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Using SIMCTS framework to model determinants of customer satisfaction: a case in an ISP

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Using SIMCTS Framework to Model Determinants of Customer Satisfaction: A Case in an ISP

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Abstract : In this paper we describe a call center simulation case study that uses real data obtained from an Internet Service Provider (ISP). The case study is conducted using SIMCTS (Simulation Modelling and Analysis of Customer Satisfaction Patterns for Telecommunication Service Providers) framework [25]. The applicability of this framework to model ISP business scenario is discussed in detail. The simulation case study reveal that the dimensions of service quality have huge impact on customer satisfaction and also provide valuable insight in to gap analysis of customer perception and expectation. Various key satisfaction variables in relation to call center are modelled using SIMAN simulation language and ARENA simulation software. The simulation case study investigates service quality dimension, technical (or) functional service quality and their role in evaluation of overall satisfaction judgment. The simulation model collects transient performance measures which can be used to make competitive marketing decisions.

1. INTRODUCTION

Service quality measurement and customer satisfaction are increasingly becoming important for service firms to stay in the business. Service quality measurement process differs across different industrial domains as the service managers account for unique nature of services, different service attributes acting as determinants of customer satisfaction, complex interrelationship and dependability that exists between them. Several service quality models such as SERVQUAL [19], SERVPERF [20] are used by different service industries to measure service quality. To achieve excellent service quality it is important to understand the interrelationship between various service quality attributes and their dimensions. Telecommunication service providers (TSP'S) should exercise more effort to understand their customer well through relationships concepts such as length, nature and quality of customer's prior experience with service organizations especially in the context of a highly competitive market . Understanding how service can be used to differentiate and enhance business-to-business relationships is very crucial for telecommunications service industry. Service quality involves customer perspective that is based upon both customer perceptions and expectations. Service quality factors that influences customer can be determined using statistical survey techniques. Both qualitative and quantitative approaches can be used to measure service quality factors. For service quality monitoring process assessment customer expectations followed by subjective as well as objective analysis of customer perception is necessary. The paper is organised as follows. Section 2 discusses customer satisfaction in relation to call center. Section 3 highlights the importance of service guarantee process. Section 4 discusses the service quality issues in ISP industry in Australia. Section 5 describes the call center definition within the context of this study. Section 6 describes SIMCTS simulation modelling, experimentation, analysis and validation steps. Section 7 concludes the paper.

2. CUSTOMER SATISFACTION IN RELATION TO CALL CENTER ENVIRONMENT

The goal of ISPs providing service is to meet customer needs and satisfy them to build long term partnership with their customers. For instance, service quality is associated with customer service, complaints handling, customer loyalty and retention [22]-[24]. Broadband service providers are cutting down subscription prices in an effort to attract new customers. In a recent report published by Zanthus [1], which is a leading telecommunications consultant it was stated that to build a stable and profitable subscriber base price cut alone is not enough. Providers need to collect larger payments every month. This is accomplished by having value added service for customers and introducing bundling packages that includes broadband service with other services such as mobile phones, television . The customer services should not only troubleshoot broadband issues, but other services as well. The customer service representative will have to answer queries from multiple customers who encounter multiple services. They need appropriate tools to respond to customers on several service fronts. Thus there is always a need for increased knowledge of multiple technology (broadband, wireless, cable tv etc). This puts pressure on call centers. The industry faces several challenges arising out of high staff turn over, lack of problems analysis and resolution tools and inability to share best service practices across various levels of customer service representative (CSR) ability [1].

3. CUSTOMER SERVICE GUARANTEE AND SERVICE AWARENESS:

With the rise in the usage of telecommunication services it is important to raise awareness and knowledge of various telecommunication issues. The ACA (Australian Communication Authority) survey taken in 2002 [11] about the consumer awareness of communications issues and information highlighted that there was a substantial increase in the number of internet connections particularly among small businesses. The high speed internet connections are increasing and constitute a growing component of internet market.[11]. The telecommunications industry has changed a lot over last few years with new providers entering the market and some providers merging and other ceasing operations. Thus small Internet Service Providers should be prepared to support new technology based network services that influence the transformation of telecommunications industry.

Some of the important information that needs to be collected from consumer awareness survey are identifying the gaps between information provided and the demographic areas these gaps apply, developing customer information strategies that make sure they are very well informed about service guarantee and also monitor them to see if they have raised consumer awareness and collect information related to attitudes towards competitive environment. Internet service providers in Australia need to comply with the Customer service guarantee standard that was developed by ACA [11] to encourage various improvements in service delivery and also guard consumers against poor service quality. It involves managing operations, quality, marketing and human resources. The service providers who fail to deliver the performance requirements as stated in customer service guarantee are required to compensate their customers. It is important for small and medium size internet service providers to identify what determinants of service quality when managed properly leads to indications of greater satisfaction among ISP customers[11].

Currently the high speed internet connections are growing at a steady rate and are the preferred option for customers who who intend to have internet connection in next 12 months according to [11]. The study in [11] found that the consumer awareness about various telecommunication issues were positively correlated with gross annual income, employment and level of education. Small ISP's who serve their customers on a regional basis should be aware about the speed and reliability that customers expect from them. It is also important for them to understand the changes in customer requirements over time and when ISP expand their services they have to make sure customers are able to pay extra for speed and reliability. Service guarantee can convey to customers benefit they get from using a service and convey to employees the results they are expected to produce for customers. It also helps providers to recognize and re-design service process for service failures. For marketing service quality and achieving it, service guarantee is a powerful tool. Service guarantee also affects the performance of providers in several ways. Using defensive and offensive marketing affects both customer complaints, customer retention and relationship with customer in shaping their expectations. There are significant costs and risks associated with service guarantee policy [8].Thus serveability has become very important aspect to study. This decides service guarantee and helps to understand its relationship to quality, marketing strength and business success [8].

