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Reducing Call Center Wait Times Through Six Sigma

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The six-sigma process was applied for improvement of efficiency (cost) and quality of customer service at a medical education company. Parametric and nonparametric tests showed (a) a poor capacity utilization of the in-house call center versus outsourced calls and (b) a statistically significant reduction in call wait times and talk times. Cost per call was reduced from $16.70 to $3.50, with overall savings over $125,000 annually. The company transitioned permanently to the outsourced call center. The overall benefit is contingent on the ability of phone operators to answer questions comprehensively and to customers' satisfaction, which has yet to be determined.

Keywords: Six Sigma, Call Center, DMAIC, Quality Control

JEL Classification: M11, M54

I. Introduction

Customer satisfaction is critical to call centers for maintaining both company profitability and viability. Over the past decade, companies have experienced pressure to improve their productivity, quality, and customer service, yet have been required to maintain or reduce operating costs (Akbulut-Bailey *et al.*, 2012). Customer service and cost reductions have received increased focus for companies and call centers across the globe. Ultimately, customer satisfaction is a matter of quality and a measure of "the extent to which a product successfully serves the purpose of customers" (Jahanshahi *et al.*, 2011, p. 254). Furthermore, there is a strong correlation between customer satisfaction and company loyalty that results in company profitability (Jahanshahi *et al.*, 2011).

Six sigma is a business process improvement approach that targets the improvement of the efficiency and quality of output using statistical methods, models, and process improvements (Prasanna and Vinodh, 2013). The six-sigma approach has been applied across many industries and processes within them to analyze the effectiveness of procedures and their impact on quality. This paper discusses the application of six sigma and its Define, Measure, Analyze, Improve, and Control ("DMAIC") procedure (Wang *et al.*, 2014) to define inefficiencies in a call center for a U.S. medical education company with the goal of evaluating improvements and alternative solutions. In systematically outlining the application of DMAIC to improve the quality of the customer service call center in terms of efficiency both for the company in terms of staff cost and for customers in terms of call wait times, this research demonstrates the value of the DMAIC process in improving quality for the company.

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Given the role of customer satisfaction in business success through company profitability and viability, it is important to understand both how changes in areas of customer interaction impact customer satisfaction and how these changes impact operating costs. The case presented herein is motivated by the need to balance these two areas—customer satisfaction and operating costs—for optimal performance and business success. In doing so, this study contributes to the current body of knowledge on application of the six-sigma process for call center profitability and viability through a detailed presentation of the DMAIC process in the case of a U.S. medical education company. In demonstrating the process for the company in this study, this paper emphasizes the value of the DMAIC approach as a business process improvement methodology, and also provides enough robustness in the approach to allow for the methods to be reproduced for similarly situated call centers beyond the case presented herein. To this end, this paper begins with a review of the literature focused on business process, improvement methodologies, the six-sigma process, six-sigma successes, and call center needs, followed by an overview of the methodology, including an introduction to the case study, the problem experienced by the company, and the associated research questions and hypotheses. Next, findings are presented to trace the decisions made by the company, alternatives to these decisions that were considered, and the data supporting each of these decisions. Finally, the discussion addresses the company's ultimate decision to outsource the call center and how this initiative addressed their two problems of wait times and staff costs.

II. Literature Review

A. Business Process Improvement Methodologies

The success of any organization is dependent on its ability to attain acceptable performance quality through identifying opportunities for improvement in its processes to yield a better outcome. Process improvements commonly fall into three categories: quick hits, incremental improvement, and reengineering. Quick hits are low risk improvements that provide immediate rewards; incremental improvements focus on making small changes over time to achieve gradual progress in business results; and reengineering focuses on major changes at the organizational level to yield process transformation and dramatic results (Shin and Jemella, 2002). These business process improvements may focus on the primary processes of an organization that directly relate to the customer or support processes, such as accounting or human resources (Hill *et al.,* 2002).

Research on Business Process Improvement ("BPI") can be carried out using many different approaches. Vero-Baquero *et al.* (2015) argue that while BPI is more of an "art than a science," there are five phases: 1) identify business process models that can be monitored and improved, 2) collect data on the performance of these models, 3) capture behavioral and structural data about the implementation of the models, 4) establish and implement quality control measures, including non-compliance, and 5) use the findings from Steps Two through Four to assess deficiencies in the process identified in Step One, and repeat after the improvement processes have been implemented to continue the BPI method. BPI methodologies have differing procedures and tools, but they all seek to understand processes to improve quality (Rashid and Admad, 2013).

