THE IMPACT OF SPEECH RECOGNITION SYSTEMS

ON BUSINESS EFFECTIVENESS

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THE IMPACT OF SPEECH RECOGNITION SYSTEMS

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ABSTRACT

Nedim Cem Aytekin, “The Impact of Speech Recognition Systems on Business Effectiveness”

The main purpose of this study is to examine the effects of speech-enabled interactive voice response systems in contact centers, specifically in Turkey. In order to perform this analysis, data was collected from two Turkish companies in the retail and airline sectors, who are very well known in their respective areas of commerce. The data from the speech recognition systems in the companies were studied in order to reveal patterns in multiple criteria, which were determined according to the research questions designed previously. It is determined that a speech-enabled IVR system generates a rapid return on investment, as well as a significant increase in contact center metrics across the board, if the system is congruent and well-designed. Multiple implications were determined and detailed in the conclusion along with three managerial suggestions. Limitations were the analysis of inbound systems only, the existence of time-wise asymmetrical data, and the low number of existing systems providing data to the study.

TEZ ÖZETİ

Nedim Cem Aytekin, “Konuşma Tanıma Sistemlerinin
İşletme Verimliliği Üzerindeki Etkileri”

Bu çalışmanın temel amacı konuşma tanıma sistemlerinin özellikle Türkiye’deki çağrı merkezlerinin üzerindeki etkilerini araştırmaktır. Bunun yapılabilmesi için, mağazacılık ve havacılık sektörlerinde faaliyet gösteren, alanlarında oldukça tanınmış iki firmadan veri toplanmıştır. Bu toplanan veriler üzerinde incelemeler yapılarak, çalışma öncesinde araştırma sorularına dayanarak hazırlanmış kriterlerin değerleri analiz edilmiş, ve bu analizden ortaya çıkan yapılar belirlenmiştir. Sonuç olarak, yerinde ve iyi tasarlanmış bir konuşma tanıma sisteminin çok hızlı bir yatırım getirisi ortaya koyduğu ve diğer çağrı merkezi kriterlerini de iyileştirdiği gözlemlenmiştir. Çıkarılan diğer sonuçlar ve üç adet yönetimsel öneri beşinci bölümde detaylanmıştır. Çalışmayı sınırlayan unsurlar ise, sadece iç arama yapan sistemlerin analiz edilmiş olması, süre açısından asimetrik veriler bulunması ve de Türkiye’de konuşma tanıma sistemlerinin seyrek bulunması sebebiyle, sayıca çok sistemin incelenememiş olmasıdır.

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INTRODUCTION

Technology has made a dramatic impact in both the service sector (Zeithaml and Bitner, 2000) and the manufacturing sector (McDonough, 1993), and continues to do so as the development of new products, systems and ideas results in an increase in the overall efficiency in human industry (Lienhard, 1985). In today's market, technology is seen as a strategic and tactical weapon to support organizations in developing competitive strategies and to enable them to achieve sustainable competitive advantages (Harrison and Samson, 1997).

The main reasons behind this increase in the function of technology in today's organizations are twofold: to decrease costs and to minimize uncertainties (Kelley, 1989). New technological developments serve to decrease costs differently in the service and the manufacturing sectors. In the manufacturing sector, technology enables the use of new tools and machines that are more efficient in their tasks and more flexible in adapting to changing business requirements (Milgrom and Roberts, 1990). On the other hand, technology in the service sector enables organizations to provide well-suited, personalized services to the customer (Bitner, 2001).

Development of telecommunication throughout an economic community has been causally linked to macroeconomic growth (Röller and Waverman, 2001), as well as microeconomic growth (Lenert, 1998). This dependence led to an explosive

proliferation of touch-tone interactive voice response (IVR) systems, and in the last ten years automatic speech recognition (ASR) systems (Cohen et al., 2004).

These ASR systems enable users to command systems to perform pre-defined tasks using their voices over telecommunication systems, mainly mobile or land-based telephones. The main strength of the speech recognition systems when compared to touch-tone systems is the customer dissatisfaction with complicated touch-tone menus and interactions (Cohen et al., 2004). Also, this technology allows humans to interact with computers in a mode that they use to communicate between themselves; which is a very important distinction to note compared to other, more traditional forms of input, such as keyboards, mice, or telephone keypads (Rudnicky, Hauptmann, and Lee, 1993).

In this study, I will be trying to understand some of the effects of the deployment of ASR systems in Turkish companies. Mainly, the return on investments, customer satisfaction, and other key performance indicators determined by the case in question will be examined to help reveal patterns in current and future speech recognition systems in Turkey.

Two cases will be examined in this study; Company A, a prominent airline, and Company B, an electronics retail chain that have deployed speech recognition systems. Although both are technically equivalent, the system specifications are quite different; therefore, at times, the quantitative data available in the two cases might be different in nature and extent.

CHAPTER 2

BACKGROUND

Speech Recognition Systems

As Markus Forsberg (2003) puts it, “Speech recognition, or more commonly known as *automatic speech recognition* (ASR), is the process of interpreting human speech in a computer” (pp. 2). This definition, while sufficient in layman’s terms, is lacking in explaining what actually this process is technically. A more specific definition might be the mapping of acoustic signals to word strings (Jurafsky and Martin, 2000). This mapping enables the system designer to evaluate these word strings to critical concepts that are “understood” by the application in question.

An ASR system is basically a mathematical model that converts given acoustic signals, or sounds, into words of a predetermined language. All languages can be modeled by speech recognition systems, and languages share many commonalities (Schultz and Waibel, 2001); however the process of language modeling requires rigorous and extensive work. The Turkish language has been modeled by many different organizations to date with different levels of success. For commercial purposes, only recent developments in the last five to six years have allowed for deployment of Turkish ASR systems.

Technical Overview

The typical components of an ASR system are: a speech signal, a representation/ conversion of the speech signal as feature vectors, a modeling/classification, and a complex search function supported by training data. The output of this process, obviously, is the set of recognized words.

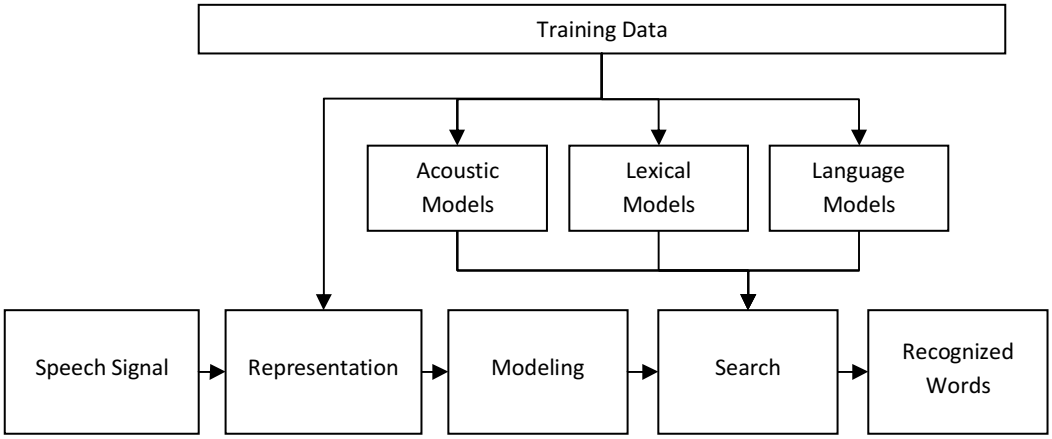

Figure 1. Components of a typical speech recognition system

In current speech recognition technology, using hidden Markov models is the most successful and most widely used method of the modeling of acoustic signals (Juang and Rabiner, 1991). A regular Markov model is a system in which the likelihood of a future state only depends on the current state and none of the past states. In hidden Markov models, the same condition holds true, but the current system state is unknown; only the possible states and their outcomes are known.

For this application (i.e. speech recognition), hidden Markov models have been used since the 1970's (Rabiner, 1989). Many variations and combinations of algorithms and processes used alongside hidden Markov models exist, such as context dependency, cepstral normalization, discriminative training techniques and the Viterbi algorithm. These algorithms and processes are not further detailed; however a simple, three-state Markov chain is given in Figure 2 as an example.

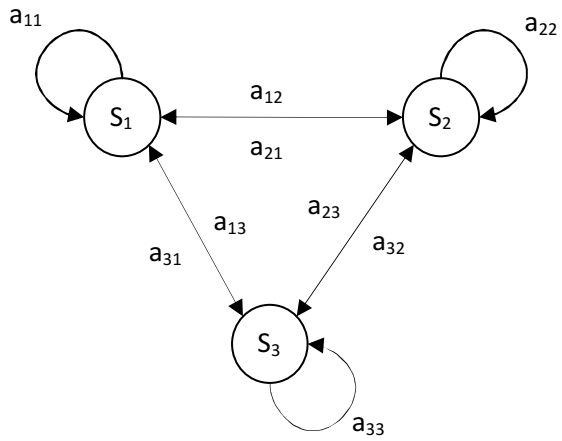

Figure 2. A three-state Markov chain

In Figure 2, states are given by S_1, S_2, and S_3, while the transitions are given by a_{11}, a_{12}, etc. In this example, the system can either stay in its current state, or perform a transition to any other. Each change of state (even examples such as a_{11}, in which the system stays in its current state, count as transitions) occurs according to a set of probabilities that are given for that condition.

Each state in the hidden Markov model corresponds to pre-defined speech units in the language model, whereas the transitions correspond to the feature vectors that are extracted from the acoustic signal. By assigning probabilities to each

transition, the combination of the states with highest probability with a given origin is calculated, resulting in a word recognition.

While these processes go on in the background, the user listens to prompts from the system, and tries to respond to them with appropriate answers. The voice user interface (VUI) is the face that the designer presents to the user. The VUI performs basically the same functions a graphical user interface (GUI) performs for any regular visual application: it enables human-computer interaction. Almost all functions one can access in the IVR application have to be delivered through the VUI to the user, as the user has no way of knowing what they can say to perform a certain function, excepting some commands which might be ubiquitous (like, “operator” or “go back”).

Designing the voice user interface is a very critical part of the speech recognition system design process. VUI designers come from a wide assortment of backgrounds such as speech technology, user interface design, cognitive psychology, linguistics, and software development. These fields and many more supply the vast knowledge base that is required for efficient and successful VUI design, while at the same time making standardization of techniques much more difficult (Cohen et al., 2004).

The success of the speech recognition system is ultimately connected to both the quality of the recognizer and the quality of the voice user interface (Kotelly, 2003). Even if the recognizer in an ASR system is of the highest quality, it will still be judged by the ease-of-use and accessibility of its interface.

Today, speech recognition systems are being used increasingly in telephone-based applications in finance, transportation, telecommunication and other sectors (Kotelly, 2003). Such applications as shop locators and flight information prompters are able to be developed for telephones as these functions cannot be adequately performed by a touch-tone IVR system. For example, passing along destination and departure information via a telephone keypad is very impractical, assuming the customer inputs airport codes (which might prove ambiguous in some combinations). With speech recognition, this becomes an easy task, which requires almost no conscious effort from the user's side, whereas the same user might not know the three-digit IATA Airport Code of their departure or destination, and has to search for it to accomplish their aim.

Generally, speech-enabled IVR's might be considered an upgrade over touch-tone systems; however there are some situations in which users prefer touch-tone over speech: entering private information like PIN codes, or credit card numbers. Also, because of the technical nature of current speech recognition technology, short utterances are sometimes hard to discern from one another. For example, in Turkish, numbers like "bir" and "iki" can be sometimes confused because of the short duration of speech and similar sounding phonemes. This problem can be circumvented by directing the user to enter more, and hopefully relevant, information by the voice user interface. In some cases, the most optimal solution is the combination of touch-tone and speech recognition systems to produce an input pattern which the user feels comfortable with (Walker et al., 2000).

Thousands of commercial speech recognition systems have been deployed all over the world for different purposes: trading stocks, tracking packages, checking airline schedules, booking flights, renting cars, getting weather and traffic conditions et cetera (Cohen et al., 2004). Not all these applications are considered successful; there are different criteria for each category of application depending on the strategy of the deploying company. In the contact center sector, mainly, two important criteria present themselves: the ability of the user to accomplish their aim without problem and on time. In almost all cases where these two criteria are fulfilled, there will be significant cost savings to live agents, as well as significantly improved customer service compared to touch-tone systems (Fluss, 2003).

Two main methodologies of ASR system deployment are complementing existing live agent-based contact center portfolios and replacing touch-tone based IVR platforms. In live agent-based contact centers, the main benefits are cost reduction and constant presence. Agents incur high costs and almost in all cases at least some functions performed by live agents can be replaced by the ASR system. Also, the ASR system can provide a constant presence that customers will come to depend on, whereas agents might not be available because of off-hours or peak-hours. As mentioned before, touch-tone based IVR platforms can totally be replaced by speech recognition systems. In cases where touch-tone based applications perform poorly (*i.e.* usage rates are low), speech recognition systems are observed to perform even better; as shown on Table 1.

Table 1. Projected Speech Recognition Usage

Current Touch-tone Usage Rate	Projected Increase Rate	New Usage Rate
< 20%	80% - 150%	34% - 50%
20% - 30%	45% - 100%	29% - 60%
31% - 45%	40% - 50%	43% - 68%
> 45%	10% - 30%	50% - 70%

Source: Fluss, 2003

During times of economic decline, such as in today's global market, companies naturally undertake measures to decrease costs and minimize expenditure deemed unnecessary. One of the results out of this line of thought in contact centers is the decrease in the number of live agents, which inevitably leads to a decrease in customer service quality. As acquiring new clients are far more expensive than maintaining current ones (Chiou and Droge, 2006), companies should strive towards keeping their existing customer base, while at the same time reducing costs.

