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Simulation applied to Evaluate and Improve the Operation of a Soccer Ticket Club Call Centre

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Simulation applied to Evaluate and Improve the Operation of a Soccer Ticket Club Call Centre

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ABSTRACT

Today, call centres are complex systems, consisting of various technological appliances, employing different skilled agents and often spreading on a multi-site worldwide environment. Simulation seems to be the appropriate technique to analyze and optimize such complex systems and has been applied to several cases. This paper examines the appropriateness of the simulation method on a case study where the modelling objectives are derived by the simulation outcomes. It facilitates the "interaction" between the researcher and the model, a process which can enhance the whole study and lead to useful conclusions. Furthermore, the presented simulation models incorporate a combination of aspects including a variable input schedule, multiple services, retrials, call routing, a complex resource allocation policy and queue abandonment phenomena. The methodology followed in the case study includes the assessment of the initial operation of a call centre and the evaluation of improvement scenarios. As shown in this paper, simulation can be applied on different phases of a call centre's operation such as the evaluation of its performance, the improvement of its operation and the support of day to day activities.

Key-words: Business Process Simulation, Call Centre, Performance Evaluation, Improvement.

RÉSUMÉ

Aujourd'hui, les centres d'appels sont des systèmes complexes, mettant en oeuvre différentes technologies,nécessitant des qualifications variées et souvent localisés sur plusieurs sites à l'échelle mondiale. La simulation semble être la technique appropriée pour analyser et optimiser de tels systèmes complexes et a été appliquée dans de nombreuses situations. Cet article examine l'adéquation d'une approche par simulation dans le cadre d'une étude de cas où les objectifs de modélisation sont déduits des résultats de simulation. La simulation facilite l'interaction entre le chercheur et le modèle; ce qui peut améliorer l'étude et mener à des conclusions utiles. En outre, les modèles de simulation présentés contiennent une grande variétés d'aspects incluant un calendrier d'entrées, des services multiples, des possibilités d'itérations, l'acheminement d'appels, une politique d'allocation complexes de ressources et des phénomènes d'abandon de file d'attente. La méthodologie suivie dans l'étude de cas inclut non seulement l'évaluation de l'opération initiale d'un centre d'appels mais aussi celles envisagées dans des scénarios d'amélioration. Cet article montre que la simulation peut être appliquée à différentes phases des opérations dans un centre d'appels comme l'évaluation de ses performances, l'amélioration de son management et le soutien aux activités routinières.

Mots-clés : Simulation, processus métier, Centre d'appels performance, Amélioration.

INTRODUCTION

Call centres have gained remarkable attention during the last decades with a momentous portion of companies utilizing them as a component of their enterprise strategy (Datamonitor, 2004). According to existing research studies, financial services, outsourcing, manufacturing and communications were the largest vertical markets at the end of 2003 while the fastest growing verticals are now the public sector, health care, outsourcing, entertainment and utilities.

A call centre is defined as any group of employees whose principal business is talking on the telephone to customers or prospects (Mehrotra, 1997). Today, the call centre's role is enhanced, prompted by the penetration of Word Wide Web, towards a broader department which enables the company's communication with customers, prospects, vendors and partners. The extended call centre, stated as e-Contact Centre, consists of several multimedia channels including a call centre, a Web site, online chat rooms and e-mail services (Scullin, Fjermestad and Romano, 2004). Well-run call centres are the primary contact points for providing much needed business intelligence for a company's marketing and operations functions (Arussy, 2002).

Depending on the functions fulfilled in a call centre, they can be classified in four different ways (Brown, Maxwell, 2002):

- Customer service/sales
- Single/bi-directional calls
- Industry of operation
- Service provided classification: advertising response, telephone banking, catalogue purchasing, production information and service, insurance cover and claims, complaints, accounts and billing, purchase orders, after sales support in repairs and servicing.

Managing call centres is a set of challenges cocncerning the maintenance of a thin, fragile balance among service quality, cost and employee satisfaction (Mehrotra and Fama, 2003). Taking into account that the personnel related cost in a call centre is estimated to be up to 65% of the total cost (Gartner Group, 1996), many managers are attempting to achieve 100% utilization rates of their agents, but risk ruining service quality (Duder and Rosenwein, 2001). Measuring service quality and call centre performance can be achieved via a set of indicators including [(Anton, 2002), (Feinberg, Kim, *et al.*, 2000)]:

- ASA (average speed of answer)
- Queue time
- Abandonment rate
- Percentage of call blocked
- Service Levels (calls answered in less than x seconds divided by number of total calls).

The necessity for both better service and cost reduction led to the adoption of state of the art technological systems, and all the while, outsourcing services are continuously increasing their market share. Typical systems applied in call centres include ACD (Automatic Call Distribution), which place each call to a queue and direct it to the next available agent, and IVR (Interactive Voice Response) system, an automated answering device which routes calls to the appropriate place based on user defined steps and responses to prompts.

Historically, call centres have relied on Erlang-C based estimation formulas to help determine the number of agent positions and queue parameters (Bodin and Dawson, 1996). In that context, the center is modeled as an M/M/n queue, with Poisson arrivals, exponential service times, identical servers (agents) and no customer abandoning the queue or receiving a busy signal. The M/M/n model is appealing because the number of calls in the system as a function of time is then a continuous time Markov chain (CTMC) whose steady-state (long-run) probabilities are easily determined. However, assumptions applied in the Erlang-based analysis are extremely limiting on modelling more complex systems (Bapat, Mehrotra and Profozich, 1997).

Erlang-C estimators have worked fairly well in traditional call centres, however recent trends such as skill-based routing, electronic channels and interactive call handling demand more sophisticated techniques (Cleveland and Mayben, 1997). Consequently, the Erlang-C model has been modified to accommodate features such as abandonment (Brandt and Brandt, 1999a), call blending (Brandt and Brandt, 1999b), retrials (Fayolle and Brun, 1998) and time dependent arrival rate (Mandelbaum and Massey,1995).

Although, Erlang-C model has been modified to accommodate modern call centres features the coexistence of aspects such as time dependent arrival rates, call balking, abandonments, retrials and multiple service times, prevent the use of an analytical method. Moreover, there is a variety of cases where simulation is considered the most appropriate solution including (Bapat and Pruitte, 1998):

- Service level analysis
- Priority queuing
- Customer abandonment patterns
- Skill-based routing
- Agent preferences and proficiency.