As many BPI efforts continue to fail, it is important to consider both the process and the outcome. Over the last thirty years, many BPI strategies have been touted as superior to others. As many of these methodologies share common features, they are evaluated by their effectiveness (Rashid and Ahmad, 2013). According to Rashid and Ahmad (2013), there are eight distinct BPI

methodologies that are leading the field: model-based integrated process improvement methodology (MIPI), super methodology, benchmarking methodology, PDCA methodology, six-sigma methodology, lean thinking, kaizen methodology, and total quality management (TQM). There is also a hybrid six-sigma methodology and lean methodology, referred to as lean six sigma (Rashid and Ahmad, 2013). This research employs six sigma, defined by Rashid and Ahmad (2013, p. 47) as "a business strategy that aims to determine and remove errors, defects, failure causes in business processes through concentrating on outputs, which are imperative to customers. It is also a quality measure that seeks to eliminate defects using the statistical methods application." As the case company is focusing on improving call center quality, both in terms of wait times and staff costs, the six-sigma process is an appropriate quality measure for this research.

B. The Six-Sigma Process

The six-sigma process is a technique created in 1986 by Bill Smith, an engineer and scientist from the Motorola Company (Godfrey, 2002; Rashid and Ahmad, 2013), but it did not become well known until Jack Welch of General Electric (GE) took the process as his business' central focus in 1995. While six sigma has traditionally been used by manufacturing and logistics companies to improve product quality and produce line efficiencies, it is now widely used in across companies in many different industries as a means to significantly reduce cost, improve cycle times, and increase customer loyalty and satisfaction (Venkatesh *et al.*, 2014). Six sigma is used to improve the efficiency and quality of a process and its output by removing the underlying causes of defects, where defects are defined as any results that do not fall within the specified parameters. The term "six sigma" was derived from σ, a statistical term meaning standard deviation, which indicates a process with extremely low variability and extremely high consistency (Montgomery and Woodall, 2008). As the fastest growing management system in the business industry, six sigma has been claimed to save billions of dollars worldwide for businesses in the past decade. Six sigma combines statistical-based quality improvement methods with organizational support and professional training to tackle problems on a project-by-project basis (Tjahjono *et al.*, 2010). The common goals of these projects are to enable accomplishment of specific processes to meet key requirements with a high degree of consistency.

The basic improvement unit by six sigma is a process, which can be a service, such as customer service, a service provided to customers outside, or an internal process of a business, such as a production or billing procedure (Nakhai and Neves, 2009; Noone *et al.*, 2010; Wang *et al.*, 2014). The purposes of the improvement are to enhance performance outcomes and reduce performance variation, leading to reduction of defects, greater quality of service, improved employee efficiency, and higher profits to the effect of business excellence. These improvements occur through the five phases of DMAIC (Tjahjono *et al.*, 2010; Rashid and Ahmad, 2013; see Table 1).

Table 1: DMAIC

Step	Description
Define	Define the problem, the project goals, and the customer.
Measure	Measure the current process and establish baselines.
Analyze	Analyze the problem to determine the defects and the root causes of those defects.
Improve	Improve the process by eliminating the defects identified.
Control	Establish controls for the new process to eliminate reoccurrence of prior defects.

In the *definition* phase, a problem is defined and a related analysis is performed. In the *measure* phase, the selected problem is operationally defined to enable measurement of a characteristic critical to quality ("CTQ"). In the *analyze* phase, causes and influence factors determining CTQ behaviors are identified. In the *improve* phase, adjustments to the problem are designed, implemented, and applied to improve performance and qualities of CTQ. Lastly, in the control phase, the control system and process management are modified based on results from the analysis and improvement phases (Van den Heuvel *et al.*, 2006). Each of the DMAIC phases contains several steps to guide the project.

As a disciplined approach in quality management, six sigma is unique among many other quality improvement approaches, including the popular total quality management ("TQM") approach. Briefly, the major differences of six sigma can be summarized as (a) it "places a clear focus on achieving financial returns to the bottom line of organizations;" (b) it is important to have strong leadership with "support required for its successful deployment;" (c) its problem solving methodology "integrates human and process elements of improvement;" (d) "it utilizes tools and techniques for fixing problems in a sequential and disciplined fashion;" (e) "it creates an infrastructure of champions, master black belts, black belts, and green belts to lead, deploy, and implement the approach;" (f) "it emphasizes data and decision making based on facts," not assumptions; and (g) "it utilizes statistical concepts, process controls, and experimental design to facilitate defect reduction through variability control" (Antony, 2006, p. 244).

C. Six-Sigma Successes

Six sigma has been applied successfully in manufacturing companies, but its application in service industries is limited comparatively (Arumugam *et al.,* 2012). Multiple service-oriented businesses considered the success of the six-sigma process to be limited to the manufacturing sector, without realizing that it can bring significant financial and other returns to service-based organizations. For instance, most service providing companies perform at sigma quality level less than 3.5 with a 23,000 ppm (parts per million) defect rate or expressed as 97.7%. By using the six-sigma approach to improve the sigma quality level to 4.0, it will result in a drop of the defect rate significantly to 6, 210 ppm or 99.38%, which means clearly an improvement of 3.5 fold in performance and financial return (Arumugam *et al.*, 2012).