One of the most important elements in reducing operational costs while maintaining customer service quality is deploying a speech-enabled IVR system, which can resolve 20% to 60% of calls (Dawson 2003). With a well-implemented ASR system, the call volume can even increase as the operational costs decrease; by decreasing wait times for customers and abandoned call rates (Argaman, 2009). .

Also, one of the greatest cost items in contact centers is a high volume of unnecessary calls, comprised of calls which do not bring additional value to the contact center. Managers today are trying to divert these calls to self-service systems, one of which is the speech recognition system. ASR systems are currently not the most widely used systems for this purpose; however, the main trend in self-service

applications is leading towards web-based self-service and speech recognition in today's market, as shown on Table 2.

Table 2. Interactions by Self-service Application

Self-Service Application	% of Self-Service Interactions (2006)	% of Self-Service Interactions (2005)
Touchtone IVR	43%	59%
Speech Recognition	10%	3%
Web-based Self-Service	47%	38%

Source: Contact Babel, 2004

Although the research is detailed and extensive on the subject of IVR and ASR system implementation, each company has unique capabilities and weaknesses. These details should be known before the IVR system implementation, so that a financial report that calculates the return on investment (ROI) can be formed. According to Fluss (2003), the following criteria are necessary in order to accurately calculate the payback from a speech-enabled IVR application:

- Average call length
- Average talk time of the DTMF (touchtone) IVR system
- Average talk time of the speech IVR system
- Average hold time for agent calls
- Toll free cost/minute
- Cost per agent-handled call

These criteria enable an analyst to determine the ROI within a certain range of error, effectively predicting the success (or the failure) of the IVR system deployment. As mentioned before, even though multiple thorough analyses have

been performed on many, many cases, a personalized return on investment report is critical for the overall success of an IVR system installation.

In calculating the payback, or the ROI, of a speech recognition system, there are both “hard” and “soft” benefits (Fluss, 2003). Three main areas of hard benefits exist, with which a speech investment can be justified: increase in productivity, reduction in current cost, reduction in anticipated cost. Productivity increase is basically the reduction in the number of agents a contact center has to employ, which leads to reduced numbers of supervisors, trainers and quality assurance specialists. Reduction in current cost is the time that live agents do not have to spend with customers on the line, as well as the number of calls live agents have to handle. Reduction of anticipated cost is derived from the scalability of the speech recognition system when compared to the scalability of the number of agents when the total number of calls is increased. IVR systems, especially those with speech recognition support, scale very well with increasing number of calls (Cohen et al., 2004). This scalability allows the variable costs that can be incurred in the future through increasing called volume to be minimized.

“Soft” benefits are very hard to quantify or attribute to specific investments. However, the accumulation of multiple “soft” benefits alongside well-calculated, “hard” benefits will lead to a greater sense of success. A selection of “soft” benefits that should be examined through a ROI analysis for an organization is as follows (Fluss, 2003):

- Reduction in customer call backs
- Reduction in call center hardware and software
- Reduction in agent attrition
- Increase in customer satisfaction

- Increase in customer loyalty
- Increase in revenue

In an ASR system deployment, some of these items might not exist. Nevertheless, the system and its components should be analyzed well not to miss any "soft" benefits from the return on investment calculation.

The many advantages the IVR system offers also come with a set of disadvantages. There are three main areas of dissatisfaction with IVR self-service: the low number of customizable points in the transaction, technical errors in the speech recognition software, and a preference with live, human agents over computers (Dean, 2008).

Many users, sometimes rightfully, observe a lack of customization in their conversations with speech recognition systems. This is obviously derived from the fact that computer artificial intelligence (AI) has not been developed to a point which it passes the Turing test (Turing, 1948); that is, to such a point that the user cannot tell the difference between a computer and a human only through a communicative medium. This lack of intelligence sometimes leads to points in conversation in which the system can no longer satisfy the needs of the user. At this point, the most prudent option is to allow the user to connect to a live agent, to solve their problem without any further agitation (McCartan-Quinn et al., 2004). While the option to connect to a live agent is very critical, the loss of customer loyalty and satisfaction may be unavoidable at that point, since the customer then thinks the transaction cost for them is increased (*i.e.* more time and effort required than before), and the system was introduced for the benefit of the company, rather than the customer (Dean, 2008).

The second main concern is the technical errors associated with IVR systems. Telephony based speech recognition systems obtain an average of 82-84 percent

success rate in accuracy (Rolandi, 2007). Although this seems like a high rate, out of every ten utterances the user inputs, on average one or two of them will fail to be understood by the system. These failures add up, especially over the course of a long, transaction-based system, and the user finds that they are no longer satisfied with the service offered by the company.

The third point, preference for live agents over computerized systems, lies with the perception of the customer that they, the customer, is providing human time, whereas the company is providing machine time (Dean, 2008). This imbalance, according to the Fairness Theory (Folger and Cropanzano, 1998), creates dissatisfaction for the customer, which manifests itself in the form of lower customer loyalty and inferior company image.

Although mentioned before, in the light of these analyses it is once more pointed out that the customer being able to connect to a live agent at any point they wish is of extreme importance. “Reactance” describes the mental state of a person whose freedom to behave as they wish has been threatened in some form (Brehm, 1966). A user who has been able to connect to a live agent before the deployment of an IVR system, who can now only interact with a speech recognition system will understandably be in a state of reactance. In this case, an IVR system complementing live agents has to position itself well; that is, it should be very clear to the user that they can in fact connect to a live agent as soon as they want, and that the system is in place to streamline their operations and help them, not hinder them.

In viewing these disadvantages compared to the advantages of the IVR system, today’s marketing trends have to be taken into consideration. The main reason for IVR implementation is cost reduction rather than customer satisfaction (Snow, 2005), and this is contrary to marketing philosophy today. In the last hundred

years, the focus has shifted from the needs of the company (cost reduction, additional revenue, additional profit) towards the needs of the customer (customer satisfaction, customer loyalty), and companies attempt to convert this additional satisfaction and loyalty into revenue by placing themselves above their competitors in their respective sectors (Kerin, Hartley, and Rudelius, 2004).

According to this analysis, most companies would not prefer IVR systems in their contact centers over live agents. However, as mentioned before, the proliferation of IVR systems in today's environment is very comprehensive; almost all contact centers, in one fashion or another, use IVR systems to respond to their customers. This apparent dilemma can be explained through the strong cost reductive properties of the IVR system; that is, during times of economic struggle, especially during economic crises, companies will search for multiple avenues of cost reduction, accepting the sacrifice of customer satisfaction in order to cut their losses.

The critical point, then, is to find the optimal point of cost reduction and customer satisfaction in the deployment of an IVR system. While the recent growth in speech recognition technology has helped matters by lowering error rates and lowering response times (Cohen et al., 2004), self-service systems have a self-defeating side in reducing cost while reducing customer satisfaction leading to a weaker position in the market for the company, equivalent to the generation of less revenue (Brown, 2004). Finding this critical point of optimization is quite difficult; however it can be accomplished by the diligent collection of data and rapid response to the conclusions reached from the analyses on the data.

Literature Review

The technical aspect of speech recognition is studied academically in a very detailed way; however, academic studies on the business effects of IVR systems on organizations are very few; in fact, a thorough research only revealed a total of two academic papers on the subject (McCartan-Quinn et al., 2004 and Dean, 2008). However, a wide selection of white papers originating from multiple sectors and countries exists; a very good, if sometimes biased, set of resources.

White papers by multiple consultancy firms, along with books on speech recognition implementation have been studied alongside the few non-technical speech recognition academic papers. As IVR and ASR systems depend on many disciplines for successful application, other academic-level papers on such subjects as psychology, mathematics and economics have also been studied.

The existing work on IVR self-service in the management literature reports a certain level of frustration with IVR systems, and the study by Dean (2008) reveals the theoretic explanation as to the reasons of this phenomenon. This study, alongside multiple success stories by multiple consultancy firms on cost reduction has been studied in a detailed way in order to form a multifaceted understanding of the current position and placement of IVR systems in today's economy.

As mentioned before, there is a very limited selection of speech enabled IVR implementations in Turkey. Therefore, the documentation and published studies of previous implementations are almost nonexistent. This study is, in that context, an original work, taking data from live speech recognition systems in Turkey, and trying to evaluate that data in the light of previous studies in other countries.

CHAPTER 3

METHODOLOGY

Overview and Research Problems

Two speech enabled IVR implementations in Turkey were examined in this study: Company A, a chartered airline, and Company B, a retail chain store specializing in electronics. Both IVR systems have been designed, developed and implemented by a Turkish software company specializing in speech recognition systems, which has been providing the data.

The three main research questions that were developed before the study began are as follows:

- How does a speech-enabled IVR system affect sales of a company?
- How does an IVR system perform from a ROI perspective?
- How does an IVR system perform from a cost reduction perspective?

All these questions are to be answered regarding IVR systems in Turkey, a topic not studied previously, depending on research of certain databases that cover related topics.

The main research methodology employed in this thesis is the longitudinal study. Longitudinal study can simply be defined as the observations of items over

long periods of time (Menard, 2002); this study observes the companies in question for over three years.

Generally, longitudinal studies are used to analyze populations in biology, sociology or other fields requiring demographics. Longitudinal studies are useful for studying individual-level change over time, where the vital statistics for any system are under inspection, to provide analyses that might elude researchers when using a method that shows a snapshot of the system. In this study, the data that were analyzed over time were gathered from both the contact centers, as well as the speech recognition systems. The selection of longitudinal study as the main method is critical: the lifetimes of the contact centers of the two companies are analyzed in order to present a meaningful picture of what the introduction of the IVR system changes throughout these operations.

Backgrounds of Observed Companies

Company A, a chartered airline based in Turkey, has been using speech recognition technology in their IVR system since July 2007. The IVR system that was in place for the company before the July of 2007 was only a call direction system by which the users were directed to respective agents based on skill sets.

The IVR consisted of the following options:

- Ticket purchase and reservations
- Flight information requests
- Customer relations
- English-speaking agents
- German-speaking agents

These touch-tone options then led to respective agents, who handled the calls. The speech recognition enabled IVR system was installed over the current touch-tone based IVR system, which enabled the redirection of a certain amount of calls that requested flight information from agents to the ASR system. The quantity of redirected calls, along with other related information about the system, is given further in this study.

The ASR system consists mainly of three distinct input steps: departure location, arrival location and date. An example dialogue would commence in the following form.

A sample dialogue between Company A System and Caller:

System:	Hello, welcome to the Company A flight information service. Please tell me your departure and arrival locations.
Caller:	From Istanbul to Ankara.
System:	Very well, when would you like to go?
Caller:	Tomorrow.
System:	Sure, we have 3 flights from Istanbul to Ankara; 10:30, 12:00 and 15:30. There are 3 empty seats in 10:30 for 95 TL, 4 empty seats in 12:00 for 90 TL, and 1 empty seat in 15:30 for 100 TL. You can now connect to an operator by saying “sales” in order to purchase a ticket or make a reservation. You can also hear the previous information again by saying “repeat”.
Caller:	Sales.

At this point the caller is connected to a live agent with the departure, arrival and date information also passed along, enabling the agent to continue the transaction without redundant answers required on the part of the caller.

As a previous study by Dean (2008) points out, the freedom to speak with a live agent at any point in the conversation is critical to the success of any IVR system. In the Company A flight information system, a caller can say “operator” at any point to connect to a live agent, or say “help” in order to get further instructions regarding the juncture they are in. Also, in the case of three consecutive errors on the part of the caller (an error being defined here as one of three events: timeouts, in which the caller is silent; low confidence utterances, in which the system is unable to understand the caller; and DTMF errors, in which the caller uses the touch-tone system on their phone instead of speaking), the caller is automatically transferred to a live agent, with the system apologizing for its inability to help the caller.

Company B is a retail chain store with many locations spread throughout Turkey. It is currently the strongest of its kind in gross sales, as well as number of locations. Company B currently has a distributed contact center system, in which calls are distributed between two outsourced contact centers depending on load on either one.

The speech-enabled IVR system is basically a shop locator application, which aims to reduce the load on live agents, by performing a function that can be automated. The regular IVR system that was in place before the speech-enabled system consisted of the following functions:

- Store contact information
- Item ordering
- Physical store information (stocked items, etc.)

- Internet store information
- Authorized service information
- English-speaking agents

These functions were grouped according to specialized skill sets required, and calls were distributed to live agents as they arrived. The current IVR system also has these touch-tone based options; however, currently the Store contact information option leads to the speech-enabled IVR system, if load permits. As there are thirty ports available currently for this deployment, the thirty-first concurrent user requesting this option through the IVR system is connected to a live agent.

Authorized service information section is also currently speech-based; however, that section is not in the scope of this study, as the data available on it is not of a sufficient quantity.

An example dialogue for the Company B store contact information system is provided below.

A sample dialogue between Company B System and Caller:

System: Hello, welcome to the Company B store contact information system. Which city is the store you want contact information in?

Caller: Istanbul.

System: Very well... There are too many stores in Istanbul for me to list. In which district or shopping mall is the store you are looking for?

Caller: Sarıyer.