4. SERVICE QUALITY ISSUES FACING ISP'S IN AUSTRALIA:

There are a large number of risks associated with running an ISP in Australia. Government took the initiative to try and build a framework that will force all ISPs to do filtering of all content downloaded . This will force the ISPs to move offshore to avoid huge investments in developing these real time filtering technologies. Various other risks include competition and pricing pressures, management of growth, customer turnover, technological change, governmental regulation, and unauthorised use of proprietary technology, system failures and a variety of stock market-related risks.[12]-[14]. The main service quality issues that are of concern in outsourcing is the scalability and flexibility of services, performance and reliability of applications, comprehensive service level agreements and high speed network connectivity [12].

Many ISP's operate in a very highly competitive market with slim profit. There is difficulty to sustain in countries where telecommunications liberalisation occurred after explosion in internet use. Service

managers need to make sure that all selected customer satisfaction variables that help customers to make decisions are relevant, comprehensible, quantifiable, measurable, comparable, revealing and available. In the internet service provisioning process there are many relatively new services offered. Many consumers are still learning to judge the service they receive. This is complex and depends on many different factors[12].
ISP technical support is very important for newcomers to internet and those who have limited technical skills. There is no easy technique to objectively measure the quality of technical support on offer as this widely depends on individual ISP and quality of staff manning the help line. Customer technical support offers telephone support, email support, chat services and website support. Zanther report [1] also highlights the results of survey of 550 broadband customers. Majority of the customers preferred to use the telephone support services. It emphasizes that customer support can be a competitive advantage in keeping customers. When customers were asked about their minds in selecting provider, they indicated that price, availability in their area, service reliability and quality of technical support drives their decision. Good customer service builds a relationship and strengthens customer loyalty and discourages them from switching providers for price. In the current situation customer service department will be asked to serve more customers on broader scope of issues and problems and as cost effective as possible [1].ISP subscribers want a variety of technical support options. ISP's need to provide excellent functional service in situations where technical support is required. These include key service quality dimensions such as tangibles, reliability, responsiveness, assurance, empathy. These quality dimensions performance determines the quality gap. Particularly issues like internet access problems, connectivity problems, email problems, password problems, search engine problem, technical related problems emphasizes that responsiveness nature of service providers to customers is very important [1]. This will minimize customer exodus and reduce the churn rate [ISP's should identify things that they have (i) no direct control and (ii) have direct control. Churn rate should be tracked].

5. DEFINITION OF CALL CENTERS WITHIN THE CONTEXT OF THIS STUDY

Customer call centers (CCCs) have emerged over the last decade as a competitive tactic based on the development and improvement of customer relationships . The strategic objective behind the concept of customer call centers is to gain the competitive advantage through improved customer standards and delivery. This emphasis has customer call centers becoming one of the most dynamic and expanding industries of the. 21st century. The implications on society, now and in the future, are therefore substantial and warrant investigation [13][16].

Customer call centers can be conceptualized as interactive service work mediated by telephones and computers. Here rows of office assembly lines are depicted by operators receiving inbound calls concerned with transactions, customer service, complaints and inquiries [14][15] [18][19]20]

Call centers can be broadly classified as outbound call centers and inbound call centers where (a) Outbound call centers are associated with telemarketing and sales targets; and (b) Inbound call centers are concerned with transactions and customer service, complaints and inquiries. Inbound operators (Customer Service Representatives (CSRs)) can be conceptualised as interactive service workers [`17][16][15].

This study investigates inbound call centers and takes the stance that their defining feature "is the interaction of a termed Customer Service Representatives with a customer to deliver a service,"[16] via telephones and computers. The nature of the interaction from the CSRs' perspective is to answer incoming customer service queries in relation to such activities as billing, collections, transfers, new orders, product information etc., while simultaneously inputting information directly into the computer in relation to the issue/s raised by the customer . The role of a CCCs within an organizational context is to improve the performance of the organization [17].Therefore the function of CCCs can be depicted as a "tool used by companies to enable their employees to make the most of every contact with customers, to achieve customer loyalty" [19]. Placed in a broader organizational context "call centers cater for customer demands with organizations improving their day to day operations and service performance" [20]. Recent call center based on skills routing, electronic channel and interactive call handling require more sophisticated techniques. In [5] author states that in call center customer experience determines the real personality of their business.

5.1 Key Dimension Operational Definition With The Context Of This Study

Courtesy is tested to determine differences in personal service, friendliness, tone of voice, greetings and conduct of CSRs towards customers. *Convenience* is tested to determine differences in flexibility of services such as extending payment options, transaction choices, transfer of calls to different departments. *Accuracy* is tested to determine differences in CSRs' ability to provide correct information to customers, accurately record information such as name, address and inquiry type. *Responsiveness* is tested to determine differences in CSRs' ability and velocity to reply to the inquiry. *Problem solving* is tested to determine differences in CSRs ability to solve inquiries, provide solutions to problems, apply solutions to customer's satisfaction. *Empathy* is tested to determine differences in CSRs' effectiveness to truly understand a customer's feelings and needs and ability to reflect an understanding back to the customer. *Timeliness* is tested to determine differences in call centers velocity to answer calls, amount of time. Call center performance analysis includes staffing, trunking capacity [4].

6. ISP CALL CENTER SERVICE SYSTEM CASE STUDY: SIMULATION STRATEGIES AND METHODOLOGIES IN CUSTOMER SATISFACTION

Simulation " is the process of designing a model of real system and conducting experiment with this model for the purpose either of understanding the behavior of the system (or) evaluating various strategies (within the limits imposed by a criteria) for the operation of the system" [27].