Countless business organizations have benefitted from six sigma and its quality-improving approach. To give a few examples, Citibank Group decreased its internal call-backs by 80%, its external call-backs by 85%, its customer cycle time by 67%, and statement process cycle time by 46% (Rucker, 2000). Companies employing six sigma in the healthcare industry increased 33% in radiology throughput, and decreased 21.5% in radiology costs, generating savings up to

$1.2 million dollars (Thomerson, 2001). In addition, British Telecom Wholesale applied six sigma to increase customer satisfaction level and save over $100 million dollars (Best Practices, 2006).

Well-designed studies have been conducted to determine critical success factors (CSFs) in successful deployment of six sigma in service industries (Antony *et al.,* 2007; Chakrabarty and Chuan, 2007). It was found that, among fifteen CSFs, the most important CSF was relating six sigma to business strategy, the second most important was project management skills and customer focus, and the third most important was management involvement and commitment. Determining critical success factors helps to promote continued improvement and establish relations between quality tool uses and company performance.

Wait time for various processes is used as an important performance metric in hospitals. Six sigma can be used to analyze existing hospital processes to determine the root causes of longer average wait time and re-design specific processes to reduce average wait time drastically (Van den Heuvel *et al.,* 2006; Yu and Yang, 2008). Similar six-sigma approaches have been applied to hospitals worldwide to achieve wait time reduction and sustainable cost reduction in wait time of registration (Yu and Yang, 2008), customer cycle time (Kemper *et al.,* 2010), wait time for staff members like nurses, clinicians, and technicians (Gijo *et al*., 2013), wait time for a periodic health evaluation (Wang *et al.,* 2014), and wait time for an outpatient surgery process (Southard *et al.,* 2012).

D. Call Center Needs

Six sigma, since its introduction by Motorola in the 1980s, has been widely implemented in both the manufacturing and service sectors. Its use in the service industry, however, remains controversial (Laureani *et al.,* 2010). Chakrabarty and Tan (2006) argue that implementing six-sigma methodologies for BPI should not be problematic so long as key performance indicators ("KPIs") are identified for the service process and evaluated for critical to quality characteristics ("CRQs"). This is not viewed as a barrier to its use, however, because "six sigma is a generic method. The advantage of such methods is that they are versatile" (de Mast and Lokkerbol, 2012, p. 605). The procedures can thus be adapted to the service industry accounting for KPIs and CRQs, as recommended by Chakrabarty and Tan (2006). Specifically relevant to this study, a six-sigma approach has been successfully applied to service-oriented companies to improve call center wait times, reduce variation in customer service procedures in call centers, and reduce related costs (Laureani *et al.,* 2010). Call centers are critical for multiple businesses that are struggling to provide better services at a lower cost. Given the large operating volume of call centers, even a slight improvement in sigma value is expected to reduce the defect rate –which in the case of calls translates to satisfactory responses to calls— and increase financial benefits to the bottom line of organizations. The present study used DMAIC tools to solve problems and to improve the first call resolution, increase customer service satisfaction, and achieve significant cost improvement.

E. Shortcomings in the Literature

Although the six-sigma process and associated successes have been well documented in the literature in the areas of manufacturing and the service industry, there is a paucity of research that systematically demonstrates how KPIs and CRQs can be incorporated in real examples with robust data provided for reproducibility. Given that six sigma has been labeled a "generic method" (de Mast and Lokkerbol, 2012), it is important to advance the literature to demonstrate the many

ways in which it can be used to improve business performance and viability. Furthermore, there is limited research presenting the use of the DMAIC process in improving call centers for benefiting the bottom line of organizations; yet, organizations are increasingly reliant on call centers for customer service. Thus, the literature is ripe for more research demonstrating the application of the six-sigma DMAIC process in decisions related to call centers.

III. Methodology

Case studies are the preferred research design for the implementation of six-sigma methodologies and the application of DMAIC given the in-depth nature of the process (de Mast and Lokkerbol, 2012). Based on the review of BPI methodologies dominant in the extant literature, six-sigma methodologies were determined to be most suitable for the case of a Jacksonville, Florida, not-for-profit company that provides medical education programs to physicians and healthcare professionals, herein referred to by a pseudonym, "MedicEd." This section systematically outlines the implementation of the DMAIC procedures in the case study company, beginning with an overview of the case to which the DMAIC methods were applied and the steps taken in regards to the case as prescribed by the DMAIC method. In the next section, Findings, we present the findings from each of the steps, including the actions taken as the result of each finding, and the outcome of the process. These findings are then presented and discussed in the next three sections, Results, Discussion and Conclusion.