System: The information on Company B stores in Sarıyer are as follows…

The system then proceeds to relay the relevant information to the caller, which includes addresses, phone numbers and fax machine numbers for the closest 5 Company B stores to the district given, determined by a geographical algorithm. After the information is communicated to the customer, the customer retains the option to ask another store for contact information, connect to a live agent, listen to the same information again, or disconnect the call.

As with the Company A speech recognition system, multiple consecutive errors are handled by transferring the caller to a live agent. Again, the caller is free to say “operator” at any point in the conversation in order to connect to a customer representative.

As it can be observed from the above case details, the two ASR systems are in fact quite similar in some perspectives. Both are deployed over existing touch-tone IVR systems to complement their functions and perform automation where it cannot be realized only with a touch-tone interface. In the Company A system, departure and arrival locations are far too numerous to handle without a coding system (such as the IATA airport codes), which unnecessarily complicates things. Also, inputting dates are far less intuitive, as the caller can simply say “tomorrow”, “two days later” or “next week”, whereas in the touch-tone system, the numbers have to be dialed in a certain format for the computer to recognize. In the Company B system, 81 cities in Turkey, as well as copious amounts of districts within larger cities, such as Istanbul, Ankara, Izmir or Bursa, have to be coded in an elegant way, not to throw off any users.

A detail that is shared among the systems is that both of these ASR systems are of “limited vocabulary”. That means, what the user can say is quite limited; the designer can predict all possible answers that will be accepted by the system, and define the system accordingly. This leads to lower customization; however, accuracy is increased in a very significant way. Accuracy or the regular rate of success, in Turkish is about 76-80 percent; in these types of “limited vocabulary” systems, this rate is increased to about 85-90 percent.

Another similarity is in the reason of the development and deployment of these two systems: they aim to take off load from live agents by resolving relatively simplistic and repetitive tasks on the agents’ part and conserving valuable talk-time for the contact center, as well as try to enable employees to conserve enthusiasm and achieve high morale, increasing level of service and customer satisfaction (Carlaw, Carlaw, Deming, and Friedman, 2002). Also, the reduction in talk-time leads to a lesser number of abandoned calls; number of abandoned calls being one of the main factors in the service level, a very critical key performance indicator (KPI) in contact center literature and business. Both contact centers aspire to a certain service level, which the systems try to help with.

The differences between the systems should also be considered; however, for many purposes they are actually quite similar. The main, and most critical, difference is the design philosophy behind each system. The systems were designed to perform different functions, and to deal with different customer bases, even though underlying algorithms and technology are very much equivalent. The voice user interfaces reflect the difference most clearly, where every word uttered by the system is important. As this is a quantitative study, there is no practical and realistic way to

compare the effects of different phrases on users; this approach will be omitted from the study.

Data Collection

The data collection phase of the study was long and arduous, as the companies in question are understandably particular about handing out data on their contact center systems. Also, some data were received through the software company which developed these two systems, over the course of almost a year.

One half of the data is on the speech recognition systems, while the other half is on the contact centers. The part on the speech recognition systems was received from the software company, as these systems are charged on a per call basis, and detailed invoices are collected for transactional purposes.

The contact center based data was received from Company A and Company B; however, as there were multiple contact centers outsourced at different times to perform the same jobs, the data was amalgamated in order to produce a more manageable data set.

Expected Results and Propositions

In this study, it has been previously explained how an IVR system affects a contact center's daily operations. According to these guidelines, there were a few key themes, through which five propositions were developed.

Theme 1: Value as an Investment

The IVR system is expected to prove a valuable investment when applied as a solution to a relevant problem, and designed and implemented in a high-quality manner. One of the most concrete ways of calculating and measuring economic value in today's market is the return on investment; ROI will be examined in multiple manners to provide a detailed overview of the value of the IVR system as an investment.

P1. A speech-enabled interactive voice response system that is well-suited and well-designed will provide a premium return on investment.

Theme 2: Effects on Transactions

While these systems do not provide direct options to purchase items, nor any form of transaction, they allow the customers to procure relevant information without connecting to a live agent. This cascading effect is expected to affect number of call per sale (or transaction) ratio in a positive way. A general overall positive effect on sales is also tentatively expected; however, it is expected to be very difficult to separate a regular trend from the increase caused by the implementation of the IVR system.

P2. A speech-enabled interactive voice response system providing information on products or services will decrease the number of calls per transaction.

P3. A speech-enabled interactive voice response system providing information on products or services will increase the absolute number of transactions.

Theme 3: Number of Calls and Load on Agents

Number of calls incoming to a contact center is very critical, since businesses generally do not employ a sufficient amount of employees to handle all calls; some are inevitably abandoned, a direct result of not being able to respond to incoming calls. It is also a very critical indicator of contact center performance as mentioned previously.

It is expected for the IVR system to reduce the load on agents by 20 percent at the minimum, as determined by the frequency of callers requesting information from live agents. Also, the absolute number of abandoned calls is expected to decrease, or stay the same in the case of no trends acting otherwise, such as a general increase in the number of calls. In any case, the ratio of abandoned calls to total incoming calls is expected to be reduced.

The “soft”, ill-defined benefits of the IVR system on the employees and customers cannot be formed as propositions, since it is very difficult, and not in the scope of this study, to estimate employee morale or customer satisfaction. However, these benefits deserve to be mentioned; namely, employee morale is expected to increase as repetitious tasks are relegated to automated machinery, and customer satisfaction is expected to increase as more enthusiastic employees respond better to callers. Also, fewer live agents are expected to handle the same amount of calls,

therefore hardware and software costs for the contact center are expected to be reduced.

P4. A speech-enabled interactive voice response system will reduce call load on agents by the frequency of callers requesting relevant information. This reduced call load also leads to a number of imprecise and ill-defined benefits for the organization.

P5. A speech-enabled interactive voice response system will reduce the ratio of abandoned calls to total incoming calls in a contact center.

CHAPTER 4

RESULTS AND DISCUSSION

Overview

For both systems, collected data was processed in spreadsheets to construct graphs in order to present the results. The graphs will be accompanied by explanations as necessary. No statistical methods were deemed necessary, as the data is clear and the graphs represent the results in a concise manner.

The IVR system for Company A was deployed in the July 2007, whereas the data on the contact center extended further back into January 2006. Company B started using their system in May 2007, however, the contact center data only went back to January 2007. The scarcity of data previous to the IVR system deployment complicates the analysis of trends and other variables in Company B statistics through the duration of transition to the new system. In any case, mostly, the data and the results are clear enough to be able to be acceptable, and any questions left by the scarcity of data are pointed out.

Company A Results

Figures 3 and 4 display the number of incoming calls to the contact center, the number of incoming calls diverted to the IVR system, and the ratio of each to the total amount of incoming calls. In these figures, abandoned calls are not included in any way. Figures 5 and 6 represent the absolute number of abandoned calls and the ratio of abandoned calls to the total incoming calls.

Figures 7 and 8 deal with transactions; Figure 7 is the absolute number of transactions committed through the contact center, whereas Figure 8 is the ratio of calls per transaction, in effect demonstrating a criterion for contact center sales efficiency.

Figure 9 is about the ratio of calls completed in the IVR system corresponding to the calls transferred to a live agent from the IVR system. Figure 10 represents the studies on return on investment from January 2008 through April 2009. In this graph, the ROI is the comparison of TL value of the IVR system versus the TL value of live agents who would have been employed if the system were not used. This is the monthly operational cost of the system subtracted from the Total ROI, in essence, the true cost trimmed down by the company each month.

Some baseline values are accepted in calculating the return on investment: 22 workdays per month, eight hours per workday, and an agent efficiency of 65 percent, as determined by the consultancy firm in charge of the contact centers.