Categorizing simulation studies and literature, three modes of practice are identified (Robinson, 2002):

- Simulation as software engineering
- Simulation as a process of organizational change
- Simulation as facilitation.

Simulation studies that aim to guide organizational change make problem understanding and solving a priority. The methodological approach of such studies is well documented including the phases of problem formulation, system and simulation specification, model formulation and construction, verification and validation and experimentation and analysis (Kelton, Sadowski and Sadowski, 1998). In this case, the model is developed to answer specific questions about a problem; therefore it is essentially thrown-away when the study is completed (Robinson, 2002).

However, simulation can be more than a problem solving methodology. Interaction between the model's outcome and the developer can lead often to useful findings, sometimes measurable and others qualitative. Doomun and Jungum (Doomun and Jungum, 2008) present a flexible simulation aided reengineering framework in which simulation findings can result in the reformulation of modelling objectives.

The main research question behind this paper is the examination of the flexibility of simulation in a case of a call centre reengineering, where the study's objectives are affected by the findings of the simulation model. This paper reports on a case study and shows how the study's objectives were achieved through various modifications of a simulation model via an interactive and adaptive approach.

Instead of formulating a unique model, to support researchers on the solution of each sub-problem, a base model was initially designed. Reusing the majority of the model's components enables us to respond to several of the stakeholders' questions and concerns. The purpose of the paper is to demonstrate the use of simulation as a practical management support tool rather than an analytical technique. Multiple level decisions, strategic, such as the investment on technological appliances, tactical, such as the staffing policies, and operational, such as the daily schedules, can be examined via simulation modelling providing management a powerful tool to examine its hypothesis and evaluate the systems performance under any condition. Simulation modelling can be applied to support the whole life cycle of a call centre.

Beyond the dependence of study's objective on the simulation findings, this paper deals with the effect of the retrial phenomenon on service quality, a result owed to the lack of queue. Furthermore, the simulation model incorporates aspects including a variable input schedule, multiple services, call routing, a complex resource allocation policy and queue abandonment phenomena.

The case study concerns the operation of a Greek football club's ticket call centre. The initial purpose of the study was the evaluation of the call centre's operation and the examination of future improvements. As the call centre didn't utilize a call waiting system typical quality metrics, such as the ASA, couldn't be applied. Therefore, a simulation model was used to estimate the effects of customer retrial behaviour, which results from the centre's lack of a call waiting system. The simulation of customer retrial behaviour showed that an important percentage of customers, more than 10% on high traffic days, could not be serviced by the call centre. Furthermore, the customers had to call several times in order to reach an idle agent. The above findings were sufficient to indicate the need for improvements. Therefore, the model was modified in order to simulate the call centre's operation after the installation of either an ACD or an IVR system. Taking into account service quality requirements, such as the ASA and the percentage of the aborted customers, the staff needs for various input levels were estimated. The findings of the simulation indicated that the choice of an IVR system would require fewer agents. Moreover, the initial number of agents, aided by an IVR system, could service a similar amount of incoming calls under specific service quality requirements. Specifically, the IVR aided call centre simulation indicated that the 70% of the incoming calls would reach an agent in less than 30 seconds and the percentage of the aborted customers would be lower than 5%. Besides the technological improvements, the model was used to simulate the call centre operation under a rolling agents' schedule. The use of simulation as a decision support tool regarding the stuffing needs was also evaluated.

2. THE SOCCER TICKET CLUB

2.1. Goals of the Study

The feasibility and the success of any study are strongly dependent on the clear statement of specific targets. Therefore, prior to the impression of the business processes and the development of the simulation models a consideration about the expected outputs of the study should be conducted. However, the academic character of the whole project would permit a partial redirection of the research process in case of peculiar findings turn up.

The generic goal of such studies is the improvement of selected business processes evaluating the usage of different types of resources. In order to develop successful and efficient simulation models, a clearer goal statement should be made, as those models have to serve specific needs of a company. Recognizing those needs is not always a straight forward process. Definitely, managers and administrators expect the simulation study to give answers on specific questions, such as what is the appropriate staffing level or how they will optimize the utilization of their resources. Although the study was conducted in order to satisfy the stakeholders demands, in many cases those demands are based on personal approaches to the system. On the other hand, as the process of modelling aids in developing a better understanding of a system's dynamics, the analyst often encounters several unexpected characteristics, which could point the whole study on a different direction.

Taking into account the above considerations, we decided to follow a two-phase study. During the first phase, the current condition (AS-IS) would be modelled aiming to better understand the call centre operation and to evaluate its performance. Modelling the AS-IS process would also increase the credibility of the simulation method in the eyes of the stakeholders. In the second phase, scenarios regarding possible future improvements would be proposed and examinedcomprised.

2.2. Business Process

Referring to the business process the main operation of the call centre was ticket selling via inbound calls. The company collaborated with three major Greek clubs and administrated part or the whole number of their available tickets, depending on the contract established with each club. Each soccer match held in the home field of a club acted as a trigger event causing customers to approach the call centre in order to either acquire information or buy a ticket. The soccer clubs participated in different kinds of tournaments, as it is shown in Table 1, (League, Cup and European Tournaments) causing the company's event schedule to be extremely variable. There were long periods of time where hardly any match was held, and on the other hand the number of the simultaneous matches on the same week could be more than four. Examining each match there were several factors that could affect the ticket demand such as the popularity of the event, the clubs performance, the weather and the opponent. Furthermore, not only was the volume of demand unstable, but its curve was as well. It was noticed that prior to popular matches, customers tended to buy their tickets early, while in cases of indifferent matches they waited until the last day. Another variable parameter concerning each match was the time its tickets were available for sale. In some cases tickets were released two or three weeks prior to the match, while this period could be as short as one or two days.

	League Matches	Cup Matches	European Matches
Club A	✓	✓	✓
Club B	×	×	✓
Club C	✓	✓	×

Table 1. Types of events.

The call centre was not the only method of selling tickets, and customers could buy tickets via a sales branch or via Internet. Both the call centre and the sales branch operated from Monday until Friday with one daily shift (9:00 – 17:00). A remarkable characteristic of the company's operation was the way the call centre and the sales branch were staffed. There was a common pool of agents who where staffing either the call centre or the sales branch depending on a daily schedule projected by the administrators. These two service points were in remote geographical locations and it was not feasible to transfer agents between them on the same day. Looking into details of the process of determining the schedule, it became clear that the administrators couldn't state specific rules they applied, and as the company was pretty new, they admitted of still experimenting with such rules.