This research applies six-sigma methodologies to the case of MedicEd. The company owned and operated the call center in-house until 2015, staffing the center with both full-time and part-time employees, for the purpose of providing clients and customers with a customer support center for questions or concerns. By employing a six-sigma approach in evaluating the customer support call center, we could identify and eliminate non-value-added steps to help the company achieve better customer interaction through improved services, reduced wait times, and reduced costs. This paper thus describes how the six-sigma DMAIC process could be applied in the case of MedicEd, and also demonstrates the value of the process for this case and more broadly through revealing the outcomes of the process.

A. Overview of the Problem

MedicEd experienced pressure to improve productivity, quality, and customer service while being able to maintain or reduce costs. The company identified a potential area for substantial improvement by outsourcing customer service calls instead of maintaining an in-house customer service call center. This research employed the six-sigma DMAIC process to evaluate the move to an outsourced call center (see Table 2). We began the assessment by reviewing the problems described by MedicEd regarding productivity, quality, and cost in regards to customer service. Next, we developed baseline measures of two KPIs—capacity utilization and staff costs— for the purpose of providing a better understanding of the use and for having a baseline to compare against once changes have been implemented. We then analyzed the preferences of the managers in regards to staff costs and wait times for each of four potential call center strategies. Based on this review, one of the strategies—outsourcing the call center—was identified as the most suitable for meeting the needs of the company, and this change was implemented in the "improve" step of the process. Finally, we evaluated the change through an assessment of the key variables to determine that the BPI strategies were effective for the case company.

Table 2: DMAIC Study Application

Step	Application
Define	MedicEd problem defined as pressure to improve productivity, quality, and customer service while maintaining or reducing costs.
Measure	MedicEd's pre-outsourcing capacity utilization and staff costs measured to determine baselines (see tables 3 and 4).
Analyze	MedicEd's problems analyzed and identified through baseline data.
Improve	MedicEd's process improved through decision to outsource the call center.
Control	MedicEd's decision evaluated through assessment of talk and wait times at outsourced call center.

B. Research Questions and Hypotheses

Through these five steps of the six-sigma DMAIC process, we are addressing two research questions, each with an associated null and alterative hypothesis. The research questions focus on the outcome KPI of wait times, as a measure of quality that was identified as not meeting standards in the in-house call center and expected to improve by outsourcing the call center.

Research Question 1: Is there a significant difference in customer wait times between the in-house call center and the outsourced call center after the outsourcing was completed?

$H1_o$: There is no significant difference in customer wait times between the in-house call center and the outsourced call center after outsourcing was completed.
$H1_a$: There is a significant difference in customer wait times between the in-house call center and the outsourced call center after outsourcing was completed.

Research Question 2: What is the relationship between talk times and wait times in both the in-house call center and the outsourced call center?

$H2_o$: There is no significant relationship between talk times and wait times in both the in-house call center and the outsourced call center.
$H2_a$: There is a significant relationship between talk times and wait times in both the in-house call center and the outsourced call center.

IV. Findings

We now present the DMAIC process following the steps outlined above. While this section provides evidence collected for analysis of the BPI change for the case company, these changes are further discussed in the sections, Discussion and Conclusion.

A. Define the Problem

The researchers worked closely with the company management to determine the information needed for each of the six-sigma DMAIC processes. The data from phone analytics reports were reviewed, as well as financial statements from the accounting system, to identify two correlated problem statements:

> **Problem Statement 1**: The average wait time for a customer on hold is around five minutes, which is outside what the company deems as acceptable for providing superior customer service (i.e., ideal maximum hold time of less than one minute).
> **Problem Statement 2**: Call center payroll is 557% over budget. The annual labor cost for staffing to support the call center is $167,076; payroll costs to support the call center exceed the company's budget for that expenditure, which was set at $30,000.

The remainder of the steps focused on employing an evidence-based strategy that addressed these two indicators: wait time and staff cost. In improving these indicators, we were improving both customer satisfaction and company costs. Thus, these KPIs have been identified as essential for improving overall quality for MedicEd.

B. Measure Capacity Utilization of Call Center

First, consideration was given to capacity utilization at the call center. Collecting this data was beneficial for baseline data in the event of a move to outsource the call center, but it revealed longitudinal inequalities in capacity utilization that could be used to better understand issues relating to wait times and staff costs. To measure call center capacity, we compared the number of calls each representative was able to take in a given work day and divided it by the total number of calls they were expected to take. Based on the results in Table 3, the company call center was heavily under-utilized relative to its capacity, only reaching full capacity ($\geq$ 85%) four out of the twelve months they were measured. As the call center was not working to capacity the majority of the time, the heavy financial burden of the fixed costs required to employ the call center staff represented wasted resources. This, in part, provides an explanation for this issue of high staffing expenditures and will be used to assess improvement in the problem following process changes.