6.1 Simulation Case Study Importance: Call Models For Serveability Performance:

The simulation case study will reveal the dimensions of service quality that have huge impact on customer satisfaction and also will provide valuable insight in to gap analysis of customer perception and expectation. By understanding the simulation results ISP's can develop effective marketing strategies that will maximize service performance in line with their customer needs. This in turn will improve the customer loyalty and retention for ISP's. The results helps managers to check what services are delivered and how it is delivered in relation to SLA. Using the service quality data obtained from simulation models managers can do different "what-if" scenarios to compare the relative importance of various service quality dimensions (Tangibles, Reliability, Responsiveness, Assurance and Empathy) in predicting overall service quality perception and quality expectation. Majority of simulation studies in quality arena are related to quality control process rather than quality management studies. Thus very limited literature on use of simulation and design indicates a potential left unrealized in design and implementation of service quality management system [4][5]. Case study employs SIMCTS framework shown in Figure 1a for modeling process.

6.2 Case Study Explanation:

A ISP customer receives a busy signal if the entire capacity is utilized (all 32 trunks are used). The service system for this ISP involves recording 3 types of service options. They include technical support service, ISP information service and telecommunication product order . Based on the data collected on a particular day of week (collected on Thursday Oct 21st 2004) they were classified as 52%, 23% and 25% respectively. The estimated time here is UNIF(0.4,0.8) min [10].

6.3 Technical Support Service and ISP Information Service:

After consultation with the service manager it was understood that any caller who chooses technical support goes through 3 main call types. Based on expert judgement the statistical distribution was UNIF(0.4,0.6) mins for that particular day. The types included are classified as 41%, 29% and 30% respectively. Technical support person currently available for selected support service answers the call. If there is none currently available customer is placed in the queue until the person becomes available. The distribution here follows TRIA(4,9,12) mins. On that particular day nearly 26% of the ISP calls required further investigation after completion of the call. The questions that need to be answered are routed to higher level which prepares a response. Based on the expert judgement the responsiveness service nature of customer technical support is EXPO(80) mins. Support person needs to return the call to the customer that has estimated time of TRIA(3,5,8) mins. Any customer service call request that couln't be processed same day is given first priority the next day. The return call gives priority over incoming calls in the above case. 11 operators are in technical support calls services.

Customer departs the system once his service request is fulfilled. Because of privacy reasons it was not possible for us to exactly get the percentage of complaint calls made as part of technical support services. However it was generalized that complaints did fall under one of the types of service. The calls that deal with ISP info follow a TRIA(4,15,18) mins. The operators provide information to new customers. The call is terminated after the customers are served [10][21][3].

6.4 Service Strategy Employed:

Popularity of internet, new technology and increase in customer expectations has made the management and design of call centers very complicated [effective call routing and staffing strategies]. In the call center system, all customers who arrive after hours can leave a message in the ISP interactive voice response unit. Operators can then return their call next day. All call operators have different call handling skills. Customers level of service request determines whether operator can handle his call and provide service (or) route to higher level. "Time" is the most critical resource in call center system. In current telecommunications market nature of business keeps changing rapidly. Thus there is a change in call patterns, serving times. This complicates things as ISP's are under pressure to redefine the customer serving processes [5]. Apart from 11 technical support operators 6 operators are dedicated for ISP information services[10] [4].

6.5 Telecommunications Products Order Status Service:

Customers who request to find out the status of their telecommunication product orders over phone follow a estimated transaction time of TRIA(10,15,20) mins. Nearly 15 % of users required further information on product and are routed to ISP information line and have to wait for a representative to answer their call. The waiting time here is estimated as TRIA(12,14,19) mins. The ISP doesn't have 24 hour technical support service , however customers are encouraged to visit their website to solve very commonly occurring problems (After 7 p.m). Few skeletal staff operate between 6-7 p.m. Nowadays self service has become very important as part of real time internet services platform [10].

6.6 ISP Company objective: [5]

(I)Achieve high service level, (II) Understand customer needs, (III)Offer products, (IV) Provide service solutions and support, (V)Manage customer service time, call volumes and waiting time effectively, (VI)Allocating operators in short period of time, (VII)Provide appropriate information to caller in a most efficient manner (call handling time). **Call center**: Serve, interact and transact with ISP customers. **Self-service**: Solve problems before user calls (Technical malfunctions.)**Assisted service**: Solve problems when a user requires assistance (Functional service) [5]

Customer satisfaction Determinants in the case study: [10] [3][4]

Number of busy signals, customer waiting time for service provisioning. Investigating the service strategies to minimize the number of customers receiving busy signals and reduce waiting time until call reaches appropriate person

Key factors affecting customer satisfaction [10][3][4]

Performance indicators describe the system performance. These indicators need to be managed properly to avoid inefficiency in service process. Number of available lines, Staffing schedule, idle time of the help desk person, type of support that has a huge waiting time and call abandonments

6.7 Simulation Model: [18][19]

The call center model uses the following assessment process

-Select the types of calls whose quality need to be assessed

-Select the number of calls to be subject to different types of quality related measurements (representative samples)

Thus by measuring customer perceptions for various aspects of service quality elements helps service providers to fulfill customer expectations. If the perceptions measurement is carried out properly with appropriate tools, resources then service providers can strengthen their market position. A number of different aspects of service quality needs to be integrated to achieve improvements of the standard of quality offered [2].

6.8 Assumptions:

The customer return call takes priority over incoming calls.

6.9 Model Service Data Definition: [10]

Call volume: Arrival rate of incoming calls, calls per period of time, time between calls, call spread across day, call arrival based on input distribution specified.

Service time delay: Identifies the delays in processing calls, call handling time (or) routing delays

Routing process: route calls to appropriate support section

Schedule: To model resources it is important to identify how many resources are available throughout a time period.

Call routing strategies used: skills based routing.

In [4] author indicates that it is important to understand how changes to be made affect call center, which technology is best for serving customers?. So this ultimately leads to answering the question "what tool is available for decision makers to experiment with technology without having any real impact on their business?—SIMCTS simulation [4]. Various contributing factors became evident as the model service quality data was collected and further research was required to better understand their impact on the call centers quality objectives. These include deeper consideration of the implications of call centre type on customer expectations and the appropriate management style for this type of call centre. Development of behavioral management skills by coaches and associated support infrastructure within the Call Centre to enable them to put these skills into use needs to be investigated.

