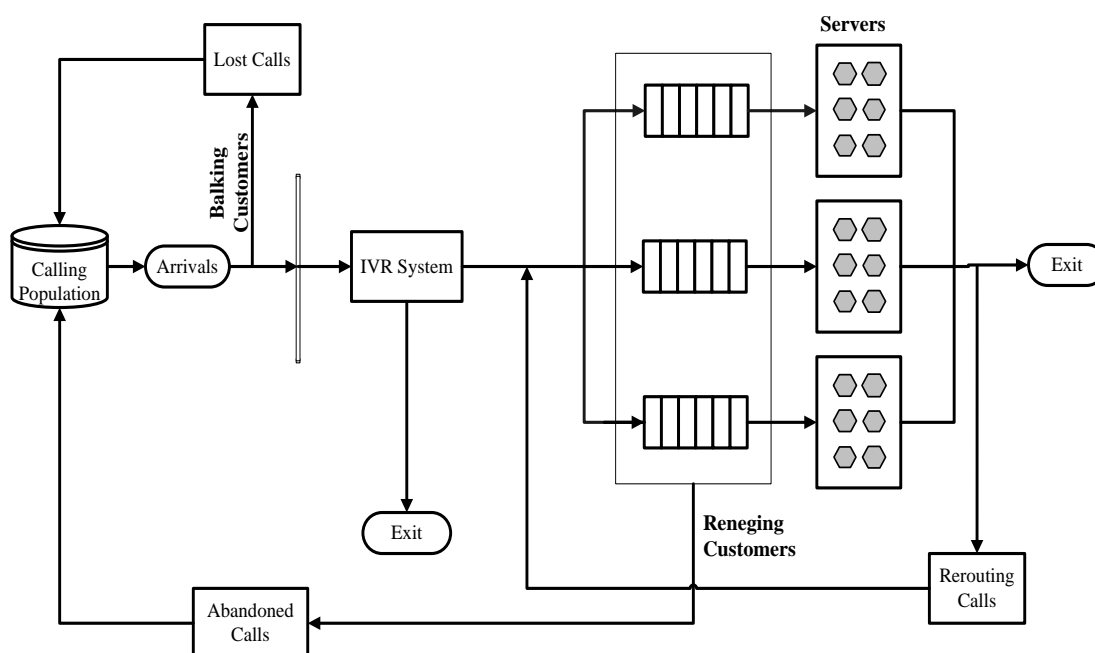


Figure 2.1 Inbound calls flow in call center

2.1.2. Call Center Management Decisions

Call centers have emerged as an important tool for providing higher customer satisfaction (Anton, 1997). In call centers, human agents and/or automatic voice response machines handle computer assisted telephonic communications with customers (Armistead et al., 2002). Companies use call centers for establishing direct communication with their customers. The primary objective of call center operations is customer care and achievement of high levels of customer satisfaction. Call centers are increasingly playing a crucial role in CRM. Most business organizations see call centers services as a potentially

effective way of keeping customers happy and satisfied, and gaining competitive advantage (Jaiswal, 2008).

However, the call center industry has been perceived to suffer from some of the problems associated with industrial mass production. The nature of the requirement to answer a high number of calls in these centres had led to the use of a traditional "production-line" management approach. The advantage of a production-line approach is that the organisation controls the system and leaves nothing to the discretion of the employee. Agents complete information on screen by following a script. Supervisors and team leaders are under continual pressure from management to perform to high targets. Such surveillance can be visual: agents cannot move from their workstations without permission. Most call centers are constantly endeavouring to increase call numbers, reduce call time and wrap-up time (Taylor and Bain, 1999), putting constant pressure on employees. This type of management relies heavily on technology to monitor, control and evaluate work. However, supervisory practices influence job control and help develop employee empowerment, therefore constituting an essential variable attenuating the link between telephone surveillance and work stress (Curry and Lyon, 2008).

Those responsible for managing call centers face a very difficult set of challenges. At a high level, they must strike a balance between three powerful competing interests, as shown in Figure 2.2.

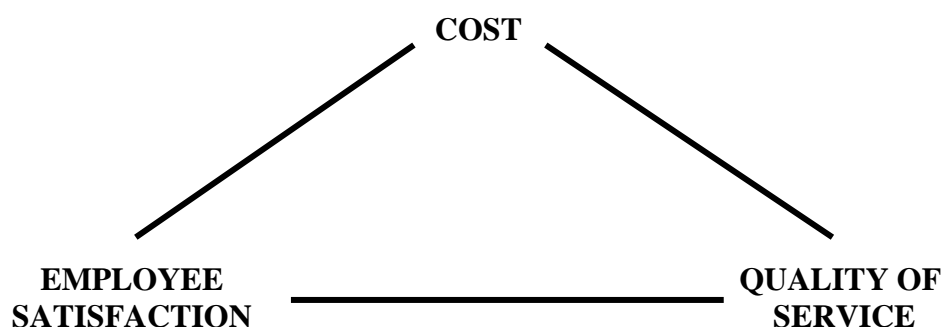


Figure 2.2 Call center management balancing act

On a day-to-day basis, while simultaneously keeping costs, service quality, and employee satisfaction, the managers must (implicitly or explicitly) answer a number of important questions for which decision support models are valuable:

- How many agents should we have on staff with which particular skills?
- How should we schedule these agents' shifts, breaks, lunches, training, meetings and other activities?
- How many calls of which type do we expect at what times?
- How quickly do we want to respond to each type of inbound call?
- How should we cross-train our agents?
- How should we route our calls to make the best use of these resources?
- Given a forecast, a routing design, and an agent schedule, how well will our system perform?
- What is our overall capacity? How will a spike in call volumes impact our overall performance? If the changes are significant, what can I do to respond to minimize the impact on the rest of the day or week?
- What has changed since we did our last forecast and published our schedules?

The hierarchy of call-center decisions can be summarized as follows:

- *Strategic decisions*: made by upper management, concerning the role of the center in the company, the type of service to be delivered and the budget.
- *Tactical decisions*: how resources (e.g., budget, human knowledge) should be used; hiring and training of agents.
- *Planning decisions*: usually, on a weekly basis, new rosters (work schedules for each employee) are made by planners at the call center.
- *Daily control*: reactions to the current situation, usually taken by shift leaders that monitor service levels and productivity. Typical reactions may be: if the load is less than planned for, then release agents for training or other activities; if the load is more than planned for, then make employees work overtime.

2.2. Service Quality

Service quality developed as a field separate from manufacturing quality in the late 1970s and early 1980s. Quality had been advocated as a weapon that companies could use to survive fierce global competition, but different models from those created for the manufacturing world needed to be developed for controlling the QoS delivery. The differences between services and goods made the objective, technical methods of controlling quality for goods difficult to apply to intangible, heterogeneous service delivery in the world of consumer services. Thus, the service quality literature was developed. Furthermore, this literature has grown and gained in importance as services have become a larger part of economies.

2.2.1. Definition of Service Quality

In today's changing global environment, many businesses are facing intensifying competition and rapid deregulation, and in order to achieve competitive advantage and efficiency, businesses have to seek profitable ways to differentiate themselves. In the "age of customer", the essential strategy that has been related to success is the delivery of high service quality.

A basic problem of the management of service quality has to do with the "nature" of services. Service is abstract and difficult to define. The instruments developed for measuring product quality are linked to the technical specifications of goods. However, (Edvardsson et al, 1994) indicated that product-oriented methods eventually proved insufficient for defining and measuring service quality.

More importantly, the conditions under which services are produced differ from those for good production. Consequently, we need to measure service quality in different

ways. Edvardsson (1994) pointed out that the manufacturing process takes place at one time and in one place, the customer is not present, nor does he participate in the process. He added that in the case of services, however, the customer does take part in the process as co-producer; the customer is present and affects the result in terms of added value and quality. Usually a service process includes interactions of the service personnel and customers. Therefore both the personnel and customers influence service quality. The customer participation has an effect on the process: customers can provide resources needed as inputs in the process. The inputs they give and the actions they take may vary in general and in quality. This means that the service company faces difficulties in delivering quality service because of the varied actions and inputs of the customers.

Then, if we state a general definition of service quality: the service must correspond to the customers' expectations and satisfy their needs and demands. Also, it meets expectations of the employees and owners (Edvardsson, 1994). Satisfied customers spread the good news quickly, something which is satisfying for the employees and most likely also for the owners. Quality improvement can be regarded as a game where all participants are winners. However, how a customer receives the service and experiences the service process has a great influence on the customer's satisfaction with the service. (Grönroos, 2001) argues that the service quality seen by customers has two dimensions: a technical and functional quality. The first dimension means what the customer gets and the latter one how the customer receives the service.

At the time of purchase, the customer decides if expectations have been met by comparing the "perceived performance" with the "expected performance". Hence, after a service delivery process, if the customer can define the perceived quality as the quality he/she expects, it means that the customer is completely satisfied with the service. It is a fact that the customer's perceptions of quality depend on many factors: expectations, experiences and image.

The customer's perception of quality is affected by the customer's expectations, which are related to his/her past experiences with the same firm or to the image of the business. Besides, customers bring their previous experiences and overall perceptions of a service firm to each encounter (Grönroos, 2001). Perceived quality is further affected by the image of the business, i.e. the reputation of the supplier and the service in the market. An image can be better or worse than the real thing, but it acts as a filter for perceived quality. Therefore, the image concept was introduced as another important component for the perceived service quality.

Perceived quality as a concept is difficult to grasp because it contains both subjective and objective factors and is dependent on the characteristics features of the customer: education, income, life style, values, state of mind, etc. To improve quality, it is necessary to influence expectations, experience and image- this is the task of people who have contacts with customers including frontline staff (Edvardsson et al., 1994).

As an inference, service quality is an important antecedent of consumer assessments of value. Value assessments in turn have been found to influence consumer satisfaction and motivate behavioral intentions. Notable examples of behaviors motivated by a favorable service quality assessment are repurchasing intentions, loyalty and word of mouth (Imrie et al., 2002).

2.2.2. Dimensions of Service Quality

In today's competitive environment, organizations must earn the customer's trust by consistently meeting or exceeding expectations. Therefore, managers should monitor customers' perceptions of service quality; identify the causes of service-quality shortfalls and then take appropriate action to improve the QoS. The disparity between expectation and perception is the major determining factor in a customer's assessment of QoS. As service quality is becoming a major part of business practice, it is important to be able to

measure and research its effectiveness. “What is the best way to measure it?” is the question to be answered.

Parasuraman, Zeithaml and Berry, three of the best-known researchers on service quality, launched their program of research dedicated to understanding service quality. This program resulted in the development of a model and accompanying measure of service quality called SERVQUAL. It can be used for performing a gap analysis of an organization’s service quality performance against customer service quality needs. The method involves the development of an understanding of the perceived service needs of target customers. These measured perceptions of service quality for the organization in question, are then compared against an organization that is “excellent”. The resulting gap analysis may then be used as a driver for service quality improvement. One important finding that has emerged from this qualitative research was support for the idea of consistency across services in the types of factors that people considered in evaluating service quality (Schneider and White, 2004).

Parasuraman, Zeithaml and Berry (1990) realized the multi-dimensionality of service quality because they noticed that while customers evaluate an organization’s service quality they use or benefit from some dimensions related to service they receive. With this respect, they identified ten dimensions used to evaluate the service quality in general. These dimensions are displayed at Table 2.1.

By following the steps explained in Figure 2.3, they obtained a service quality scale with 22 questions grouped into five dimensions. When the format of SERVQUAL instrument was examined in detail it is seen that while dimensions which are tangibles, reliability and responsiveness remained the same, assurance and empathy was added as two new dimensions. The main modification between the old and new one is that the dimension of assurance covers competence, courtesy, credibility, security, communication and dimension empathy covers access and understanding. Finally, the original SERVQUAL instrument comprises 22 statements used to assess service quality across five

dimensions is obtained. Each statement is used twice: once to measure expectations and once to measure perception.

Table 2.1 Dimensions of service quality and definitions

Dimension	Definition
Tangibles	Appearance of physical facilities, equipment, personnel, and communication materials.
Reliability	Ability to perform the promised service dependably and accurately.
Responsiveness	Willingness to help customers and provide prompt service.
Competence	Having necessary knowledge and capability in providing service.
Courtesy	Being polite, respectful and behaving friendly
Credibility	Being reliable, honest and believable.
Security	Away from danger, risk and any doubt.
Access	Accessibility and easy to contact.
Communication	Listen to its customers and acknowledges their comments, keeps customers informed, contact with them in a language which they can understand.
Understanding	Making effort in identifying customers and knowing their needs.

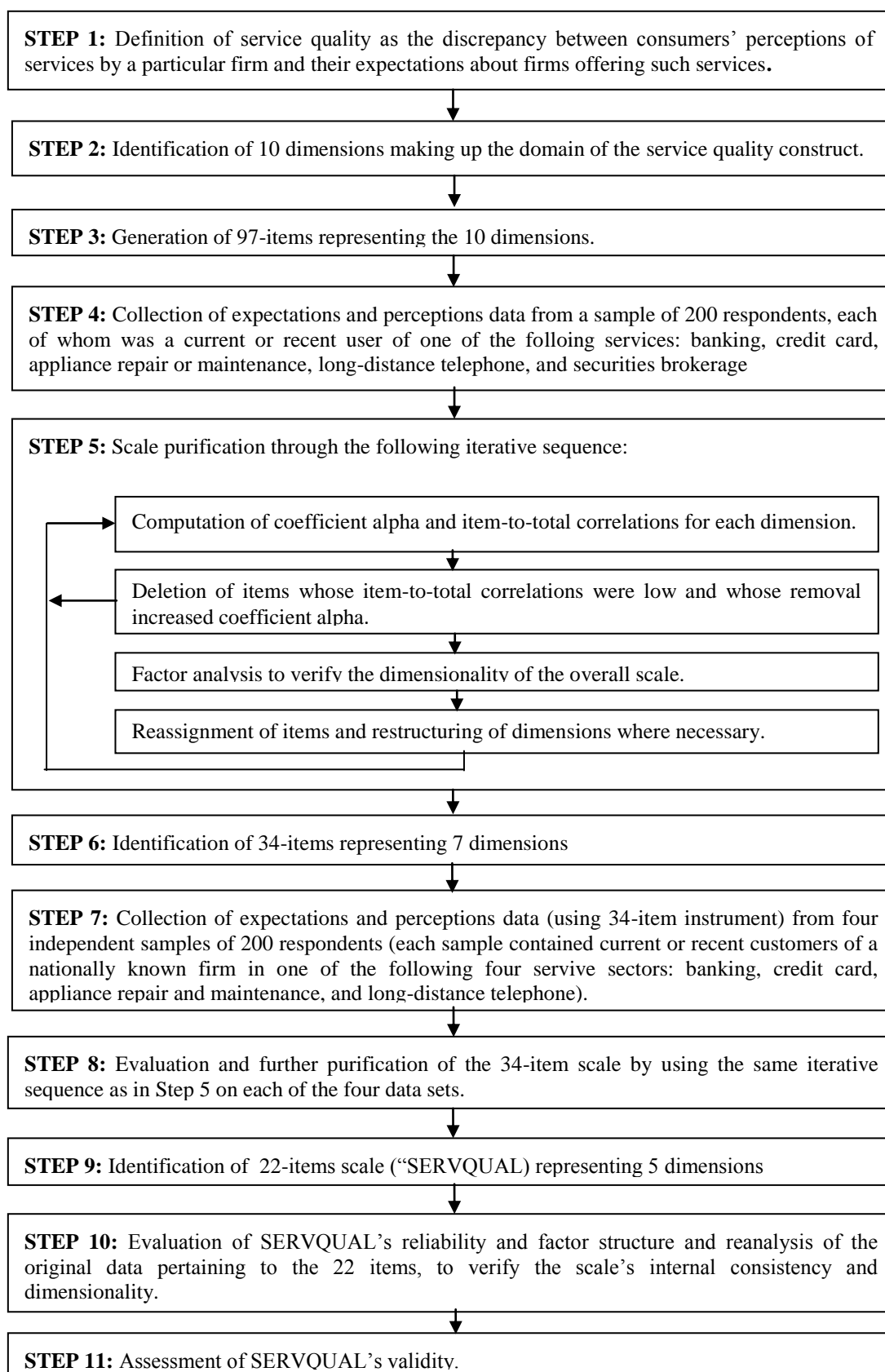


Figure 2.3 Steps employed in developing the service quality scale

2.3. Background

The research areas which inspired this study can be classified into call center performance measurement, service quality scale SERVQUAL and decision making method AHP.

2.3.1. Call Center Performance Measurement

With recent advances in technology and the changing nature of business, call center management has become a rapidly growing industry. Current trends regarding call centers reflect a substantial growth in this sector which trigger numerous studies to improve call center performance. The majority of these studies, however, have focused on operational issues associated with efficient call center management (Bordoloi, 2004; Gans et al., 2003; Zohar et al., 2002). Research regarding call centers, customer satisfaction, and customer loyalty has been much less explored.

Call center performance measurement is heavily weighted towards productivity measures rather than an emphasis on quality. There are a lot of studies in the literature, which analyse a quality versus quantity dilemma. A trade-off between productivity and service quality can be confused with the difference between quantitative and qualitative measures, even though some quantitative metrics, such as call waiting time and sojourn time, are clearly measures of service.

(Bennington et al., 2000) find out in his study that customers are less satisfied with call center operations than they are with more traditional office-based (in-person) services. Furthermore, researchers have found that most of the metrics used to efficiently manage call centers are not positively correlated to customer satisfaction (Feinberg et al., 2002;

Miciak and Desmarais, 2001). The call center industry tends to accept that “first call resolution” and customer satisfaction goes hand-in-hand.

Fernie (2004) suggests that call center work varies according to skills, knowledge, monitoring and HR practices. His study explains that call center agents are often required to answer a great number of calls regardless of the quality of the call as they are judged on how quickly they deal with the inquiry.

Robinson and Morley (2006) is interested in investigating what the key management responsibilities are in managing call centers and the KPIs used in managing call centers in their study. This research focuses on call center management responsibilities and KPIs used in Australian call centers. 130 managers in six different call centers were asked to list the existing formal KPIs for their role in their call center, and then asked what would be the three most important KPIs if they were to write their own KPIs. These KPIs were listed as service level, sales, costs, customer satisfaction and other. Respondents were then asked to rate eight given KPIs, customer satisfaction index, staff turnover rate, abandonment rate, wrap-up time, average handling time, occupancy rate, number of calls per agent, in order of importance to themselves as the call center manager. The customer satisfaction index was ranked the most important KPI and the number of calls per agent was ranked the least important one. When the responses were analyzed, there was evidence of a paradox in that customer service was the main goal of most call center managers, yet there was an emphasis on measuring productivity aspects of the call center’s activities. This study analyses call centers by a managerial perspective. It confirms that the metrics available and employed in call centers have resulted in managers concentrating on the call itself rather than the outcome of the call from the perspective of the customer or the organisation. It demonstrates for call center managers it could be strategically important to not rely on a limited set of standard and readily available metrics to manage, but to expand the metrics monitored to include quality measures and to incorporate other approaches to management and performance assessment.

Gilmore (2001) analyzes four call centers in order to find out how they measure the service quality. By interviewing the managers, he found out that there was a predominant concern with the tangible aspects of service quality by managers, with little concern for the intangible service delivery issues. The tangible dimensions of service quality such as the number of calls, speed of response, length of call and standardised response were continually assessed. However the intangible aspects such as empathy, courtesy, responsiveness were not taken into the consideration. He indicated that call centers need management which recognises both the tangible and intangible aspects of service delivery and their contribution to overall quality of service.

Jaiswal (2008) tries to understand the current practices of measuring customer satisfaction and service quality in call centers. In his study, he conducted 12 in-depth interviews with senior managers of four large call centers in a South Indian city in order to see how managers measure service quality. He determined KPIs used for the performance evaluation and quality control in these call centers such as average speed of answer, abandonment rate, longest delay and service level. By using the hypothesis proved by (Feinberg et al., 2002) that KPIs have weak effect on caller satisfaction, he concluded that call centers managers overly depend on metrics comprising operational measures for service quality evaluation and operational variables cannot provide a true picture of how customers perceive service quality.

Staples and Dalrymple (2001) find that the four attributes of tangibility proposed by Parasuraman et al., were not “portable” to the virtual setting of call centers as customers do not encounter visual cues. Similarly, a study carried out by (Keiningham et al., 2006) conducted from the customers’ perspectives has shown that call center satisfaction has all the dimensions as found in SERVQUAL, for example, reliability, responsiveness, assurance, and empathy except tangibility.