Table 3: MedicEd Capacity Utilization

Month	Capacity Utilization	Capacity Utilization %
January	High	0.80
February	High	0.80
March	Low	0.39
April	Medium	0.64
May	Full	0.85
June	Full	0.85
July	High	0.80
August	High	0.80
September	Full	0.85
October	Full	0.85
November	Medium	0.64
December	Low	0.39
Average	-	72.2

Note: *SD* = 17.2; full = 81% - 85%, high = 65% - 80%, medium = 40% - 64%, low < 39%.

Next, we turned our attention to better understanding the company's issues surrounding staff cost. Weekly total staff salary was $3,213 on average, totaling $167,067 annually. The in-house call center handled 10,000 annual incoming calls at an average of $16.70 per call. Labor costs of call center employees typically account for 60% to 70% of operating costs for call centers (Gans *et al*., 2003). As the company set the call center budget at $30,000, the labor costs were well beyond the operational budget. While call center costs can be somewhat improved through better operations management, in the case of this company, it made sense to employ six-sigma methodology to research alternative call center solutions. More information is provided in its applicability in the literature review section of this paper.

C. Analyze Alternatives Considered by the Call Center

The company's need to manage its call center capacity and processes, while reducing costs, resulted in evaluating alternatives to the slated move to outsource their customer support call center to a third party company that specializes in handling inbound calls. These alternatives included (a) leaving the call center "as is," (b) reducing staff, (c) increasing staff, (d) outsourcing to a shared third party call center, or (e) a combination thereof. The key values for the company were wait times, staff costs, and service levels. Based on MedicEd management's input, we created a weighted table to help evaluate the alternatives based on these three key inputs in which a score for each of the inputs was computed for each of the alternative solutions. All scores are out of 10 (highest) and then adjusted by the weights assigned to each value. The results, as provided in Table 4, indicate that outsourcing, with a combined weighted score of nine out of ten, was perceived as the most beneficial option, while leaving the call center "as is," with a combined score of one out of ten, was perceived as the least beneficial option. Thus, this step of the analysis revealed that in regard to wait times, outsourcing was perceived by company management to be the best option among those considered, while doing nothing—leaving it "as is"—was considered to be the least beneficial option. While increased staff was perceived as a beneficial option for

reducing wait times, the data revealed that this would not address the issue of staff costs. In fact, this would most likely increase the already astronomical staff costs. Thus, in regard to staff costs, reducing staff and outsourcing were perceived as equally suitable options. Finally, for service level, outsourcing was again viewed as the option that would be best for addressing the two aforementioned problems. While it is clear that leaving the call center "as is" would not be an appropriate solution to the problems (as would also be confirmed by business process improvement models), the combined weighted scores of reducing staff and increasing staff fell short of outsourcing as each of these options relating to changes in staffing levels would only shift the balance of problems: a staff increase would reduce wait times, but increase staff costs, while a reduction of staff would reduce staff costs, but increase wait times.

Table 4: Values Important to MedicEd Company

	Wait Times			**Staff Costs**			**Service Level**			
Alternative Solutions	Rank	Weight	Weighted Score	Rank	Weight	Weighted Score	Rank	Weight	Weighted Score	Combined Weighted Score
Reduce Staff	2	0.5	**1**	8	0.25	**2**	2	0.25	**0.5**	**3.5**
Increase Staff	7	0.5	**3.5**	1	0.25	**0.25**	6	0.25	**1.5**	**5.25**
Outsource	9	0.5	**4.5**	8	0.25	**2**	10	0.25	**2.5**	**9**
Leave "As-is"	1	0.5	**0.5**	1	0.25	**0.25**	1	0.25	**0.25**	**1**

D. Improve: The Decision to Outsource

Based on our joint discussions with management regarding the weighted priorities, customer complaints of long wait times, and the vision for the direction the company wanted to take, the decision was made to outsource the call center to a third party, a measure that would have the most benefit to the company's wait time, service levels, and costs, as supported by the above table. When measuring the call center's success, we analyzed the following variables: wait times, talk times, wait time per staff member, staffing cost, and capacity utilization. This decision was further supported by the high labor costs of MedicEd's call center relative to its operating costs. Based on the findings, it was determined that the company could improve customer service while reducing call center costs by utilizing a third-party call center that used a shared resources system and a pay-per-call model. The outsourced call center has professionally trained staff, with team leaders, and is managed by operational experts and experts in the field of customer service. The outsourced call center has a high standard for call wait times, including a call pickup time of thirty seconds or less upon the first ring, which is considerably less time than the approximate five minutes of the medical education company's standard wait time. They are also able to reduce costs for the medical education company by utilizing a shared resource system that allows them to only charge the companies support for the calls that come in for that company, rather than a standard labor rate. By transitioning to a third-party call center, the company has positioned itself to not only reduce costs, but also to improve the level of customer service by reducing wait times. The purpose of this study is to use six-sigma approaches to evaluate the company's decision to outsource through

a comparison of the effectiveness, both in terms of talk and wait times and cost, of the outsourced call center to that of the company when it was operated in-house.