6.10 ISP Call Center Scheduling Process:

After discussions with service manager it was understood that call scheduling was a important and difficult task. The benefit of simulation in relation to call center scheduling has been widely covered in literature.[8] used heuristic approach to simulate scheduling operation. The heuristics approach covered three main scheduling methods that are hourly scheduling (dynamic optimisation), daily scheduling (batch optimized) and call sequence (heuristics). In our model some of the outcomes such as wrong party contact, where customer is not available to take return calls were not covered. However the right part contact for customer whose queries were processed next day and call returned by same representative was modelled. The data in the specific schedule in *Figure 1* generates calls based on scheduled nature. The sensitivity analysis results discussed later in the paper indicated that improvement in the number of customer, serviced and resource utilization were based on service delay time. However the operational benefits need not be uniform throughout the day, but will help to decide the situations where the resources are busy most of the time."REPORTS" feature in ARENA was used to record balked entities on a 30 minute basis [7][8][10].

Effective agent schedules help to increase the call center productivity. Simulation model helps to analyse the current schedule and identify bottlenecks and assess the performance of system against ISP management goals [7][8][10][21].

The current ISP schedule is has planning of call centers based on multiple skills of customers. This is very important as customers telephone calls are routed based on different service types. The model thus covers cross-trained agents that will help ISP's to save time and cost (a single agent can handle different support types) [9].

Arrival Rate	Time slot	Repr 1	Repr 2	Repr 3	Repr 4	Repr 5	Repr 6	Repr 7	Repr 8	Repr 9	Repr 10	Repr 11
225	1 (8 a.m)	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes
231	2 (8:30)	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes
191	3 (9:00)	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
63	4 (9:30)	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
45	5 (10 a.m)	Yes	No	Yes	No	Yes	x	Yes	Yes	Yes	Yes	Yes
170	6 (10:30 a.m)	Yes	Yes	x	Yes	Yes	Yes	Yes	x	Yes	Yes	Yes
100	7 (11 a.m)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
140	8 (11:30 a.m)	x	Yes	x	Yes	x	Yes	x	Yes	Yes	Yes	Yes
200	9 (12:00)	Yes	Yes	Yes	Yes	x	Yes	Yes	Yes	x	Yes	Yes
25	10 (12:30)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
210	11 (1:00)	Yes	x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	x	Yes
132	12 (1:30)	Yes	Yes	Yes	x	Yes	Yes	Yes	Yes	Yes	Yes	x
140	13 (2:00)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
123	14 (2:30)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
261	15 (3:00)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
70	16 (3:30)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
68	17 (4:00)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
43	18 (4:30)	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No
61	19 (5:00)	No	Yes	No	Yes	No	No	Yes	No	No	No	No
295	20 (5:30)	No	Yes	No	Yes	No	No	No	No	No	No	No

Figure 1: Technical operators call schedule and call inter-arrival rates

6.11 Conceptual Model:

According to [21], simulation studies achieve 50% beneficial aspects just from the conceptual model alone. Modeller needs to have a very good understanding of the service operations system in order to develop simulation models. By using a consistent framework like SIMCTS modellers can seek for appropriate information on service quality elements and the requirements to build simulation models. Thus credible and valid simulation models can be built by using SIMCTS framework. Using simulation technology to model various elements of SIMCTS service quality conceptual model increases the framework robustness [7] [21].

Using simulation software helps modelers for rapid model development , make prototyping more feasible and have greater level of iteration between conceptual modeling and computer modeling. The simulation model represents a real world system and needs to have a experiment frame that highlights the conditions under which system was observed. The framework is software independent and ARENA simulation software was selected to model the SIMCTS framework elements. The five main qualities of an effective model are validity, usability, value to providers, feasibility and aptness for problem situation[21][3].

It is also very important to avoid the development of an over complex model. The aim is to keep the model s simple as possible to meet the simulation study objectives [21] .

6.12 SIMCTS Steps Involved in the Case Study:

In the project specification it is important to have a means for representing the content of the conceptual model. The logic flow diagram shown in Figure 3 is used to represent the model logic. It is very important to understand the cause and effect relationship. If customer support services are understaffed (cause) then it leads to poor customer service (effect). We found that increasing the resources alone cannot lead to increased levels of customer satisfaction. What is actually required is the change in business process[7][4].

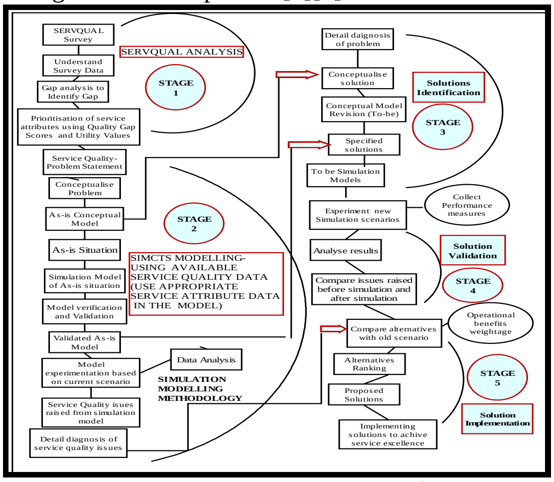

Figure 2: Various steps involved in SIMCTS framework . Note: For more information on SIMCTS framework working process, building blocks please refer to [22] [25].

In relation to aggregating model components black box modeling technique was used to reduce the level of detail. The complete service business model of ISP was developed as a series of interconnected sub-models each represented as black box.