Beside the ticket sales, customers contacted the three service points for a range of demands. Customers of the company were members and consequently there was a registration process. Beyond the registration process, whenever a ticket sale was accomplished, the ticket should be dispatched to the customer. The customer had the possibility to choose between a courier shipment, if there was adequate time before the match, or he could manually collect it by the sales branch. The customers' demands and the agents' tasks are presented on the Table 2 in combination with the three service points.

2.3. Technical Framework

The whole operation of the company was supported by an e-Commerce application. Agents either working in the call centre or in the sales branch and customers via the Internet had to log into the e-Commerce portal in order to service or be serviced. The company had made the functionality of the e-Commerce application a very high priority, investing considerable resources to optimize its operation. Consequently, the service processes in the call centre and in the sales branch had become a secondary priority.

The call centre industry today is moving quite fast and there are several innovative technologies that could make modelling very challenging. A typical call centre is equipped with queuing and IVR (Interactive Voice Response) systems which direct customers to the appropriate agent and attempt to create a pleasant environment for waiting. Indeed, the call centre under study had nothing more than phones. The initial impression was that the modelling process would be simplified, in comparison to a high – tech call centre, but the system's dynamic, due to the lack of queuing space, had proved tricky to model. There were four work stations equipped with a personal computer and a telephone, but the most unexpected characteristic of the call centre was the lack of queuing space, as there were only four balk lines. Therefore, if four agents were staffing the call centre and assuming that all of them were busy, the customers attempting to call would receive a busy signal. However, in cases

	Information	Complaints	Registrations	Sales	Tickets Dispatch	Tickets Delivery
Call Centre	✓	✓	✓	✓	✓	×
Sales Branch	✓ (very rare)	✓ (very rare)	✓ (only with a sale)	✓	×	✓
Internet	✓	×	✓	✓	×	×

Table 2. Customers demands and agents tasks.

with less than four agents, the unoccupied phone lines acted as a queuing space with distinctiveness. Consequntly, if less than four agents were staffing the call centre and assuming that all of them were busy, customers who would attempt to call would receive a waiting signal instead of a recorded waiting message. Of course, if none of the agents would be released in a sensible amount of time, customers would abandon the call and might try again later.

2.4. Operational Data

The business processes blueprint was a major priority in order to create a fair simulation model. However, simulation, similar to other operation research problems, is considered as a GIGO (Garbage In – Garbage Out) methodology. Therefore, the success of the whole study is strongly depended on the validity of the statistical data representing the company operation in numbers. The process of data gathering could be a whole project but in the case of the call centre, things were easier. There was a voice recording system from which the daily volume of calls, their seasonality and their duration were gathered and in addition, agents maintained a database with all customers' demands.

The nature of the soccer ticket market is characterized by the extremely variable demand due to the above mentioned parameters. The daily calls serviced by the call centre for a two month period are outlined in Figure 1.

An important issue in cases of simulating service processes is the distribution of the customers' arrivals throughout a constant period of time. Examining the data gathered by the voice recorder, we attempted to identify two occasions of seasonality. The first kind of arrival seasonality could be weekly. It was assumed that more customers would call on specific days of the weeks, i.e. the non working days. Such kind of seasonality couldn't be justified by the call centre data and that could be owed to

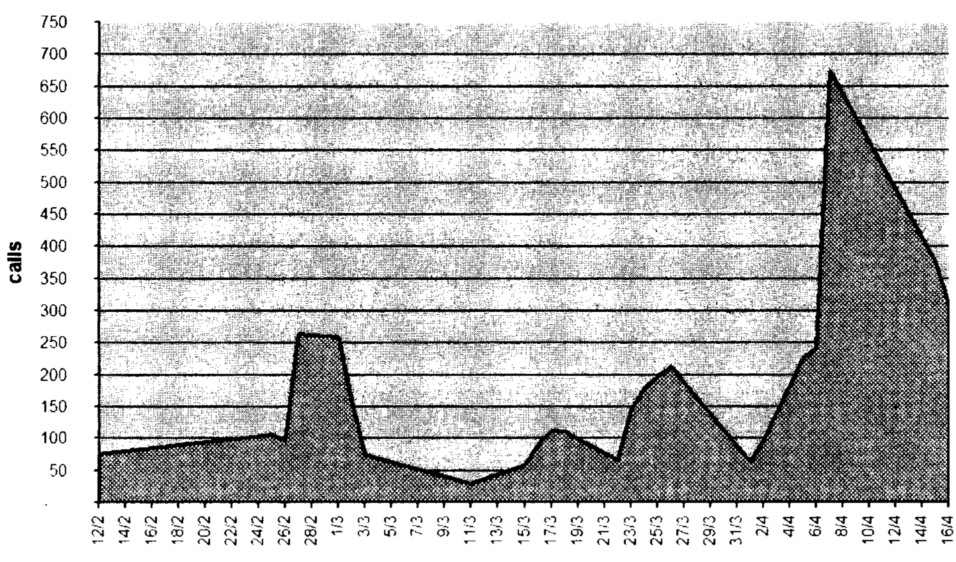

Figure 1. Daily calls in the call centre.

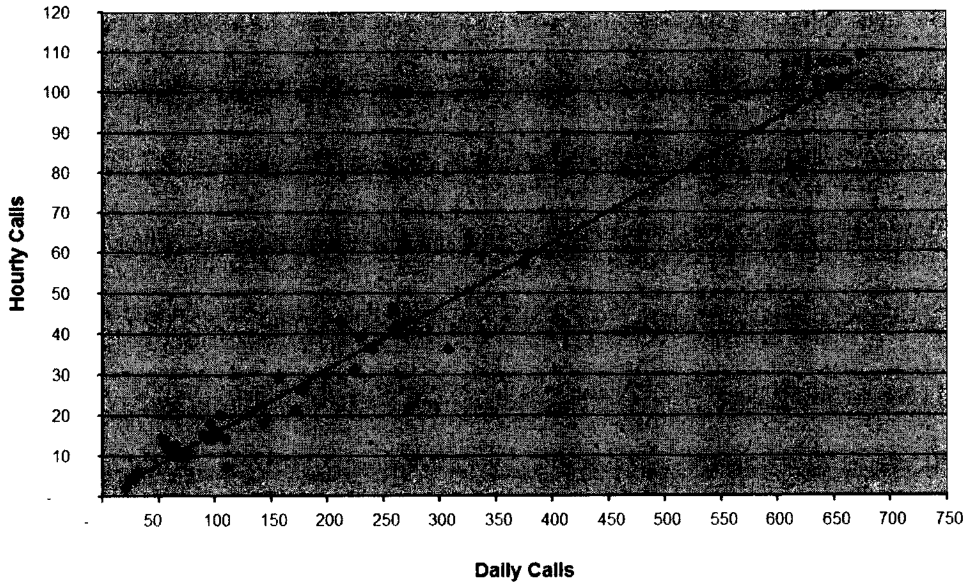

Figure 2. Hourly calls in combination with the daily calls.