E. Evaluation

E.1. Data Collection

For evaluation, data were compared between the in-house call center in 2014 and the outsourced call center in 2015. The 2014 baseline data consisted of a random sample of calls made to the company's own intake center during the months of January, February, March, May, June, and July of 2014, and another random sample taken from the outsourced call center during the same months during 2015. The company did not supply data for April due to low call volume during that month; hence April was excluded for both samples. The total *N* was 6,180, evenly split between the two years. The variables collected from both samples were date of call, time of call, hold time measured in seconds, and talk time measured in seconds.

E.2. Evaluation Data Analysis

The analysis relied on descriptive statistics, graphical displays of data, and both parametric and nonparametric tests. The nonparametric tests were used to deal with the problematic distributions of the hold and wait time variables, which remained non-normal even after a log transformation.

Kendall's Tau was used to determine if there was a relationship between hold times and talk times. Just like the more familiar Pearson's *r*, Kendall's tau ranges from negative one (a perfect negative correlation) to positive one (a perfect positive correlation), with zero representing no association at all. Following Cohen's (1988) criteria, a correlation of .1 indicates a small effect size, .3 indicates a medium effect size, and .5 indicates a large effect size.

An independent samples *t* test adjusted for unequal variances along with a Mann-Whitney U test were used to determine if the average hold times and talk times varied between the two samples. The independent samples *t* test determines if there is a statistically significant ($p < .05$, two-tailed test) difference in means between two groups. It assumes equal variance and normal distributions in both groups. Tests rejected the null hypothesis, indicating that the equal variance assumption was met ($p < .001$), thus adjusted *t* tests for unequal variances are presented below. The lack of normality in the variables remained even with a log transformation, thus violating the second assumption. The Mann-Whitney U test also can be used to compare the central tendency of two independent groups, but it does not require any distributional assumptions. Thus, *p*-values for the Mann-Whitney U test are presented as robustness tests to complement the *t* tests. Cohen's *d* is presented as the effect size. Following Cohen's (1988) criteria, a value of .2 indicates a small effect size, .5 indicates a medium effect size, and .8 indicates a large effect size. The sample size was adequate to achieve .8 power for two-tailed tests with alpha set at .05 for moderate effect sizes.

V. Results

Table 5 presents summary statistics for the whole sample and each year separately. It also stratifies the values by month. The table shows a large decline in mean hold times (in seconds) between 2014 (M = 338.69, SD = 444.94) and 2015 (M = 52.28, SD = 105.92). It shows a much more modest decline in talk times from 2014 (M = 285.42, SD = 372.99) to 2015 (M = 221.69, SD = 247.18). Given that times cannot be less than zero, the large standard deviations accompanying the means in the table indicate substantial skew in the data. This was confirmed though boxplots (not shown).

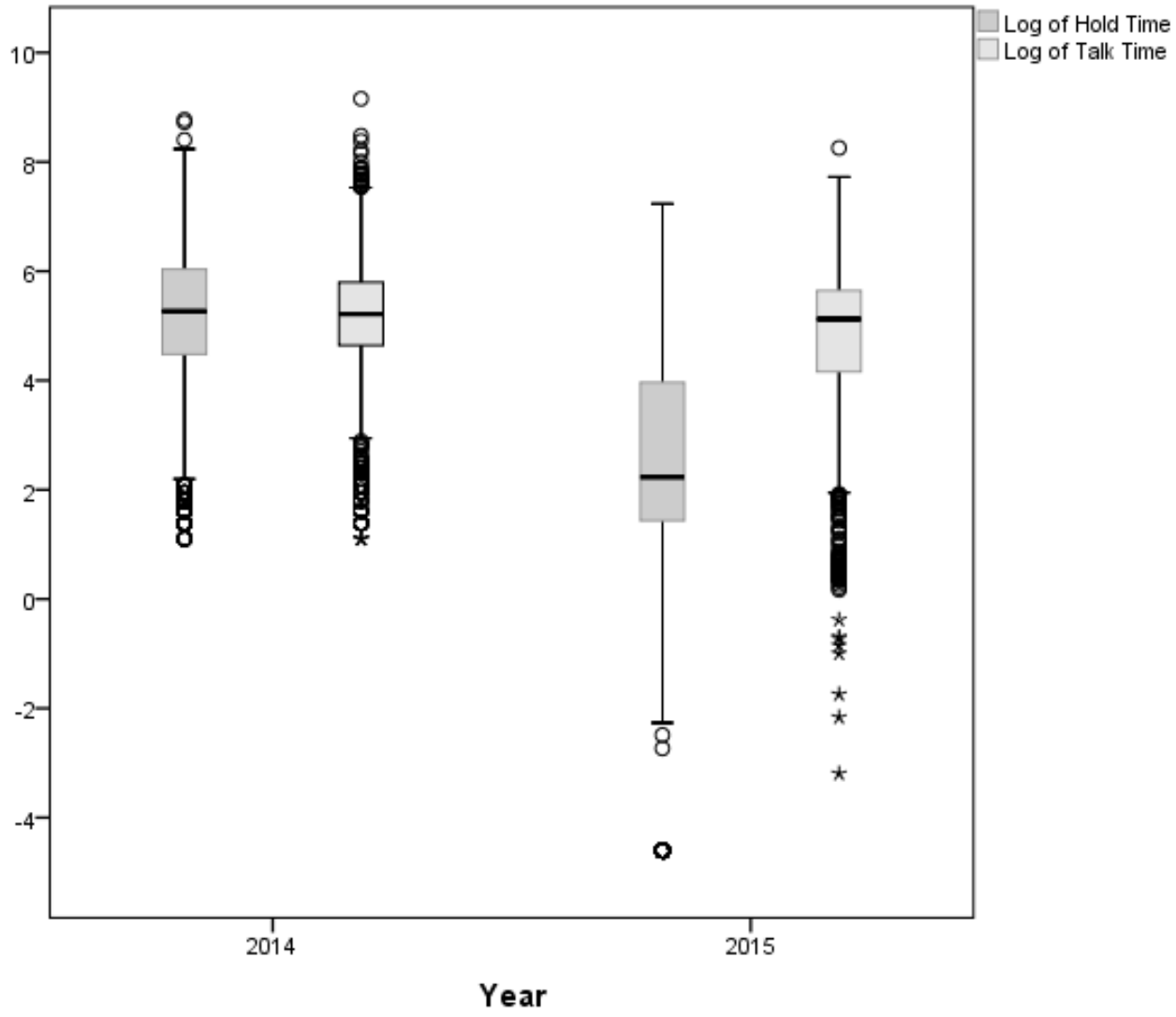
Table 5: Descriptive Statistics for Wait Times and Talk Times (in Seconds)