Ramseook-Munhurrin et al. (2009) assess service quality of a call center perceived by its employees using the SERVQUAL model. In this study, data were collected in a

particular call center in Mauritius using a modified SERVQUAL questionnaire with 19 items. Using factor analysis, the gap scores were examined and three main factors are emerged as dimensions of service quality in the call center: Assurance-Empathy, Reliability-Responsiveness, and Tangibles. Based on the new three factors derived from the factor analysis, a multiple regression analysis was used to determine the relative importance of service quality characteristics in predicting the overall employee satisfaction and behavioural intentions, namely willingness to stay with the organisation and to recommend the organisation to others. Based on regression analysis, it was found that reliability-responsiveness was the only significant predictor of employee satisfaction.

2.3.2. Service Quality Scale: SERVQUAL

Research indicates that service quality has been increasingly recognized as a critical factor in the success of any business (Parasuraman et al., 1988). Therefore, in recent decades, a substantial body of literature has examined the concept of service quality, its dimensions and measurement methods. The most widely used instrument to assess service quality is SERVQUAL (Schneider and White, 2004).

Following the initial development of the SERVQUAL instrument by Parasuraman et al. in 1988, various researchers have attempted to adapt this instrument to their specific field of study. SERVQUAL instrument was used in many service sectors such as in travel agency (Bigné et al., 2003), telemarketing services (Kassim and Bojei, 2002), library (Cook and Thompson, 2000), education (Peter and Cuthbert, 1996), bank (Newman, 2001), information technology (Kang and Bradley, 2002) and hospital (Lam, 1997) to measure the service quality.

Some empirical evidence suggests that the five components of service quality are not consistent when compared across different types of service industries (Cronin and Taylor, 1992). Therefore, they advise managers to carefully assess which issues are important to

service quality in their particular situations and to modify the SERVQUAL scale accordingly. It is a fact that the type of industry affects the design of service. Chowdhary and Prakash (2007) indicate that empathy and responsiveness are found to be more important for labor intensive industry while tangibles and reliability affect the assessment of quality dimensions in case of capital intensive services. As the dimensions of service quality may vary from one industry to another, it is a must to make a simple adaptation of the SERVQUAL items to effectively address service quality in some environments.

Staples et al. (2002) examined the applicability of the SERVQUAL Model to the context of a virtual organization, specifically the call center industry. As Parasuraman et al. (1988) contend that SERVQUAL is a generic instrument, Staples et al. (2002) try to find an answer for the following question: If SERVQUAL is a generic instrument is, it portable to the virtual service encounter that takes place between a call center and its customers? In this study, they claim that there is little ‘tangible’ about a call center service encounter because a customer never comes into contact with the physical appearance of a call center. They indicate that via the telephone, agents’ voice, their tone, their language are the critical aspects. In addition, reliability is accepted as a difficult dimension to assess because they think that it is not possible for the customer to fully evaluate whether the agents have performed dependably and accurately. This can be only confirmed with retrieval of records. Then, they indicate that the other dimensions, assurance, empathy and responsiveness, are dependent to agents’ skills such as their knowledge and their behaviors. Hence, they conclude that in the absence of visibility, the only way of transmitting any of the dimensions of service quality is through the agents’ voice.

Many researchers have found SERVQUAL very useful and sufficient but many researchers who have used the SERVQUAL instrument criticize it due to some insufficiencies. They have been criticizing the use of difference scores, unstable dimensionality, and varying interpretations of expectations (Landrum and Prybutok, 2004). First of all, SERVQUAL is built on the theory that service quality is the gap between what customers expect and what performance they actually perceive (Parasuraman et al., 1988). But, some studies have indicated that performance scores alone exhibit better reliability

and validity than difference scores, and some researchers have suggested that service quality should be calculated just with performance scores (Babakus and Boller, 1992; Cronin and Taylor, 1992). Secondly, many researchers have questioned the dimensionality aspect of SERVQUAL. Few studies have found support for the original five dimensions proposed by Parasuraman et al. (1988). Newman (2001) claims that SERVQUAL's dimensionality has not proved universal. Newman's argument has been proved because published empirical studies have produced a variety of dimensions. For example, (Babakus and Boller, 1992), in their study, confirmed two SERVQUAL dimensions and added two from the original ten dimensions of service quality. Another argument was that the responsiveness, assurance, and empathy dimensions tend to collapse into a single dimension, leaving SERVQUAL with a three-dimensional structure (Kettinger and Lee, 1994). Finally, the evaluation of customers' expectation has interrogated by (Taylor and Cronin, 1992). Expectations can be interpreted as predictions of service, as an ideal standard. (Avkiran, 1999) indicates that there is a tendency to set expectations higher than perceptions thus making a gap between perceptions and expectations inevitable.

While SERVQUAL has been criticized and its applicability to other service industries has been questioned, it provides a basis for understanding service quality and its dimensions. It would be dangerous, however, to utilize SERVQUAL or any other instrument without first validating that it is applicable in a particular industry. Developing a list of quality dimensions for a specific service industry requires determining what is important to customers in that industry.

2.3.3. Decision Making Method: AHP

The AHP is a multi-attribute modeling methodology which was first developed and applied by Saaty. He developed AHP in the early 1970s in response to the scarce resources allocation and planning needs for the military (Saaty, 1980).

AHP is based on the innate human ability to make sound judgments about small problems. It facilitates decision-making by organizing perceptions, feelings, judgments and memories into a framework that exhibits the forces that influence a decision.

AHP is an approach to decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion, and determining an overall ranking of the alternatives. In order to evaluate the ranking operations, a tailor-made questionnaire is used to collect the perceptions from experts or decision-makers on those criteria (Cheng and Li, 2002).

In the 25 years since the publication of the first papers, books, and software, AHP has been used by decision makers all over the world to model problems in more than 30 diverse areas (Shahin and Mahbod, 2007). The AHP approach has been adopted in many applications including resource allocation (Barbarosoglu and Pinhas, 1995), business performance evaluation (Lee et al., 1995), project selection (Mustafa and Al-Bahar, 1991), and auditing (Yau, C. and Davis, 1993). Additional application areas include problems in public policy, marketing, procurement, health care, corporate planning, transportation planning and many other areas because of the ease of its use (Saaty, 1994). Then, new application has been found in the fields of information and management (Yang and Huang, 2000).

(Bayazit, 2005) proposed an AHP model to guide the management of Turkish Tractor Manufacturing Plant who are contemplating a decision about whether flexible manufacturing system should be implemented in the entire plant or not. After evaluating 28 primary factors which influence the objective of the decision-making model considered, AHP enabled to incorporate 28 factors that were both qualitative and quantitative to assess the flexible manufacturing system implementation.

Chen and Huang (2007) identified four main criteria such as assets, business criteria, cost and delivery and 16 sub-criteria which are clustered into these four dimensions stated above in order to select the most favorable supplier. The weight of each criterion at each level was calculated and the final rank of potential suppliers was determined by using AHP method.

Gaudenzi and Borghesi (2006) suggested an analytic hierarchy process model to identify supply chain risk factors with a view to improve the objective of customer value. The major supply-chain objective in the model was set as the creation of customer value. Therefore, four critical objectives which affect the customer satisfaction were determined: on-time delivery; order completeness; order correctness; and damage-free and defect-free delivery. Then, the prioritization of supply chain objectives was done by applying the AHP method.

Shahin and Mahbod (2007) provided an integrated approach that prioritizes organizational key performance indicators (KPIs) based on SMART criteria (Specific, Measurable, Attainable, Realistic, and Time-sensitive). After building an AHP hierarchy in which, the goal is to prioritize KPI alternatives with respect to SMART criteria, AHP enabled to select of KPIs that are more relevant to organizational goals.

As seen in the literature survey, the concept of service quality is gaining importance day by day and becomes a key driver for the service sector. In particular, managers should pay attention to the service quality in their call centers because call centers are the common customer relationship channel. However, the literature revealed that call center managers focus on criteria related to the productivity. Additionally, the applicability of SERVQUAL method, which is a common service quality scale in service sector, creates a topic of discussion in the literature. In the next sections, we will emphasize on that the service quality is as important as the productivity in terms of call center performance assessment and SERVQUAL method applicability to call centers will be demonstrated.

3. PROBLEM DESCRIPTION AND STUDY OBJECTIVE

As it is emphasized in the previous chapters, the call center industry has emerged as one of the most rapidly growing industries in recent years. Many companies carry out their standard CRM activities such as customer information update, subscription renewals and complaint collection via call centers. Thus, call centers are quickly becoming many organizations' main customer interface channel. This also reflects the desire of companies to improve access to their services, in a cost-effective manner, and retain satisfied customers.

In the call center management, efficiency is important since call centers must provide speed of delivery and operate at a low cost to remain competitive. As illustrated in the second chapter, the studies related to the call center management show that call centers are managed based on different KPIs such as abandonment rate, average speed of answer etc., which affect the efficiency. Managers concentrate on tangible aspects of performance assessment rather than the outcome of the call from the customer perspective so that call center operators are often required to answer a great number of calls regardless of the quality of the call as they are judged on how quickly they deal with the inquiry. Thus, based on literature survey done, it is concluded that call center managers believe that efficiency implies the customer satisfaction. But they overly depend on operational metrics which can not provide a true result of customer perception quality.

On the other hand, the applicability of the quality instrument SERVQUAL to the call center is questioned in the literature as stated in the second chapter. Authors defend that SERVQUAL model has an inappropriate dimension namely "tangible" because a customer never comes into contact with the physical appearance of a call center and face-to-face communication doesn't exist in a call center. In addition to that, "reliability" dimension is considered as a difficult dimension to access because they think that customers can not evaluate whether the agent's performance is dependable and accurate.

This study defends that both delivering high service quality and providing an efficient call center management are compulsory in order to retain customer satisfaction in a call center. Thus, this study seeks to examine a call center performance based on two different perspectives: efficiency and effectiveness.

In scope of this study, the primary objective is to identify the most important KPIs which have to be taken into consideration by call center managers for providing efficiency in call centers.

The second objective is to measure the customer perceived quality which is an indicator of effectiveness in call centers. Thus, the aim is to propose a new service quality scale to measure it: a customized SERVQUAL. As we mentioned in the literature survey, researchers explore that SERVQUAL doesn't appear to be universally applicable to all situations without customization. They have always recognized the potential need to modify service quality dimensions. Based on this idea explored in the literature, it is proposed to modify the fundamental dimensions of SERVQUAL's model according to the service sector chosen - call centers. In addition to that, within the customization procedure of SERVQUAL model, the tangible components existing in a call center will be defined and the portability of the dimension "tangible" to a call center will be proved.

After evaluating a call center performance from two different perspectives, efficiency and effectiveness, it is suggested to improve the weak aspects of call center performance in order to increase customer satisfaction. These improvement opportunities created will be applied on a simulation model.

This study proposes to balance two opposing goals of efficiency and service quality in call center management. Thus, it can be viewed as a significant enhancement for the previous studies which indicate that call center managers just focus on the productivity rather than the QoS.

4. RESEARCH FRAMEWORK AND METHODOLOGY

The proposed framework explained in the previous section in order to asses a call center performance from two different perspectives; efficiency and effectiveness, is illustrated in Figure 4.1.

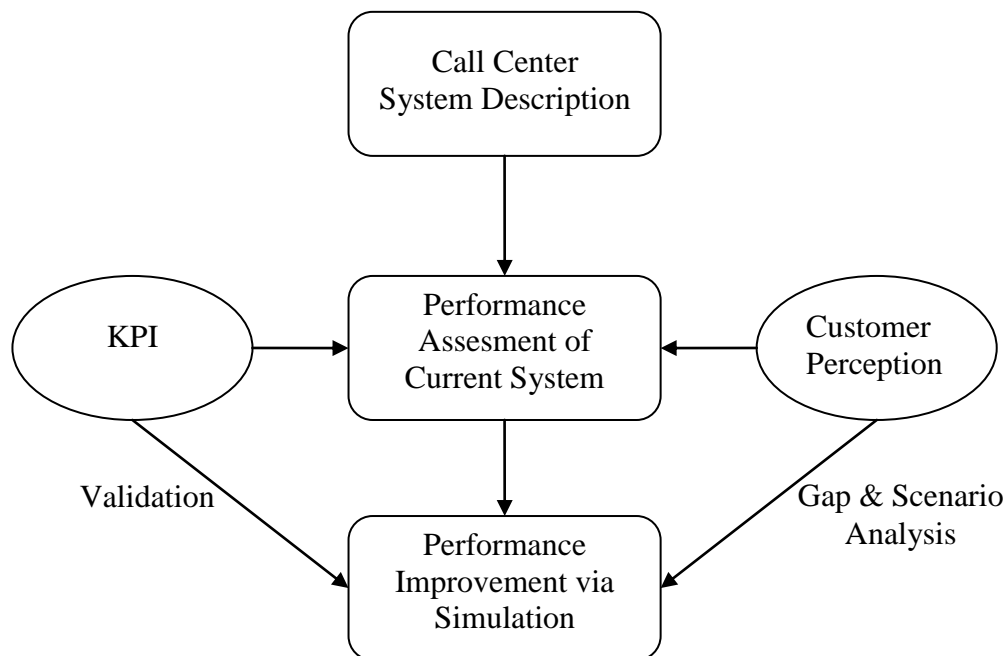


Figure 4.1 Proposed research framework

In the methodology implemented for the proposed research framework, the primary issue in evaluation of call center performance is to identify KPIs which affect the efficiency of the call center such as the number of calls handled in a specified time period, the amount of agent time spent per call. In order to find out the most important KPIs, a multi-criteria decision method AHP is suggested for the purpose of determining the importance weight of each KPI. When the weight of each KPI is calculated by AHP, the factors will be ranked in descending order according to their weights. The most important

factors, which have the highest weight, will be used in the simulation model in order to validate the real call center system.

Then, it is proposed to couple the efficiency indicators with the intangible factors such as empathy and reliability which may be influential on customer perception of service quality. In order to evaluate the customer perception of service, a customized service quality scale for call center is constructed. This customized SERVQUAL scale is created by following the steps of the original SERVQUAL methodology explained in the Section 2.2.2.

In order to establish the customized SERVQUAL for call centers, first of all, qualitative factors, which affect the customer perception, are identified based on a literature survey and they are grouped into six different dimensions. Then, each factor is transformed into a SERVQUAL's type of questions so it is obtained a survey instrument with 35 items assuring that it is appropriate for the chosen application area and copes with the requirements of the call center systems. After that, an adequate number of customers, who are chosen based on the random sampling method, participate to the survey study. For each item, participants gave a rating score on the corresponding perception (P) and expectation (E) statements respectively in the survey study. Then, based on P and E value, a difference score Q is defined as $Q=P-E$ for each item. After obtaining Q values for each item, reliability analysis is offered to be carried out for Q values at a reliability level of 0,7 in order to check the internal consistency of our Servqual instrument. To test its reliability, we computed Cronbach's alpha coefficients which can be written as a function of the number of test items and the average inter-correlation among the items as stated:

$$\alpha = (N \cdot \bar{c}) / (\bar{v} + (N-1) \cdot \bar{c}) \quad (4.1)$$

where N is equal to the number of items, \bar{c} is the average inter-item covariance among the items and \bar{v} equals the average variance.

At the end of the reliability analysis, 12 items are eliminated from the survey in order to increase the internal consistency of the SERVQUAL instrument. After performing the reliability analysis, a factor analysis is performed as a second step in order to test the dimensionality of the service quality scale.

In factor analysis, $Y_1, Y_2 \dots Y_{23}$, are defined as the variables respectively representing questions $Q_1, Q_2 \dots Q_{k23}$ stated in the refined survey. The unobservable factors $F_1, F_2 \dots F_6$ represent one of the six dimensions, namely D1, D2...D6. It is suggested that the variables of interest $Y_1, Y_2 \dots Y_{23}$ are linearly related to a smaller number of unobservable factors $F_1, F_2 \dots F_6$. In other words, it is assumed that each Y variable is a linear function of six factors and error terms, as follows:

$$\begin{aligned}
 Y_1 &= \beta_{10} + \beta_{11} F_1 + \beta_{12} F_2 + \beta_{13} F_3 + \beta_{14} F_4 + \dots + \beta_{16} F_6 + e_1 \\
 Y_2 &= \beta_{20} + \beta_{21} F_1 + \beta_{22} F_2 + \beta_{23} F_3 + \beta_{24} F_4 + \dots + \beta_{26} F_6 + e_2 \\
 &\vdots \\
 Y_{23} &= \beta_{230} + \beta_{231} F_1 + \beta_{232} F_2 + \beta_{233} F_3 + \beta_{234} F_4 + \dots + \beta_{236} F_6 + e_{23}
 \end{aligned} \tag{4.2}$$

Then, the parameters β_{kj} , which are referred to as loadings of variable Y_k on factor F_j , are calculated based on principal component analysis (PCA) and varimax rotation method. Based on β_{kj} value, the survey items are grouped appropriately. At the end of the purification stage of the survey done based on reliability and validity analysis, the inappropriate items are eliminated. Thus, a refined survey is obtained.

In the next step of the methodology, a weighted SERVQUAL scores (WSQ) are calculated for each dimension of our SERVQUAL. In a mathematical system, WSQ are calculated as stated below:

(i) For each participant, the average SERVQUAL score (SQ) for each dimension is calculated: add the SERVQUAL scores on the statements pertaining to the dimension and divide the sum by the number of statement making up the dimension.

$$SQ_z^i = \frac{\sum_{x=1}^{x=X} (A_z^x - B_z^x)}{X} \quad \text{for } i = 1, \dots, 265$$

$$z = 1, \dots, 6$$

$$x = 1, \dots, X$$
(4.3)

SQ_z^i = SERVQUAL score for i^{th} customer in dimension z

X = the number of statements in each dimension

B_z^x = Expectation score given by the customer for the x^{th} statement in dimension z

A_z^x = Perception score given by the customer for the x^{th} statement in dimension z

(ii) For each customer i , WSQ^i is calculated: multiplying the SQ^i value for each dimension by the importance weight assigned by the customer to that dimension to obtain a combined weighted SERVQUAL score.

$$WSQ^i = \sum_{z=1}^6 (k_z^i \times SQ_z^i) \quad \text{for } i = 1, \dots, 265$$

$$z = 1, \dots, 6$$
(4.4)

where k_z^i = the importance weight of the dimension z for i^{th} customer

(iii) Overall WSQ score is calculated: add the scores obtained in step 2 across all 265 customers and divide the total by 265.

$$WSQ = \frac{\sum_{i=1}^{265} WSQ^i}{265} \quad (4.5)$$

In this approach, a negative score indicates poor quality so the WSQ concludes with the service quality dimensions of poor quality for call centers in our model. The results obtained from WSQ approach form the basis of creating scenarios for improvement opportunities.

In order to analyse the effect of the improvement strategies and determine the requirement of the current system for decreasing the customer perception gap, a simulation model is incorporated in the methodology as a final stage. In this simulation model, call center is defined as a queueing network system with an infinite queue capacity, infinite calling population and prioritized queue discipline. In this system, there are two stations where customers can get service successively: IVR and agents. For both service stations, the distributions for service time, arrival process and waiting time are defined. After selecting the appropriate distributions for collected input data and after the assumptions related to the model are justified, the call center model is constructed in ARENA simulation software package. Then, the model is validated based on the most important KPIs determined by AHP via hypothesis testing. Finally, the scenarios are assessed through what-if-analysis on the simulation model and the optimal strategy is obtained to increase the customer satisfaction and perceived service quality and upgrade the call center system performance.

Figure 4.2 summarizes the methodology proposed for the call center performance assessment where the integration of three methods, AHP, SERVQUAL and Simulation, are illustrated systematically.