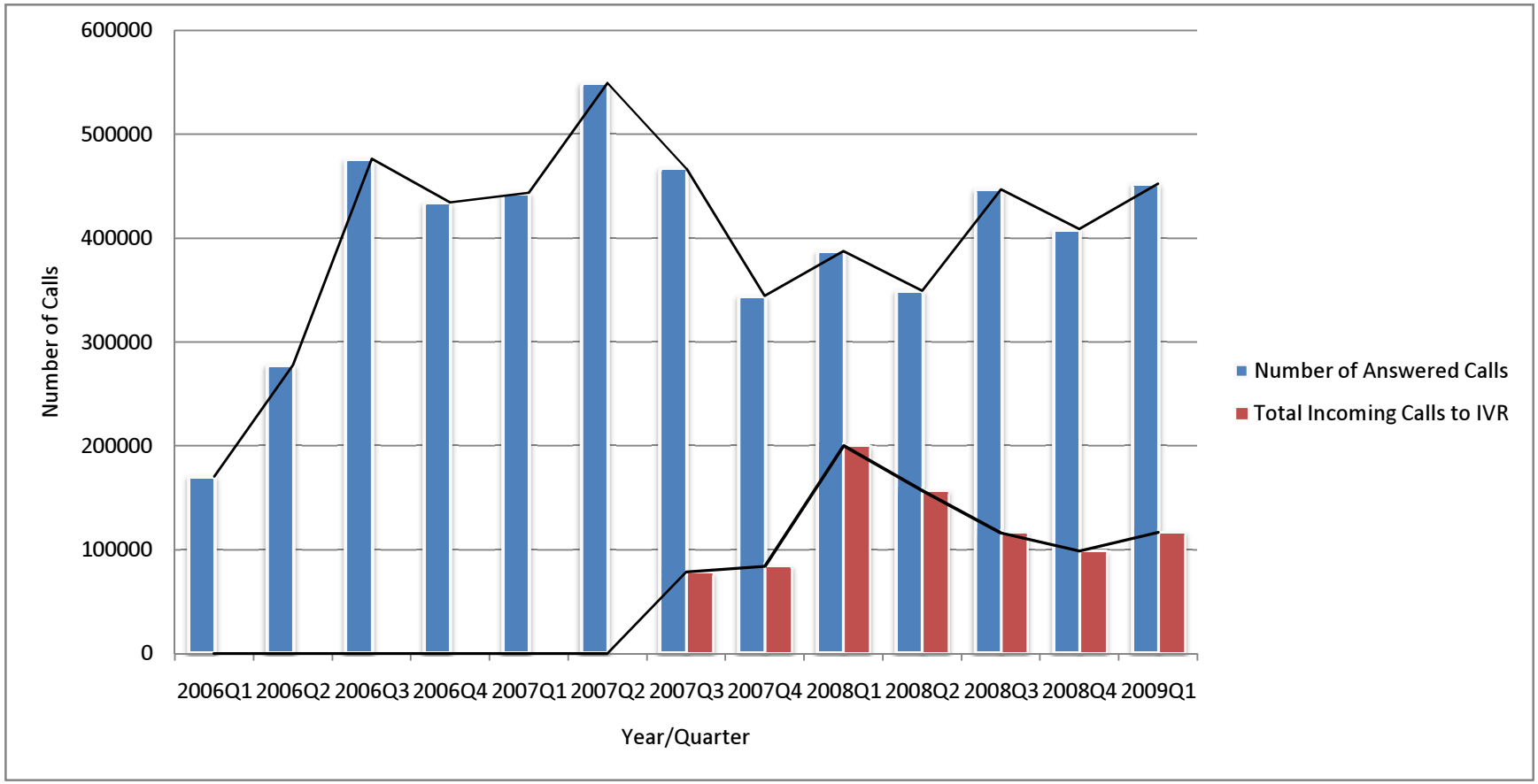

Figure 3. Company A, number of incoming calls

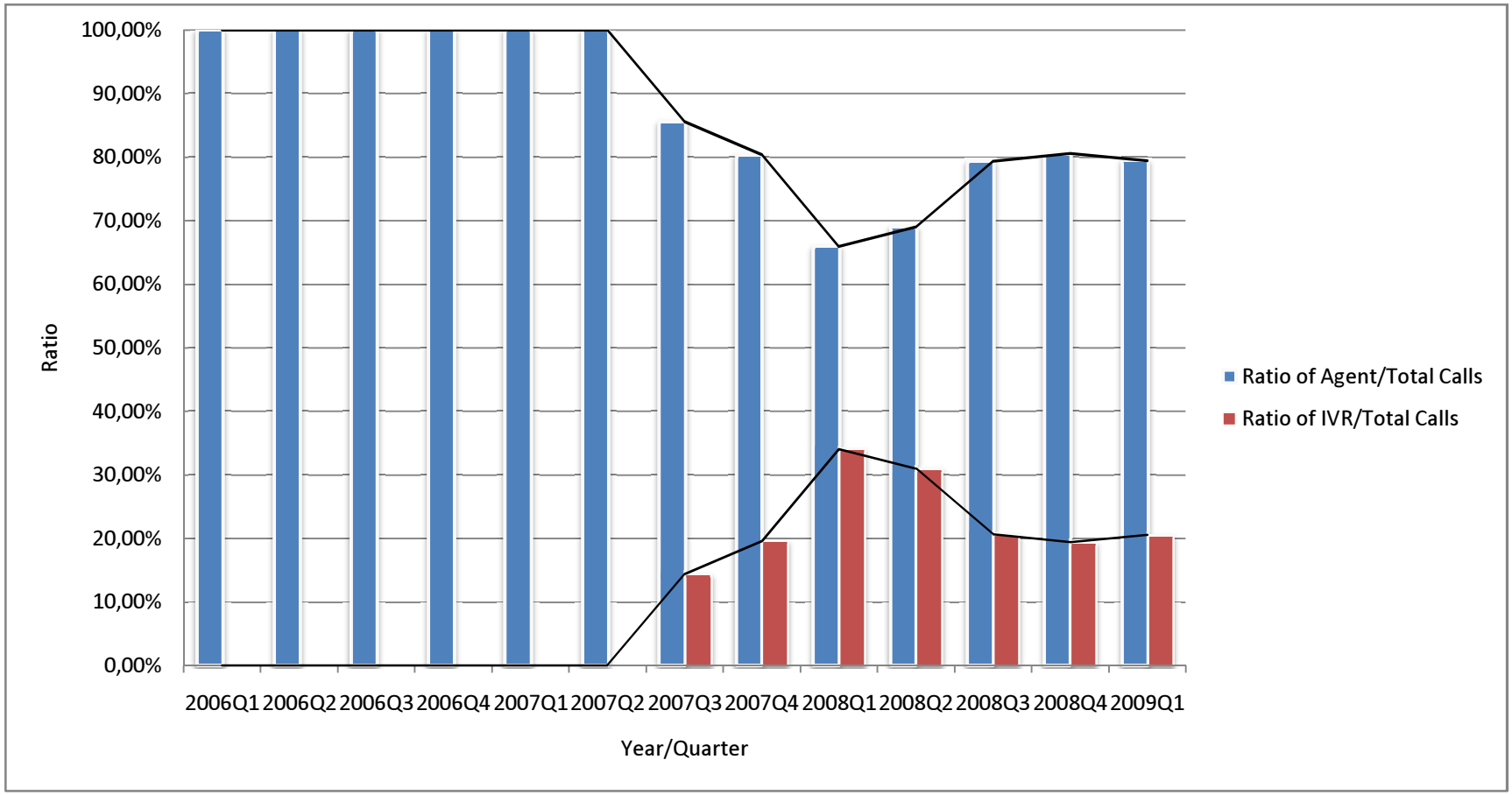

Figure 4. Company A, ratios of agent/total and IVR/total incoming calls

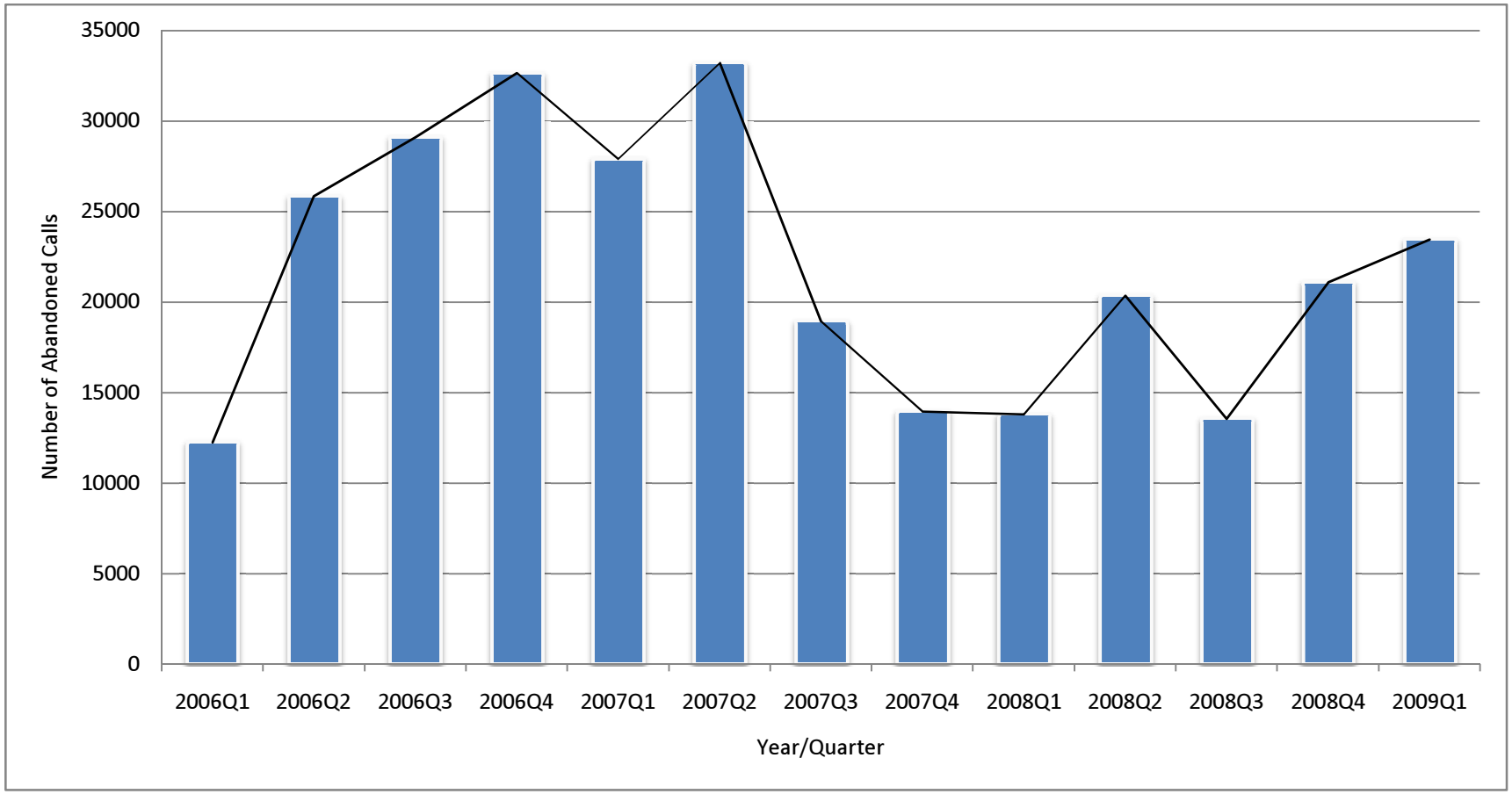

Figure 5. Company A, abandoned calls (Absolute)

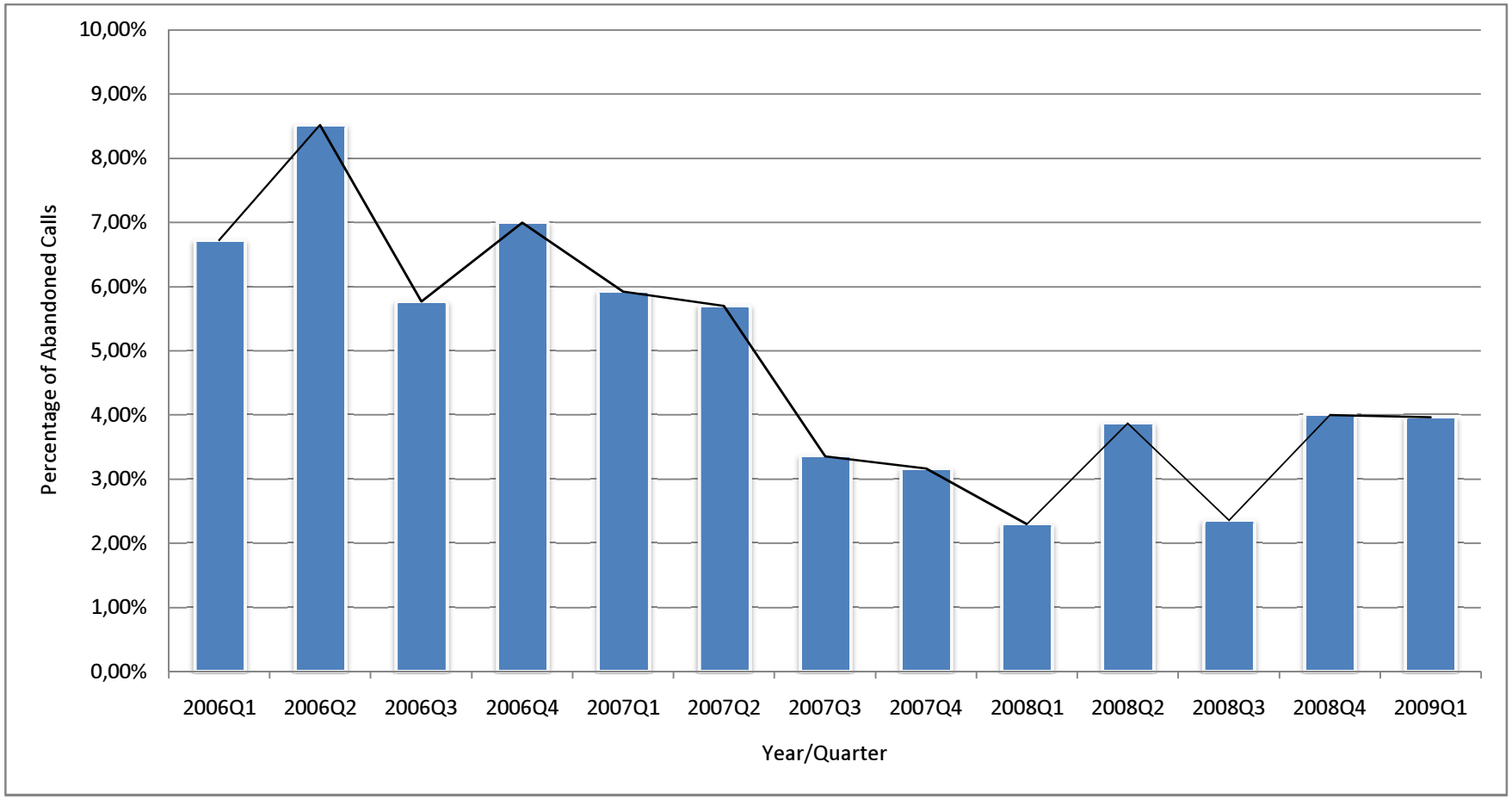

Figure 6. Company A, ratio of abandoned calls to total incoming calls

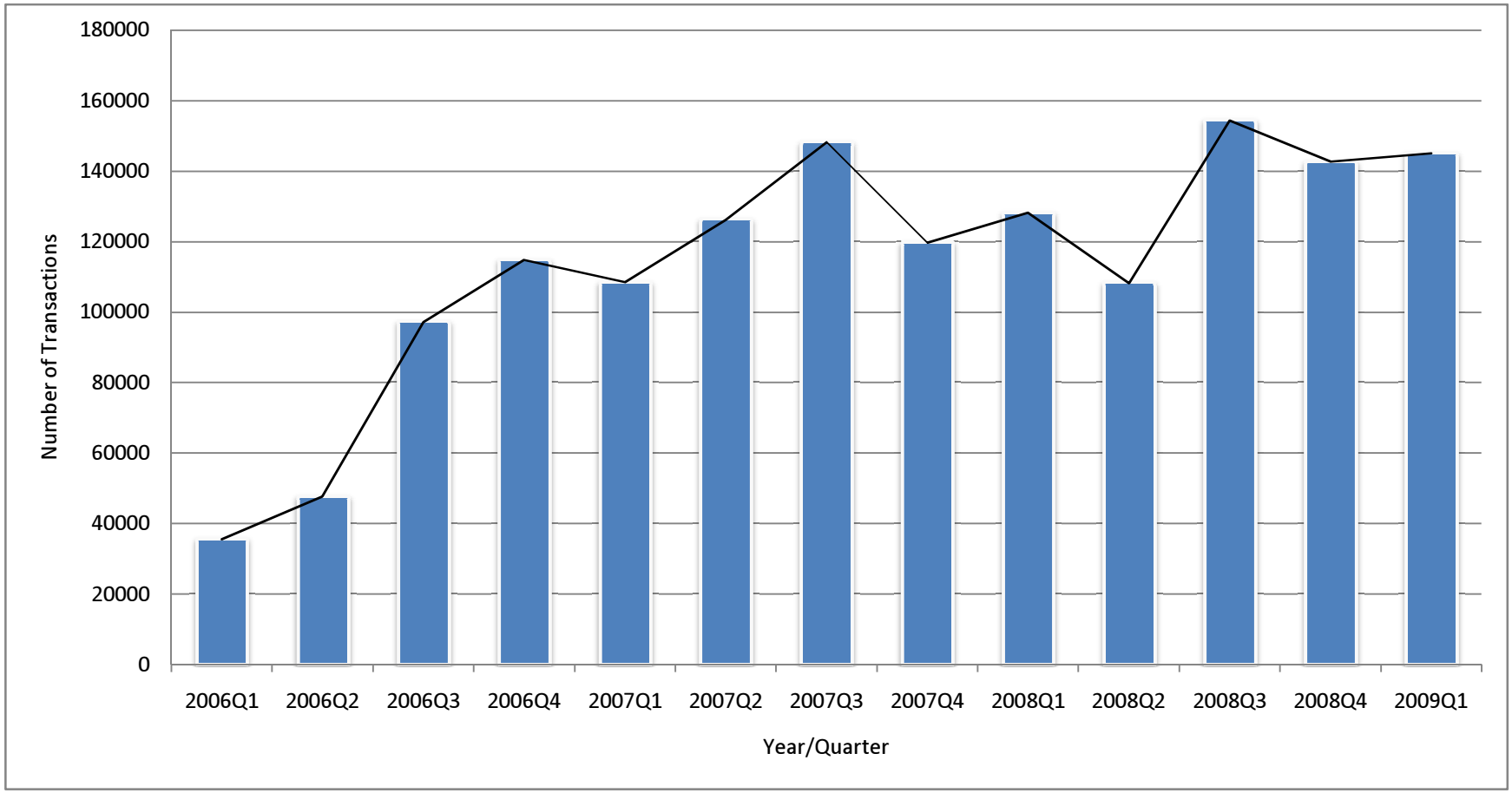

Figure 7. Company A, number of transactions (Absolute)