Time	**Whole Sample**		**2014**		**2015**	
	M	*SD*	*M*	*SD*	*M*	*SD*
Average Hold Times (All Months)	195.49	353.68	338.69	444.94	52.28	105.92
January	169.48	303.32	267.52	378.24	71.45	147.77
February	157.63	308.87	277.69	398.27	37.57	59.84
March	252.82	456.40	459.18	568.50	46.45	91.58
May	205.54	409.08	365.96	523.15	45.12	98.68
June	167.92	200.86	269.96	220.15	65.88	107.03
July	159.44	202.72	275.75	219.10	43.12	84.63
Average Talk Times (All Months)	253.55	317.98	285.42	372.99	221.69	247.18
January	290.43	282.46	355.97	291.12	224.89	257.56
February	267.92	272.14	294.18	225.69	241.65	309.93
March	199.22	175.32	181.50	161.56	216.94	186.50
May	218.45	247.00	261.92	218.74	174.98	265.50
June	333.94	578.42	408.95	768.87	258.93	259.98
July	271.19	348.08	299.91	427.72	242.48	240.85

Note: N = 6180 (January n = 1242, February n = 578, March n = 1636, May n = 1134, June n = 742, July n = 848).

Based on the observation of this skew, the wait and talk variables were logged. As Figure 1 shows, taking logs of the two variables improved the symmetry of the distribution, but the distributions remained too heavy tailed to be considered truly normal. Thus, the statistical tests used were both parametric and nonparametric (i.e., distribution free). Figure 1 also gives the impression of a substantial decrease in wait times, consistent with Table 5. Also consistent with Table 5 is a smaller decline in average talk times.

Figure 1: Box Plots of Log Transformed Variables by Year



The first hypothesis was that there is a relationship between talk times and hold times. This was tested using Kendall's tau both on the data aggregated for the two years, as well as separately for each year.

[1] The results found a statistically significant, but substantively small, effect for the pooled data (τ = .091, p < .001). The relationship was not significant in 2014 (τ = -.022, p = .068). The significance found for the pooled data was driven by a stronger, though still substantively small, relationship in 2015 (τ = .184, p < .001). The positive sign on the estimate means that customers who spent more time on hold also tended to talk more, but only after the outsourcing call center took over. This relationship was not strong, however, and not reflected at all in the 2014 data.

[1] Because Kendall's tau is based on ranks, it is equivalent whether estimated on the logged or unlogged versions of each variable.

The second hypothesis was that hold times and talk times changed systematically between 2014 and 2015. Table 6 displays the results of independent samples *t* tests complemented by *p*-values from the nonparametric Mann-Whitney U test. The results agree that the changes observed in Figure 1 are statistically significant; in other words, the log of both hold and talk times decreased significantly between the years. In addition to both comparisons being significant ($p < .001$), the effect size for the decrease in hold times was quite large ($d = 1.395$). The effect size for talk times was much smaller ($d = .370$), indicating that the outsourcing company was more effective at reducing hold times than actual talk times.