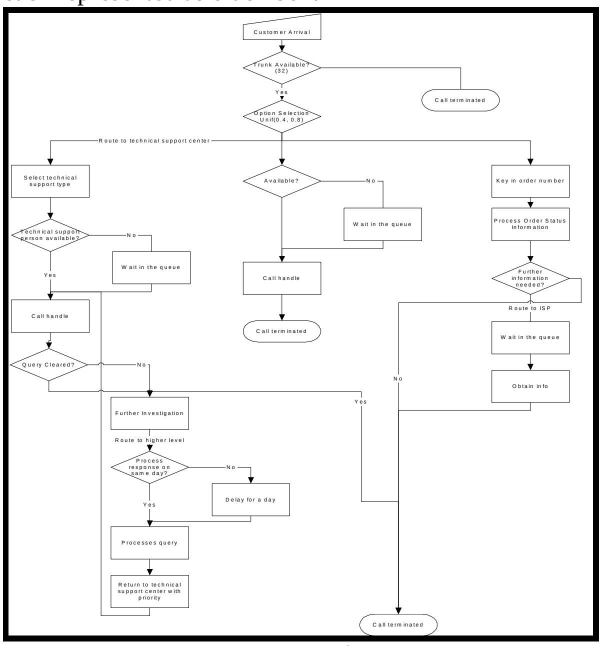

Figure 3: ISP service system flow logic [10]-[14]

The satisfaction variables can be collected by calculating the time entity enters the black box and time entity leaves the box. The time entity spends in the box is sampled from a distribution [7].

6.11 Model Working Process:

Modelling Objective:

- The % of customers who can be serviced everyday with current service design and to investigate the % of the customers who queue for less than 12 minutes for ISP service.
- To achieve a 20% increase in customer service process based on changes to existing service design [scheduling, utilization, number of operators and trunks]

Careful consideration was given to input modelling process. Input modelling uncertainty and its impact on simulation model output results was understood. All service time in the model are independent of one another and of arrival process. The uncertainty is related to the call center arrival rate of the poisson distribution, exponential distribution inter-arrival times. The service distributions and parameters used were obtained through combination of expert judgement and real data collection. It was interesting to note that varying service delay time did have huge impact on number of balked and renege customers (highly sensitive to input parameters). Sensitivity analysis was used to understand impact of input model uncertainty. It was however clear that sampled distributions will not exactly match the true distributions and may produce erroneous results. Using real data that was very well analysed using the ARENA input analyser and expert fit software helped us to choose the best fit for the data and thus ensure that uncertainty is minimized (mean square error played a important role) [6].

<u>Input model uncertainty in call centers [6]</u>

The arrival process plays a very important role. Underestimating this in call centers leads to poor customer satisfaction as appropriate resource levels are not identified. Overestimating arrival rates increase the cost inspite of the fact that it provides good services

6.12 Non-stationary poisson process:

In our call center ISP model there are arrivals between 8 a.m and 6 p.m. This corresponds to 20 half hour periods. The arrival rate in units of calls per minute are (7.5,7.7,6.36,2.1, 1.5, 5.66, 3.33, 4.66, 6.66, 0.83, 7, 4.4, 4.66, 4.1, 8.7, 2.33, 2.26, 1.43, 2.03, 9.83). The rate function is defined within the simulation model to generate arrival pattern. This process involves generating arrivals at peak rate and then use the current rate/peak rate to thin out arrivals. The main reason for using this thinning approach was due to the fact that the mean time between arrivals in our model was large. The rate function $\lambda(S)$ where "S" changes with time (S). Events occur one at a time, independent of each other and events occur during intervals [S1,S2] is poisson and are given by Λ (S1,S2) = $\int_{S1}^{S2} \lambda(S)$. This is large over time intervals where $\lambda(S)$ is high and small where $\lambda(S)$ is low. We us the piecewise constant method and all changes occur over 30 minutes period. Here the λ^* is the estimated rate function and generated events at peak rate function by calling the exponential inter-arrival time. With mean $1/\lambda^*$. To thin out the events we use $\lambda^{\wedge}(S) / \lambda^*$ where $\lambda^{\wedge}(S)$ is estimated rate function at time S[10][21][3][4][2].

6.13 TERMINATING SIMULATION:

After inspecting the input data it is clear that they change over simulation run (customer arrivals change at simulation progresses). This clearly highlights that the model is terminating and produces transient output.

6.14 Model Building:

The modelling approach involved a great deal of time to understand how to enter and store the data in the model. Once this was done the modelling constructs/modules available in ARENA simulation software were identified. A service system has many different service parameters. The call center services require data about size of center, number operators, schedule, inter-arrival times, service times and delay times. In case of modelling telecommunications product order, types of order, process times need to be available. Thus choosing appropriate data to model service system is crucial to success of the simulation project[10][21][3][4].

In the service simulation model occurrence of events changes the system state. The various events include customer arrival, service beginning and service completion. The beginning of service is a endogenous event that occurs within the simulated system. The arrival of customer is a exogenous event that occurs outside simulated system. In our model the system state variables are variables that are used to track the system variables. The system state variable remain constant over intervals of time and change value only at well defined points called event time in discrete simulation models. In the simulation model the customer entity moves through the model and is dynamic. The call center operator is a static entity that serves other entities. Attributes that belong to particular entity are local values (time of arrival) [10]. Some of the key modules selected in ARENA platform for model building include Arrive, Depart, Sets, Assign, Resources, Server, Queue, Expressions, Chance, Choose, Reports, DSTAT, Count, Process, Delay, Seize, Release, Tally, Variable and Leave. For more information on these modules and their functionalities refer [10]. Figure 4 shows a snapshot of simulation model and series of submodels.