the extraordinariness of the soccer ticket market. Thereafter, the seasonality of calls throughout a day was examined. A day was divided into hourly periods and for a given period its calls were combined with the total daily calls. In order to export the percentage of the daily calls occurred on each hourly period the least square method was applied keeping the constant parameter equal to zero. The above process for the 13th period (12:00 – 13:00) is demonstrated in Figure 2.

Due to privacy issues, the recorded phone calls weren't used in order to gather statistics for the customers demand types or their durations. Instead, the database data was used to determine the demand's types, while calls' duration for each type was estimated by the agents. The durations were validated using the total daily busy durations, derived from the voice recorder, for a range of days. The conclusions of this analysis are presented in Table 3.

The company couldn't provide information related to the sales branch and the Internet. Consequently, these two service points were excluded from the study, although their operation was modelled.

Demand Type	Percentage	Min time	Average time	Max time
Information	59,5%	0,5'	0,75'	1'
Registration	27,0%	4'	5'	6'
Ticket Sale	9,5%	5'	6'	7'
Complaint / Problems	4,0%	1'	2'	3'

Table 3: Demand's types and durations.

3. MODELLING THE AS-IS OPERATION

3.1. Specification

Having all the necessary data for the modelling process the first action was to determine the specifications of the As – Is model, in cooperation with the call centre administrators. The goals of the As – Is model were derived from the above mentioned goals of the whole study and are outlined in the following points:

- demonstration in order to increase the credibility of the method;
- evaluation of the present operation of the call centre;
- framework for future models;
- evolution to a decision support tool.

The demonstrative sub-goal of this phase called for a relatively detailed model, which included the majority of the functions conducted in the call centre. Furthermore, an evaluation of the present operation of the call centre demanded a flexible and fully parametric model enabling the simulation of alternative operational scenarios.

An important issue that turned up during the formulation of the specifications was the definition of the service points which would be modelled. Although, most of the available data referred to the call centre it was decided to model the operation of the sales branch as well, due to the administrators concerns. On the other hand, the Internet services wouldn't be modelled as this effort would require data that was too hard to gather, such as the e-Commerce server's load. In addition, the number of customers serviced via Internet was significantly smaller than those who were serviced via the call centre and the sales branch.

Considering the next phase's requirements along with the above mentioned goals the specifications of the first model were formulated as:

- detailed modelling of business functions;
- flexibility;
- call centre and sales branch operation included in the model;
- variable parameters in order to conduct alternative scenarios

3.2. Simulation Model Framework

The simulation model was constructed using Arena©. Arena is a popular simulation software, which is based on SIMAN© simulation language, enabling object oriented programming using a graphical windows interface. Modelling with arena is achieved through the integration of several components, performing specific actions, which are called modules.

The desired flexibility of the initial model had impact on its architecture. The model was divided into sub-systems and we attempted to reduce the dependencies among them. The sub-systems composing the As-Is model are described below:

- File data input: Text files were used in order to import the parameters of a simulation scenario so the subsystem could read the files and import the appropriate variables.
- Resources, queues and storages: Two kinds of resources were defined, the agents and the trunk lines.
- Variables, expressions, etc: All the system variable, constants and expressions used by other subsystems were defined here.
- Staff schedules: The schedule of the agents staffing the call centre and the sales branch is defined here.

- Call centre arrivals: The customers' contacts to call centre were implemented through a Non Stationary Poisson Process using the in-day seasonality via thinning technique.
- Call centre balking & reneging: As a call centre has a limited number of trunk lines, if all of them are busy customers calls are rejected. This phenomenon is called balking. Reneging is the phenomenon of customers abandoning their calls due to the long wait time. In the particular case reneging has a peculiar form as described on section 2.3.
- Call centre service: This subsystem simulated the process of servicing the alternative customers' demands. The function of preparing the tickets for dispatch was included in this subsystem.
- Sales branch arrivals: The customers' arrivals to the sales branch were implemented similar to call centre.
- Sales branch reneging: Assuming the sales branch has unlimited queue space only reneging existed here.
- Sales branch service: Sales branch service is simulated in this subsystem
- Visual feedback: For presentation purposes there a schematic animation system including graphs was included.
- Data gathering: This subsystem generated data files which would be used for further statistical processing of the scenarios outputs.

The model logic is outlined in Figure 3. The customer service process in the call centre is presented taking into account alternative possibilities. The process begins when a customer attempts to call the call centre. If there is an available trunk line, it is seized, else the call is balked. Next, the customer has to seize an agent in order to be serviced. There are three possibilities: the existence of an idle agent, all of the agents serving other customers, and the existence of at least one agent who is preparing tickets for dispatch. In the case of an idle agent, the customer would seize the agent, while in the case of non-available agent, the customer should wait to be serviced. If the wait time is fairly long, the customer will stop his call. The third possibility exists due to the particularity of the case study.

Besides the customer service they provide, the agents were required to print and prepare the tickets, which would be sent by courier. But, in real life, an agent preparing a ticket would stop this job in order to serve a customer call. Modelling the temporal cancelling of a job, in order to carry out a higher priority task and the continuation the first task for the remaining time is not a functionality included on the high level Arena modules, and so it was implemented using low level SIMAN modules.