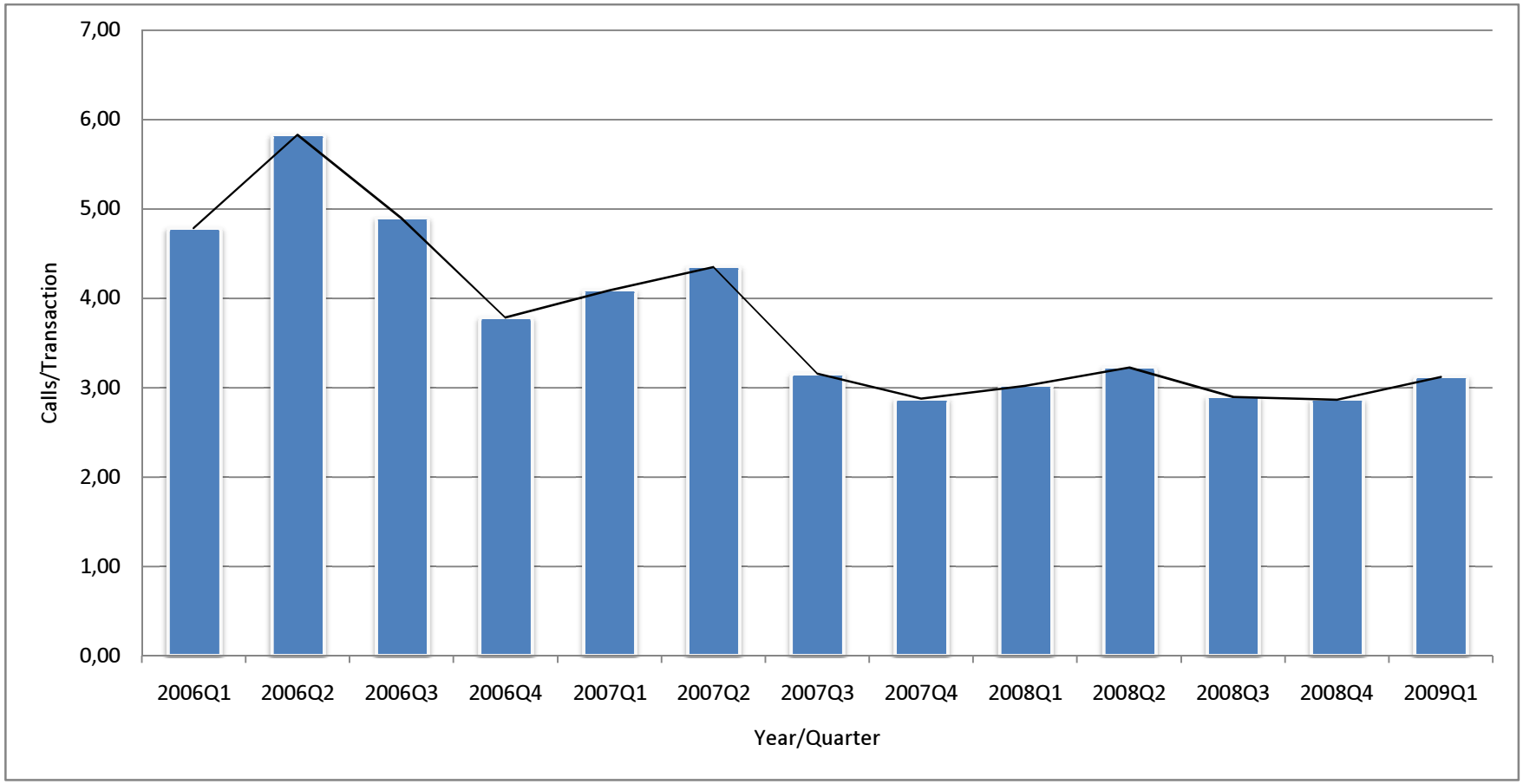

Figure 8. Company A, calls per transaction

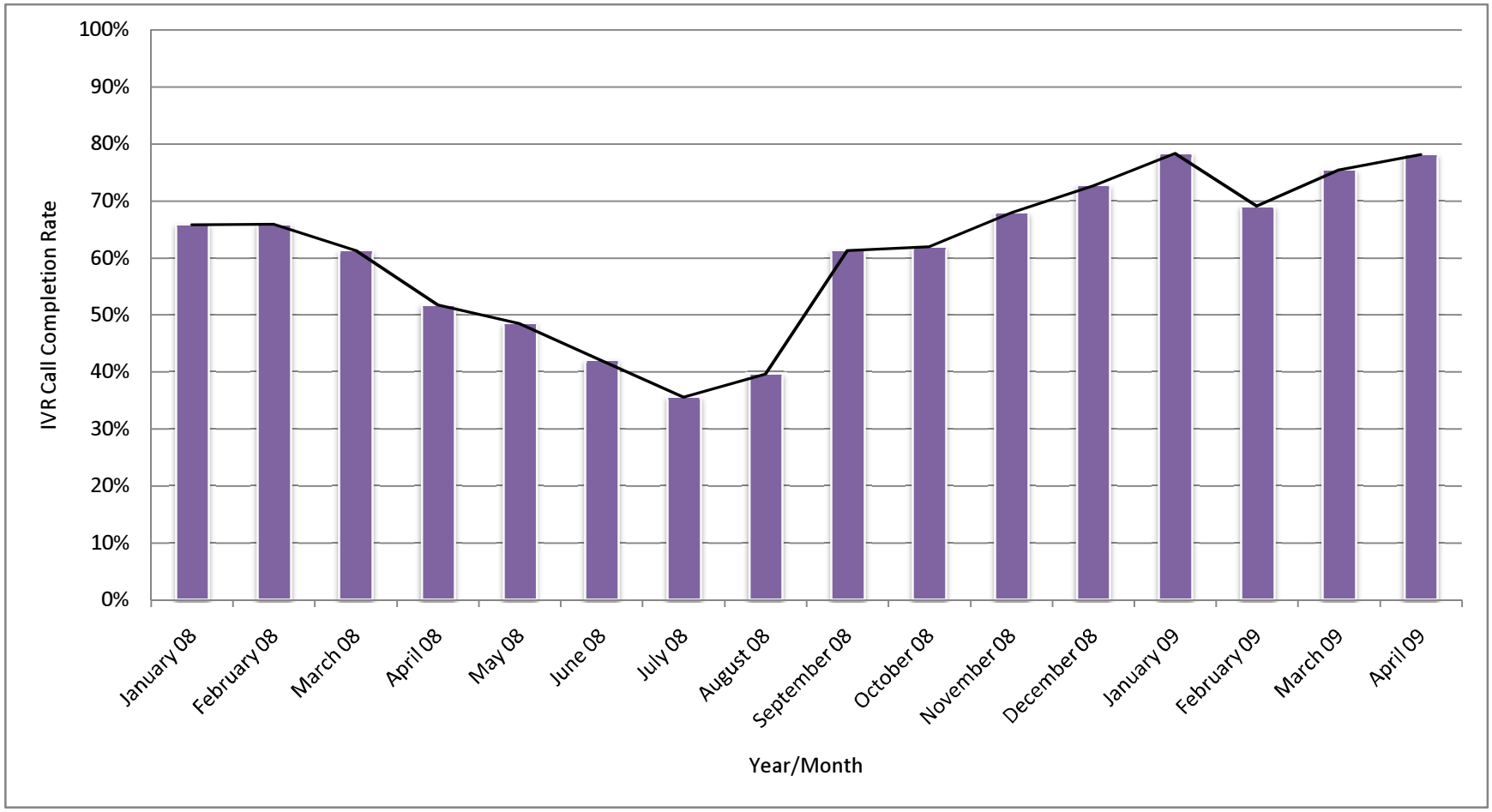

Figure 9. Company A, IVR system call completion rate

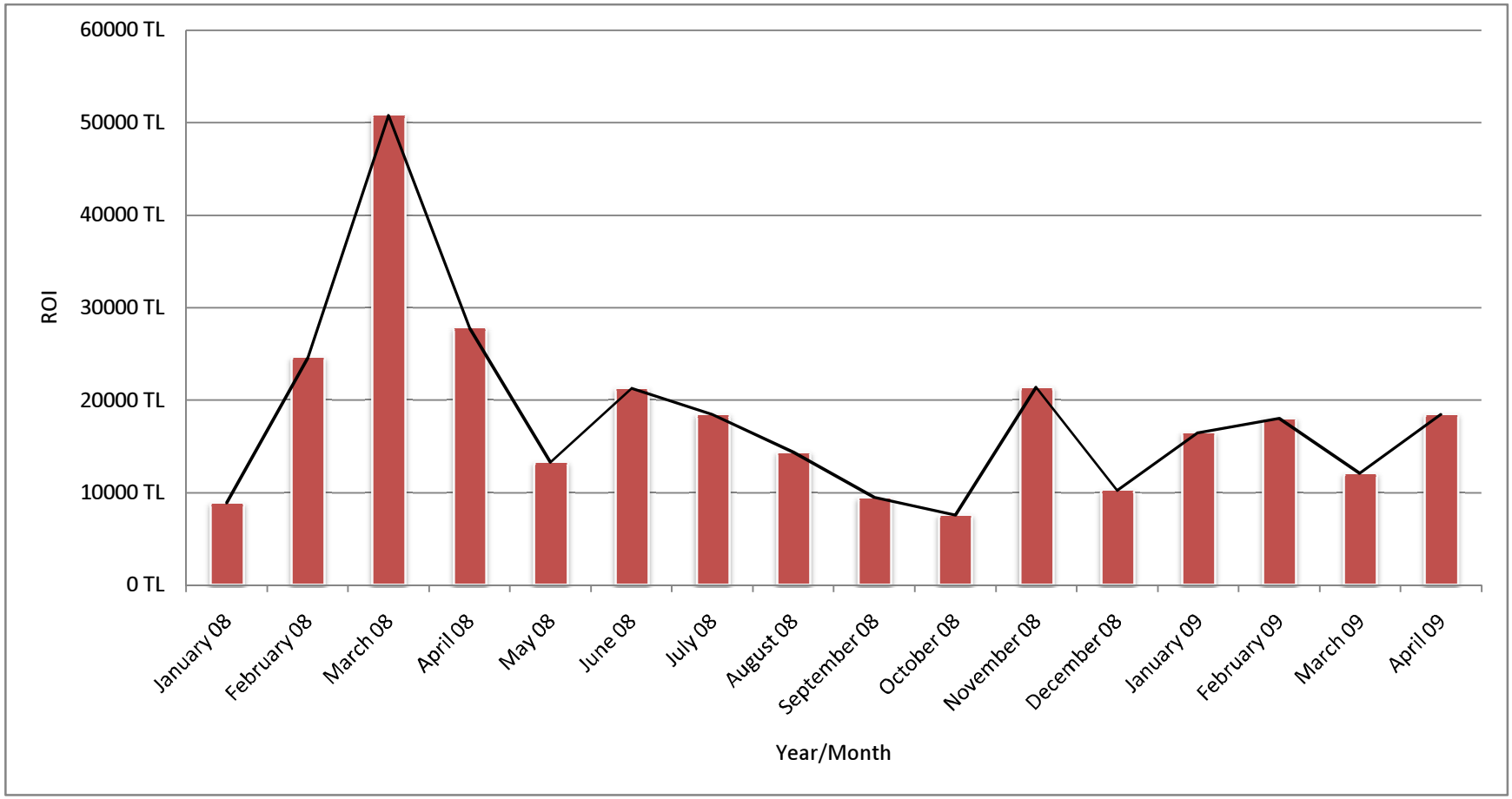

Figure 10. Company A, return on investment of the IVR system

Company B Results

The results for Company B are given in the same format as Company A; to reiterate the figures and their details, Figure 11 is the total number of incoming calls to the contact center, compared to the total number of calls incoming to the IVR system; Figure 12 displays the ratios of agent managed calls versus IVR system managed calls. Abandoned calls are displayed absolutely in Figure 13, and as a ratio to the total incoming calls in Figure 14.

Figure 15 is the total number of transactions that have taken place in the duration of the study, and Figure 16 is the ratio of calls per transaction committed. Figure 17 is the percentage of calls completed in the IVR system without any need for interaction by a live agent. Figure 18 displays the return on investment provided by the IVR system for Company B.