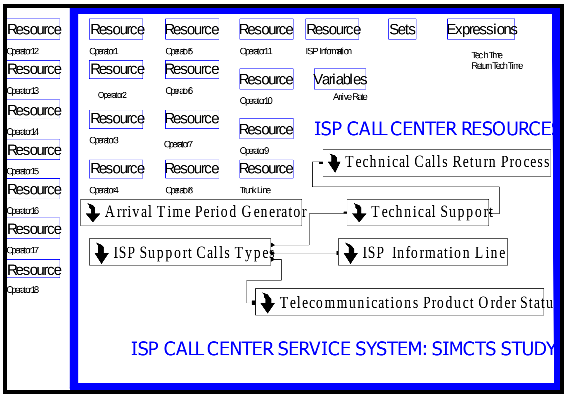

Figure 4: Simulation model of ISP call center scenario [10]

A resource (ISP Operator) is a entity that provides service to dynamic entity. The dynamic entity requests for resource and permitted to capture it for duration and then releases the resource. ARENA has several resource states. They are idle, busy, inactive, failed and starved. Entity list is used internally to represent queues. Delay is an indefinite duration caused by combination of system condition. In [1] author indicates that service manager need to know certain phenomena that occur in real system. Using simulation they can reconstruct the scene and determine answers by performing different "what-if" scenarios. In real system it is hard to accomplish this due to lack of full control. Simulation models can provide excellent training for call service representatives/operators. They can run the simulation model, provide decision inputs and learn to operate better [10][15][16][21][3][4].

The model developed serves only for the set of objectives mentioned.

6.15 Experimentation and Validation:

In our case study the simulation experimentation was not performed to obtain concrete solutions to ISP service systems, but instead help develop a very good understanding of the real world. Implementing the results of simulation study is very important. There are several ways of implementing the simulation results. In this case study we look at alternative staff schedule impact on the determinants of customer satisfaction and identify the best schedule. New ISP's can implement such models and their effectiveness can be continuosly monitored. Thus apart from learning the service processes and their interaction ISP's can also make very confident business decisions. Service managers of ISP thus need to understand the effect of help desk and trouble ticketing features and their direct impact on customer service. This will increase their responsiveness attitude as simulation will help them to understand the effect of one customer satisfaction variable on another. Model was run for multiple replications of day long scenarios [10] [21].

The simulation model has 32 trunk lines and 17 operators. The call center has several links to its branches within Sydney city. This particular center operates with 11 technical support calls operators. The changes in schedule occur very frequently based on the availability of staff. There is also a automatic call routing strategy used to re-direct customers to operators located in other centers. Automatic Call Distributor (ACD) is a telephone answering method to handle very high volume of incoming calls. It distributes them to agents in various ISP call center branches equally using standard telephone lines. This is again based on the availability of the operators in that center. The authors were particularly interested to see the relationship between the number of trunk lines and number of operators. Most small ISP call center do not operate 24 hours and also do not increase the operators unless there is a absolute necessity. After conducting the simulation scenarios we believe that the the relation between the trunk lines and number of operators depend upon the subscriber base, frequency of calls, nature of enquiry, cost of providing service and waiting time threshold. Managing these factor helps ISP to synchronize service operations [10][3][4][16][17].

Proposed Changes:

Schedule A:

There are 35 operators in all inter-connected centres and 30 are busy entire 8 hours(Each operator works for 8 hours)

	ISP Center Utilisation Statistics:				Scenario	
Shifts =2 (each shift 4 hours)	Schedule A		Schedule B		Schedule C	
	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2
Number Busy	30	30	25	18	20	20
Number Scheduled	35	35	30	20	30	25
Utilization per shift	85.7%	85.7%	83.3%	90%	66.66%	80%
Total hours busy	240		172		160	
Total hours scheduled	280		200		220	
Average number busy	30		21.5		20	
Average number scheduled	35		25		27.5	
Scheduled Utilisation	85.75%		86%		72.27%	
Utilisation	85.70%		86.65%		73.33%	

Figure 5: Technical support services proposed schedule changes and related utilizations

Schedule B: There are 30 operators in inter-connected call centers working first 4 hours and 20 operators working next 4 hours. 25 are busy the first 4 hours and 18 last 4 hours.

Schedule C: There are 30 operators in inter-connected call centers for first 4 hours and 25 for last 4 hours. 20 of the operators were busy for all 8 hours. Figure 5 looks at utlisation statistics reported from simulation for above 3 schedules

The following scenarios were explored for technical support center. The scenarios explored reflect the technical support services operations. However there is a still a direct impact of these scenarios in ISP information line where 6 operators are dedicated for this operation, *Figure 5*

Scenario 1: Impact of trunk lines on number of abandoned calls without changing the number of operators. From the graph (*Figure 6*) we observe that the increasing the trunk lines increases the % of balked calls. This is because more customers are able to get to the call center network but only few are serviced by operators and rest balk from the system. The model helps ISP managers to set service levels and the standard % for abandoned calls and thus plan for number of operators and trunk lines required. Several key statistics such as line time, trunk line utilisation were also collected and analysed to derive meaningful conclusions of the model. Rather than assigning a higher priority to return calls over incoming calls, it is better to dedicate a few trunk lines for this purpose. Understanding the relation between number of calls, average time, available time of operator, utilization rate at which ISP call center is running helps to decide the number of operators.

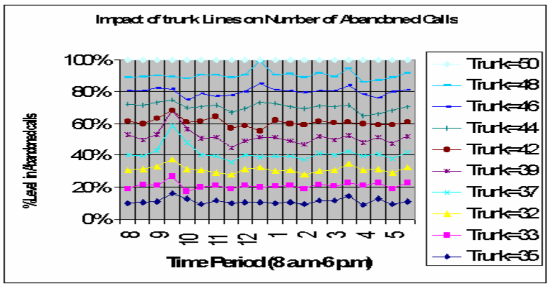

Figure 6: Impact of trunk lines on number of abandoned calls with current operator levels

Scenario 2:All the technical support operators are available continuosly with the schedule 1@480, 0@180 [each operator works for 8 hours (480 mins) and in total there are 660 minutes of call center operations). 1 represents a individual operator, 0 represents the unavailability of operator, 32 trunk lines.

Scenario 3:***Operator 1-Operator 5*** 1@480, 0@180, ***Operator 6***: 0@150, 1@180, 0@30, 1@300, ***Operator 7***: 0@30,1@210, 0@150, 1@270 , ***Operator 8***: 1@180, 1@480, ***Operator9-Operator 11***: 1@480, 0@180 , 32 trunk lines.