Returning to the service process, given that the customer has seized an agent, the customer would then be delayed for a period of time which depends on the category of his demand. After the delay, the customer releases both the agent and the trunk line. Assuming that the customer call concluded in a ticket sale, there is a possibility that the customer might demand to receive the ticket by courier. In simulation language, both the customer and the ticket are entities, so in the case of a courier shipment, the customer's entity is transformed into a ticket entity. The ticket entity seizes an agent, is delayed and then releases the agent. As it is mentioned above, the ticket preparing process can be temporarily cancelled, in order a customer to be served.

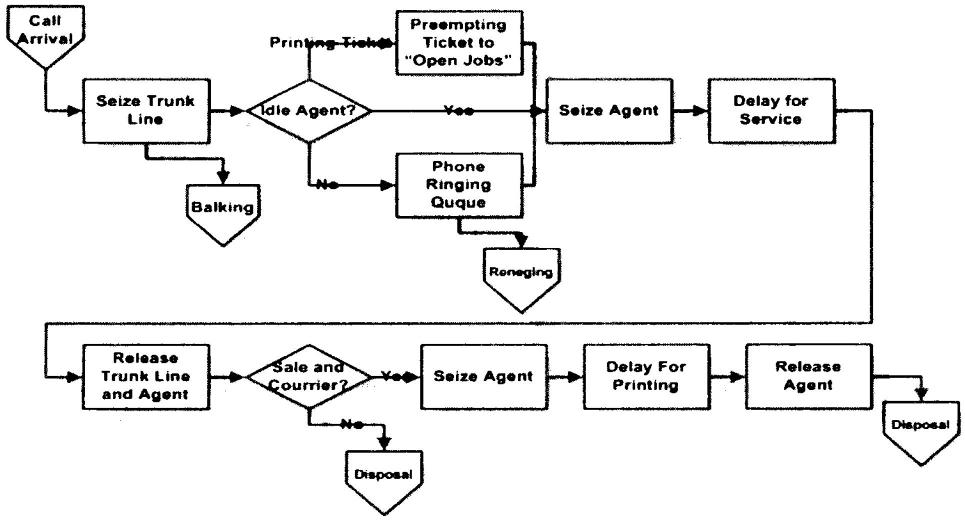

Figure 3. Service process in the call centre.

3.3. Model Verification & Validation

As far as verification of the constructed models is concerned, all of the subsystems of the model were examined performing input-output correlation analysis and step debugging. Validation proved to be a more challenging issue in our simulation study, leading to the enhancement of the constructed models.

Validation is the process of securing the equivalent behaviour of the model related to the real system. In case of simulation use for organizational change, validation is considered in terms of whether the model is sufficiently accurate for its purpose (Robinson, 2002). However, due to assumptions and simplifications which are typically applied in order to model real systems it is often impossible to validate the models.

Regarding our case study, it was attempted to validate the operation of the call centre. Several single days were simulated using as input to the scenario variables real data derived by the voice recording system and the database held by the agents. The input variables consisted of: daily customer arrivals, in-day seasonality, service type distribution, agents' schedules, delay times and printing possibility.

Each day was simulated for a number of replications and the output data were processed using Output Analyzer, an Arena integrated module of statistical analysis. The major issue raised during the data processing was the difference between the input customer arrivals and the output serviced customers. This difference increased as the number of incoming calls raised. In the scenarios simulating the call centre operation on peak days, the number of the output serviced customers proved to be significantly lower than in reality, implying that some of the assumptions were impairing the validity of the model.

As the verified simulation model couldn't justify any loss of customers entities, the additional customers (called but not serviced) were either getting balked due to the lack of trunk lines or abandoning their calls because of long waiting time. In the real call centre a portion of these customers would attempt to retry, but this phenomenon wasn't modelled yet. Regarding the sub-purpose of evaluating the call centre operation, the retrial behaviour and its impact on the customers' service level was an initial finding. As for the simulation model it was decided to model the customers' retrial behaviour.

3.4. Modelling the call centre customers' retrial behaviour

The adjustment of the model in order to include the retrial behaviour was accomplished by looping not-serviced customers to the call centre entrance as it is shown in Figure 4. The new parameters applied to model the customers' retrial behaviour are Recall Probability and Waiting Time. In reality Recall Probability is expressed as a function of the number of retrials of each customer but as there were inadequate data to estimate the function it was modelled as a constant number. Concerning the statistical analysis of the retrial behaviour's simulations, an important value is the customer's Mean Patience. Mean Patience is defined as the mean number of retrials customers would attempt without finally being serviced and is an expression of the Recall Probability:

$$MP = \sum_{n=0}^{\infty}\left[n \cdot p^{n} \cdot (1-p)\right] = \frac{1}{1-p} - 1$$

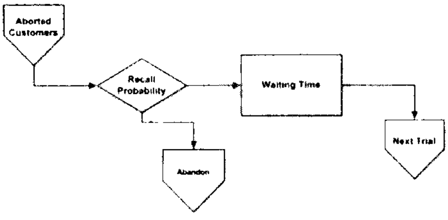

Figure 4: Customers' retrial behaviour modelling.

Regarding the Waiting Time, it expresses the average time between two attempts and it described by a Poisson distribution.

In order to continue with the simulation of the retrial behaviour an estimation of the above mentioned parameters was required. As there were no relevant data in company records, and the administrators of the call centre couldn't make a secure estimation, simulations had to be conducted for a range of the parameters.

During the simulation experiments it was attempted to follow a standard output of serviced customers by adjusting the volume of incoming customers, the mean waiting time before retrial and the retrial probability. Similar sets of experiments were conducted, covering a range of typical customers' arrivals, where a high abandon rate was noticed in the initial simulations. The correlation of the percentage of the aborted customers with the customers' mean patience for a range of mean times between retrials is presented on Figure 5. Figure 5 refers to a number of 450 total serviced customers.

Along with the above mentioned experiments, the agents' utilization for various input parameters was examined. The agents' utilization doesn't depend on the retrial phenomenon and is only connected to the arrival volume and the service times. As it was expected, in the case of low abandonment rate the utilization was pretty low, while the utilization was satisfactory only when the abandonment rates increased significantly.