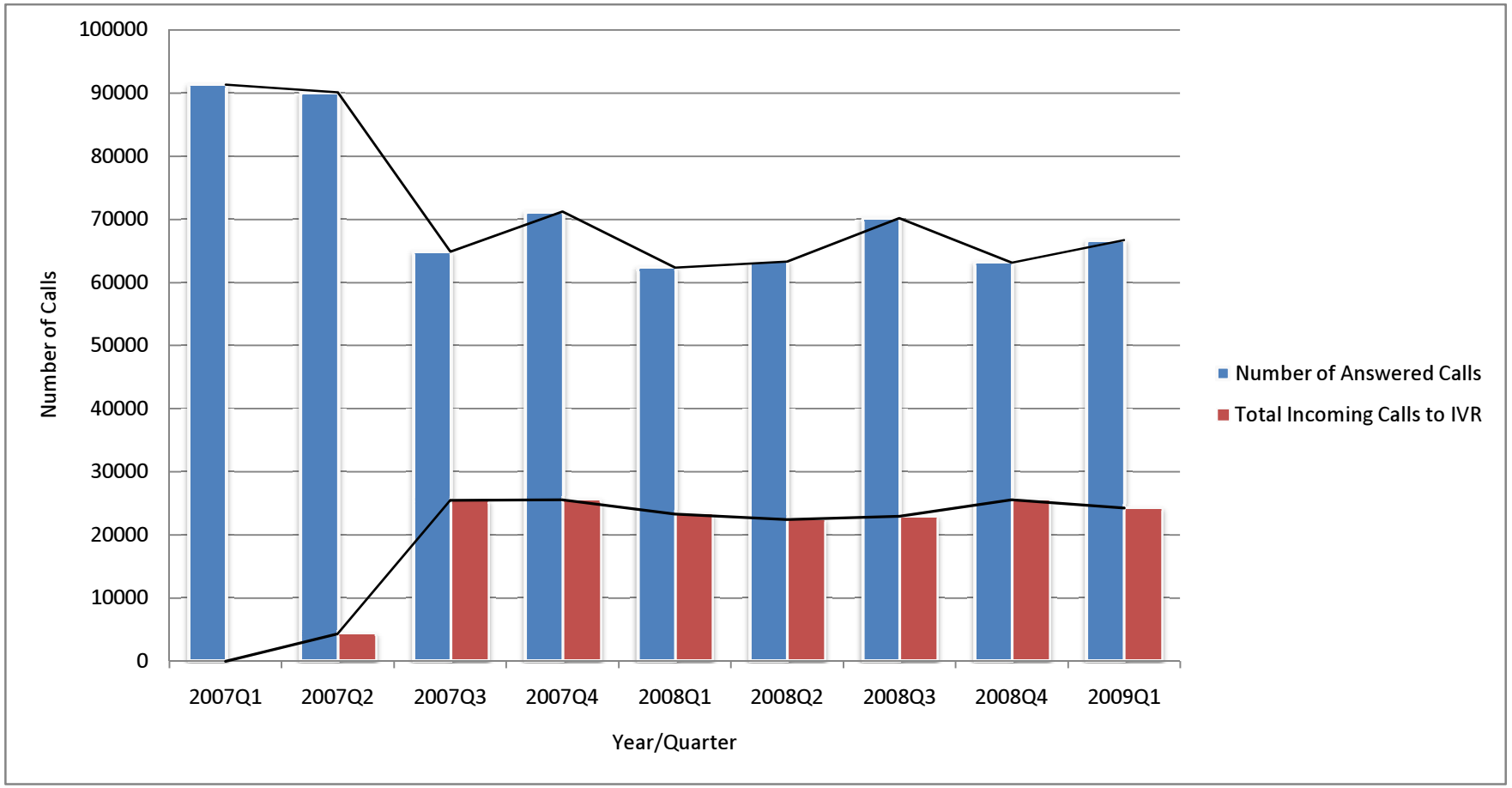

Figure 11. Company B, number of incoming calls

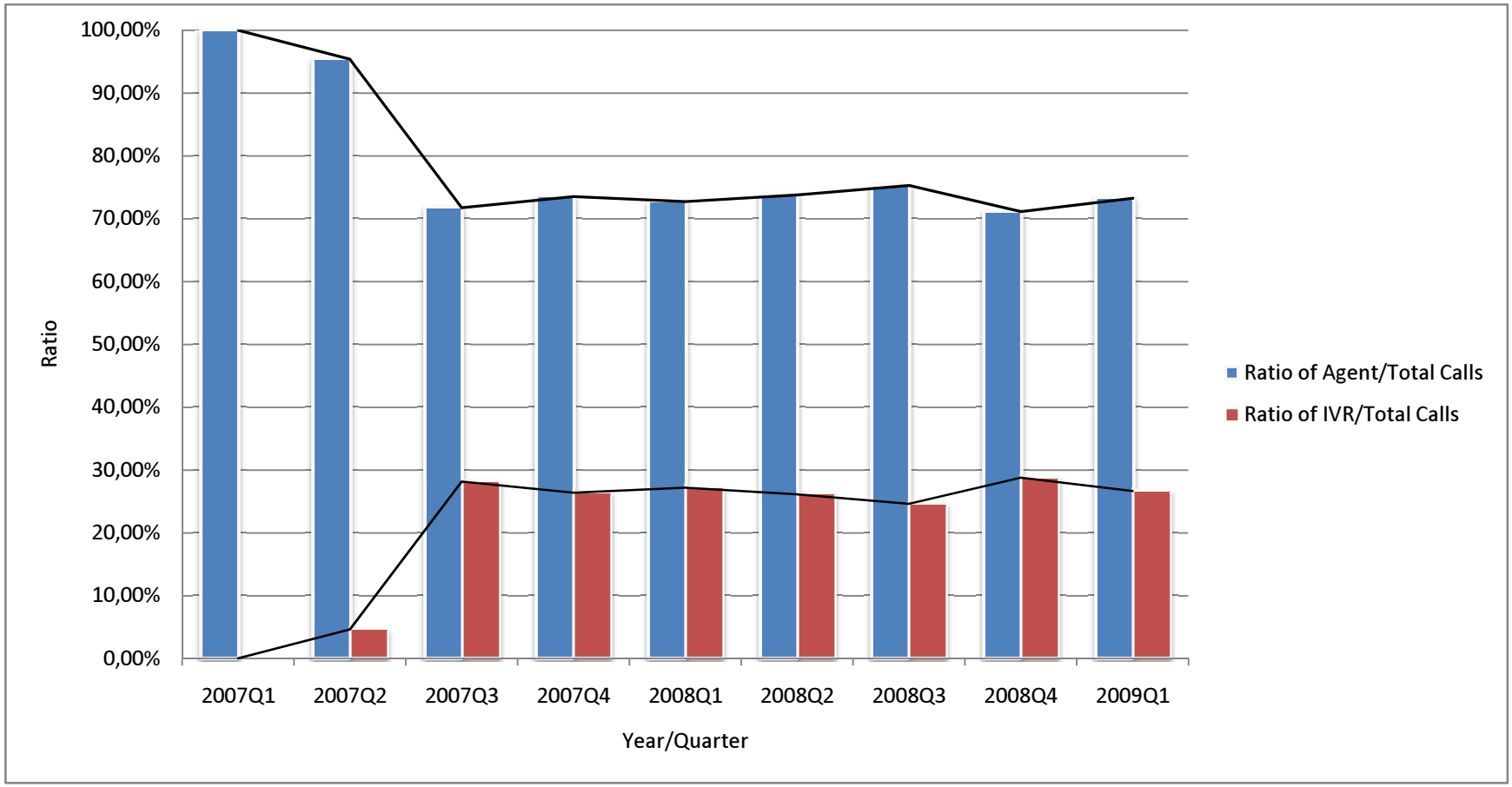

Figure 12. Company B, ratios of agent/total and IVR/total incoming calls

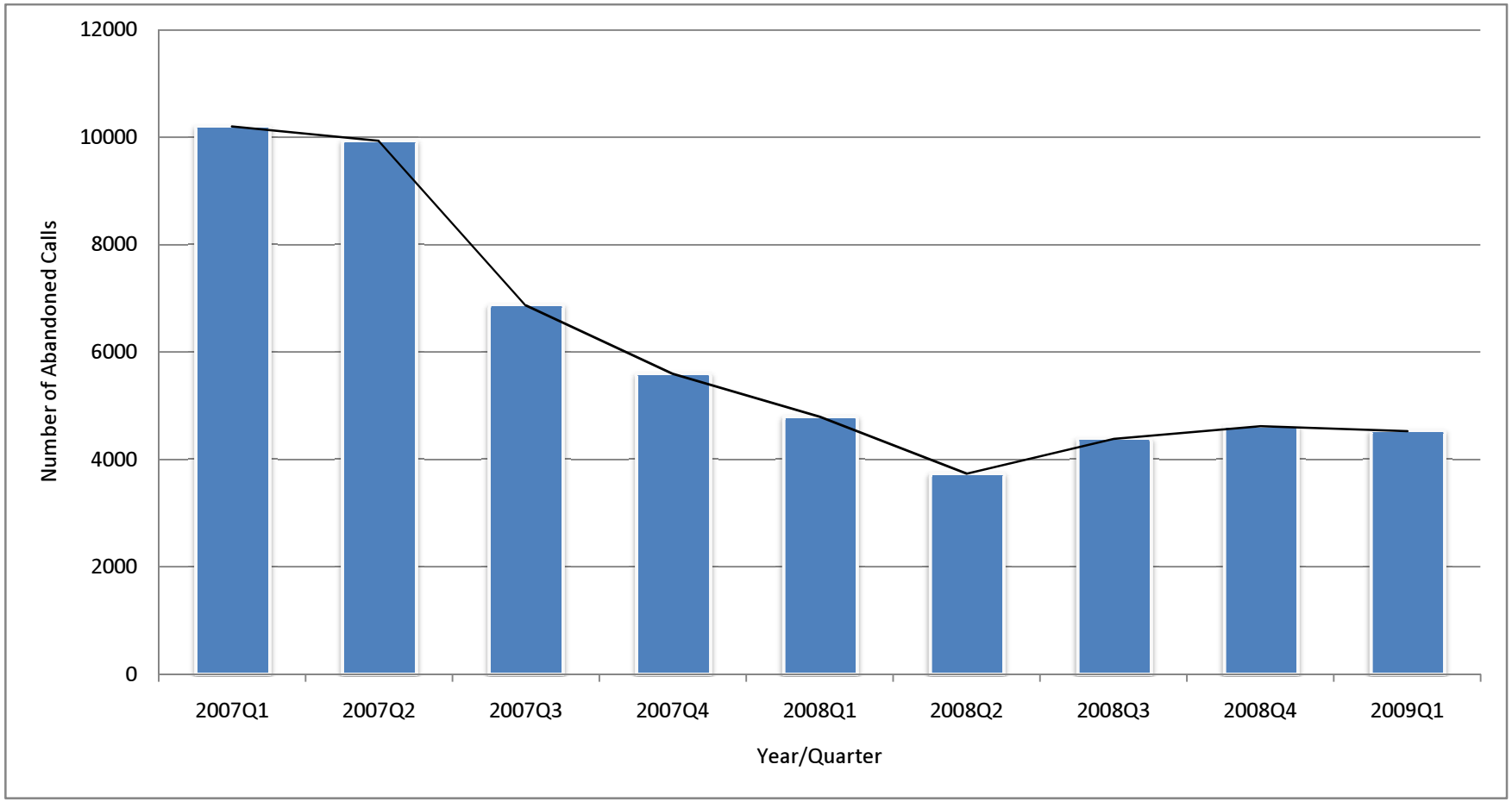

Figure 13. Company B, abandoned calls (Absolute)