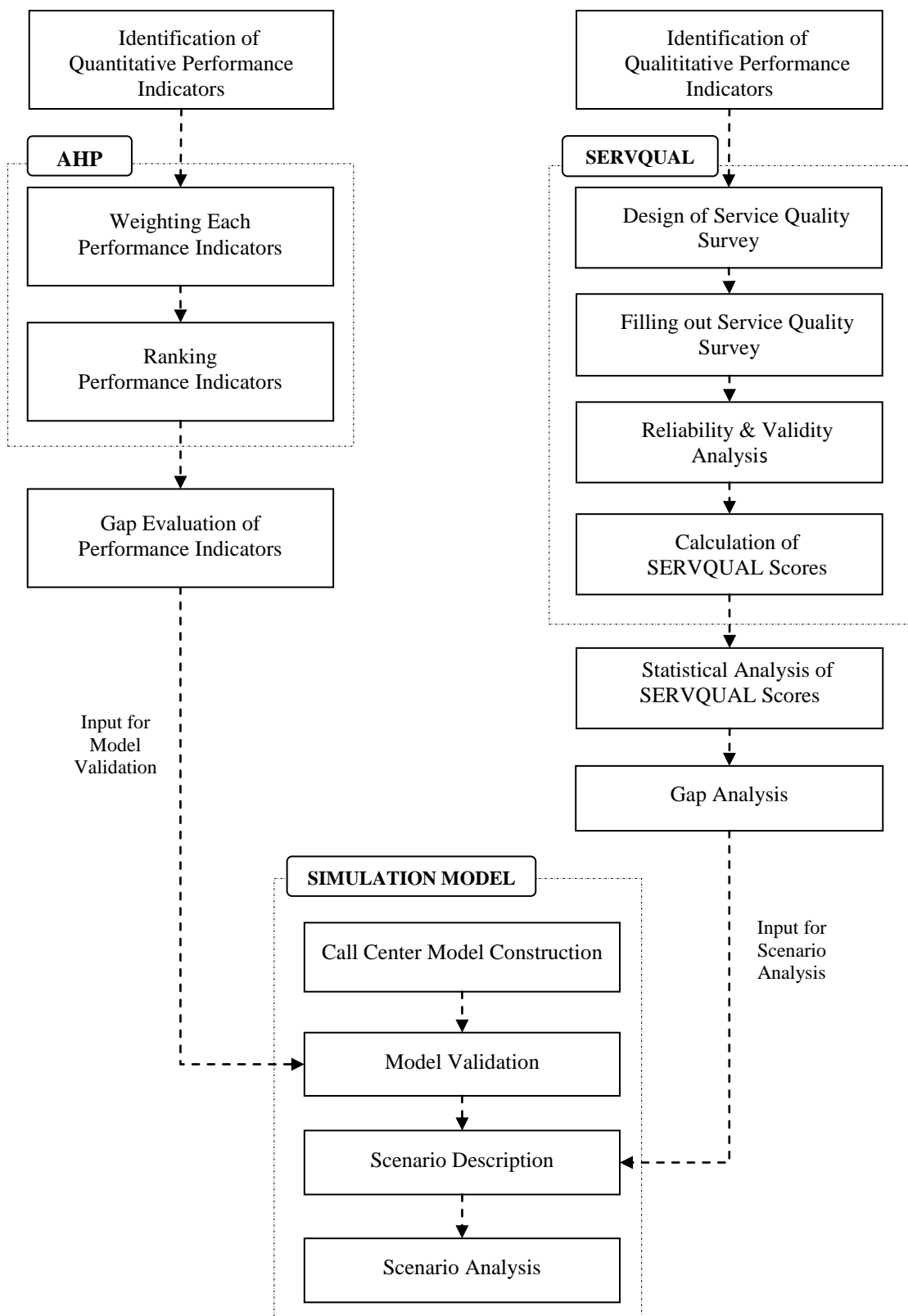


Figure 4.2 Call center modeling methodology

The methodology proposed in this study is applied in a private bank's call center in Turkey in order to measure its effectiveness and efficiency in the following chapter. The first method AHP is used for calculating the weights of the quantitative performance indicators of the call center. Then, the second method SERVQUAL is designed in order to find out the factors, which affect the call center's service quality. SERVQUAL method's results give the most important dimensions of the service quality for the customer of XYZ Bank's call center and we find out the factors which cause customers dissatisfaction. The application continues with designed experiments on the constructed simulation model. The simulation model shows firstly how the XYZ Bank's call center operates currently. Some improvement opportunities are suggested and are implemented on the simulation model. Based on the results of the scenario analysis, it is desired to increase customer satisfaction. Chapter 5 indicates that the results are quite promising. Simulation model has served as an excellent experimentation platform for the call center managers.

5. APPLICATION OF THE METHODOLOGY

This chapter includes the application of the methodology in a private bank's call center in order to measure its service quality and its performance. The methodology applied consists of the integration of three different tools: AHP, SERVQUAL and Simulation as explained in the previous section. As a first step of the methodology, all qualitative and quantitative factors, which affect the performance of call center, are identified. Then, the first method AHP is employed for calculating the weights of the KPIs affecting the efficiency. Using SERVQUAL, those factors of service quality are identified that the customers are not satisfied with. The application concludes with a simulation model design. The simulation model shows firstly how the XYZ Bank's call center operates currently and then, it exposes the result of scenarios established for improving the customer perception of service.

5.1. Identification of Key Performance Indicators

There is a trade off between productivity and service quality in call centers. On one side of a call center system, there are factors which affect the productivity of the system and on another side; there exist other criteria which influence their service quality. The qualitative KPIs have been introduced in an effort to address service quality issues, and the quantitative KPIs are captured in order to display the productivity level of a call center (Feinberg et al., 2002). Thus, in order to examine the performance of a call center, it is necessary to analyze all qualitative and quantitative factors, which affect the performance of call center.

5.1.1. Quantitative Criteria Affecting Performance of Call Center

There are a set of operational metrics that are recommended as being important to monitoring and building excellence in call centers. The managers who want to measure the productivity and the quality of call center, have been tracked the quantitative management information. All of this kind of information is available on a real time basis as well as in cumulative report form. The record and the availability of this kind information have played a large part in determining targets for call center agents (Robinson and Morley, 2006).

The important operational metrics, quantitative KPIs, are collected based on the relevant studies done by Tanir and Booth (1999), Kawanishi (2008), Marr and Parry (2004), Tuten and Neidermeyer (2004), Duder and Rosenwein (2001), Robinson and Morley (2006), Lam and Lau (2004), Deslauriers et al., (2007) and Pichitlamken et al. (2003) which analyze the call centers' operations.

The quantitative criteria that affect the performance of call centers:

- (i) The number of agents per shift: the number of servers present in call center during one shift.
- (ii) The average incoming call volume per hour: the average number of inbound calls' arrival in one hour.
- (iii) The percentage of calls blocked: the percentage of callers who received a busy signal and could not even get into the call center.
- (iv) The number of calls answered per agent per day: total inbound calls per agent in one working day.
- (v) The amount of time spent in an IVR system: the total time it takes for a customer to go through the maze of options.
- (vi) The number of retrial calls per day: calls generated by customers who abandon an initial call and call back shortly thereafter.

- (vii) The rate of customer abandonment: the fraction of customers lost because of excessive waiting time who terminate their call after departing the IVR system in order to reach an agent.
- (viii) The average queue length: the number of people waiting in the queue.
- (ix) The average handling time: the amount of talk time spent per call.
- (x) Agent utilization per day: the percentage of time agents handle calls versus waiting for calls to arrive in one day.
- (xi) The average patience time of customer: the average time caller held on before giving up in queue.
- (xii) The percentage of callers who have satisfactory resolution on the first call: the percentage of call in which agents fail because of inadequate information.
- (xiii) The average speed of answer: the average speed in which a customer is reached by an available agent after being placed in queue.
- (xiv) The average work time after call: the amount of time needed to finish paper work, do research after the call itself has been completed.
- (xv) The rate of mismatches: the fraction of customers that are connected to one of the irrelevant agent.
- (xvi) The average returning time to the customer: the amount of time that an agent keeps customer waiting to do customer's transaction.
- (xvii) The service level: the percentage of calls answered within a specified timeframe.

5.1.2. Qualitative Criteria Affecting Performance of Call Center

In a competitive environment, an organization must have satisfied customers in order to survive. Therefore, an organization must understand what customers want and expect. Today, QoS has become one of the remaining differentiators between firms, and it is also a key performance indicator. But, people consider several types of factors in evaluating service quality of a call center. From among these key factors, some are relatively more important than others for the consumer. Based on the literature review, it is found that several common criteria has emerged in terms of the facets of service that customers consider in judging the quality of a service. These qualitative factors fall into the six

dimensions. The relative importance of these dimensions may vary from one consumer group to another.

The qualitative factors which affect the customer satisfaction in call center, are collected based on the relevant studies done by Landrum and Prybutok (2004), Kang and Bradley (2002), Newman (2001), Bigne'et al. (2003), Parasuraman et al. (1988), Saravanan and Rao (2007), which apply SERVQUAL method in different service sector.

The qualitative criteria that affect the service quality of a call center, thus the customer satisfaction, are stated below:

5.1.2.1. Agents' Skills and Behaviors. It refers to the personal attributes of agents, such as their ability to deal with customers' requirements and expectations. A superior service quality in a call center requires staff to have the knowledge to answer customers' questions and the ability to provide competent, confidential, courteous and friendly service. Therefore, in order to evaluate the key factor of a good service quality in a call center, agents' skills and behaviors come into question.

- (i) Level of personnel's willingness to help customers.
- (ii) Level of personnel's courtesy.
- (iii) Instilling confidence in customers.
- (iv) Degree of offering personalized attention and information to their customers.
- (v) Extent of looking for the best for the interests of their customers.
- (vi) Showing a sincere interest in solving customer's problems.
- (vii) Ability of understanding the specific needs of customers.
- (viii) Level of expertise of personnel about the products and services offered to answer customer's questions.

5.1.2.2. Systematization of Service Delivery. This refers to streamlining the systems and procedures involved in the service delivery. Customers always expect the service delivery processes to be simplified and standardized in such a way that they could receive the service in a convenient manner. Thus, the significant factors of systematization of service delivery:

- (i) An IVR system that is easy to use and understandable.
- (ii) An IVR system which is so comprehensive/detailed that customers can find a solution for their problem.
- (iii) Level of simplification and standardization of delivery process so that services are delivered conveniently and without excessive bureaucracy.
- (iv) Level of simplification and structure of delivery process so that the service delivery times are minimum.
- (v) Enhancement of technological capability (e.g. computerization, networking of operations) to serve customers more effectively.

5.1.2.3. Attributes of Service Delivery. This refers to the attributes of services being delivered by agents in a call center. This dimension is concerned with the objective attributes of call center services, such as whether or not they are being provided within a reasonable timeframe. In addition, it is a union of responsiveness and reliability dimension which actually incorporates a number of activities, including the readiness of staff to inform customers exactly about service realization, the provision of prompt service, keeping promises, making customers feel safe and providing timely and accurate information to customers.

- (i) Providing service as promised.
- (ii) Dependability in handling customers' problems.
- (iii) Performing service right the first time.
- (iv) Providing the service in the agreed time.
- (v) Providing prompt service to customer.

- (vi) Making no mistakes in records.
- (vii) Feeling safe in transactions.
- (viii) Effectiveness of customers complaints' system.

5.1.2.4. Quality of Information. This refers to the qualification of answers or information given by the agents to the customers. It is suggested that it may be important to measure aspects of information quality when measuring service quality. In a call center system, it is evident that the content and the qualification of answers given by agents have a significant role in providing customer satisfaction.

- (i) Accuracy of information received.
- (ii) Reliability of information received.
- (iii) Completeness of information received.
- (iv) Relevance of information received.
- (v) Up-to-dateness of information received.

5.1.2.5. Tangibility of Service Delivery. It refers the tangible aspects of the service in a call center system. As it is a virtual service encounter that takes place between a call center and its customers, it is impossible to talk about the physical environment properties for the tangible aspects. Therefore, in a call center system, tone of the voice or the background music played come into question.

- (i) Ease of remembrance of call center's phone number.
- (ii) Diversification of background music playing while waiting.
- (iii) Customer satisfaction level for background music played.
- (iv) Customer satisfaction level for voice record's tone in IVR system.
- (v) Customer satisfaction level for agent's tone of voice.
- (vi) Understandability level of voice record's language.
- (vii) Understandability level of agent's language.

5.1.2.6. Responsibilities of Agents. It refers to the responsibility of the agents towards the customers and their work. It is important because caring for the customers and supporting the regularity of their work will give an organization a competitive advantage in the long run. This dimension helps in improving the organization's image and thus it influences the customers' overall evaluation of service quality and their loyalty to the organization.

- (i) Extent of equal treatment to all customers irrespective of their status in society.
- (ii) A sense of public responsibility among agents (in terms of being punctual, regular, sincere).

5.2. Application of AHP

AHP method is based on the following three principles: decomposition, comparative judgment, and synthesis of priorities (Cheng et al., 2002; Saaty, 1980; Saaty, 1994). In the decomposition step, the decision maker structures problems in the form of a hierarchy or a set of integrated levels, such as, the goal, the criteria, and the sub-criteria (Liberatore and Nydick, 2008).

At the first step of the AHP application, quantitative factors which affect the performance of the call center system are taken into consideration in order to construct the hierarchy. The quantitative factors, which are called KPIs, are already determined based on the literature research at the beginning of the chapter five. For this purpose, 17 KPIs found are considered. The most important factors among them will be used in simulation model for model validation and for displaying the performance of call center system created based on scenario analysis. Two performance indicators, namely "the number of agents" and "the percentage of calls blocked", are not included in the ranking process. The number of agents will be set in simulation model at the beginning whatever its importance weight. In addition, calls blocking has a very low possibility to occur that's why the second factor

excluded, the percentage of calls blocked, is eliminated from the weighting process. Finally, 15 KPIs are processed according the principal of AHP.

The formation of the hierarchy is based upon two assumptions (Cheng and Li, 2001):

- It is expected that each element of a level in the hierarchy would be related to the elements at the adjacent levels. AHP recognizes the interaction between elements of two adjacent levels.
- There is no hypothesized relationship between the elements of different groups at the same level.

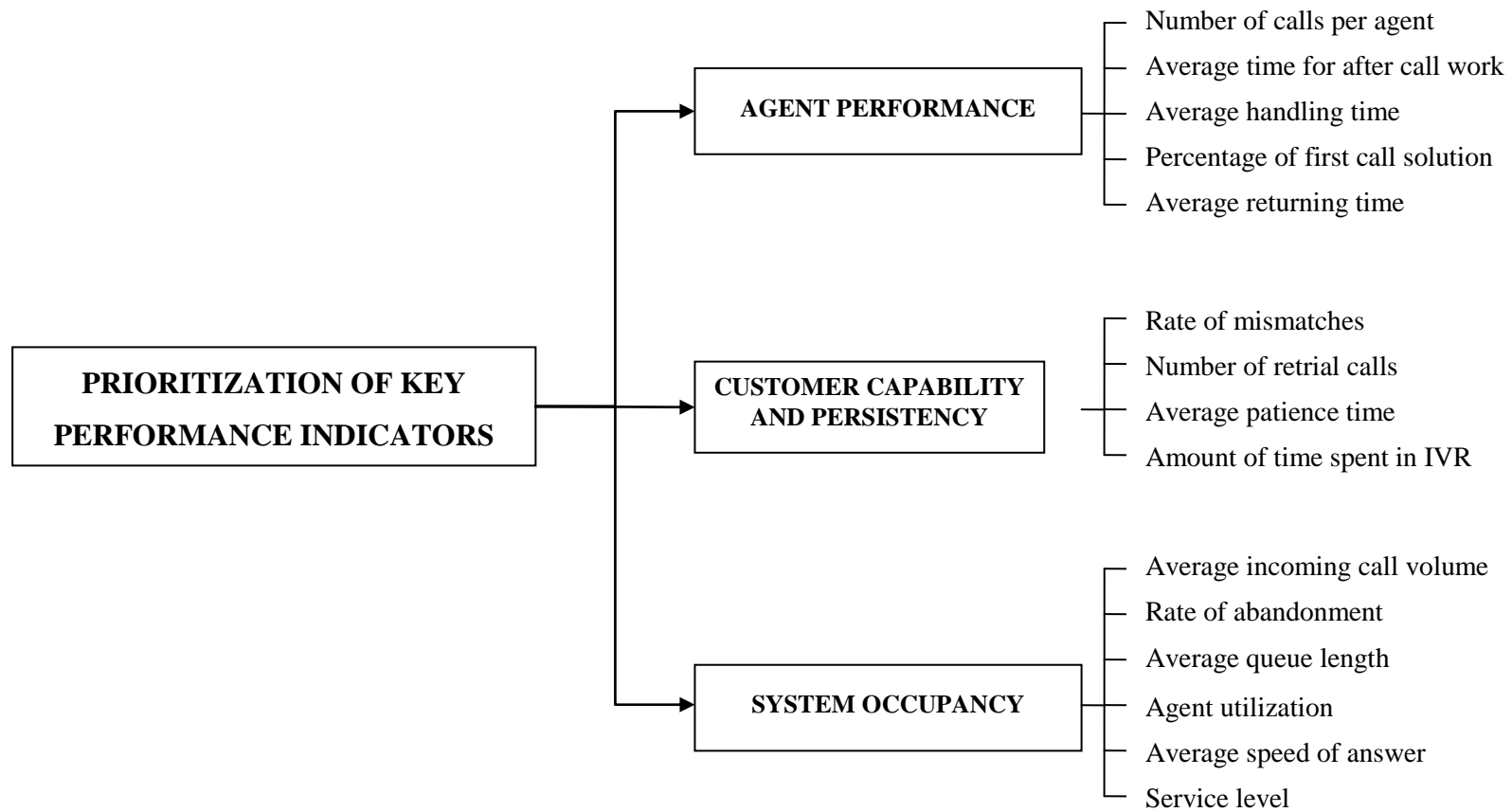


Figure 5.1 AHP hierarchy for key performance indicators in call center

The hierarchic structure for KPIs is illustrated in Figure 5.1. The goal is to prioritize KPIs. There are three main factors at the first level in the hierarchy: agent performance, customer capability and persistency, system occupancy. At the second level, five sub-factors form “agent performance” dimensions; “customer capability and persistency” dimension consists of four sub-factors and six sub-factors form the final dimension.

Secondly, a questionnaire is designed in order to capture data from the supervisor of the call center mentioned. This data collected are used to assign weights to the elements for the pairwise comparison of each of the hierarchy level of the AHP model. Comparisons are then organized in a pairwise weighting matrix. The pairwise comparison matrix is organized such that the diagonal elements are unity and the upper-right and lower-left triangular blocks are reciprocal. The Saaty’s scale of measurement is used to rate the intensity of importance between two elements. The scale used is shown in Table 5.1.

Table 5.1 Scale of importance

INTENSITY OF IMPORTANCE	DEFINITION	EXPLANATION
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate Importance	Experience and judgment slightly favor one over another
5	Strong Importance	Experience and judgment strongly favor one over another
7	Very strong Importance	An activity is strongly favored and its dominance is demonstrated in practice
9	Absolute Importance	The importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate values	Used to represent compromise between the priorities listed above

The next step consists of the computation of a vector of weights from the constructed comparison matrix. The matrices created would go through a sequence of calculations to attain the relative weights of the elements in each matrix. To compute the eigen vector of a matrix:

- Sum the elements in each column.
- Normalize by dividing the elements of each column by the sum of that column.
- Add the elements in each resulting row.
- Divide this sum by the number of elements in the row.

After doing comparisons pairwise between each factor at each level, the weight of each criterion is derived according to AHP algorithms. The four following tables displayed below present the comparison matrices evaluated by the supervisor of the call center and the local weights of each criterion calculated.

Table 5.2 Pairwise comparison matrix and local weights of main factors

TECHNICAL CRITERIA	AP	CCP	SO	Local weight
Agent Performance (AP)	1	5	1/4	0,244
Customer Capability and Persistency (CCP)	1/5	1	1/8	0,067
System Occupancy (SO)	4	8	1	0,689

Table 5.3 Pairwise comparison matrix and local weights of AP

AGENT PERFORMANCE	NCPA	AACW	AHT	PFCR	ART	Local Weight
Number of calls per agent (NCPA)	1	4	3	3	5	0,433
Average after call work (AACW)	1/4	1	1/6	1/2	2	0,088
Average handling time (AHT)	1/3	6	1	1	5	0,259
Percentage of first call resolution (PFCR)	1/3	2	1	1	2	0,159
Average returning time (ART)	1/5	1/4	1/5	1/2	1	0,060

Table 5.4 Pairwise comparison matrix and local weights of CCP

CUSTOMER CAPABILITY AND PERSISTENCY	RM	NRC	APT	ATS _{IVR}	Local Weight
Rate of mismatches (RM)	1	3	2	5	0,483
Number of retrial calls (NRC)	1/3	1	1	3	0,208
Average patience time (APT)	1/2	1	1	3	0,229
Amount of time spent in IVR (ATS_{IVR})	1/5	1/3	1/3	1	0,080

Table 5.5 Pairwise comparison matrix and local weights of SO

SYSTEM OCCUPANCY	AICV	RA	AQL	ASA	AU	SL	Local Weight
Average incoming call volume (AICV)	1	3	6	2	4	3	0,348
Rate of abandonment (RA)	1/3	1	7	1/2	2	1/3	0,124
Average queue length (AQL)	1/6	1/7	1	1/7	1/3	1/8	0,030
Average speed of answer (ASA)	1/2	2	7	1	2	1/2	0,171
Agent utilization (AU)	1/4	1/2	3	1/2	1	1/4	0,074
Service level (SL)	1/3	3	8	2	4	1	0,251

Final step in application of AHP is to calculate the consistency level of the weighting vector which is calculated based on the judgments. In other words, consistency ratio (CR) is used to screen out the inconsistency of responses. To estimate CR:

- (i) Calculate the largest eigenvalue: λ_{max}
- Multiply the comparison matrix by the estimated weight vector
 - Divide each element of the vector obtained by the related element of the estimated weight vector
 - Take the average of the element of the final vector obtained
- (ii) Calculate consistency index (CI) by $CI = (\lambda_{max} - n) / (n-1)$
- (iii) Find out the appropriate consistency index, namely Random Index (RI) from Table 5.6.