The incentive for supplementing the simulation model with the customers' retrial behaviour was the validation effort. However, lacking exact knowledge of the parameters which determine the retrial behaviour, the validation couldn't take place. In fact, the actual operation of the call

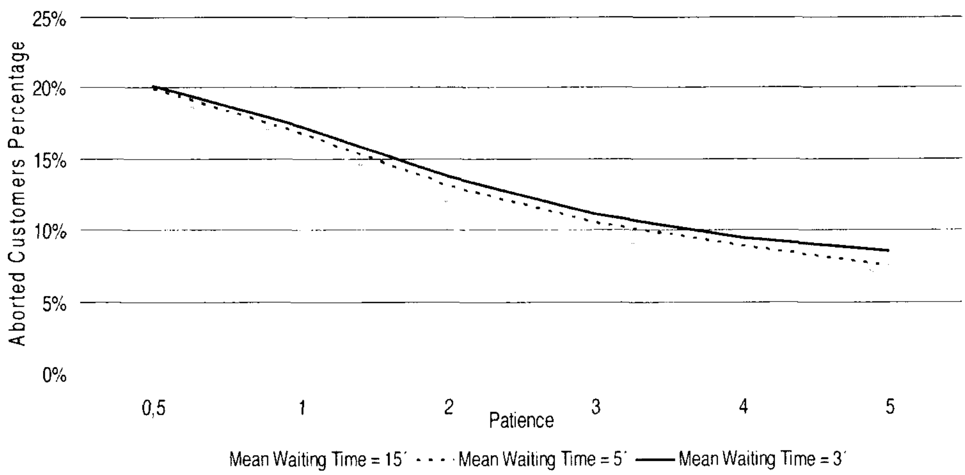

Figure 5. Correlation of mean patience with percentage of aborted customers.

centre could be simulated for various pairs of retrial probability and waiting time, but this technique couldn't be considered as a holistic validation of the entire model. Excluding the arrival sub-system and the retrial module, the service operation in the call centre could be considered as validated, as long as the hourly motive of arriving calls wasn't impaired. Additionally, only the parameter sets with lower waiting time and higher retrial probability didn't affect the call centre in day seasonality.

3.5. As-is conclusions

The study of the call centre As-Is operation with the use of simulation resulted in interesting findings. In the call centre industry, indicators such as the Average Speed of Answer and the Percentage of Aborted Customers are often used to express the offered service quality. In the tickets club call centre, such indicators couldn't be applied as the lack of queue space didn't permit the creation of queues. As a result the initial objective of the service level determination was modified in order to demonstrate the effect of the customer recall behaviour. The eventual formation of the simulation model, including the retrial module, aided the performance evaluation of the call centre.

The importance of the retrial phenomenon is highlighted in Figure 6, which demonstrates the number of retrials required to achieve a desired arrival rates assuming the customers have unlimited patience. The simulation model used to generate Figure 6 data, assumes 4 agents in the call centre, each one servicing any type of calls.

In fact, Figure 5, which demonstrates the effect of customer recall behaviour on the percentage of abandoned calls, proved to be very useful to highlight the impact of the retrial phenomenon in the call centre service quality. The managers could realize that they could only achieve low abandonment rates if their customers had unlimited patience. For instance, to achieve less than 10% of abandonment rate, the customers should be prepared to retry more than 4 times, while achieving the 5% rate seemed to be unrealistic. On the other hand, if the customers aren't very patient, the abandonment rate increases dramatically.

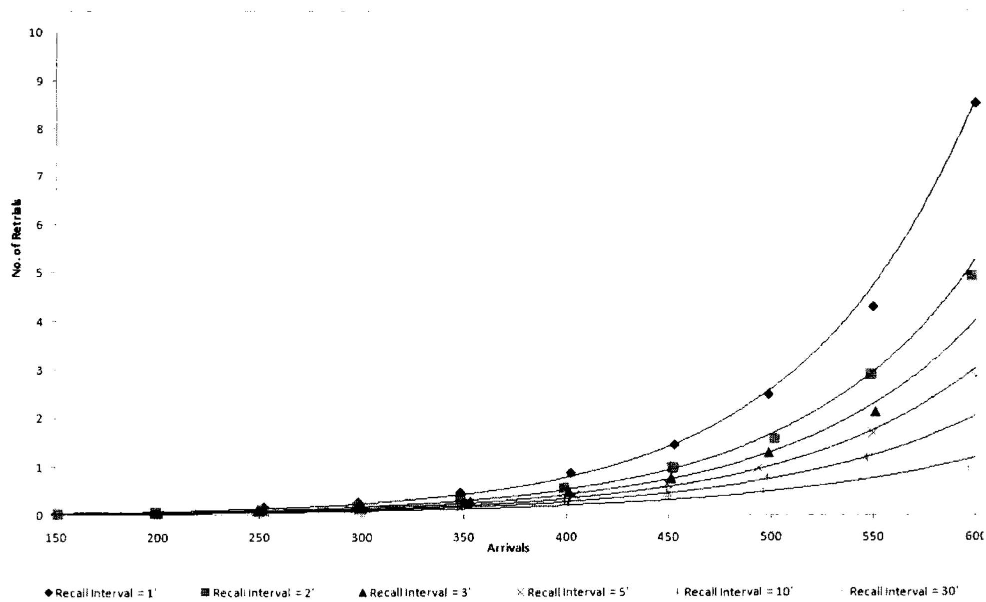

Figure 6. Correlation of number of retrials with the number of arrivals.

4. MODELLING THE TO-BE OPERATION

4.1. Alternative scenarios

Taking into account the findings of the As-Is study, the sizing of the call centre and the nature of the ticket selling business, different scenarios were examined. The supplement of a queuing system was reckoned as indispensable, so the goals of the To-Be study were the determination of additional components which could be installed in the call centre, and the estimation of the necessary resources (agents and trunk lines).

The alternative scenarios examined for the future call centre operation were:

- Installation of an ACD system. In this case, if all agents staffing the call centre were busy, the customer would listen to either a welcome message or some music.
- Installation of an IVR system. Recent VoIP (Voice over IP) telephony progress enables the installation of software IVR systems in reasonable cost, fitting the requirements of a small call centre.

Regarding the VoIP/IVR solution, the systems would be used to automatically serve customers demanding information and routing other types of requests to human agents. Additionally, the VoIP/IVR system could be integrated to the e-Commerce application offering a variety of automated services, such as ticket selling and order status feedback, but as this would demand complicated developing effort it was considered as an alternative scenario. In fact, the potential of the integration of the VoIP/IVR to the e-commerce application could be a future upgrade giving an advantage on the second scenario.