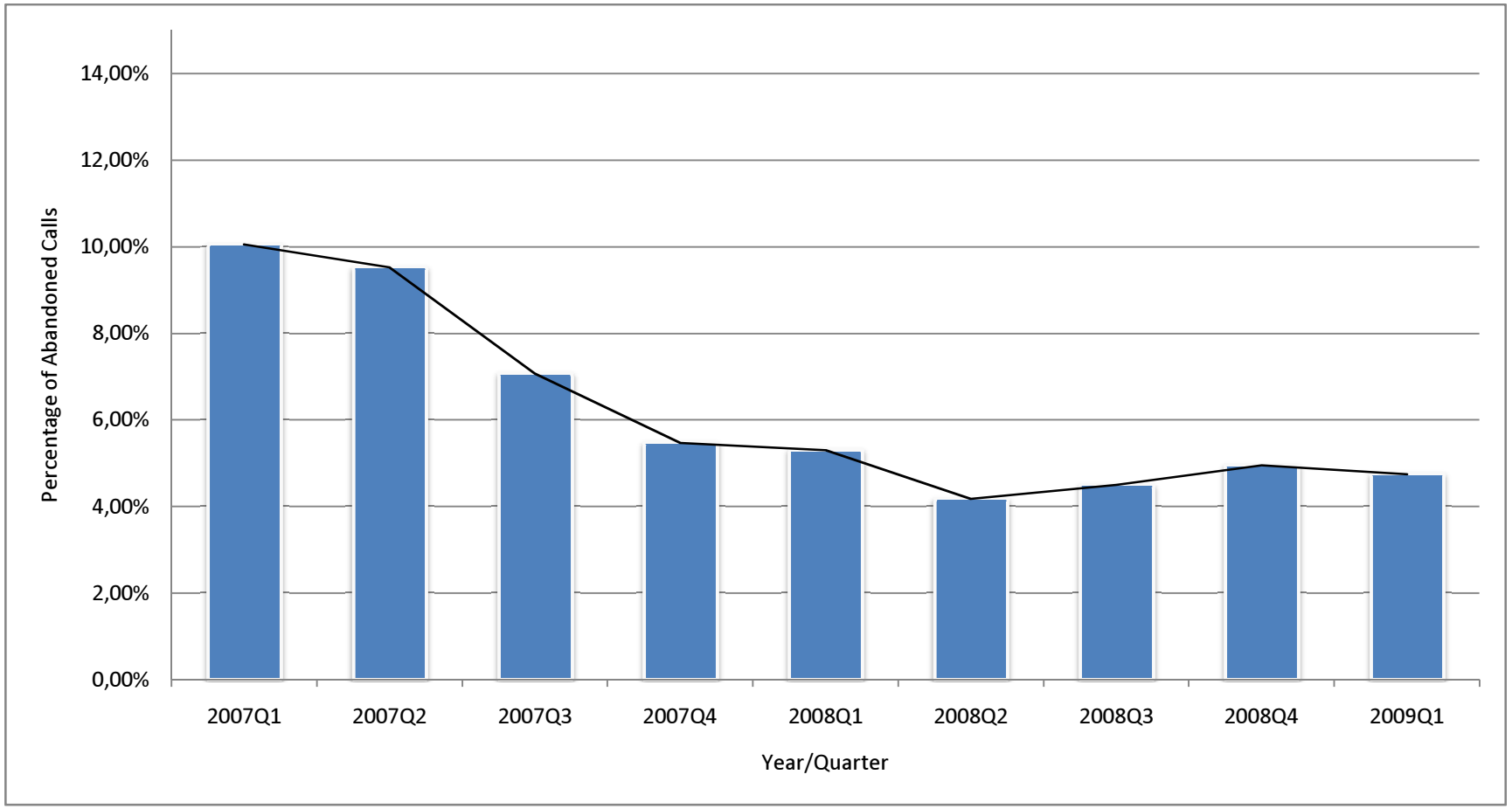

Figure 14. Company B, ratio of abandoned calls to total incoming calls

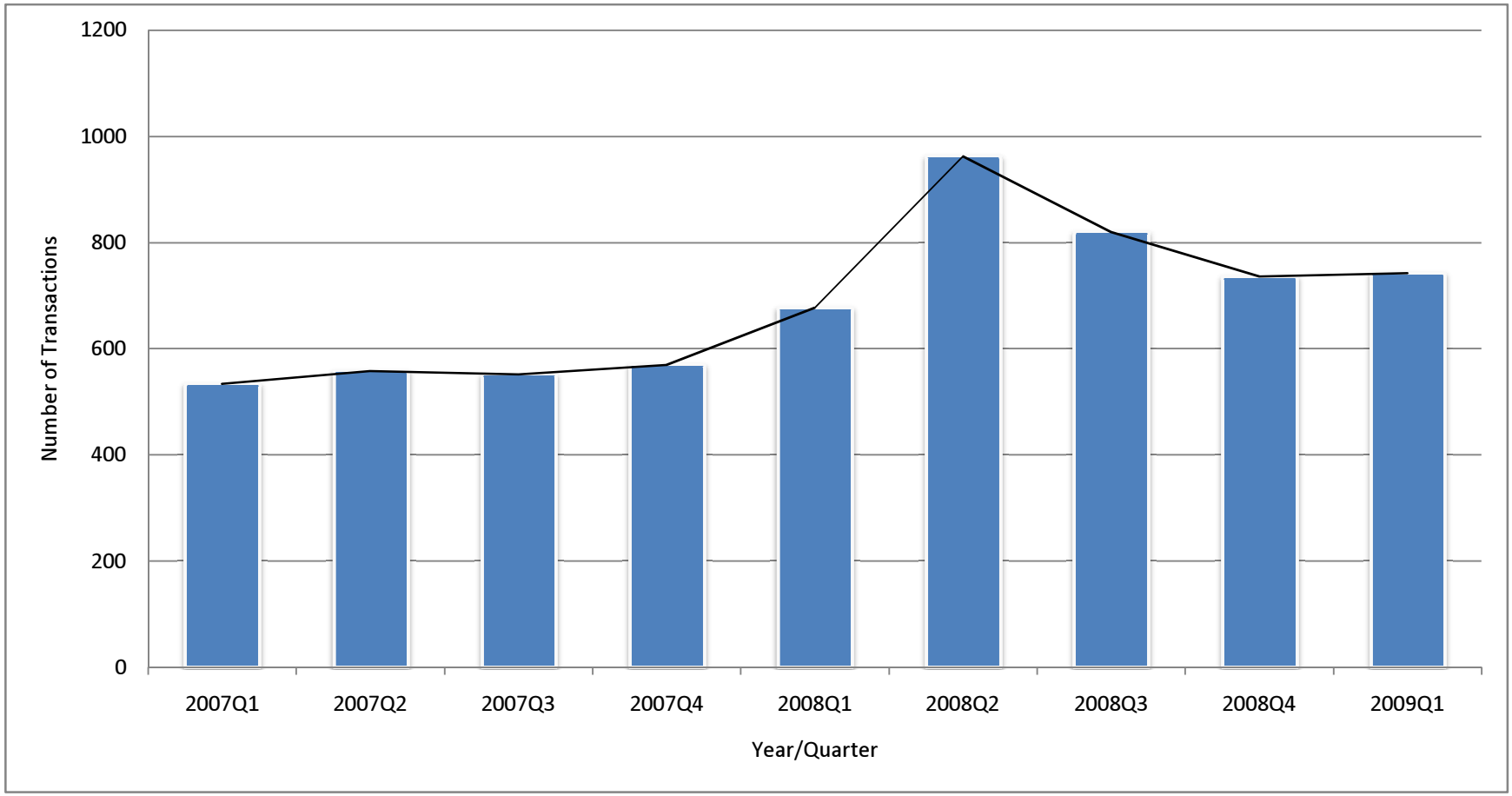

Figure 15. Company B, number of transactions (Absolute)