Table 5.6 Random index values

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

- (iv) Calculate CR using the formula $CR = \frac{CI}{RI}$

According to the CR calculation method, the consistency ratios for each comparison matrices are given in Table 5.7.

Table 5.7 Consistency of pair-wise comparison

Pair wise Comparison Matrix	CR
Technical Criteria Matrix	0,082
Agent Performance Matrix	0,012
Customer Capability and Persistency Matrix	0,051
System Occupancy	0,052

Thomas Saaty suggests that if the CR is smaller than 0,10, then the degree of consistency is satisfactory. Thus, it is clear that the consistency ratios for all the matrices are within the acceptable limits: the lowest CR is 0,012 and the highest CR is 0,082.

Finally, in order to find the rank of the factors, their global importance weight is calculated. Table 5.8 shows a brief summary of the results obtained. According to the global weights of factors, “average incoming call volume” is found to be the most important of the technical performance factors and the least important is “amount of time spent in IVR” with a priority weight of 0,005. The global weights of the quantitative factors indicate their relative importance in a call center system from a technical performance point of view. The order of the most important technical factor for call center system efficiency is as follows: average incoming call volume per day (0,240); service level (0,173); average speed of answer (0,118); number of calls per agent (0,106); rate of abandonment (0,086); average handling time (0,063). These KPIs will be used as the input of the simulation for validation of the model later on.

Table 5.8 Computed global weights for sub-factors

Main Factors	Local Weights	Sub-factors	Local Weights	Global Weights
Agent Performance	0,244	Number of calls per agent	0,433	0,106
		Average after call work	0,088	0,022
		Average handling time	0,259	0,063
		Percentage of first call resolution	0,159	0,039
		Average returning time	0,060	0,015
Customer Capability & Persistency	0,067	Rate of mismatches	0,483	0,032
		Number of retrial calls	0,208	0,014
		Average patience time	0,229	0,015
		Amount of time spent in IVR	0,080	0,005
System Occupancy	0,689	Average incoming call volume	0,348	0,240
		Rate of abandonment	0,124	0,086
		Average queue length	0,030	0,021
		Average speed of answer	0,171	0,118
		Agent utilization	0,074	0,051
		Service level	0,251	0,173

The current values of these critical KPIs for XYZ Bank call center are analyzed and they are compared with their target values set by the management. The values related to the current and target values of KPIs are displayed in Table 5.9. According to Table 5.9, it can be concluded that XYZ Bank call center can not achieve its targets set by the management in terms of daily performance measures. It is a fact that the gap between the current and target values of KPIs is very significant. For each KPIs value, the gap is stated in the last column of Table 5.9. For exemple, the service level has to be improved at the rate of 52,4 per cent in order to achieve its targets.

Table 5.9 Current & target states of XYZ bank's call center

PERFORMANCE MEASURE			
	Empirical	Target	Gap
Incoming Call Volume	35.748	-	-
Service Level (%)	39,38	60	52,4%
Number of Calls per Agent	103	120	16,5%
Rate of Abandonment (%)	33	20	39,4%
Average Handling Time (sec)	224	120	46,4%
Average Speed of Answer (sec)	115	80	30,4%

5.3. Application of SERVQUAL

The SERVQUAL methodology is applied for two aims. First of all, the importance level of each dimension in a call center service would be identified, i.e. this method would clarify which dimension of a call center service is more important for the customer. Secondly, this method would be helpful to determine in which aspects, XYZ bank's call center fails or succeeds to meet their customers' expectations.

A modified version of SERVQUAL is used in this study. SERVQUAL survey with 35 items is formed according to the specific characteristics of call center services. 15 items used in the 1881 version of SERVQUAL are preserved. The remaining 20 items are added to the survey after making literature research thoroughly. Then, the questionnaire draft is presented to and discussed with the different call centers' supervisors. The final version of the survey with 35 items takes its final shape after consulting several times with the different call centers' supervisors.

35 items are grouped into six dimensions, namely, systematization of service delivery, agents' skills and behaviors, quality of information, attributes of service delivery,

tangibility of service delivery, responsibilities of agents. The items with their corresponding dimension are shown in the table below.

Table 5.10 Clustering of survey items

DIMENSION'S NAME	QUESTION NO
Systematization of Service Delivery	1-5
Agents' Skills and Behaviors	6-13
Quality of Information	14-18
Attributes of Service Delivery	19-26
Tangibility of Service Delivery	27-33
Responsibilities of Agents	34-35

The 35-item survey includes four parts. The first part is formed to obtain personnel information about the participant of the study. The second part includes 35 questions to measure service quality expectations about the call center service generally and the following part includes 35 questions to measure service quality perceptions about XYZ bank's call center. The final part is created in order to get importance level of each dimension mentioned above. A seven-point scale ranging from "Strongly Agree" (7) to "Strongly Disagree" (1) is used while answering questions in the part two and three. The survey is given in the Appendix A.

5.3.1. Data Collection and Sampling

For the purpose of the study, a sufficient sample size has to be determined. "Sufficient" refers to a sample size large enough to be reasonably confident to obtain accurate results. Thus, 350 people, who call the XYZ bank's call center at least once, are participated to the study. These participants of the study are chosen randomly.

The survey is mailed out to 110 people that we know they are familiar with the XYZ bank's call center services but only 78 useable responses are received. In addition, the survey is distributed as handout to 240 customers of the XYZ bank. nine customers can not answer the questions because they have never called this call center. 44 of 240 customers did not call the call center in three months recently, thus, the answers given by them are not taken into consideration because it is believed that the data gathered from them would not be current. Eventually, 265 customers of XYZ bank respond to the survey.

5.3.2. Descriptive Analysis of the Respondents

The first part of the survey helps us to get personnel information about the respondents. These 265 respondents are the customers of XYZ bank who called the bank's call center at least once in three months recently. The personnel information gathered about the sample is analyzed and is displayed in the following tables. The tables below provide details about the demographic characteristics of the respondents such as gender, age, education level and profession.

The following tables show the distribution of these customers by the categories they fall in.

Table 5.11 Gender of the respondents

	Frequency	Per cent (%)
Female	123	46,4
Male	142	53,6
TOTAL	265	100,0

Table 5.11 indicates that 53,6 per cent of 265 people, who participate to the study, are male and the remaining people, 46,4 per cent, are females. According to these data, it is found out that most of attendees are men.

Table 5.12 Age categories of the respondents

	Frequency	Per cent (%)
25 and below	51	19,2
26-30	68	25,7
31-35	33	12,5
36-40	19	7,2
41-45	19	7,2
46-50	22	8,3
51-55	21	7,9
56-60	16	6,0
60 and above	16	6,0
TOTAL	265	100

According to Table 5.12 which shows the frequency of various age groupings in our research on who uses the call center services, it is concluded that 57,4 per cent of the attendees are below the thirty-five years old. Participants, who are above the fifty-five years old, form only 12 per cent of the sample size. Thus, it is concluded that the majority of the attendees is young or middle-aged.

Table 5.13 Education level of the respondents

	Frequency	Per cent (%)
Secondary School Graduate	20	7,5
High School Graduate	62	23,4
College Graduate	145	54,7
Master's Degree	37	14,0
Doctorate	1	0,4
TOTAL	265	100,0

According to Table 5.13, the participants of the study are mostly graduated from college or high school. The percentage of these people in the sample size is 54,7 per cent and 23,4 per cent respectively. It is remarkable that there is only one person who obtains his doctorate and none of the attendees are primary school graduate. Then, it is a fact that the participants' level of education is high. Thus, we are confident that the data gathered from this sample are reasonable and that they evaluate the service quality of the call center accurately. But we can not neglect someone's assessment from a low education level because the call center services appeal to all kinds of people.

Table 5.14 Profession categories of the respondents

	Frequency	Per cent (%)
Student	39	14,7
Unemployed	27	10,2
Employed	152	57,4
Retired	24	9,0
Housewife	23	8,7
TOTAL	265	100,0

Table 5.14 exhibits that the participants' professions are grouped into five categories: student, unemployed, employed, retired and housewife. The majority of them are employed, i.e. they work such as white-collar worker, tradesman, lawyer etc. Then, 14,7 per cent of 265 people are student and 10,2 per cent of 265 are looking for a job. In addition, housewife's attendance rate to the survey is 8,7 per cent. As a consequence, it is found out that most of attendees are people from active business life and students.

5.3.3. Questionnaire Design

The questionnaire is designed in several steps in light of the previous studies done in the literature. Firstly, the important control variables, such as gender, age, educational level, job position and frequency of getting call center services, are determined. These

control variables are analyzed in detail in section 5.3.2. Next, the SERVQUAL and call center service quality dimensions were taken into consideration under the inspiration of previous studies. Even though SERVQUAL presents general quality dimensions for service industries, it does not include specific dimensions for each service branch. Therefore, our new 35-item questionnaire, which includes call center service quality aspects, is designed. Then, questions addressing expectations and perceptions are rated using 7-point Likert scale. In the fourth step, the questionnaire is initially examined, tested and corrected by different supervisors from different call centers. Finally, the survey was administered over four weeks and responses of 265 people, who are chosen based on the simple random sampling method, are gathered for the future statistical analysis.

(i) Reliability and Validity Analysis

If we evaluate a survey, it would be nice to know that the instrument we are using will always elicit consistent and reliable response. A dimension measured by a set of questions, is reliable if it provides essentially the same set of scores for a group of subjects upon repeated testing. Thus, Cronbach alpha is proposed to be used in order to measure internal consistency of our survey with 35 items.

This coefficient value is calculated as stated in the fourth chapter. Alpha coefficient ranges in value from zero to one. The higher the score, the more reliable the generated scale is. "0,7" is indicated as an acceptable reliability coefficient.

Then, the internal consistency of our SERVQUAL instrument prepared is tested by computing Cronbach coefficients. The raw data used in computing coefficient alpha are Q values for each item in the survey.

Coefficient alpha is computed separately for the six dimensions to verify that items making up each dimension shared a common core. The values of coefficient alpha range from 0,441 to 0,72. These coefficients are given in Table 5.15. According the alpha values displayed below, certain items from each dimension should be deleted in order to improve the alpha values. The criterion used in deciding whether to delete an item is the item's corrected item-to-total correlation like Parasuraman et al. did in 1881.

Table 5.15 Alpha values for each dimension

Dimensions	Label	Reliability Coefficient (Alphas)	Number of Items
Systematization of Service Delivery	D1	0,685	5
Agents' Skills and Behaviors	D2	0,612	8
Quality of Information	D3	0,441	5
Attributes of Service Delivery	D4	0,504	8
Tangibility of Service Delivery	D5	0,696	7
Responsibilities of Agents	D6	0,720	2

The corrected item-to-total correlation is the correlation between the item score and the sum of scores on all other items, by not including that item's score, making up the dimension to which the item is assigned. Items with low corrected item-to-total correlations whose elimination improve the corresponding alpha values would be discarded. Essentially, if the deletion of an item improves the reliability coefficient, the item would be considered for elimination. Before deleting this item, it is necessary to check the corrected item-to-total correlation coefficient. If an item has a negative "corrected item-to-total correlation coefficient"; the item would be eliminated from further consideration. Also, if this correlation coefficient is lower than 0,30, the item would be considered for elimination because good values for item-to-total correlation begin with

numbers that are moderately correlated to the total test, those in the range of +0,40 to around +0,60. Higher values indicate that items are well correlated with the total test score.

Based on the reliability analysis logic, eliminations are done one item at a time. After an item is eliminated, reliability of a scale is recalculated with remaining items. The item with highest negative correlation coefficient or the item with lowest positive correlation coefficient is eliminated first.

Thus, coefficient alpha for the first dimension, D1, is calculated at first. The corrected item-to-total correlation and “alpha if item deleted” statistics’ output from SPSS are evaluated for the corresponding dimension. Each step of cronbach-alpha analysis for the first dimension is displayed in Table 5.16.

Table 5.16 Analysis of alpha values for systemization of service delivery

STAGE NO	Systemization of Service Delivery	Corrected Item-to-Total Correlation	Cronbach's Alpha if Item Deleted
	Item No		
STAGE 1	1	0,459	0,625
	2	0,525	0,594
	3	0,502	0,606
	4	0,518	0,596
	5	0,184	0,721
STAGE 2	1	0,492	0,669
	2	0,517	0,655
	3	0,475	0,679
	4	0,552	0,632

According to Table 5.16, the only item whose elimination improves the alpha value is the fifth item. In addition, it has the lowest corrected item-to-total correlation coefficient. Thus, fifth item is eliminated from the systemization of service delivery dimension. After

this elimination, the cronbach alpha values of the first dimension with four items increases from 0,685 to 0,721. Then, we recalculate the corrected item-to-total correlation and “alpha if item deleted” statistics’ value for the remaining four items. None of the items can be eliminated further because elimination of any item decreases alpha value of the dimension which is actually equal to 0,721. In addition, the corrected item-to-total correlation coefficients range from 0,492 to 0,552. Thus, we stop the elimination process for the first dimension.

Then, the reliability analysis for the second dimension will be illustrated as a second example. We have eight items in the corresponding dimension, agents’ skills and behaviors, at the beginning. The Cronbach alpha value of this dimension is 0,612. The corrected item-to-total correlation and “alpha if item deleted” statistics’ output are computed in Table 5.17 for each stage.

The item whose elimination increases the alpha value the most is the item nine at the first stage. Besides, it has the lowest corrected item-to-total correlation coefficient with a negative value. Thus, item nine is eliminated from the dimension D2. After this elimination, the cronbach alpha values of the second dimension with seven items increases from 0,612 to 0,682. Then, we recalculate the corrected item-to-total correlation and “alpha if item deleted” statistics’ value for the remaining items and we obtain the related values shown in the stage 2. As the alpha value at the end of the first stage is not bigger than the threshold value 0,7, it is favorable to remove item 10 from D2. With the removal of the item 10, D2’s alpha value goes beyond the threshold value. It reaches to 0,743. But, we notice that the correlation coefficient of the item 13 is very small. This low correlation implies that item 13 is not really measuring what the rest of the test is trying to measure. Furthermore, if item 13 is eliminated, the alpha value becomes bigger. Thus, the dimension D2 gains more internal consistency. At the fourth stage, we observe that the deletion of the item 12 still increases the alpha value of D2. However, its correlation coefficient is not small enough to be eliminated from this dimension. In addition, none of the remaining items increases the D2’s alpha value so we stop the elimination process. In conclusion, the cronbach alpha value of the second dimension is equal to 0,758.

Table 5.17 Analysis of alpha values for agents' skills and behaviors

STAGE NO	Agents' Skills and Behaviors	Corrected Item-to- Total Correlation	Cronbach's Alpha if Item Deleted
	Item No		
STAGE 1	6	0,324	0,576
	7	0,610	0,482
	8	0,496	0,516
	9	-0,026	0,682
	10	0,070	0,655
	11	0,553	0,499
	12	0,341	0,574
	13	0,259	0,594
STAGE 2	6	0,353	0,657
	7	0,667	0,560
	8	0,500	0,613
	10	0,069	0,743
	11	0,589	0,585
	12	0,376	0,652
	13	0,255	0,678
STAGE 3	6	0,390	0,730
	7	0,710	0,632
	8	0,524	0,694
	11	0,634	0,657
	12	0,375	0,733
	13	0,242	0,758
STAGE 4	6	0,399	0,756
	7	0,728	0,636
	8	0,532	0,715
	11	0,670	0,658
	12	0,316	0,777

The reliability analysis for the remaining dimensions is realized by following the same elimination steps as explained above. After all of the elimination steps, the output of the reliability analysis is displayed in Table 5.18.

Table 5.18 Result of scale purification based on reliability analysis

Dimensions	Label	Reliability Coefficient (Alphas)	Number of Items	Items
Systematization of Service Delivery	D1	0,721	4	1,2,3,4
Agents' Skills and Behaviors	D2	0,758	5	6,7,8,11,12
Quality of Information	D3	0,713	3	14,15,16
Attributes of Service Delivery	D4	0,814	3	21,22,23
Tangibility of Service Delivery	D5	0,722	6	27,28,29,31,32,33
Responsibilities of Agents	D6	0,720	2	34,35

Thus, this reliability procedure resulted in a refined scale with 23 items spread among six dimensions. The refined scale after reliability analysis is displayed in the Appendix B.

(ii) Factor Analysis

The factor analysis is performed as a second analysis in order to test the dimensionality of the 23 item-scale. In factor analysis, it is assumed that the variables of interest Q_i (with $i=1, \dots, 23$) is a linear function of six dimensions and it is suggested to test the relationship between the question Q_i (with $i=1, \dots, 23$) and the six dimensions.

First of all, a 23 by 23 intercorrelation matrix is computed and the factorability of the matrix is tested. Then, an initial solution is extracted by PCA. From the initial solution, we determine the appropriate number of factors to be extracted in the final solution. Finally, the factors are rotated with varimax rotation to clarify the factor pattern in order to better

interpret the nature of the factors. In order to elaborate the dimensionality analysis, the steps of factor analysis are given in details in Appendix C.

The factor analysis results show that the 23 items have to be grouped under six factors. These factors were already named: systematization of service delivery; agents' skills and behaviors; quality of information; attributes of service delivery; tangibility of service delivery; responsibilities of agents. While preparing our survey questions, we already grouped the variables into six factors at the beginning. Then, the factor analysis done above verifies also the grouping we did based on the literature research.

In conclusion, the new service quality scale for call centers is finalized with 23 items after reliability and factor analysis. Thus, for further analysis, the responses given to these 23 items are taken into consideration.

5.3.4. Calculation of Servqual's Results

This study develops a new structure to define call center service quality dimensions. In addition, this method would be helpful to determine in which aspects, XYZ bank's call center fails or succeeds to meet their customers' expectations.

(i) Importance Level of Factors for Customers

While the customers of call center answer the questionnaire, they also indicate which dimension of call center service is more important for them. For this purpose, they grade each dimension on the scale of 100. Thus, the importance level of each dimension determined by the participants is displayed in Table 5.19.

Table 5.19 Distribution of service quality dimension's importance level

Dimensions	N	Min	Max	Average	St. Dev.
Systematization of Service Delivery	265	5	41	25,89	5,96
Agents' Skills and Behaviors	265	5	40	14,97	3,80
Quality of Information	265	9	30	16,20	3,88
Attributes of Service Delivery	265	10	42	27,31	5,62
Tangibility of Service Delivery	265	2	16	7,72	2,60
Responsibilities of Agents	265	1	20	7,87	3,06

According to Table 5.19, the attendees indicate that the most important factor for service quality of the call center is “Attributes of Service Delivery”. Then, “Systematization of Service Delivery” is the following significant factor. In addition, they point out that “Responsibilities of Agents” and “Tangibility of Service Delivery” are the least significant factors with average 7,87 and 7,72 respectively.

(ii) Weighted SERVQUAL Scores

First of all, the participants, who are asked to give answers to the 23 items in SERVQUAL survey by using Likert Scale with seven points, score the each statement in the questionnaire. The survey is organized in two different formats. The first format of survey consists of perception statements and the second format is composed of expectation statements. In other words, 23 items are designed to capture, in two separate columns, customers' perceptions and expectations of a service on those dimensions, making a total of 46 questions in all. As (Parasuraman et al., 1988) concluded that service quality could be viewed as the gap between perceived service and expected service, the gap scores Q as $Q = P - E$, are calculated for each item of the survey.

Based on the formula stated in the fourth section, WSQ are calculated and are displayed in Table 5.20.

Table 5.20 Servqual scores

Dimensions	Servqual Score
Systematization of Service Delivery	- 0,41
Agents' Skills and Behaviors	- 0,05
Quality of Information	0,09
Attributes of Service Delivery	- 0,54
Tangibility of Service Delivery	0,15
Responsibilities of Agents	0,09

Overall Service Quality = -0,67

SERVQUAL scores are most often negative numbers because customer perceptions typically fall short of customer expectations. Negative numbers reflect service shortfalls or gaps.

According to the scores displayed in Table 5.20, it is a fact that XYZ bank's customers are not satisfied adequately by the service they receive because the overall service quality score is negative. The scores of two dimensions, systemization and attributes of service delivery, which are the most two important dimensions for customers, indicate that these dimensions are needed to be improved notably. Thus, it is necessary to analyze each factor present in two dimensions mentioned below and to determine for which aspects the customers are not satisfied. Then it is essential to build up improvement opportunities for the elimination of deficiencies of the call center system.

5.3.5. Statistical Gap Analysis

Service quality is considered as the gap between perceived service and expected service. As the perceived service quality differs from person to person and as the customer expectations may be affected by different factors such as past experiences or word of mouth communication, service quality is evaluated differently by each customer. In order to see how service quality varies according to the customer profile, multivariate analysis of variance test is applied in order to investigate if the demographic profiles (gender, age, education level or profession) point any significant difference among participants in terms of service quality satisfaction. The details about the statistical analysis take place in Appendix D.