4.2. Model Transformation

Modelling the call centre operation with the supplement of either the queuing system or VoIP/IVR required a few modification of the basis As-Is model. The model flowchart for the call centre service operation is outlined in Figure 7.

The service process of both the VoIP/IVR solutions was simulated in a common model. The differentiation between them consists in the value of specific parameters. For instance, in the case of the single queuing solution, the Welcome Message Waiting Time was set to zero while in the case of the VoIP/IVR solution it was estimated to fit a uniform distribution between 20 and 40 seconds. Similarly, the VoIP/IVR route, simulating the automated information supply, was isolated with a decision module in order to model the single queuing scenario.

An important issue which appears in Figure 6 is the probability a customer would be satisfied from the automated information supply. It is expected that a percentage of customers requiring information would prefer being serviced by a human agent instead of the automated system. The value of this probability was proved critical in the performance of the VoIP/IVR solution.

A matter of consideration was the case of customers whose initial handling by the VoIP/IVR information supply system was followed by a ticket purchase or a member's registration handled by a human agent. This route wasn't modelled due to the lack of essential data, as relevant cases were recorded either as a ticket sale or a member registration. In fact, this phenomenon indicated that the pure ticket selling delay is actually smaller, related to the value used in the simulation, which includes an information supply delay. The effects on the simulation output for the case of the VoIP/IVR scenario would be a slight reduction of the agents' workload, as the mean service time delay would be lower. On the other hand, there would be a necessity of more trunk lines assuming that the total delay time on this case would be bigger with both information and purchase/registration being handled by the VoIP/IVR system. Regarding the ACD system scenario, there would be no differentiation on the agents' workload.

4.3. Solutions Comparison

In order to compare the two possible solutions, simulation experiments were conducted for a range of incoming volume. On each value of incoming calls, call centre operation was simulated for a single day for several replications. The purpose of the simulations was to determine the required resource level, for both cases, where the call centre operation compromised on the two following quality restrictions:

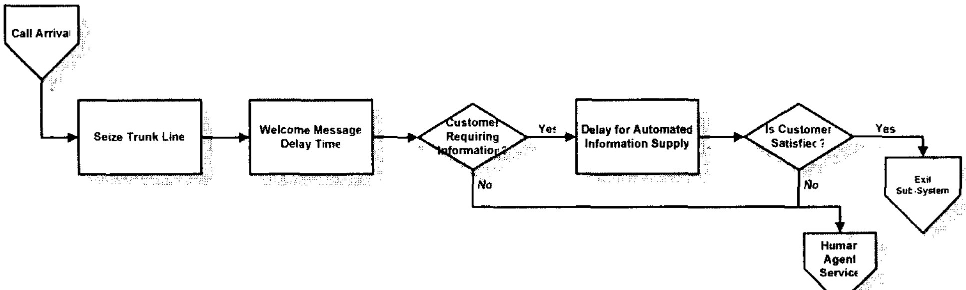

Figure 7. Call centre sub-system modification.

- the percentage of aborted customers should be lower than 5%;
- 70% of the incoming calls requiring agent service should reach an agent in less than 30 seconds.

The comparison of the two solutions was based on the number of agents each one required. The reason for selecting the number of agents as an indicator was that it is accounts for up to 65% of the total operational cost of a call centre. The agents' requirements for several values of daily calls are stated on Table 4.

According to Table 4, it turns out that the VoIP/IVR solution generally requires fewer agents than the ACD system, a fact which would justify the additional cost of an upgrade. A critical issue on the operation of the VoIP/IVR solution is the probability a customer requires further information by a human agent. For the above results, it was assumed that 75% of the customers requiring information would be satisfied by the automated service. However, as this probability could importantly affect the results, sensitivity analysis was conducted in order to estimate its critical value. The conclusion of the sensitivity analysis was that the critical value varied between 50% and 65%, depending on the volume of incoming calls.

Incoming Calls	Queuing System	VoIP/IVR
200	4	3
300	4	4
400	5	4
500	6	5
600	6	5
700	7	6

Table 4. Agents Requirements

Moreover, the potential of integrating the VoIP/IVR system to the e-Commerce application contributed on the attractiveness of this solution. Additional simulation experiments were carried out in order to collect more data concerning the call centre operation with a VoIP/IVR system.

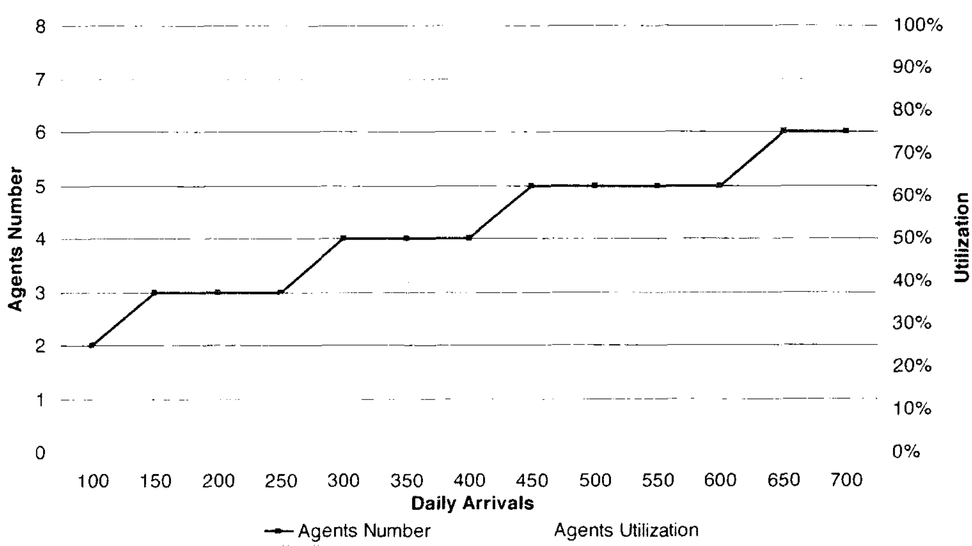

Figure 8. Correlation of agent's number and utilization with incoming calls.

On Figure 8, the number of agents and their utilization for a range of daily incoming calls is shown.

An interesting perspective of the Figure's 7 plots is the improvement of the call centre flexibility and performance as the number of daily calls increases. It is not only the increase of the agents utilization that is important, but also the fact that a steady number of agents can offer quality service for a bigger range of incoming traffic when the daily volume is higher. Indeed, this fact can justify the modern trend of outsourcing and consolidating call centre and similar service.