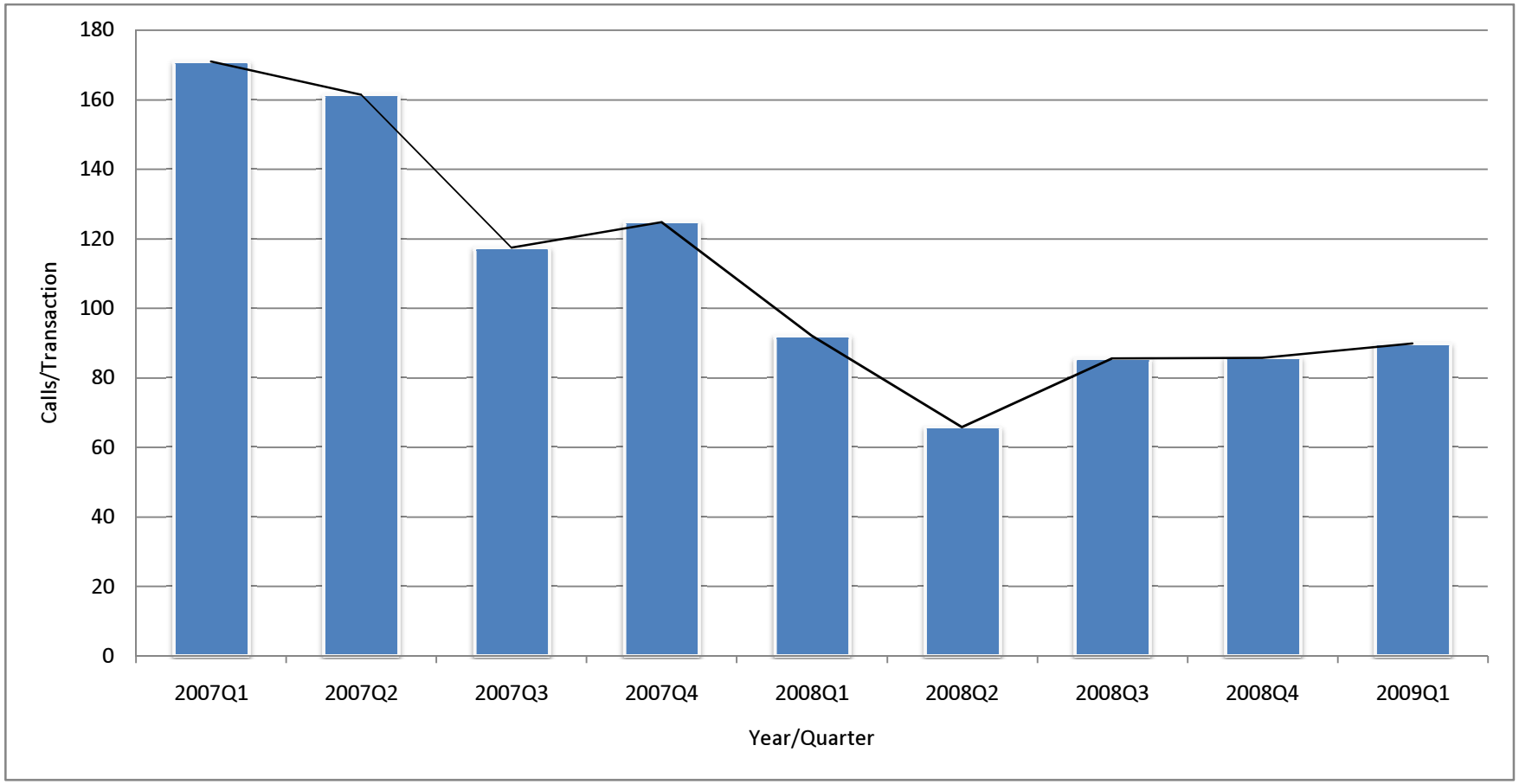

Figure 16. Company B, calls per transaction

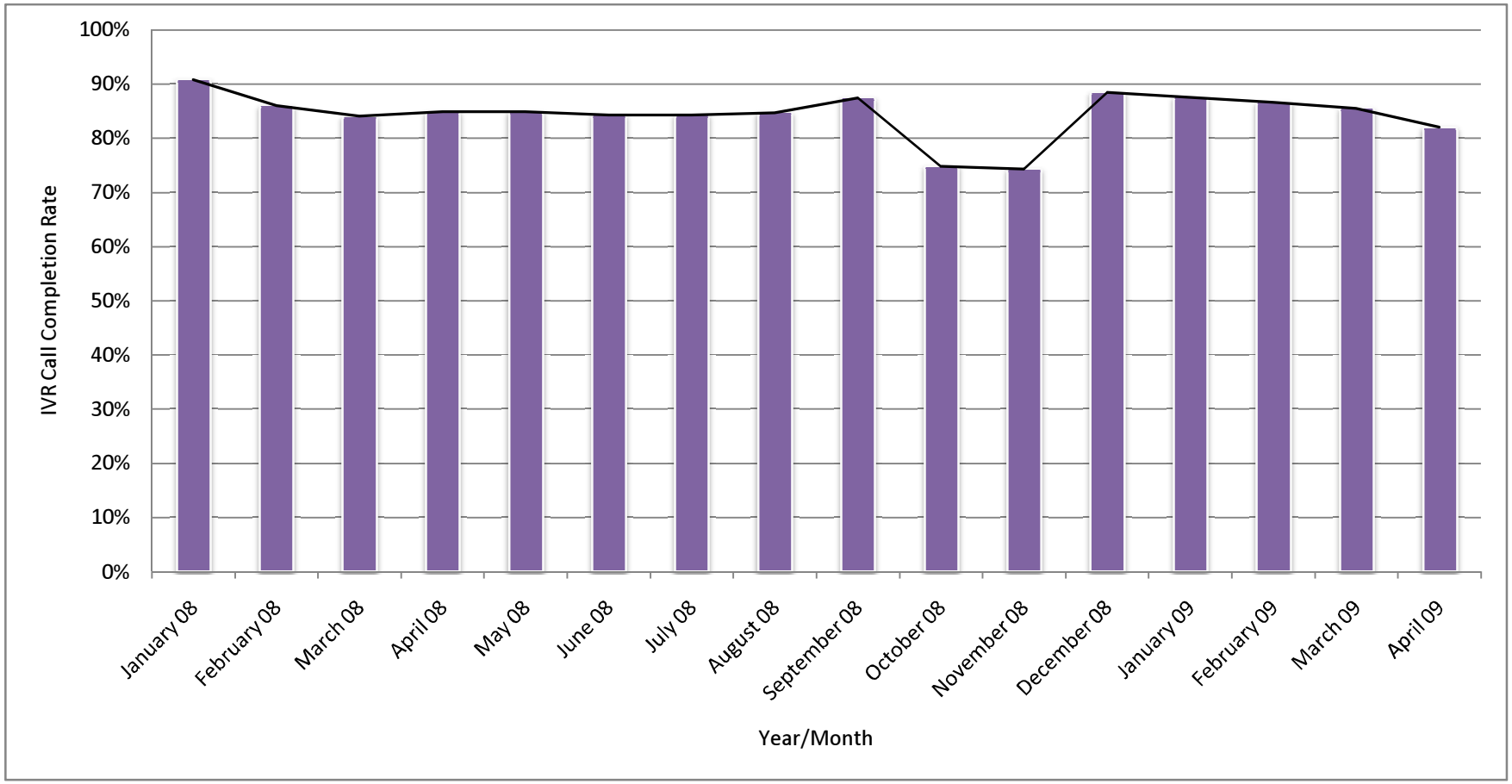

Figure 17. Company B, IVR system call completion rate

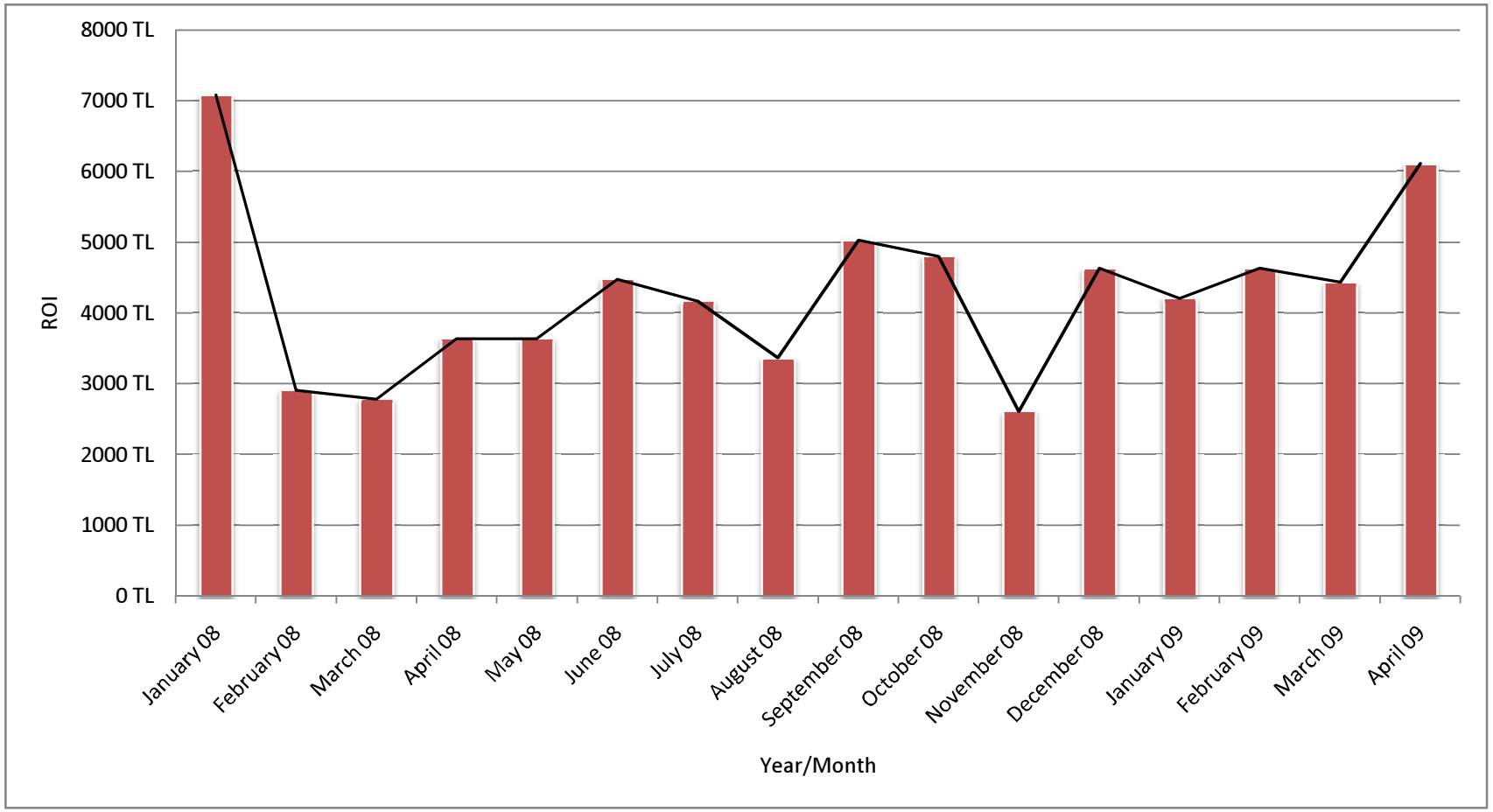

Figure 18. Company B, return on investment of IVR system

Discussion of Results

In general, the results are in line with the expectations previously stated; however, the validity of some propositions could not be ascertained from the amount of data available to the study. To present the findings in a concise manner, the findings are again arranged by theme; three previously expected themes are explained in the Methodology section, whereas any new themes derived from the results are described for the first time in this chapter.

Theme 1: Value as an Investment

The results show a clearly positive return on investment on both companies, as evidenced by the Figures 10 and 18. P1 proposed that a well-designed and well-placed speech-enabled IVR system would perform well as an investment. When the total cost reduced (based on the Invoice) is divided by the number of calls, a sense of how well the system performs from a cost reduction performance can be gleaned. In the Company A system, the value of cost saved per call amounts to 0.345 TL, whereas in the Company B system, it amounts to 0.394 TL; the weighted average of the two values is 0.353 TL. While the formula for charging each call differs for the companies, the values are quite close per call, and the weighted average, along with the absolute return on investment values, gives enough information to conclude that the data in our study is consistent with P1.

Theme 2: Effects on Transactions

The results concerning transactions are twofold; Figures 7 and 15 deal with absolute number of transactions, while Figures 8 and 16 deal with number of calls processed by live agents per transaction.

P2 predicted an increase in efficiency, i.e. a decrease in number of calls per transaction; in the Figures 8 and 16, we can see a significant decrease in this value throughout the lifetime of the system.

P3 predicted an absolute increase in the number of transactions. This proposition is not as easy to demonstrate or refute as the others, as the transaction data does not clearly show an increase. It is very hard to remove the trend from the transaction data, and that means the proposition does not seem in line with the data.

However, there are two factors that remedy the situation: the fact that a cost oriented approach is being taken and that the global economy is in a state of crisis are both reasonable justifications for the inability to observe an increase in the total number of transactions. Actually, sales numbers staying the same during an economic crisis is actually a very desirable situation; whether the speech recognition system has enabled that or not is very hard to determine.

Theme 3: Number of Calls and Load on Agents

The absolute number of incoming calls to live agents and the IVR system are given in the Figures 3 and 11, and the ratios are given in Figures 4 and 12. The number of abandoned calls (calls that were supposed to be answered by live agents, but couldn't

be answered for some reason) is given in Figures 5 and 13, while the ratios are given in Figures 6 and 14. Also, calls completed in the IVR system are given in Figures 9 and 17.

P4 stated that the load on agents will be reduced by the frequency of callers requesting the information supplied by the IVR system, and this reduction of load will result in multiple, intangible benefits. It can be observed from the ratio of calls handled by live agents that the load is, on average, reduced by 22.8 percent, which is a significant reduction. The absolute amount of calls handled by live agents does not decrease in any significant manner, since there seems to be an upward trend in the absolute number of incoming calls to the call center. While the first part is in line with the data, in the second part of the proposition, the intangible benefits stated deserve a section of their own, and thus are explained in a new theme.

P5 proposed a decrease in the ratio of abandoned calls to total calls; this is revealed to hold true from the Figures 6 and 14. Furthermore, the absolute number of abandoned calls seems to decrease as well, even with the increasing amount of total incoming calls.

"New" Theme 4: Soft Benefits

As mentioned in the theoretical part of the study, "soft" benefits are advantages provided by the IVR system that are difficult to quantify. Some theoretical examples are given in the Business Overview section.

In the Company A and Company B systems analyzed, a number of "soft" benefits have been observed throughout the long duration of this study; some of these findings are presented under this theme. However, it should be mentioned that the

findings under this theme are not directly derived from the previous results and mainly supported by the experiences of the personnel; therefore, all findings in this section should be tentatively accepted.

As the literature suggests, in the systems studied, the decrease in the number of abandoned calls leads to a decrease in customer callbacks, and an increase in customer satisfaction. This increase in customer satisfaction does not seem to directly translate into higher revenue; however, further study might reveal a pattern to this situation as well.

The IVR call completion rate is higher on average in the Company B system compared to the Company A system. While this may emerge from the difference in user interface designs, or any other design decision, the most probable cause is the technical differences between the two systems. The Company A system is more complicated and secure, while the Company B system is simpler. This complication has led to poor system performance at times, causing customers to connect to live agents unnecessarily; especially in the second quarter of 2008.

The reduction of load mentioned in Theme 3 increases agent morale, by not having to manage simple and repetitious calls, as mentioned previously in the theoretical section of the study. This increase in morale led to a direct increase in customer satisfaction in both contact centers.

Finally, for some customers, it has been observed that performing transactions through the IVR system proposes some sort of difficulty and that they prefer to speak to live agents. This also has been supported by existing academic literature (Dean, 2008, McCartan-Quinn, et al., 2004); however, with the option of connecting to a live agent at any point, as well as a learning-enabled voice user interface, the customer is either connected to a live agent, or is taken through the

process in a slow manner. The main reason for this negativity seems to be technological aversion, and is generally observed in the older customer base.

CHAPTER 5

CONCLUSION

The main aim of this study was to detail the nature of speech-enabled IVR systems in Turkey, along with demonstrating the advantages they can provide to Turkish companies. Through the examination of data provided by two speech-enabled IVR system implementations, it has been shown that the IVR system is a cost saving option with a rapid return on investment for companies considering lowering their contact center costs.

Both systems have displayed a similar rate of return on investment over time, as savings per call are very similar. This shows that a congruent speech recognition system with a per call payment business methodology performs very well in the Turkish market; especially in the current economical crisis, no or little initial payment makes for a very attractive offer on the part of the business. Speech-enabled IVR systems are very appropriate for this kind of a business model; as calls are being transferred to the IVR system, some portion of the cost reduced by lowered agent-time and talk-time for the company is redirected to the system owners. This leasing-style business model has been successfully applied in these two projects, and the future of similar projects in Turkey looks promising.

A contact center managing calls has multiple priorities in matters that should be analyzed in qualitative methods as well as quantitative methods. Many metrics, such as the ratio of abandoned calls, or the service level are used in order to determine the success of the contact center. Beyond these numbers, the contact

center has to provide its services in a way to satisfy most of its customers, as well as making sure that the agents are providing almost the same level of service to each and every customer through inefficient quality assurance methodologies.

It has been demonstrated in the study that the existence of a working speech-enabled IVR system reduces both the absolute number of abandoned calls, and the ratio of abandoned calls to total calls, which also directly benefits the service level. A significant increase in transaction efficiency in relation with the existence of the IVR system has also been shown in the study; that is, a decrease in the number of calls processed per transaction committed occurs as the information required by callers previous to purchase is distributed via the IVR rather than live agents. This is particularly valid in the airline sector, where the customer needs to make sure that the locations available matches their travel itinerary previous to purchasing a ticket.

In conclusion, a speech-enabled IVR system implementation is a beneficial project for any contact center in Turkey trying to reduce costs while keeping customer satisfaction at the same level. The success of the implementation depends on the quality of development and design, especially on the recognition rate of the system and the usability of the voice user interface. When deciding on the feasibility of a speech recognition project, it should always be kept in mind that the IVR system cannot be a complete replacement for a live agent with the current level of technology, but can only complement the agent services in a contact center, providing a very welcome, and necessary, approach to cost reduction.

Managerial Implications

The points mentioned until now are all observable with the right tools; diligent collection of data and a detailed analysis are enough to provide a contact center with information to compare itself to indicators of success or failure. One of the main points encountered in this study, however, is that as the human factor is inevitably involved in the contact center business; there will be unquantifiable indicators as well as the ones mentioned above, which a manager has to watch in order to be successful in any meaning of the word.

In today's market, the customer's satisfaction has taken its place in front of decreasing costs as a method of generating more revenue and profit for the company. Considering this, a very critical point emerged through the study: all IVR system implementations have to take care in not making the customer feel restricted by taking away the option of speaking with a live agent at any point in the conversation in order to reduce costs further. This type of behavior actually generates significant displeasure on the part of the customer, leading them away to competitors. Rather, the IVR system has to be considered a tool in increasing level of service to most of the customers by increasing agent morale and enthusiasm through automated handling of repetitious tasks. If this approach is taken, as was in both studied implementations, the customer will not be feeling alienated or restricted, and will view the IVR system as an additional option, which exists for the sole purpose of helping them. At this point, it is worth to mention that it has been observed that in most situations, IVR systems cannot increase customer satisfaction; generally a contact center should aim to keep customer satisfaction at the same level while implementing an IVR system.

Another interesting point that arose in the study is that the speech recognition system has a unique advantage placement-wise in Turkey: it is a fairly new and unheard of technology by the general public. Initial reaction from many users has been awe and wonder, which generally leads to a positive bias towards the system. Obviously, this advantage will not exist forever, and companies who can leverage this potential will be one step ahead of the rest. Here, it should specifically be mentioned that transactional systems do not yet exist in Turkey, and after some studies are conducted in existing systems in foreign countries, an investment in a transactional system (such as a stock purchase/sale automation system, or a bill payment system) might harvest this potential.

This unique advantage also offers a unique challenge as well: the voice user interface has to be designed in such a way that a technologically unfamiliar user will be able to perform the tasks the system requires, without the system being abrasive or frustrating. This becomes a more sensitive issue, as the customer base using the IVR system is expanded. The level of education and familiarity with technology shows a significant deviation in Turkey based on multiple factors, so these factors (such as location, income, etc.) have to be considered in designing the voice user interface; even when deciding on the feasibility of the IVR system for the project at hand.

Limitations

The present study has three main limitations. First, speech recognition systems are relatively new to Turkey; not many applications exist, which limits the extent of data available from multiple companies in the same sector. Second, the study focuses on inbound calls and inbound call handling systems; contact centers working with

outbound calls might experience different results. Third, the data in the study is asymmetrical time-wise; Company A data goes back to 2006, while Company B data goes back to 2007. This asymmetry causes some amount of hesitation in declaring some propositions consistent or inconsistent with the data. Further data collection and analysis will help to clarify some points.

Future Research

As not many academic studies exist on the topic of IVR systems viewed in a business perspective, multiple points of potential study originate from this work. The unquantifiable benefits of the IVR system can perhaps be examined further by a qualitative method. Transactional speech recognition systems do not exist in Turkey yet, but they are probably very close to surfacing; foreign transaction-based systems may be analyzed to construct a framework for Turkish implementations. Also, a qualitative study based on reactions of Turkish users towards speech recognition systems might discover different results than existing studies conducted in other countries. Another angle that might be studied is customer satisfaction; a qualitative study on how a speech recognition system affects customer satisfaction and loyalty in detail is an interesting and important subject.

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