Comparing these two scenarios it quite clear from graph *(Figure 7)* that making all the operators available during the specified time period reduces the % of balked calls. Even though the number of balked calls is reasonably high, still it is not as high as Schedule 3. It is important for ISP managers to review these things prior to increasing the number of trunk lines and number of operators. Additional scenarios were conducted by making schedule changes and the % of balked calls were recorded and analysed to come up with feasible schedule.

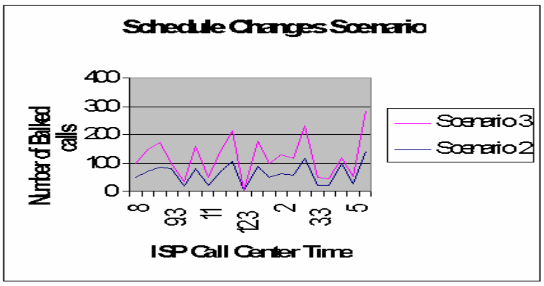

Figure 7: Optimizing the ISP schedules to set service standards

As-is Category scenario:[Technical support types]
(i) Category Type 1 calls: operator1-operator 5 technical support. (ii)**Category Type 2 calls**: operator 6-operator 10 technical support (iii)**Category Type 3 calls**: Operator 8,11,5,2,3,9,1 technical support. Alternative schedules used for scenarios listed below involving additional operators: [*Op1*: 1@300, 0@180, 1@180, *Op2-Op5*: 1@300, 0@180, 1@180, *Op6*: 0@150, 1@180, 0@30, 1@300, *Op7*: 0@30, 1@210, 0@150, 1@270, Op8: 0@180, 1@480 *Op9-Op11*: 1@300, 0@180, 1@180, *Op12*: 0@30, 1@210, 0@150, 1@270, *Op13*: 1@300, 0@180, 1@180, *Op14*: 0@180, 1@480, *Op15*: 1@300, 0@180, 1@180, *Op16*: 1@300, 0@180, 1@180, *Op17*: 0@30, 1@210, 0@150, 1@270, *Op18*: 1@300, 0@180, 1@180,]

Alternative Scenario 4: All 11operators are cross trained to handle various categories of technical support call types (categorty type 1, category type 2. category type 3) trunk lines=32, **Alternative Scenario 5**: Four additional resources were added and all 15 operators cross trained to handle 3 category types of calls trunk lines=32, **Alternative Scenario 6: 15** technical support operators cross trained to handle all category types calls and trunk lines =95., **Alternative Scenario 7: 18** technical support operators cross trained to handle all category types calls and trunk lines =95, **Alternative Scenario 8: 8** technical support operators cross trained to handle all category types calls and trunk lines =32., **Alternative Scenario 9: 8** technical support operators cross trained to handle all category types calls and trunk lines =95.

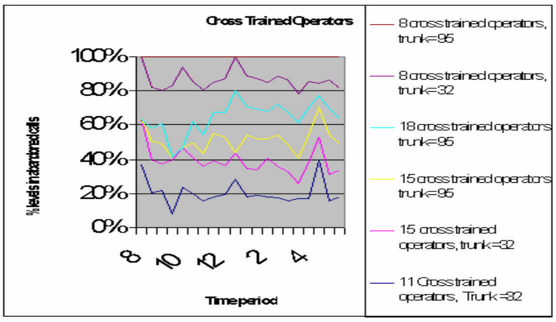

Figure 8: Alternative schedule scenarios and their % service levels

From the scenarios explored in we can clearly see from *Figure 8* that including 8 cross trained operators with 32 trunk lines and 95 trunk lines where all operators can handle 3 category types, there is around 15% decrease in balked rates for 32 lines (overall balk rate is reasonably high). There is a operational benefit in terms of cross trained agents, but still the number of operators trained, number available and total trunk decide the magnitude of the lost calls. It was interesting to see that having 11 operators cross trained with 32 trunk lines did decrease the % of balked calls. Any significant increase in trunk lines should be balanced with the number of operators cross trained and the schedule[26]

The simulation results helps ISP manager to understand and establish a Telephone Service Factor (TSF) standard. This standard defines the % of calls answered within an acceptable time. It is important to take in to consideration the average time to answer, speed of answer and balk call average waiting time. A comparison between average time to answer and balk call average time helps managers to set wait time period acceptable to customers. The simulation results thus helps to improve telephone service factor and reduce the % abandoned calls by answering them on time. The results indicate that some calls were lost due to unavailability of trunk lines and majority of calls were lost due to unavailability of operators. Trunk line utilisation, line time utilisation, and operator utilisation statistics helped us to derive this conclusion [1]. *Table 1* shows a example simulation scenario result of telephone service factor for 11 operators over 32 trunk lines[26].

Table 1: Simulation results use in setting the telephone service factor and managing service quality attributes

Time Period	Arrivals	Balk Rate	Telephone Service Factor (TSF)	Time To answer (seconds)
8-830	225	44	80.4%	9.9
830-9	231	84	63.6%	12.24
9-930	191	89	53.4%	17.64
930-10	63	8	87.3%	32
10-1030	45	13	71.1%	56.25
1030-11	170	83	50.2%	10.34
11-1130	100	25	75%	24
1130-12	140	55	60.71%	21.176
12-1230	200	107	46.5%	19.35
1230-1	25	9	64%	112.5
1-130	210	79	62.3%	13.74
130-2	132	48	63.6%	21.42
2-230	140	55	60.71%	21.176
230-3	123	52	57.72%	25.35
3-330	261	121	53.6%	12.85
330-4	70	28	60%	42.85
4-430	68	19	72.05%	36.73
430-5	43	14	67.44%	62
5-530	61	21	65.57%	45
530-6	295	133	54.9%	11.1

Verification is process to ensure that model behaves as intended based on assumptions. Validation is making sure model closely behaves as the real system. The verification method we used was allowing a single entity to enter call center model and trace that entity to make sure model logic is correct. "Step" feature in ARENA helps to control model execution. Animation speed factor was adjusted to monitor individual entity flow. Model was run under extreme conditions and no abrupt behavior was observed. This helped to check if the summary data is correct [10]. To increase our model confidence , it was essential to compare the real system and our simulation model. The ISP analyst who had detail knowledge of actual system was asked to view the model. This persons expectations and intuition helped us a lot to improve the model and make number of changes (infact several modules were deleted and the authors had to build some more sub -models). It was necessary to fine tune model to adjust some of model parameters. The analyst chose specific scenarios we ran in the model and compared a few important customer service levels parameters using the output averages. The author would like to state here that the comparison were done in order to make sure the model reflected the real system. The study undertaken was not to propose any concrete solutions to ISP. The response from the analyst was that model was indeed close to real system (distribution of data indeed played a important role) [26][10][6][7].