(i) According to the gender

Paired sample t-test is conducted to examine whether there are significant differences between the participants in terms of their gender in service quality satisfaction scores regarding each dimension. The null hypothesis tested is:

$$\begin{aligned} H_0: \mu_F(SQ_i) &= \mu_M(SQ_i) \\ H_1: \mu_F(SQ_i) &\neq \mu_M(SQ_i) \quad i=1,2,\dots,6 \end{aligned}$$

where μ_F and μ_M represent the mean for service quality score for service quality dimension i for females and males respectively.

Paired sample t-test result shows that we accept the null hypothesis for each service quality dimension. It means that there is no significant difference between service quality score for each service quality dimension according to the gender.

(ii) According to the other characteristics: Age, education level, profession

ANOVA test is conducted to examine whether there are significant differences between the participants in terms of their age, their education level and their profession type in service quality satisfaction scores respectively regarding each dimension.

The hypothesis tested is:,

H_0 : There is no significant difference between service quality score for each service quality dimension according to the characteristic in question.

H_1 : There is significant difference between service quality score for each service quality dimension according to the characteristic in question.

Table 5.21 ANOVA test results

AGE	SQ₁	Accept H_0
	SQ₂	Accept H_0
	SQ₃	Reject H_0
	SQ₄	Accept H_0
	SQ₅	Reject H_0
	SQ₆	Reject H_0
EDUCATION LEVEL	SQ₁	Reject H_0
	SQ₂	Reject H_0
	SQ₃	Reject H_0
	SQ₄	Reject H_0
	SQ₅	Reject H_0
	SQ₆	Reject H_0
PROFESSION TYPE	SQ₁	Accept H_0
	SQ₂	Accept H_0
	SQ₃	Reject H_0
	SQ₄	Accept H_0
	SQ₅	Accept H_0
	SQ₆	Reject H_0

After analyzing the service quality scores according to the demographic profiles, we will try to determine for which factors the service quality scores are significantly low. In order to evaluate with which factors the customer is satisfied and for which factors the gap is significant and need to be improved, a hypothesis test is applied for each factor separately. The null hypothesis tests whether there is a significant gap between the perceived and expected service quality.

$$H_0: \mu_p = \mu_e$$

$$H_1: \mu_p \neq \mu_e$$

Table 5.22 Distribution of service quality factors

	Average	St. Dev.	z- value
Q1	-2,34	1,07	-35,49
Q2	-0,01	0,89	-0,14
Q3	-0,46	1,07	-7,03
Q4	-3,49	1,08	-52,70
Q6	-0,13	2,00	-1,04
Q7	-0,19	2,03	-1,52
Q8	-0,49	2,10	-3,80
Q11	-0,74	2,08	-5,76
Q12	-1,95	1,26	-25,21
Q14	0,38	1,00	6,18
Q15	0,47	1,10	6,94
Q16	0,46	0,97	7,73
Q21	-2,54	1,00	-41,36
Q22	-2,68	1,99	-21,93
Q23	-2,38	1,05	-37,08
Q27	3,31	1,28	42,15
Q28	1,44	1,17	20,11
Q29	1,51	1,07	22,91
Q31	1,47	1,10	21,71
Q32	1,91	0,81	38,25
Q33	1,99	0,79	41,15
Q34	1,07	1,32	13,13
Q35	1,00	1,34	12,12

Based on Table 5.22, the factors which have the most negative z-value have to be analyzed because they fail explicitly to meet the customer's expectation. These factors belong to the attributes and systemization of service delivery dimensions which are the most important aspect for XYZ Bank' customers. The WSQ values in Table 5.20 also verify this result. Consequently, it is necessary to utilize the available resources of XYZ bank's call center to improve its unsuccessful aspects determined.

5.4. Simulation Model Design of XYZ Bank's Call Center

The intent in creating the initial model is to construct a model that represents how XYZ Bank's call center operates currently. The output of the model designed would then be verified based on the available data in order to provide a confidence level in the model. Finally, it would be used to do various scenario analyses on it.

After acquiring the data, a model is created based on the principles of XYZ Bank's call center to reflect the existing process. The software ARENA is used as the simulation tool for constructing and running the model. The tool Input Analyzer in ARENA is used to find the best fitting distribution.

5.4.1. Current Process

XYZ Bank's call center serves to their customers 7/24. The customers can call the call center by a single toll free line. As soon as the customers enter to the call center's line, they get an IVR services. Within the IVR system, the customers can get a service by dialing the right number of their phone related to their questions and by coding their credit card's number or customer's number to the system. The Figure 5.2 indicates the IVR system's section. Then, if the customers can not find a solution for their problem in the IVR's section, they try to connect to the agents and talk to them.

The customers have to press at least one button of their phone in order to reach an agent because in the IVR's section, there is no direct connection to the agents. After the customers have dialed in the IVR's system, the type of customers' call is grouped in three main sections based on the number dialed before being queued in front of the agents:

- (i) Customer Satisfaction Services
- (ii) Credit Card Applications
- (iii) Banking Services & Investment Activities

Customer satisfaction services call includes:

- (i) Customer Satisfaction Services (Suggestions & Complaints)
- (ii) English Services

Credit card applications call includes:

- (i) Lost / Stolen Credit Card Statement
- (ii) World Card Application / Password or Other Credit Card Services
- (iii) World Card's Limit Increases Request
- (iv) World Card's Travel Line

Banking Services & Investment Activities call includes:

- (i) Banking Services
- (ii) Internet Banking & POS Supporting Services
- (iii) Credits & Campaigns
- (iv) Investment Activities

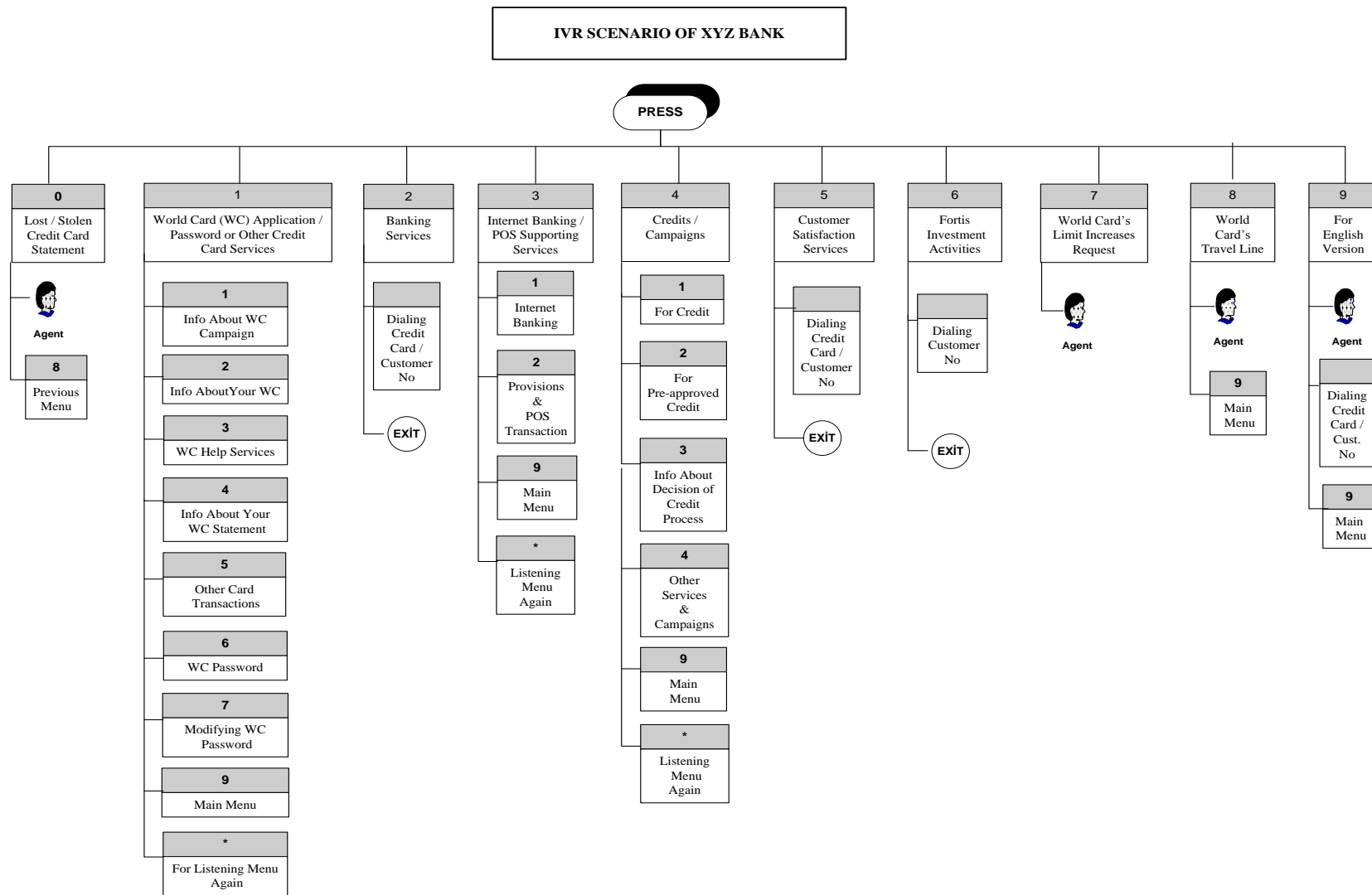


Figure 5.2 IVR menu of XYZ Bank's call center

The three different talented groups of agents answer to the customers waiting in the queue. They work 8 hours shifts. One of them is specialized on customer satisfaction services; other group on credit card applications and the third one on banking services and investment activities. According to the principles of call center, the customers who call the call center for their lost or stolen credit card should take the first place in the queue. As soon as the conversation with the agents is over, the customers leave the call center's line. In the Figure 5.3, the overview of the call center process is illustrated.

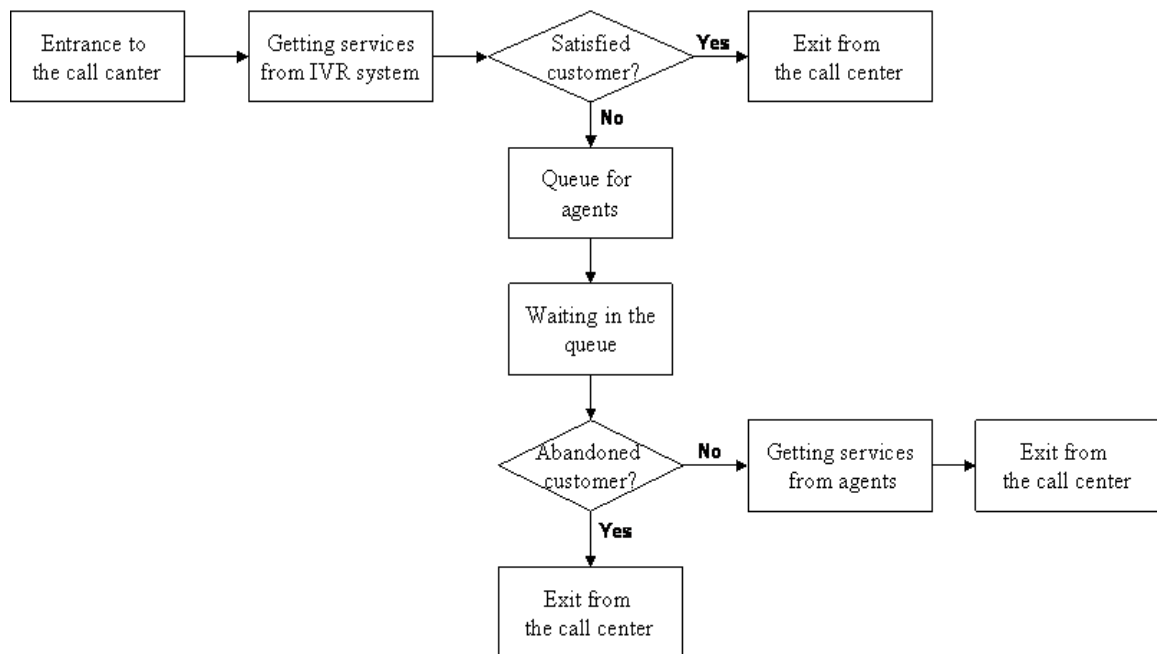


Figure 5.3 Flow in XYZ Bank's call center

5.4.2. Data Collection and Analysis

To simulate the existing operations of the call center, all the data required for constructing the model are collected. The data collected for analysis include incoming calls per day, service time in IVR system, waiting time in the queue, call handling time and work time after call.

In order to evaluate the distribution of incoming calls, related data on an annual basis are acquired from the call center's records. It is noticed that the number of incoming calls follows a non-stationary Poisson Process because its parameter value is dependent on the time of the day i.e. the number of incoming calls varies from one hour to the next hour. Consequently, an incoming call profile is constructed to simulate the arrival pattern of calls. For each hour of the day, the average of calls received in the specified hour is calculated. Table 5.23 indicates the average number of incoming calls for each hour of the day.

Table 5.23 Incoming call pattern

Time of The Day	# of Calls Received	Time of The Day	# of Calls Received
12-01	335	12-13	3716
01-02	178	13-14	3632
02-03	92	14-15	3626
03-04	52	15-16	3634
04-05	41	16-17	2847
05-06	32	17-18	1394
06-07	37	18-19	1572
07-08	118	19-20	983
08-09	656	20-21	1206
09-10	2166	21-22	970
10-11	3290	22-23	880
11-12	3665	23-24	738

The distribution for service time in IVR system is found to follow normal distribution with mean 137 seconds and variance 3019,2. It is noticed that after the customers get services in IVR system, 53,56 per cent of them are satisfied with the service they get from IVR system and leave the call center. Then, the rest of the customers who couldn't resolve their problem into the IVR system join the queue to connect to the agents. It is determined that four per cent of customers who join the queue, call the call center for affirming that their credit card is stolen or lost; 11 per cent of them call for telling their complaints; 42,5 per cent of them call for their credit card transactions and the rest of them call for their banking transactions. As soon as the customers join the queue, they have two

alternatives: they wait until connecting to an available agent and they get the service or they get bored of waiting and they leave the call center line. Accordingly, it is determined that the waiting time in queue until abandonment follows an exponential distribution with mean 75,4 seconds and the call handling time fits to an exponential distribution with mean 193 seconds. The calls are received by three different groups of agents. Each group is specialized on the different type of calls as stated in the section 5.4.1. The number of agents who work in the call center is dependent on the time of the day so a schedule is defined for every group of agents. Table 5.24 indicates daily schedule of agents according to the working hour.

Table 5.24 Average number of agents working in XYZ Bank's call center

The Time of The Day	# of Shift	# of Agents Receiving		
		Customer Satisfaction Calls Agent Group 1	Banking Services Calls Agent Group 2	Credit Cards Calls Agent Group 3
24-08	First	1	2	2
08-16	Second	12	24	24
16-24	Third	6	18	18

After the customers hang up the phone, the agents continue to work about the last customer's transaction if necessary and the work time after call follows an exponential distribution with mean 37,2 seconds.

5.4.3. Model Building

The simulation model consists of two modules:

- (i) IVR Module
- (ii) Call Service Module

First of all, an incoming call profile is defined in order to generate the incoming calls. The arrival schedule defined specifies the number of arrival entity per hour. An exponential distribution is used to evenly distribute the arrivals over each hour. Then, it is assumed that all calls enter to the network of call center because the probability of being blocked or getting a busy signal before entering to the network is very low. While analyzing the call center records, there have been no lost calls recorded since last 10 years because of the network's capacity insufficiency. As soon as the customers connect to the network, the call goes directly to the IVR module and they get service immediately by coding their customer number or their credit card number to the system. If the customers solve their problem in the IVR module, they leave the network. Since the customers are not satisfied with the service they get from the IVR module, they press the related button of their phone in order to join the queue to connect to the related agents about their problem. There are three different groups of agents specialized on different banking operations. Consequently, there are three different queues. The customers join the related queue regarding to their banking transactions. Then, the customers wait in the queue for a while before attempting to hang up. The time, callers abandon the call center network, follows an exponential distribution. If the customers are patient enough to connect to the agents, they go to the call service module. The call service module simulates the call handling and the post-call working process. When there is a free agent, a call is assigned to the agent according to first-come-first-serve basis. If the type of call is lost or stolen credit card call, it takes the first place in the credit card applications' queue because this type of call is required to be proceeding immediately. Next, the talk time with customers follows an exponential distribution. Once a call is proceed, the call is terminated. The customer leaves the trunk line but the agent is not free yet. Each agent needs some post-call processing time to finish the transaction and to get ready to answer the next call. The post-call processing time fits an exponential distribution. After an agent completes the post-call processing, s/he is available to answer to next call. Then, another call waiting in the queue is assigned to the free agents.

5.4.4. Model Validation

The simulator must accurately replicate the current configuration of XYZ Bank's call center and its performance indicators. One of the best ways to validate a simulation model is to compare the results predicted by the model with the performance of the real system (Sargent, 2008). Consequently, the validation of the model constructed is absolutely required to be done. It will be done by comparing the simulation results with the actual performance criteria.

In the first part of this section, the AHP method gave us the most important KPIs in a call center performance assesment. Thus, for the validation of the simulation model, those factors determined are taken into the consideration i.e. the output of the AHP method constitutes the input of the simulation model in one sense.

Table 5.25 Comparison of KPIs from empirical data versus simulation data

PERFORMANCE MEASURE		
	Simulated	Empirical
Incoming Call Volume	35,749	35,748
Service Level (%)	40,44	39,38
Number of Calls per Agent	102	103
Rate of Abandonment (%)	34,7	33
Average Handling Time (sec)	228,08	224
Average Speed of Answer (sec)	113,03	115

The model validation process is realized based on the comparison illustrated in Table 5.25. The performance measures indicated in Table 5.25 are the most significant KPIs determined by AHP at the beginning of this chapter. By comparing the simulation results with actual averaged data, it is concluded that our simulated results replicate closely the

performance of the present XYZ Bank's call center because there are not big differences in the simulated and empirical performance results.

In addition, the model validation will be done based on the statistical analysis. For this analysis, the hypothesis testing is used. The hypothesis test set for related performance indicator is:

$$H_0: p_{\text{model simulated}} = p_{\text{current system}}$$

$$H_1: p_{\text{model simulated}} \neq p_{\text{current system}}$$

The hypothesis settled for the validation of performance indicators, service level and rate of abandonment, is tested by two-proportion z-test. The formula stated below is used in order to calculate the value of z.

$$z = \frac{(p_1 - p_2) - (p_{\text{model}} - p_{\text{system}})}{\sqrt{p^* (1 - p^*) \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}} \quad \text{with } p^* = \frac{n_1 * p_1 + n_2 * p_2}{n_1 + n_2} \quad (5.1)$$

p_1 : the sample proportion of the current model

p_2 : the proportion obtained by the simulated model

n_i : the sample size of the current model (i=1,2)

The test is realized with two confidence interval $\alpha = 0,95$ and $\alpha = 0,99$. For $\alpha = 0,95$, z-value is equal to 1,96 and for $\alpha = 0,99$, z-value is equal to 2,58. Table 5.26 summarizes the hypothesis test results and shows in which confidence level the H_0 is accepted or rejected.

Table 5.26 Hypothesis test results for model validation-1

PERFORMANCE MEASURE	$p_1 - p_2$	Square Error of $p_1 - p_2$	Z-VALUE	$\alpha = 0.95$	$\alpha = 0.99$
Service Level (%)	0,0106	0,0074	1,43	ACCEPT	ACCEPT
Rate of Abandonment (%)	0,016	0,071	2,23	REJECT	ACCEPT

The hypothesis settled for the validation of performance indicators, number of calls per agent, average handling time and average speed of answer tested by two-sample z-test. The hypothesis test set for related performance indicator is:

$$H_0: \mu_{\text{model simulated}} = \mu_{\text{current system}}$$

$$H_1: \mu_{\text{model simulated}} \neq \mu_{\text{current system}}$$

The formula stated below is used in order to calculate the value of z.:

$$z = \frac{(x_1 - x_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (5.2)$$

x_1 : Average value obtained based on the sample of the current model

x_2 : Average value obtained by the simulation model

n_i : the sample size (i=1,2)

s_i : Standard deviation of the sample(i=1,2)

The test is realized with two confidence interval $\alpha = 0,95$ and $\alpha = 0,99$. Table 5.27 summarizes the hypothesis test results and shows in which confidence level the H_0 is accepted or rejected.