4.4. Rolling Schedule

During the initial operation of the call centre all agents worked on a common 9:00 to 17:00 shift. The recognition of the daily incoming call motive pointed that peak hours were placed on the middle of the shift, while examining the agents' hourly utilization had shown that on the rest periods the call centre was overstaffed. An alternative schedule, which could increase the total operational hours of the call centre, could be examined with the aid of simulation. It was assumed that the call centre would install a VoIP/IVR system and administrators set as goal the quality service for 350 daily arrivals.

In order to estimate the hourly incoming calls after 17:00 and formulate a modified daily motive, the hourly quotas from 14:00 to 17:00 were used. Finally, a linear fitting model was applied to estimate the quotas of incoming calls after 17:00. As it was shown from the VoIP/IVR study, the number of agents should staff the call centre in order to compromise to the service standards, for 350 daily arrivals, was 4. Alternative schedules were tested aiming to maximize the operational hours and having as restriction the service standards. The conclusion was that a rolling schedule with two agents beginning work at 9:00 and two at 11:00 could achieve the standards and increase the call centre operational hours by 25%.

5. SIMULATION FOR OPERATIONAL DECISION SUPPORT

A typical concern of the call centre administrators was the determination of the appropriate staffing levels on day to day time schedule. The nature of the soccer ticket market is the event driven character of the demand volume which didn't permit simulation to give a deterministic answer. Therefore, the assessment of the call centre performance under various demand estimations could aid the administrators decide upon the number of agents staffing the call centre. The simulation method would be the appropriate tool to estimate if a specific number of agents could satisfactory service the customer's calls owed to any combination of events.

In this manner, the model had evolved to an operational decision support tool, with the support of a spreadsheet application as it's shown on Figure 9. Administrators could place the upcoming events on a timeline defining parameters for the expected traffic of each event such as the total calls, the sales duration and the class of the event. The class of the event defined the distribution of the expected traffic through the time dimension. Regarding the classes, triangular distribution was chosen in order to distribute the expected calls in the timeframe of sales duration. Four classes were defined, using different parameters on the triangular distribution, in order to describe different types of events. For instance, a very popular event causes a big number of calls on the first day of sales.

The spreadsheet applications could produce the input files for the simulation models and administrators could run the simulation, testing different scenarios of staffing policies. The results of each simulation run include metrics of service quality, such as the average speed of answer and the abandonment rate, and data regarding the resource utilization. Therefore, the administrators could test different staffing policies in order to service the expected customers under any desired service quality level.

Adding optimization techniques applied by the simulation software would aid administrators getting a staffing schedule for each experiment. However, as the simulation output is composed of several performance measures and metrics, an objective function with a weighted contribution of specific metrics, should be formulated.

6. CONCLUSIONS

Simulation has been proven as a powerful tool in the case of evaluating and re-designing a call centre. It was used to attain several kinds of objectives such as:

- Performance evaluation in order to estimate indicators not collected by the operational systems
- Strategic decision support comparing alternative technological investments
- Policy analysis testing different kind of staffing and scheduling policies
- Operation support used as a test platform by administrators.

During the current case study simulation managed to incorporate a combination of aspects including a variable input schedules, multiple services, retrials, call routing, a complex resource allocation policy and queue abandonment phenomena. Although an analytical method could be used to study several of the above aspects, the coexistence of them requires the use of simulation.

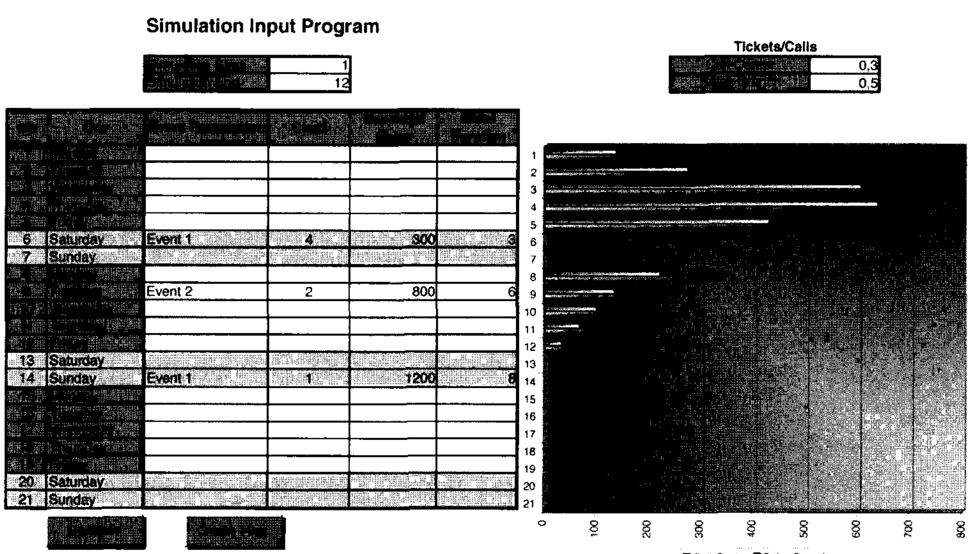

Figure 8. Simulation input program.

Moreover, simulation could be characterized as an efficient tool in cases where experimentation around a problem is desired. During the ticket club case study different scenarios were tested varying on the input parameters as on the process structure. Various aspects, such as the performance evaluation of the As-Is operation, the effects of the recall phenomenon and the potential use of an IVR systems where studied with the use of a slightly modified base simulation model.

The efficiency of simulation as a tool supporting reengineering efforts was also evaluated. Simulation managed to answer questions raised during the duration of the study, such as the effects of the customer retrial behaviour. In addition, the results of process modifications, such as the use of a queuing system, the use of an IVR system and the application of a rolling schedule, were evaluated with the use of simulation models.

However, simulation results are strongly depended on data reliability and business process integrity. The wide acceptance among the call centres industry is partly owed to the nature of call centres which usually are organized by well-defined processes and a plethora of data are available due to call handling systems.

As an operational support tool, simulation should be integrated with forecasting algorithms, offering a very useful tool for an event-driven market. User-friendliness, on the other hand, is still an issue as only experienced developers can create complex models and modify existing ones.

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