CONCLUSION

This paper looks at the effects on customer satisfaction based on real life data collected from a small Australian ISP. After examining in detail the causes and contributory factors to customer satisfaction (in respect to the actual data collected) a simulation model was developed based on the generic framework SIMCTS. The simulation input distributions and resource allocation were carefully chosen and calibrated using the data collected from the small ISP. This data included the number of trunk lines, operators and their technical training along with the known balking rates during the observation period. After the data and outputs of the simulation were compared and found to be in good agreement, some alternative scenarios were investigated with appropriate suggestions to decrease the known balking rate. However, the main purpose of this case study is to show how the SIMCTS framework (using ARENA simulation package) can be used by small ISP organizations and their call centers to improve the processes involved in providing customer service and reduce the balking rates. This can potentially improve the customer satisfaction and lead to higher customer retention in a very competitive telecommunications service industry.

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REFERENCES

[1] Zanthus Report. "Broadband Service Delivery: Is speed killing customer satisfaction?".

[2] Andrew Greasley. " The case for the organizational use of simulation". Journal of Manufacturing Technology Management, Vol 15, No 7, 2004, pp 560-566, Emerald.

[3]. Jerry Banks. "Introduction to Simulation". Proceedings of 2000 Winter Simulation Conference, pp 9-16.

[4]. Jerry Banks. "Using simulation in call centers". In the proceedings of winter simulation conference, 1998, pp 1395-1399.

[5] Oryal Tanir and Richard J.Booth. " Call center simulation in BELL Canada". In the proceedings of 1999 winter simulation conference, pp 1640-1647.

[6] Shane G.Henderson. "input model uncertainty: why do we care and what should we do about it. Proceedings of 2003 winter simulation conference, pp 90-100.

[7] Marvin k. nakayama. "Analysis of simulation output". Proceedings of 2003 winter simulation conference, pp 49-58.

[8]. Sandeep gulati and scott a.Malcolm. "call center scheduling technology evaluation using simulation". In the proceedings of 2001 winter simulation conference.

[9] ger koole, aukepot and gerome talim."routing heuristics for multi-skill call centers". In the proceedings of 2003 winter simulation conference, pp 1813-1816.

[10] Simulation with ARENA. David Kelton, Randall P.Sadowski and Deborah A.Sadowski. Prentice hall, 1995, chapter 8,9,10, Smarts 11-68, Book examples files, Chap 8,9 (Software CD)

[11] Australian Communications Authority. www.aca.gov.au

[12] Australian Bureau of statistics www.abs.gov.au

[13] Boulding, W. et. al, (1993) A Dynamic Process Model of Service Quality: From Expectations to Behavioral Intentions,Journal of Marketing Research.

[14] Barnes, P.C. [2001], People problems in call centres, Management Services, Enfield, July.

[15] Creagh, M. (1998) Call centers – the new assembly lines, Credit Control, 19, 10, 13-19

[16] Whitehead, M. (1999) Call centers attempt to shed 'workhouse' image, People Management, 5,18,13 22.

[17]] Chang, Z.Y. and Huang, L.H. [2000], quality deployment for the management of customer calls', Managing Service Quality, vol.10, no. 2, pp. 98-102

[18] Gilmore, A. [2001], all centre management: is service quality a priority?' Managing Service Quality, vol. 11, no. 3, pp. 153-159.

[19] Holman, D. and Fernie, S. [2000], Can I help you? Call centres and job satisfaction, CentrePiece, vol. 5, issue 1, Spring.

[20] Gilmore, A. [2001], all centre management: is service quality a priority?' Managing Service Quality, vol.11, no. 3, pp. 153-159.

[21] Stewart Robinson. Simulation: Practice of model development and use, Wiley publications.

[22] Karthik Vilapakkam Nagarajan, Peter Vial , Gene Awyzio and Srivalli V.N. "Towards Understanding and Managing Service Quality Data Effectively Using SIMCTS Simulation Framework". 9th International Conference on Simulation and Training Technologies (SIMTECT 2004), SIAA, CANBERRA, Australia, May 2004

[23]Telecommunications Industry Ombudsman. www.tio.com.au

[24]] Karthik Vilapakkam Nagarajan,Meena Chavan, Tamrat Woldu Tewoldeberhan, Peter Vial and Srivalli V.N. " Analysis and design of service quality models for telecommunications sector ". 10th International Conference on Simulation and Training Technologies (SIMTECT 2005), SIAA, CANBERRA, Australia, May 2005

[25] Karthik Vilapakkam Nagarajan,Meena Chavan, Tamrat Woldu Tewoldeberhan, Peter Vial and Srivalli V.N. " SIMCTS: A framework to understand and manage service quality ". 10th International Conference on Simulation and Training Technologies (SIMTECT 2005), SIAA, CANBERRA, Australia, May 2005

[26] Kokin Lam and R.S.M Lau. " A simulation approach to restructuring call centers". Journal of Business Process Management, Vol 10, No 4, pp 481-494, 2004.

[27] Shannon.E. "Sydtem simulations: the art and science".Englewood cliffs: Prentice - Hall