Table 5.27 Hypothesis test results for model validation-2

PERFORMANCE MEASURE	x_1-x_2	Square Error of x_1-x_2	Z-VALUE	$\alpha = 0,95$	$\alpha = 0,99$
Number of Calls per Agent	1	0,48	2,08	REJECT	ACCEPT
Average Handling Time (sec)	4,08	2,89	1,41	ACCEPT	ACCEPT
Average Speed of Answer (sec)	-1,97	0,98	-2,01	REJECT	ACCEPT

According to the hypothesis test results displayed in Table 5.26 and 5.27 respectively, it is concluded that the simulation model is valid within the confidence interval $\alpha = 0,99$.

5.4.5. Scenario Analysis

While doing SERVQUAL survey, it is defined that the customers of XYZ Bank complain about the service quality they get from XYZ Bank's call center. In addition, customers indicate one by one the weak aspects of the call center service via the survey's questions. The factors which cause dissatisfaction of the customers are defined in the SERVQUAL survey's results in the section 5.3.4 and 5.3.5 in details. The SERVQUAL method gives us as a result that the agents can not understand the specific needs of customers and they don't perform the service they promise in the right time. In addition to that, it is discovered that the customers are not satisfied with the usability and the understandability of IVR menu and they can not receive service in minimum time from the call center. Consequently, it is a fact that XYZ Bank's call center process needs to be improved. Thus, exploring different improvement opportunities is essential. The

implementation of each improvement opportunity and monitoring of its impact on the process could be done by performing a scenario analysis with a computer simulation program.

Thus, the simulation model constructed in ARENA is used to do the scenario analysis. In each scenario, an improvement opportunity is created in order to improve one of the factors which are very important for the customer satisfaction but which have low SERVQUAL's score. At the end, it results in three scenarios.

- **SCENARIO I: Increase the number of agents whose shift is between 08-16**

The SERVQUAL survey's results indicate that the customers can not receive service in minimum time from the XYZ Bank call center. The sample data analyzed prove the customers spend on the average 137 seconds in IVR system and after that they wait approximately 113,03 seconds in the queue. Thus, totally, a customer spends on the average 4.2 minutes in the call center before being connected to an available agent. Moreover, 34,7 per cent of customers in the queue are lost. In brief, the analysis of the sample data verifies the customers' complaints analytically. The decrease of handling time and the increase of number of agents can be two different solutions so that the customers spend less time in the call center. The effect of the decrease of handling time will be analyzed in the third scenario. In this scenario, the increase of the number of agents working is going to be analyzed.

It is observed that the incoming call volume is considerably high in the morning shift. In addition, the simulation model results show that 37 per cent of banking services and investment activities call and 41 per cent of credit card applications call are lost respectively while waiting for achieving an available agent in the queue. Consequently, it is decided to increase the number of agents who receive banking services and investment activities call and credit card applications call. One head count is added to the agent group

1 and the agent group 2 simultaneously. In the current model, in each group, there are 24 agents working between 08:00-16:00.

While the number of agents increases, it is expected that the number of calls handled, the service level and the average speed of answer improve positively. Then, in this scenario, the changes on KPIs are followed-up in accordance with the increase of number of agents in the first and second agent group. Table 5.28 summarizes the trend of KPIs.

Table 5.28 Simulation results of first scenario

	CURRENT MODEL (SIMULATED)		SCENARIO I.a	SCENARIO I.b	SCENARIO I.c
TOTAL # OF AGENTS	107		109	111	113
PERFORMANCE MEASURES	Current	Target			
Incoming Call Volume	35.749	-	35.748	35.748	35.748
Service Level (%)	40,44	60	43,06	43,21	47,44
Number of Calls per Agent	102	120	101	101	102
Rate of Abandonment (%)	34,7	20	33	33	30
Average Handling time (sec)	228,08	120	230,6	230,71	232,47
Average Speed of Answer (sec)	113,03	80	111,2	110,78	108,11
	CURRENT MODEL (SIMULATED)		SCENARIO I.d	SCENARIO I.e	SCENARIO I.f
TOTAL # OF AGENTS	107		115	117	119
PERFORMANCE MEASURES	Current	Target			
Incoming Call Volume	35.749	-	35.748	35.748	35.748
Service Level (%)	40,44	60	50,87	55,11	61,91
Number of Calls per Agent	102	120	104	105	107
Rate of Abandonment (%)	34,7	20	28	25	22
Average Handling time (sec)	228,08	120	231,87	233,61	228,16
Average Speed of Answer (sec)	113,03	80	106,5	104,05	101,15

In XYZ Bank's call center, the norm cadre is 119 personnel. However, the actual head count is 107 because of the up-to-date financial market status. Consequently, there is available capacity and equipment for 12 people. Therefore, in this scenario, the number of agents increases up to maximum 119 head count.

While increasing the number of agents, the service level and the rate of abandonment improves gradually and when the head count attains 119 people, these performance indicators achieve its target levels. It is observed that the average speed of answer decreases from 113 seconds to 101 seconds. But, it is far from the target value which is 101 seconds.

But it is difficult to recruit 12 people immediately because of the bank's financial strategies. At least six people have to be recruited for a considerable improvement in the performance measures. If sufficient additional agents are provided for the call center, the customer will be satisfied, because approximately 62 per cent of them can reach an available agent in 30 seconds and average waiting time in the queue decreases slightly.

As a conclusion, increase the number of agents in the call center can be a solution in order to improve performance measure and satisfy the customer but it can be realized in the long term.

- **SCENARIO II: Implement a new and efficient IVR module**

While the customers of XYZ Bank answer to the SERVQUAL survey's questions, they indicated that the menu of the IVR module is not efficient and user-friendly. They explained that the main menu and some sub-section are very long i.e. it is very difficult to remember all of the section at once consequently they have to listen the menu over and over again. In addition, they said some of the sub-section heading is not very clear so they

can not find the right section to be dialed. Thus, customers have to spend more time in IVR module in order to find the section they look for. As a solution, if a new IVR module with more efficient and understandable sections, the time spent in IVR system will decrease then the total time spent in call center will decrease too. Furthermore, the number of customers, who find a solution for their problem in IVR system, increases and therefore the number of customers, who leave the call center without connecting to the agents, will increase too.

In order to monitor the effect of modifying IVR menu, it is assumed that another bank's IVR menu is implemented to the XYZ Bank's IVR system. As a new IVR menu, it is decided to use ABC Bank's IVR menu because in the last ten years, ABC Bank receives seven different best call center awards from different organizations. Thus, it is assumed that its IVR menu is more understandable and user-friendly. Therefore, it is decided to analyze the data belonging to the ABC bank IVR system. While analyzing, it is determined that the service time of ABC Bank's IVR system is fitted to the exponential distribution with rate 120 seconds. It is found that 64,04 per cent of their customers is satisfied with the service they get from IVR system and they don't join the agents' queue. They leave the call center just after being served by IVR system. However, in our model, the service time spent in the IVR system is normally distributed with mean 137 and variance 3019,2. In this scenario, the ABC Bank IVR data are implemented in our model for the service time spent in IVR. Then, the changes in performance measures are monitored.

Table 5.29 Simulation results of second scenario-1

	Current	Scenario
Service Time Distribution in IVR (sec)	~N(137; 3019, 2)	~Exp(120)
Satisfaction Rate (%)	53,56	64,04
Incoming Call Volume	35.748	35.748
# of Customers Unsatisfied After Being Served in IVR	16.832	12.880
# of Customers Leaving Call Center After IVR Service	18.887	22.867
Average Time Spent in IVR (sec)	137,08	121,20
Total Time Spent in Call Center (sec)	355,47	330,63

Table 5.29 shows the results obtained in the simulation model designed with a new IVR menu. According to the results illustrated in Table 5.29, with an efficient IVR module, the number of customers who join to the agents' queue decrease with rate 11 per cent. Thus, approximately 4.000 customers don't join the agents' queue and they leave the call center just after getting services from IVR module. Thus, if XYZ Bank's call center succeeds to implement more efficient IVR module, the number of customers who find solutions for their problem without connecting an agent will increase. Furthermore, the customers will not loose time to listen the IVR menu over and over again with an efficient IVR menu so they can get more services in less time.

The decrease of the number of customers, who join the agents' queue, affects the performance measures of the call center positively. Table 5.30 illustrates the results of the scenario and compares them with the current model simulated.

Table 5.30 Simulation results of second scenario-2

	CURRENT MODEL (SIMULATED)		SCENARIO
SERVICE TIME DISTRIBUTION IN IVR (sec)	~N(137; 3019,2)		~Exp(120)
SATISFACTION RATE (%)	53,56		64,04
PERFORMANCE MEASURES	Current	Target	
Incoming Call Volume	35.749	-	35.748
Service Level (%)	40,44	60	58,90
Number of Calls per Agent	102	120	92
Rate of Abandonment (%)	34,7	20	23,59
Average Handling time (sec)	228,08	120	231,87
Average Speed of Answer (sec)	113,03	50	102,74

It is observed that the service level and the abandonment rate improve considerably. These performance measures achieve almost their target value. Moreover, it is obvious that the average speed of answer decrease slightly.

As a conclusion, incoming call volume to the agents' queue may decrease with an efficient IVR menu because the service offered in the section of the IVR menu may provide the service that the customers are looking for so the customers don't need to connect an agent. In addition, if the heading of IVR sub-section is understandable, the customers can get quicker service without losing time while deciding in which section they can find a solution.

- **SCENARIO III: Decrease the talk time of agents with customer**

SERVQUAL survey's results indicate customers have complaints about the agents' lack of information about the products and services offered by XYZ Bank. It is determined that the agents could not understand the specific needs of customers and that they could not answer their requests. Thus, the customers have to explain their requests or their problem several times in different ways. Sometimes, they have to wait on the line for a while so that the agents learn the answer of the questions from another source or people. The supervisors explain that the turn over rate of the call center is high so that all of the new recruits of the call center are not experienced enough and that the bank can not provide sufficient training program. As a solution, additional training may be given to the agents in order that they have enough knowledge about the products and services and that they can handle customers' problem easily and more quickly.

Currently, the average service time is 193 seconds and it is very far from the target which is 120 seconds. If we can decrease the average talk time gradually in order to achieve the target service, the total time spent in the call center will decrease accordingly. In this scenario, the changes in performance criteria are followed-up in accordance with the decrease of service time. Table 5.31 shows the trend of the performance measures while achieving the target service time.

Table 5.31 Simulation results of third scenario

	CURRENT MODEL (SIMULATED)		SCENARIO			
			III.a	III.b	III.c	III.d
AVERAGE TALK TIME (sec)	193		180	160	140	120
PERFORMANCE MEASURES	Current	Target				
Incoming Call Volume	35.749	-	35.748	35.748	35.748	35.748
Service Level (%)	40,44	60	44,55	50,13	59,85	64,73
Number of Calls per Agent	102	120	105	111	118	126
Rate of Abandonment (%)	34,7	20	32,7	28,5	22,8	19,1
Average Handling time (sec)	228,08	120	219,18	196,72	178,83	159,20
Average Speed of Answer (sec)	113,03	80	110,42	107,33	101,84	100,11

There is a big gap between the target and the current talk time. Therefore, it is difficult to achieve the target service time immediately. If XYZ Bank call center succeed to attain that service level, it is obvious that the performance measures improve automatically and the call center achieves most of its targets.

As a result, if the agents can have enough knowledge about the product and the services by the training program and if the bank can decrease the turn over rate by its strategies, they become more experienced so they can understand and solve more easily the customers' problems. Further more; they can do transactions more quickly in the banking system because they become familiar with the banking system as time goes by. Then, the decrease of talk time will satisfy the customers because they spent less time in call center in order to get more qualified service. Table 5.32 shows the decrease of amount of time spent in call center based on the scenario. In addition, the call center operates more effectively and efficiently because performance measures are improved.

Table 5.32 Simulation results for time spent in call center

	CURRENT MODEL (SIMULATED)	SCENARIO			
		III.a	III.b	III.c	III.d
Total Time Spent in Call Center (sec)	355,47	343,29	318,21	294,30	273,22
Total Time Spent in Call Center (min)	5,92	5,72	5,30	4,91	4,55

In conclusion, based on the scenario analysis, it is important to determine the number of agents, the efficiency of IVR module and the average talking time required to achieve the target service level set by management of the bank. In addition, management has to be aware of the factors affecting customer satisfaction level. For XYZ Bank, it is obvious that the customers are not satisfied with the service they get from the call center and they complaint of some aspects of the call center service quality. On the other hand, it is a fact that the call center can not achieve its targets considering its performance measures. Then, the bank has to plan its strategies for short and long term in order to upgrade the service quality level.

6. CONCLUSION

Service quality is recognized as a critical business requirement by enterprises in the service sector. It is emerging as a primary competitive weapon. Thus, it serves a key factor for profitability and survival. Relevant literature indicates that service quality is closely related to satisfaction and purchase intention. Therefore, evaluating and improving the service quality of a company play a crucial role in a competitive market.

An excellent service quality leads into customer satisfaction. Then, achieving customer satisfaction is the primary goal for service firms. Customer satisfaction plays a vital role not just in keeping customers but also attracting new customers through positive word-of-mouth. It is a fact that call centers are the essential component of the CRM strategies because many companies accept that call centers retain and increase customer satisfaction.

Most of the studies in the literature about the call center focus on the quantitative metrics of the call center. For many companies, one of the main ways of establishing a call center's success has been to measure how quickly agents answer calls because managers assess performance by the quantity rather than the quality of the calls. Just because there are no calls waiting in the queue and all the agents are on the phone, doesn't mean that customers are happy. Similarly, trying to ensure that all calls are kept to less than two minutes might make the call volumes look good, but it is no indication to solve customer's request effectively.

It is a fact that KPIs affecting efficiency are major issues regarding customer satisfaction. But the evaluation of customer perception of service can not be neglected if a call center performance is assessed. It is a fact that there is a dichotomy between quantitative and qualitative targets within call centers. Thus, supervisors feel the pressure of the conflict between quality and quantity, and call center agents are caught between the

needs to deliver quality customer service and to maintain productivity. However, it is an absolute necessity to evaluate both efficiency and QoS in order to analyze and improve a call center performance.

Thus, this study aims to analyze a call center from two perspectives: efficiency and effectiveness. It proposes to evaluate KPIs values in terms of efficiency and to measure the service quality in terms of effectiveness. While doing so, this study suggests utilizing an integrated methodology which incorporates AHP, SERVQUAL and a simulation model. The application of the methodology is done in a private bank's call center in Turkey.

In the proposed methodology, first of all, the quantitative KPIs are collected based on a literature survey. Then, all the performance measures collected are ranked based on their importance level according to the call center management's point of view.

After evaluating quantitative performance measures, the service quality of the call center is measured. A modified SERVQUAL model for call centers is constructed. The customers' perceptions and expectations of service quality are measured across six dimensions: systematization of service delivery, agents' skills and behaviors, quality of information, attributes of service delivery, tangibility of service delivery, responsibilities of agents. A scale based on 23 items assesses the gap between customers' expectations of the service and their perception of the actual service received. The gaps on service quality shows where performance improvement can best be targeted. The largest negative gaps, combined with assessment of where expectations are highest, facilitate prioritisation of performance improvement. Equally, if gaps scores in some aspects of service do turn out to be positive, implying expectations are actually not just being met but exceeded, then this allows managers to review whether they may be over-supplying this particular feature of the service and whether there is potential for re-deployment of resources into features which are under-performing.

Finally, a simulation model, which covers XYZ Bank's call center operations, is constructed. After validating the model by statistical hypothesis testing, a scenario analysis is performed. According to the gap analysis done at the end of SERVQUAL method, improvement opportunities are identified for decreasing the gap and they are implemented in the simulation model by scenario analysis. While performing scenario analysis, the most important performance indicators, which are determined at the beginning of the application, are monitored in order to see how close the call center management is to the performance target values.

It is concluded that the customers are not satisfied with the service they get from the call center and they complaint of some aspects of the call center service quality. In addition, the call center is far from the target performance value set by the management of the bank. Thus, the bank has to revise it strategies in short and long term respectively for increasing its own performance and the service they offer to the customers. In short term strategies, it is foreseen that a new and efficient IVR menu should be implemented; Additional training program should be organized for agents in order to inform them about the bank services and products and about the banking system they use. In long term strategies, new agents should be recruited in order to increase the total number of agents working in the call center. The call center management should decrease the turnover rate of agents by providing enough level of staff satisfaction.

The model constructed for this study provides a platform to study the productivity of call center and the level of customer satisfaction. This model demonstrares where performance improvement can best be targeted. Finally, a cost optimization point of view may be beneficial in order to see the total cost of each improvement opportunity if it is implemented.

APPENDIX A: SURVEY FOR MEASURING SERVICE QUALITY

This survey consists of two sections. In the first section, questions are related to personal information. In the second section, the questions, which are prepared in order to measure service quality in call centers, are requested. For the second section of the survey, a seven-point scale ranging from “Strongly Agree”(7) to “Strongly Disagree”(1) is employed. There are no verbal labels indicated for the intermediate scale point (i.e. two through six).

**STRONGLY
DISAGREE**

**STRONGLY
AGREE**

1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7

A.1. Personal Information

Date: __/__/2010

Respondent's information

Name, Surname: _____

Phone Number: : _____

E-mail: _____@_____

1. Gender Female () Male ()

2. Age

- | | |
|------------------|------------------|
| 25 and below () | 46-50 () |
| 26-30 () | 51-55 () |
| 31-35 () | 56-60 () |
| 36-40 () | 61 and above () |
| 41-45 () | |

3. Education Level

- () Primary School Graduate
- () Secondary School Graduate
- () High School Graduate
- () College Graduate
- () Master's Degree
- () Doctorate

4. Your job: _____

5. Reason for using call center: _____

6. Frequency of calling call center:

- | | |
|--------------------------|------------------------|
| () Once a week | () Once in six months |
| () Once a month | () Once a year |
| () Once in three months | () Other |

7. Please indicate when you last called the call center: _____

A.2. Prioritization of Call Center's Features

Listed below are six features pertaining to the call centers and the services they offer. Please indicate their importance when you evaluate a call center's quality of service. Please allocate a total of 100 points among the six features according to how important each feature is to you; the more important a feature is to you, a higher weight you should allocate to it. Please ensure that the weights you allocate to the six features add up to 100.

Table A.1 Importance weight of each SQ dimension for customers

1. Ability to perform standard and simple service delivery process.	
2. The knowledge and courtesy of agents and their ability to convey confidence.	
3. Qualification of answer given by the agents to the customers.	
4. Ability to perform the promised service dependably, accurately and promptly.	
5. Tone of voice, understandability of language, background music played.	
6. Responsibility of the agents towards the customers and their work.	

TOTAL points allocated = 100

A.3. Expected Service Quality

This survey deals with your opinions of call center services. The following set of statements relate to your feelings about the service that you expect to get from a call center. Based on your experiences as a customer of call center services, please think about the kind of a call center that would deliver excellent quality of service. Then, for each statement, please show the extent to which you think this call center should possess the features described by each statement. You should circle 7 if you strongly agree that this call center should possess that feature; and, you should circle 1 if you strongly disagree that this call center should possess that feature. You may circle any number between one and seven inclusive to reflect the strength. There are no right or wrong answers in this survey. All we are interested in is a number that best shows your expectation about the service quality of call center.

In an excellent call center;

E1. The IVR system should be easy to use and understandable.	1	2	3	4	5	6	7
E2. The IVR system should be so comprehensive that customers can always find a solution for their problem.	1	2	3	4	5	6	7
E3. The service delivery process should be so simple and standard that customers get the service they ask for without any hassles or excessive bureaucracy.	1	2	3	4	5	6	7
E4. The service delivery process should be so simple and structured that customers get the service they ask for in minimum time.	1	2	3	4	5	6	7
E5. All of the technological capability (e.g. computerization, networking of operations, etc.) should be utilized to serve customers more effectively	1	2	3	4	5	6	7

An excellent call center's agents should

E6. be always willing to help customers.	1	2	3	4	5	6	7
E7. be courteous.	1	2	3	4	5	6	7
E8. instill confidence in customers.	1	2	3	4	5	6	7
E9. offer personalized attention and information to their customers.	1	2	3	4	5	6	7
E10. look for the best for the interests of their customers.	1	2	3	4	5	6	7
E11. show a sincere interest in solving customers' problems.	1	2	3	4	5	6	7
E12. have enough knowledge about the products and services offered to answer customer's questions.	1	2	3	4	5	6	7
E13. understand the specific needs of customers.	1	2	3	4	5	6	7

The information provided by an excellent call center's agents should always be

E14. accurate.	1	2	3	4	5	6	7
E15. reliable.	1	2	3	4	5	6	7
E16. complete.	1	2	3	4	5	6	7
E17. relevant.	1	2	3	4	5	6	7
E18. valid.	1	2	3	4	5	6	7

An excellent call center

E19. promises customers to do something, then it should do as promised.	1	2	3	4	5	6	7
E20. should be dependable in handling customers' problems.	1	2	3	4	5	6	7
E21. should always perform right at the first time.	1	2	3	4	5	6	7
E22. should provide its services in the agreed time.	1	2	3	4	5	6	7
E23. should always give prompt service to customers.	1	2	3	4	5	6	7
E24. should keep its records accurately.	1	2	3	4	5	6	7
E25. should make customers feel safe in their transactions with call center agents.	1	2	3	4	5	6	7
E26. should manage effectively customer complaint system.	1	2	3	4	5	6	7

In an excellent call center system,

E27. the phone number should be easy to memorize.	1	2	3	4	5	6	7
E28. background music playing during hanging on time in an IVR system should be diversified.	1	2	3	4	5	6	7
E29. background music played in an IVR system should be pleasant.	1	2	3	4	5	6	7
E30. voice record's tone in an IVR system should not be high-pitched.	1	2	3	4	5	6	7
E31. agent's tone of voice should not be high-pitched.	1	2	3	4	5	6	7
E32. voice record's language in an IVR system should be understandable.	1	2	3	4	5	6	7
E33. agent's language should be understandable.	1	2	3	4	5	6	7

An excellent call center's agents should

E34. treat every customer in the same equal way.	1	2	3	4	5	6	7
E35. be punctual and regular.	1	2	3	4	5	6	7

A.4. Perceived Service Quality

The following set of statements relate to your feelings about the service that you get from the call center of a bank you experience recently. For each statement, please show the extent to which you believe the call center mentioned has the feature described by the statement. You should circle 7 if you strongly agree that this call center has that feature; and, you should circle 1 if you strongly disagree that this call center has that feature. You may circle other numbers if you believe the feature is fulfilled partially. There are no right or wrong answers in this survey.

In the call center;

P1. The IVR system is easy to use and understandable.	1	2	3	4	5	6	7
P2. The IVR system is so comprehensive that customers can always find a solution for their problem.	1	2	3	4	5	6	7
P3. The service delivery process is so simple and standard that customers get the service they ask for without any hassles or excessive bureaucracy.	1	2	3	4	5	6	7
P4. The service delivery process is so simple and structured that customers get the service they ask for in minimum time.	1	2	3	4	5	6	7

The call center's agents

P6. are always willing to help customers.	1	2	3	4	5	6	7
P7. are courteous.	1	2	3	4	5	6	7
P8. instill confidence in customers.	1	2	3	4	5	6	7
P9. offer personalized attention and information to their customers.	1	2	3	4	5	6	7
P10. look for the best for the interests of their customers.	1	2	3	4	5	6	7
P11. show a sincere interest in solving customers' problems.	1	2	3	4	5	6	7
P12. understand the specific needs of customers.	1	2	3	4	5	6	7
P13. have enough knowledge about the products and services offered to answer customer's questions.	1	2	3	4	5	6	7

The information provided by call center's agents is always

P14. accurate.	1	2	3	4	5	6	7
P15. reliable.	1	2	3	4	5	6	7
P16. complete.	1	2	3	4	5	6	7
P17. relevant.	1	2	3	4	5	6	7
P18. valid.	1	2	3	4	5	6	7

The call center

P19. promises customers to do something, then consider it done as promised.	1	2	3	4	5	6	7
P20. is dependable in handling customers' problems.	1	2	3	4	5	6	7
P21. always performs right at the first time.	1	2	3	4	5	6	7
P22. provides its services in the agreed time.	1	2	3	4	5	6	7
P23. always gives prompt service to customers.	1	2	3	4	5	6	7
P24. keeps its records accurately.	1	2	3	4	5	6	7
P25. makes customers feel safe in their transactions with call center agents.	1	2	3	4	5	6	7
P26. manages effectively customer complaints system.	1	2	3	4	5	6	7

In the call center system,

P27. the phone number is easy to memorize.	1	2	3	4	5	6	7
P28. background music playing during hanging on time in an IVR system is diversified.	1	2	3	4	5	6	7
P29. background music played in an IVR system is pleasant.	1	2	3	4	5	6	7
P30. voice record's tone in an IVR system is not high-pitched.	1	2	3	4	5	6	7
P31. agent's tone of voice is not high-pitched.	1	2	3	4	5	6	7
P32. voice record's language in an IVR system is understandable.	1	2	3	4	5	6	7
P33. agent's language is understandable.	1	2	3	4	5	6	7

The call center's agents

P34. treat every customer in the same equal way.	1	2	3	4	5	6	7
P35. are punctual and regular.	1	2	3	4	5	6	7

APPENDIX B: PURIFIED SURVEY FOR MEASURING QoS

B.1. Expected Service Quality

In an excellent call center;

E1. The IVR system in should be easy to use and understandable.	1	2	3	4	5	6	7
E2. The IVR system should be so comprehensive that customers can always find a solution for their problem.	1	2	3	4	5	6	7
E3. The service delivery process should be so simple and standard that customers get the service they ask for without any hassles or excessive bureaucracy.	1	2	3	4	5	6	7
E4. The service delivery process should be so simple and structured that customers get the service they ask for in minimum time.	1	2	3	4	5	6	7

An excellent call center's agents should

E6. be always willing to help customers.	1	2	3	4	5	6	7
E7. be courteous.	1	2	3	4	5	6	7
E8. instill confidence in customers.	1	2	3	4	5	6	7
E11. show a sincere interest in solving customers' problems.	1	2	3	4	5	6	7
E12. have enough knowledge about the products and services offered to answer customer's questions.	1	2	3	4	5	6	7

The information provided by an excellent call center's agents should always be

E14. accurate.	1	2	3	4	5	6	7
E15. reliable.	1	2	3	4	5	6	7
E16. complete.	1	2	3	4	5	6	7

An excellent call center

E21. should always perform right at the first time.	1	2	3	4	5	6	7
E22. should provide its services in the agreed time.	1	2	3	4	5	6	7
E23. should always give prompt service to customers.	1	2	3	4	5	6	7

In an excellent call center system,

E27. the phone number should be easy to memorize.	1	2	3	4	5	6	7
E28. background music playing during hanging on time in an IVR system should be diversified.	1	2	3	4	5	6	7
E29. background music played in an IVR system should be pleasant.	1	2	3	4	5	6	7
E31. agent's tone of voice should not be high-pitched.	1	2	3	4	5	6	7
E32. voice record's language in an IVR system should be understandable.	1	2	3	4	5	6	7
E33. agent's language should be understandable.	1	2	3	4	5	6	7

An excellent call center's agents should

E34. treat every customer in the same equal way.	1	2	3	4	5	6	7
E35. be punctual and regular.	1	2	3	4	5	6	7

B.2. Perceived Service Quality

In the call center;

P1. The IVR system is easy to use and understandable.	1	2	3	4	5	6	7
P2. The IVR system is so comprehensive that customers can always find a solution for their problem.	1	2	3	4	5	6	7
P3. The service delivery process is so simple and standard that customers get the service they ask for without any hassles or excessive bureaucracy.	1	2	3	4	5	6	7
P4. The service delivery process is so simple and structured that customers get the service they ask for in minimum time.	1	2	3	4	5	6	7

The call center's agents

P6. are always willing to help customers.	1	2	3	4	5	6	7
P7. are courteous.	1	2	3	4	5	6	7
P8. instill confidence in customers.	1	2	3	4	5	6	7
P11. show a sincere interest in solving customers' problems.	1	2	3	4	5	6	7
P12. understand the specific needs of customers.	1	2	3	4	5	6	7
P13. have enough knowledge about the products and services offered to answer customer's questions.	1	2	3	4	5	6	7

The information provided by call center's agents is always

P14. accurate.	1	2	3	4	5	6	7
P15. reliable.	1	2	3	4	5	6	7
P16. complete.	1	2	3	4	5	6	7

The call center

P21. always performs right at the first time.	1	2	3	4	5	6	7
P22. provides its services in the agreed time.	1	2	3	4	5	6	7
P23. always gives prompt service to customers.	1	2	3	4	5	6	7

In the call center system,

P27. the phone number is easy to memorize.	1	2	3	4	5	6	7
P28. background music playing during hanging on time in an IVR system is diversified.	1	2	3	4	5	6	7
P29. background music played in an IVR system is pleasant.	1	2	3	4	5	6	7
P31. agent's tone of voice is not high-pitched.	1	2	3	4	5	6	7
P32. voice record's language in an IVR system is understandable.	1	2	3	4	5	6	7
P33. agent's language is understandable.	1	2	3	4	5	6	7

The call center's agents

P34. treat every customer in the same equal way.	1	2	3	4	5	6	7
P35. are punctual and regular.	1	2	3	4	5	6	7

APPENDIX C: FACTOR ANALYSIS

Let the variables $Y_1, Y_2 \dots Y_{23}$, respectively, represent questions $Q_1, Q_2 \dots Q_{23}$ stated in the refined survey. The unobservable factors $F_1, F_2 \dots F_6$ represents one of the dimensions, namely D1, D2...D6. It is suggested that the variables of interest $Y_1, Y_2 \dots Y_{23}$, are linearly related to a smaller number of unobservable factors $F_1, F_2 \dots F_6$. In other words, it is assumed that each Y variable is a linear function of six factors and error terms, as follows:

$$\begin{aligned}
 Y_1 &= \beta_{10} + \beta_{11} F_1 + \beta_{12} F_2 + \beta_{13} F_3 + \beta_{14} F_4 + \beta_{15} F_5 + \beta_{16} F_6 + e_1 \\
 Y_2 &= \beta_{20} + \beta_{21} F_1 + \beta_{22} F_2 + \beta_{23} F_3 + \beta_{24} F_4 + \beta_{25} F_5 + \beta_{26} F_6 + e_2 \\
 &\vdots \\
 Y_{22} &= \beta_{220} + \beta_{221} F_1 + \beta_{222} F_2 + \beta_{223} F_3 + \beta_{224} F_4 + \beta_{225} F_5 + \beta_{226} F_6 + e_{22} \\
 Y_{23} &= \beta_{230} + \beta_{231} F_1 + \beta_{232} F_2 + \beta_{233} F_3 + \beta_{234} F_4 + \beta_{235} F_5 + \beta_{236} F_6 + e_{23}
 \end{aligned} \tag{C.1}$$

The error terms $e_1, e_2 \dots e_{23}$ serve to indicate that the hypothesized relationships are not exact. The parameters β_{ij} are referred to as loadings. For example, β_{12} is called the loading of variable Y_1 on factor F_2 .

The factor analysis is based on two assumptions as described below:

A1: The error terms e_i are independent of one another, and such that $E(e_i)=0$ and $\text{Var}(e_i) = \sigma_i^2$.

A2: The unobservable factors F_j are independent of one another and of the error terms, and are such that $E(F_j)=0$ and $\text{Var}(F_j) = 1$.

As an implication of these assumptions, the variance of Y_i consists of two parts:

$$\begin{aligned}
 \text{Var}(Y_i) &= \text{Var}(\beta_{i0} + \beta_{i1} F_1 + \beta_{i2} F_2 + \beta_{i3} F_3 + \beta_{i4} F_4 + \beta_{i5} F_5 + \beta_{i6} F_6 + e_i) \\
 &= \beta_{i1}^2 \text{Var}(F_1) + \beta_{i2}^2 \text{Var}(F_2) + \beta_{i3}^2 \text{Var}(F_3) + \beta_{i4}^2 \text{Var}(F_4) + \beta_{i5}^2 \text{Var}(F_5) \\
 &\quad + \beta_{i6}^2 \text{Var}(F_6) + \sigma_i^2 \\
 &= \beta_{i1}^2 + \beta_{i2}^2 + \beta_{i3}^2 + \beta_{i4}^2 + \beta_{i5}^2 + \beta_{i6}^2 + \sigma_i^2
 \end{aligned} \tag{C.2}$$

The first part ($\beta_{i1}^2 + \beta_{i2}^2 + \beta_{i3}^2 + \beta_{i4}^2 + \beta_{i5}^2 + \beta_{i6}^2$) is referred as the communality of the variable Y_i . It is the part that is explained by the common factor $F_1, F_2 \dots F_6$.

$$\begin{aligned}
 \text{Cov}(Y_i, Y_j) &= \beta_{i1} \beta_{j1} \text{Var}(F_1) + \beta_{i2} \beta_{j2} \text{Var}(F_2) + \beta_{i3} \beta_{j3} \text{Var}(F_3) + \beta_{i4} \beta_{j4} \text{Var}(F_4) \\
 &\quad + \beta_{i5} \beta_{j5} \text{Var}(F_5) + \beta_{i6} \beta_{j6} \text{Var}(F_6) + (1)(0) \text{Var}(e_i) + (0)(1) \text{Var}(e_j) \\
 &= \beta_{i1} \beta_{j1} + \beta_{i2} \beta_{j2} + \beta_{i3} \beta_{j3} + \beta_{i4} \beta_{j4} + \beta_{i5} \beta_{j5} + \beta_{i6} \beta_{j6}
 \end{aligned} \tag{C.3}$$

We can arrange all the variances and covariances in the variance and covariance matrix such that the variances of the Y variables in the diagonal of the matrix and the covariances off the diagonal. With the factor analysis method, we estimate the loadings β_{ij} .

For determining a first set of loadings, the principal component analysis is used. This method determined the values of β_{ij} which make the total communality as close as possible to the total of the observed variances of the variables.

The factor analysis is run on the SPSS. SPSS standardizes the variables so that all have mean zero and variance equal to one. This is accomplished by subtracting from each observation (Y_i) the mean of the variable \bar{Y} and dividing the result by standard deviation (s_i) of the variable to obtain the standardized observation (Y_i')

$$Y_i' = (Y_i - \hat{Y}) / s_i \quad (\text{C.4})$$

The covariances of the standardized variables are equal to the correlation coefficients of the original variables. In other words, $\text{Cov}(Y_i', Y_j') = \text{Cor}(Y_i, Y_j)$. Thus, the operations required are done based on the correlation matrix.

The factor analysis is evaluated step by step below. When analyzing the outputs stated below, just remember that Q1 represents question 1, Q2 represents question 2 and so on.

STEP1: Checking the intercorrelation among the variables.

23 by 23 intercorrelation matrix is computed. This matrix is displayed below in Table C.1. This correlation matrix can be used to check the pattern of relationships between variables. Then, it is necessary to scan the correlation coefficients. First of all, we should look for any values greater than 0,90. If such a value exists in the correlation matrix, we should be aware that a problem could arise because of singularity in the data. Variables are correlated significantly with each other because they are measuring the same "thing". In that case, it is necessary to eliminate one of the two variables causing the problem. In order to check the multicollinearity, we should check the determinant of the correlation matrix. In our case, there is not any values greater than 0,90. In addition to that, the determinant is equal to 0,001 for these data. It is greater than the necessary value of 0,00001. Therefore, the multicollinearity is not a problem for these data. To sum up, all 23 questions in the questionnaire correlate fairly well and none of the correlation coefficients are particularly large; therefore, there is no need to consider eliminating any questions at this stage.

Table C.1 Correlation matrix of 23-item scale

	Q1	Q2	Q3	Q4	Q6	Q7	Q8	Q11	Q12	Q14	Q15	Q16	Q21	Q22	Q23	Q27	Q28	Q29	Q31	Q32	Q33	Q34	Q35
Q1	1,00	0,36	0,32	0,46	-0,05	-0,08	-0,04	-0,03	0,08	-0,01	-0,05	0,05	0,11	0,04	0,10	-0,17	-0,10	-0,02	-0,08	-0,05	0,04	-0,09	-0,09
Q2	0,36	1,00	0,42	0,42	-0,01	-0,09	0,05	-0,03	-0,06	0,16	0,14	0,17	-0,04	-0,10	-0,06	0,03	0,04	-0,04	-0,08	0,06	0,15	0,17	0,10
Q3	0,32	0,42	1,00	0,38	-0,01	-0,06	-0,05	-0,04	-0,02	0,15	0,11	0,15	0,09	0,03	0,03	0,07	0,05	0,08	-0,02	0,07	0,14	0,02	0,09
Q4	0,46	0,42	0,38	1,00	0,05	-0,05	-0,02	-0,05	0,03	0,05	0,00	0,09	0,11	0,03	0,08	-0,02	-0,08	-0,01	-0,05	-0,03	0,02	0,01	0,00
Q6	-0,05	-0,01	-0,01	0,05	1,00	0,37	0,35	0,32	0,35	-0,05	0,10	0,01	-0,06	-0,03	0,00	0,05	0,03	0,03	0,12	0,01	-0,02	0,02	-0,02
Q7	-0,08	-0,09	-0,06	-0,05	0,37	1,00	0,48	0,81	0,30	-0,02	0,05	0,05	0,00	0,11	0,07	-0,03	0,07	0,02	0,15	-0,01	-0,07	-0,12	-0,05
Q8	-0,04	0,05	-0,05	-0,02	0,35	0,48	1,00	0,45	0,36	0,01	0,09	0,00	-0,02	0,06	0,04	0,02	0,03	-0,08	0,02	-0,04	-0,04	0,02	0,09
Q11	-0,03	-0,03	-0,04	-0,05	0,32	0,81	0,45	1,00	0,46	0,02	0,12	0,06	0,02	0,14	0,10	0,02	0,07	0,03	0,09	0,00	0,04	-0,09	-0,03
Q12	0,08	-0,06	-0,02	0,03	0,35	0,30	0,36	0,46	1,00	-0,03	-0,05	-0,04	0,00	0,07	0,12	-0,12	0,02	0,01	0,02	-0,17	-0,02	-0,14	-0,06
Q14	-0,01	0,16	0,15	0,05	-0,05	-0,02	0,01	0,02	-0,03	1,00	0,49	0,43	-0,05	-0,02	-0,03	0,09	0,02	0,01	0,08	0,10	0,17	0,09	0,12
Q15	-0,05	0,14	0,11	0,00	0,10	0,05	0,09	0,12	-0,05	0,49	1,00	0,43	0,03	0,05	0,03	0,15	0,18	0,12	0,13	0,15	0,18	0,16	0,16
Q16	0,05	0,17	0,15	0,09	0,01	0,05	0,00	0,06	-0,04	0,43	0,43	1,00	-0,06	-0,03	-0,10	0,13	0,06	0,02	0,10	0,05	0,09	0,10	0,10
Q21	0,11	-0,04	0,09	0,11	-0,06	0,00	-0,02	0,02	0,00	-0,05	0,03	-0,06	1,00	0,45	0,48	-0,07	-0,06	-0,14	-0,11	-0,07	-0,02	-0,03	-0,02
Q22	0,04	-0,10	0,03	0,03	-0,03	0,11	0,06	0,14	0,07	-0,02	0,05	-0,03	0,45	1,00	0,89	-0,03	0,04	0,03	-0,12	-0,01	0,05	-0,13	-0,09
Q23	0,10	-0,06	0,03	0,08	0,00	0,07	0,04	0,10	0,12	-0,03	0,03	-0,10	0,48	0,89	1,00	-0,15	-0,05	-0,04	-0,17	-0,03	0,02	-0,10	-0,07
Q27	-0,17	0,03	0,07	-0,02	0,05	-0,03	0,02	0,02	-0,12	0,09	0,15	0,13	-0,07	-0,03	-0,15	1,00	0,38	0,35	0,27	0,28	0,38	0,18	0,15
Q28	-0,10	0,04	0,05	-0,08	0,03	0,07	0,03	0,07	0,02	0,02	0,18	0,06	-0,06	0,04	-0,05	0,38	1,00	0,37	0,32	0,34	0,34	0,14	0,17
Q29	-0,02	-0,04	0,08	-0,01	0,03	0,02	-0,08	0,03	0,01	0,01	0,12	0,02	-0,14	0,03	-0,04	0,35	0,37	1,00	0,21	0,29	0,32	0,00	0,02
Q31	-0,08	-0,08	-0,02	-0,05	0,12	0,15	0,02	0,09	0,02	0,08	0,13	0,10	-0,11	-0,12	-0,17	0,27	0,32	0,21	1,00	0,22	0,24	0,11	0,07
Q32	-0,05	0,06	0,07	-0,03	0,01	-0,01	-0,04	0,00	-0,17	0,10	0,15	0,05	-0,07	-0,01	-0,03	0,28	0,34	0,29	0,22	1,00	0,33	0,15	0,16
Q33	0,04	0,15	0,14	0,02	-0,02	-0,07	-0,04	0,04	-0,02	0,17	0,18	0,09	-0,02	0,05	0,02	0,38	0,34	0,32	0,24	0,33	1,00	0,03	0,10
Q34	-0,09	0,17	0,02	0,01	0,02	-0,12	0,02	-0,09	-0,14	0,09	0,16	0,10	-0,03	-0,13	-0,10	0,18	0,14	0,00	0,11	0,15	0,03	1,00	0,56
Q35	-0,09	0,10	0,09	0,00	-0,02	-0,05	0,09	-0,03	-0,06	0,12	0,16	0,10	-0,02	-0,09	-0,07	0,15	0,17	0,02	0,07	0,16	0,10	0,56	1,00

STEP2: Determining the factorability of an intercorrelation matrix.

(i) Calculation of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy.

The KMO measure of sampling adequacy is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients. This index is calculated as stated below:

$$KMO = \frac{\sum_{i \neq j} \sum r_{ij}^2}{\sum_{i \neq j} \sum r_{ij}^2 + \sum_{i \neq j} \sum a_{ij}^2} \quad (C.5)$$

where a_{ij} indicates partial correlation of variables and r_{ij} indicates correlation coefficient of variables. KMO statistic varies between zero and one. A value of zero indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations. A value close to one indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. The KMO measures the sampling adequacy which should be greater than 0,5 for a satisfactory factor analysis to proceed. Large values for the KMO measure indicate that a dataset is "appropriate" for factor analysis. Furthermore, values between 0,5 and 0,7 are mediocre; values between 0,7 and 0,8 are good; values between 0,8 and 0,9 are great and values above 0,9 are superb. For these data, the value is 0,681, which falls into the range of being mediocre: so, we should be confident that factor analysis is appropriate for these data.

(ii) Application of Bartlett's Test of Sphericity

Bartlett's measure tests the null hypothesis that the original correlation matrix is an identity matrix. If the correlation matrix is an identity matrix then all correlation

coefficients would be zero. For factor analysis to work, some relationships between variables are needed. So clearly, Bartlett value is expected to be significant.

Bartlett's test is a chi-square statistic and it is calculated through the formula stated below:

$$\chi^2 = - \left[(N-1) - \left(\frac{2k+5}{6} \right) \right] \ln|R| \quad (C.6)$$

where χ^2 = Bartlett's test result

N = sample size

k = number of variables

$|R|$ = the determinant of the intercorrelation matrix

d.f = $k * (k-1) / 2$

Table C.2 KMO & Bartlett's test results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0,681
Bartlett's Test of Sphericity	
Approx. Chi-Square	1,902E3
Df	253
Sig.	0,000

According to the test's result obtained by SPSS, the sample intercorrelation matrix does not come from a population in which the intercorrelation matrix is an identity matrix. As $P \leq 0,05$, these data are appropriate for factor analysis.

STEP3: Extracting an initial solution.

The initial assumption of the principal component analysis is that all variance is common; therefore, before extraction the communalities are all one. The initial solution extracted by the PCA is displayed below in Table C.3.

Table C.3 Communalities obtained by principal component

	Initial	Extraction			Initial	Extraction
Q1	1	0,609		Q21	1	0,51
Q2	1	0,628		Q22	1	0,872
Q3	1	0,513		Q23	1	0,878
Q4	1	0,612		Q27	1	0,494
Q6	1	0,373		Q28	1	0,53
Q7	1	0,778		Q29	1	0,523
Q8	1	0,563		Q31	1	0,349
Q11	1	0,717		Q32	1	0,411
Q12	1	0,291		Q33	1	0,502
Q14	1	0,665		Q34	1	0,731
Q15	1	0,66		Q35	1	0,706
Q16	1	0,595				

Another way to look at these communalities is in terms of the proportion of variance explained by the underlying factors. For example, 60,9 per cent of the variance is explained by Q1.

STEP4: Determining the appropriate number of factors.

The first thing to do in the factor analysis is the determination of the appropriate number of factors. Initially, if no relationship exists between the variables then each variable would make its own unique factor. Thus, if we have k variables, then we can at most extract k factors. However, the goal is to group the variables among them according to their inter-relationships. There are a number of methods to determine the “optimal” number of factors by examining the data. A variety of methods have been developed to extract factors from an intercorrelation matrix in SPSS. In our case, factors are extracted by the most commonly used method: Principle Component Method. In PCA, inter-item correlation coefficient matrix is what is analyzed to explore the inter-relationships between the items to determine if the items can be grouped together to represent a smaller set of underlying factors.

SPSS output lists the eigenvalues associated with each factor. Before extraction, SPSS has identified 23 components within the data set. The eigenvalues associated with each factor represent the variance explained by that particular linear component and SPSS also displays the eigenvalues in terms of the percentage of variance explained. For example, the first factor explains 3,199 per cent of total variance. In the initial solution, each variable is standardized to have a mean of “zero” and a standard deviation of \pm one. Thus, the total variance to be explained is 23. Since a single variable can account for one unit of variance, a useful factor must account for more than one unit of variance, or have an eigenvalue $\lambda > 1$. Otherwise the factor extracted explains no more variance than a single variable.

SPSS then extracts all factors with eigenvalues greater than one, which leaves us with six factors. This initial solution suggests that the final solution should extract not more than six factors. The cumulative per cent of variance explained by the first six factors is 58,746 per cent. In other words, 58,746 per cent of the common variance shared by the 23 variables can be accounted for by the six factors.

Table C.4 Initial solution via principal component method

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,199	13,908	13,908	3,199	13,908	13,908
2	2,734	11,889	25,796	2,734	11,889	25,796
3	2,474	10,755	36,551	2,474	10,755	36,551
4	2,056	8,940	45,490	2,056	8,940	45,490
5	1,610	6,999	52,490	1,610	6,999	52,490
6	1,439	6,257	58,746	1,439	6,257	58,746
7	0,909	3,952	62,698			
8	0,853	3,707	66,406			
9	0,797	3,463	69,869			
10	0,763	3,317	73,186			
11	0,730	3,172	76,358			
12	0,687	2,986	79,345			
13	0,629	2,733	82,078			
14	0,589	2,561	84,639			
15	0,571	2,483	87,122			
16	0,555	2,414	89,536			
17	0,510	2,218	91,754			
18	0,458	1,992	93,746			
19	0,429	1,866	95,612			
20	0,388	1,686	97,297			
21	0,369	1,605	98,902			
22	0,167	0,727	99,629			
23	0,085	0,371	100,000			

In addition, another way to determine the number of factors to extract is scree plot. The scree plot is a two dimensional graph with factors on the x-axis and eigenvalues on the y-axis. This is a plot of the eigenvalues associated with each of the factors extracted, against each factor. The “Scree test” states that we should plot the eigenvalues of the

correlation matrix in descending order, and then determine the number of factors equal to the number of eigenvalues that occur prior to the last major drop in eigenvalues magnitude.

From the scree plot in Figure C.1, we can see that the first six factors account for most of the variance, and then the remaining factors all have small eigenvalues.

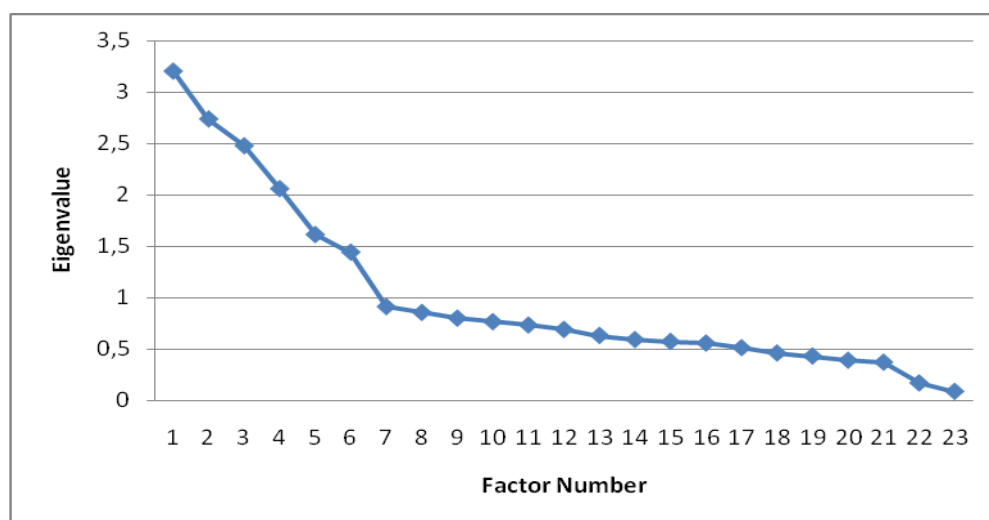


Figure C.1 Scree plot

The application of the eigen one rule had us with six extracted factors. Furthermore, the scree plot could be interpreted as supporting six meaningful factors. Thus, we conclude with both SPSS application and the scree test that 23 items related to service quality in call center, are grouped into six factors.

STEP 5: Calculating a factor matrix.

After the appropriate number of factors has been determined, a factor matrix is calculated. The factor matrix is displayed in Table C.5.

Table C.5 Factor loadings of each variable

	Component					
	1	2	3	4	5	6
Q1	-0,074	-0,131	0,582	-0,252	0,428	0,037
Q2	0,321	-0,143	0,546	-0,393	0,121	0,194
Q3	0,269	-0,090	0,585	-0,189	0,233	0,012
Q4	0,050	-0,109	0,611	-0,286	0,348	0,147
Q6	0,047	0,523	-0,078	-0,252	0,086	0,145
Q7	-0,067	0,847	-0,079	-0,215	0,046	0,018
Q8	-0,019	0,646	-0,016	-0,283	-0,083	0,242
Q11	-0,016	0,826	-0,013	-0,185	0,029	0,003
Q12	-0,189	0,446	0,040	-0,148	0,179	-0,020
Q14	0,415	0,029	0,263	-0,164	-0,433	-0,457
Q15	0,511	0,191	0,299	-0,090	-0,404	-0,320
Q16	0,407	0,063	0,247	-0,248	-0,356	-0,420
Q21	-0,256	0,104	0,472	0,402	-0,175	0,139
Q22	-0,266	0,344	0,500	0,641	-0,148	0,002
Q23	-0,334	0,297	0,554	0,584	-0,156	0,071
Q27	0,622	0,080	-0,130	0,259	0,116	0,065
Q28	0,561	0,205	-0,101	0,329	0,225	0,061
Q29	0,450	0,110	-0,093	0,327	0,415	-0,145
Q31	0,453	0,208	-0,234	0,083	0,178	-0,089
Q32	0,548	0,029	-0,044	0,285	0,117	0,115
Q33	0,545	0,079	0,119	0,303	0,275	-0,133
Q34	0,452	-0,125	-0,020	-0,039	-0,382	0,602
Q35	0,464	-0,044	0,033	-0,037	-0,361	0,597

This matrix identifies the relationship between the variables and the factors i.e. it indicates the correlation of each variable with each factor. The relationships are referred to as factor loadings. For example, the first question correlates 0,582 and 0,428 with the third and fifth factor respectively. The total proportion of the variance in Q1 explained by the six factors is simply the sum of its squared factor loadings. This is called the communality of the variable Q1 and it is already displayed in Table C.3.

$$[(-0.074)^2 + (0.131)^2 + (0.582)^2 + (-0.252)^2 + (0.428)^2 + (0.037)^2] = 0.609 \quad (\text{C.7})$$

$$[(0.321)^2 + (-0.143)^2 + (0.546)^2 + (-0.393)^2 + (0.121)^2 + (0.194)^2] = 0.628 \quad (\text{C.8})$$

It is easier to identify the group that each variable belongs to if we suppress values that are low ($< 0,40$). The matrix obtained after being suppressed is displayed in Table C.6.

Table C.6 Suppressed factor matrix

	Component					
	1	2	3	4	5	6
Q1			0,582		0,428	
Q2			0,546			
Q3			0,585			
Q4			0,611			
Q6		0,523				
Q7		0,847				
Q8		0,646				
Q11		0,826				
Q12		0,446				
Q14	0,415				-0,433	-0,457
Q15	0,511				-0,404	
Q16	0,407					-0,42
Q21			0,472	0,402		
Q22			0,5	0,641		
Q23			0,554	0,584		
Q27	0,622					
Q28	0,561					
Q29	0,450				0,415	
Q31	0,453					
Q32	0,548					
Q33	0,545					
Q34	0,452					0,602
Q35	0,464					0,597

Then, it is necessary to determine which variables load highest on one factor and low on the other five factors. Sometimes one or more variables may load about the same on

more than one factor, making the interpretation of the factors ambiguous. Ideally, the analyst would like to find that each variable loads high on one factor and approximately zero on all the others. Therefore, sometimes the factor pattern can be clarified by "rotating" the factors in F-dimensional space.

While analyzing the suppressed factor matrix in Table C.6, we notice that it is not easy to interpret the factors because some variables load highly onto more than one factor. For example, Q14's loading onto factor1, 2 and 6 is approximately 0,40 at the same time. Therefore, the factor matrix should be rotated in order to clarify the factor pattern.

STEP 6: Rotating the factor matrix.

The factor matrix is rotated with one of the most common procedure called "varimax". It is a kind of orthogonal rotation. It states that the factors may only be rotated in such a manner that the factors are kept at right angles to each other. The factors are rotated or shifted to improve the relationships between the variables and each factor, keeping the right angle restriction.

The factor matrix rotated with "varimax" method is shown in Table C.7. The values which are lower than 0,40, are suppressed in order to analyze easier the factor pattern. Then, we notice that the rotated factor pattern is clearer than the previously unrotated pattern. The rotation increased the strength of the relationship between the variables and the factors related.

Analysis of our rotated factor matrix from the factor analysis reveals a total of six factors. These factors were already named: systematization of service delivery; agents' skills and behaviors; quality of information; attributes of service delivery; tangibility of service delivery; responsibilities of agents.

While preparing our survey questions, we already grouped the variables into six factors at the beginning. Then, the factor analysis done above verifies also the grouping we did based on the literature research.

Table C.7 Supressed rotation matrix

	Component					
	1	2	3	4	5	6
Q1				0,748		
Q2				0,718		
Q3				0,676		
Q4				0,778		
Q6		0,597				
Q7		0,868				
Q8		0,723				
Q11		0,828				
Q12		0,482				
Q14					0,811	
Q15					0,770	
Q16					0,759	
Q21			0,695			
Q22			0,923			
Q23			0,930			
Q27	0,658					
Q28	0,713					
Q29	0,702					
Q31	0,520					
Q32	0,593					
Q33	0,670					
Q34						0,842
Q35						0,825

APPENDIX D: STATISTICAL GAP ANALYSIS

H₀: There is no significant difference between service quality score for each service quality dimension according to the gender.

H₁: There is significant difference between service quality score for each service quality dimension according to the gender.

Table D.1 Results of paired sample t-test

	SQ for D1		SQ for D2		SQ for D3		SQ for D4		SQ for D5		SQ for D6	
	F	M	F	M	F	M	F	M	F	M	F	M
Mean	-1,59	-1,56	-0,68	-0,71	0,42	0,46	-2,61	-2,47	1,93	1,94	1,01	1,05
Variance	3,18	2,94	3,94	4,29	1,03	1,07	2,03	2,04	1,58	1,48	1,78	1,77
Sample Size	123	142	123	142	123	142	123	142	123	142	123	142
T value	-0,141		0,142		-0,318		-0,796		-0,079		-0,272	
t_{263,0,025}	1,960											
Result	Accept H ₀		Accept H ₀		Accept H ₀		Accept H ₀		Accept H ₀		Accept H ₀	

(i) **According to the age**

ANOVA test is conducted to examine whether there are significant differences between the participants in terms of their age in service quality satisfaction scores regarding each dimension. The hypothesis tested is:

H₀: There is no significant difference between service quality score for each service quality dimension according to the age.

H₁: There is significant difference between service quality score for each service quality dimension according to the age.

Table D.2 Results of ANOVA test for systemization of service delivery-1

SQ for D1				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	655,40	1		
Between	3,74	8	0,47	1,53
Within	78,05	256	0,30	
Total	737,19	265		
F _{8,256, 0,05}	1,94			
Result	Accept H ₀			

Table D.3 Results of ANOVA test for agents' skills and behaviors-1

SQ for D2				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	75,14	1		
Between	5,76	8	0,72	1,41
Within	130,85	256	0,51	
Total	211,75	265		
F _{8,256, 0,05}	1,94			
Result	Accept H ₀			

Table D.4 Results of ANOVA test for quality of information-1

SQ for D3				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	31,94	1		
Between	24,48	8	3,06	7,88
Within	99,48	256	0,39	
Total	155,90	265		
F _{8,256, 0,05}	1,94			
Result	Reject H ₀			

Table D.5 Results of ANOVA test for attributes of service delivery-1

SQ for D4				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	180,32	1		
Between	3,62	8	0,45	1,26
Within	91,88	256	0,36	
Total	275,81	265		
F _{8,256, 0,05}	1,94			
Result	Accept H ₀			

Table D.6 Results of ANOVA test for tangibility of service delivery-1

SQ for D5				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	900,61	1		
Between	24,47	8	3,06	12,80
Within	61,14	256	0,24	
Total	986,22	265		
F _{8,256, 0,05}	1,94			
Result	Reject H ₀			

Table D.7 Results of ANOVA test for responsibilities of agents-1

SQ for D6				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	264,91	1		
Between	44,80	8	5,60	5,99
Within	239,20	256	0,93	
Total	548,91	265		
F _{8,256, 0,05}	1,94			
Result	Reject H ₀			

(ii) According to the education level

ANOVA test is conducted to examine whether there are significant differences between the participants in terms of their education level in service quality satisfaction scores regarding each dimension. The hypothesis tested is:

H_0 : There is no significant difference between service quality score for each service quality dimension according to the education level.

H_1 : There is significant difference between service quality score for each service quality dimension according to the education level.

Table D.8 Results of ANOVA test for systemization of service delivery-2

SQ for D1				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	610,25	1		
Between	1,99	4	0,50	3,85
Within	33,69	260	0,13	
Total	645,94	265		
F _{4,260, 0,05}	2,37			
Result	Reject H_0			

Table D.9 Results of ANOVA test for agents' skills and behaviors-2

SQ for D2				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	221,39	1		
Between	15,28	4	3,82	9,68
Within	102,52	260	0,39	
Total	339,19	265		
F _{4,260, 0,05}	2,37			
Result	Reject H_0			

Table D.10 Results of ANOVA test for quality of information-2

SQ for D3				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	46,13	1		
Between	2,24	4	0,56	3,69
Within	39,48	260	0,15	
Total	87,85	265		
F _{4,260, 0,05}	2,37			
Result	Reject H ₀			

Table D.11 Results of ANOVA test for attributes of service delivery-2

SQ for D4				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	2246,48	1		
Between	42,71	4	10,68	34,00
Within	81,66	260	0,31	
Total	2370,86	265		
F _{4,260, 0,05}	2,37			
Result	Reject H ₀			

Table D.12 Results of ANOVA test for tangibility of service delivery-2

SQ for D5				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	950,12	1		
Between	7,81	4	1,95	15,96
Within	31,82	260	0,12	
Total	989,74	265		
F _{4,260, 0,05}	2,37			
Result	Reject H ₀			

Table D.13 Results of ANOVA test for responsibilities of agents-2

SQ for D6				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	463,67	1		
Between	33,10	4	8,27	19,63
Within	109,59	260	0,42	
Total	606,36	265		
F _{4,260, 0,05}	2,37			
Result	Reject H ₀			

(iii) According to the professions type

ANOVA test is conducted to examine whether there are significant differences between the participants in terms of their professions type in service quality satisfaction scores regarding each dimension.

The hypothesis tested is:

H₀: There is no significant difference between service quality score for each service quality dimension according to the professions type.

H₁: There is significant difference between service quality score for each service quality dimension according to the professions type.

Table D.14 Results of ANOVA test for systemization of service delivery-3

SQ for D1				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	657,15	1		
Between	1,64	4	0,41	0,90
Within	118,80	260	0,46	
Total	777,59	265		
F _{4,260, 0,05}	2,37			
Result	Accept H ₀			

Table D.15 Results of ANOVA test for agents' skills and behaviors-3

SQ for D2				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	121,83	1		
Between	2,82	4	0,71	1,78
Within	103,18	260	0,40	
Total	227,84	265		
F _{4,260, 0,05}	2,37			
Result	Accept H ₀			

Table D.16 Results of ANOVA test for quality of information-3

SQ for D3				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	42,71	1		
Between	3,45	4	0,86	2,72
Within	82,31	260	0,32	
Total	128,47	265		
F _{4,260, 0,05}	2,37			
Result	Reject H ₀			

Table D.17 Results of ANOVA test for attributes of service delivery-3

SQ for D4				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	1759,86	1		
Between	2,11	4	0,53	0,38
Within	356,99	260	1,37	
Total	2118,96	265		
F _{4,260, 0,05}	2,37			
Result	Accept H ₀			

Table D.18 Results of ANOVA test for tangibility of service delivery-3

SQ for D5				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	935,79	1		
Between	4,20	4	1,05	1,61
Within	170,04	260	0,65	
Total	1110,02	265		
F _{4,260, 0,05}	2,37			
Result	Accept H ₀			

Table D.19 Results of ANOVA test for responsibilities of agents-3

SQ for D6				
Source	SSq.	Dof	Mean Sq.	F-ratio
Mean	229,96	1		
Between	7,89	4	1,97	2,59
Within	197,93	260	0,76	
Total	435,79	265		
F _{4,260, 0,05}	2,37			
Result	Reject H ₀			

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