Table 6: Parametric and Nonparametric Independent Samples Comparisons

	Mean Diff	***SE***	***t***	***df***	***p***	***p* from Mann-Whitney Test**	**Effect Size (*d*)**
Log Hold Times	2.998	0.055	54.82	4543.26	< .001	< .001	1.395
Log Talk Times	0.457	0.031	14.532	5620.64	< .001	< .001	0.37

In sum, although there is (at best) weak evidence that hold times are related to talk times, the results show that outsourcing the call center did yield savings in both. Using the KPIs to evaluate the improvement to the business processes of MedicEd, we conclude that the decision to outsource had a positive BPI impact on quality.

VI. Discussion

This research is a study of quality and how quality can be improved and measured using the DMAIC processes. Jahanshahi *et al*. (2011, p. 254) define quality as "fitness for use, or the extent to which a product successfully serves the purposes of customers." Call center customer service is thus an organizational process that has a strong relationship with customer satisfaction and loyalty. We both determined the move to outsourcing and evaluated its effectiveness using quantitative metrics of quality. As a result of systematic considerations of the pre-determined KPIs and in light of the stated issues experienced by management, the company chose to outsource its customer support call center to a third-party company that specialized in handling inbound call centers. To assess the quality impact of this move, we compared 2014 in-house call center wait times and talk times to that of the 2015 outsourced call center.

The root problems were identified within this research as (a) wait times and (b) staff costs. Thus, the success of the change for the company was measured by changes in these KPIs. We have identified the root causes for each of these as follows:

1. Wait times: not enough support during peak times; no motivation for productivity;
2. Staff costs: fixed costs; paying for staff during downtime; benefits expenses.

By outsourcing the call center, the company attempted to solve these identified items in the following ways:

1. Wait times: Outsourced call center (OCC) guarantees wait times no longer than thirty seconds and staffs accordingly; OCC is open twenty four hours a day / seven days a week, which should help alleviate backlogs;
2. Staff costs: MedicEd will only be paying $3.50 per call taken, regardless of how long the call is, which means MedicEd is only paying around $35,000 per year (assuming 10,000 incoming calls for the year) for call center services and will save over $125,000 annually.

As noted in several places within this report, MedicEd will be looking for improvements in wait times and costs, while increasing existing service levels. Over time, MedicEd will request from OCC various reports to help identify whether these improvements are being implemented, and whether customer wait time and talk time have decreased, along with running a customer satisfaction scale. These reports will be as follows:

1. Every day, a phone analytics report is sent to MedicEd showing the time of day, day, wait time, and talk time for each call. This will allow for the KPIs assessed within this research to continue to be assessed to ensure that the decision to outsource maintains its value over time. In the event that the outsourced call center does not meet the established standards, the same DMAIC process can be used to determine the BPI most suitable for the new problem.
2. Every week a cumulative report showing the same phone analytics is sent to MedicEd. This will allow the company to monitor the KPIs and to address any issues that appear in the reports before they become trends and impact customer satisfaction. Early detection of issues might allow "quick hit" solutions that are less costly to the company than re-engineering the processes.
3. Once per week a MedicEd employee will visit the call center to listen to calls live to ensure service level expectations are being met. Training sessions will be provided if the provision of service does not meet the expected service level. Training will also be provided when there are any changes to the MedicEd products or services to ensure that the customer service provided by the outsourced company is equivalent of that which would have been received in-house to ensure customer satisfaction.
4. Finally, since all calls are recorded, once per month MedicEd will randomly select ten calls to listen to in order to ensure that quality expectations are met. The random selection provides that all customer service representatives have an equal chance of being audited for quality. As the primary form of assessment is wait times, this will ensure that beyond their initial wait, customers are still receiving quality attention for the customer service representatives.

The results show that MedicEd clearly took advantage of economies of scale by outsourcing its call center operations to reduce wait times. Following the recommendation of Chakrabarty and Tan (2006) for focusing on KPIs, we were able to successfully use the six-sigma DMAIC process to improve quality in this case study. In doing so, we also contributed to the academic debate regarding the ability of the six-sigma methodologies to be effectively applied in the service

industry and have advanced this field of study. Specifically, this research builds upon the work of Chakrabarty and Tan (2006) and Laureani *et al.* (2010) in that the systematic implementation was outlined to both evaluate the process and outcomes for the company, and also to demonstrate the value of six sigma's DMAIC as a BPI model for the service industry. This also seemed to lead to shorter talk times, although the time savings is much smaller for talk times compared to wait times. The reduction in hold times should have the positive downstream effect of improving customer satisfaction as well, as customers no longer have to experience frustrating waits. These metrics are treated as proxy to customer satisfaction and overall quality, given the established relationship between these variables (Jahanshahi *et al.*, 2011).

There remain some considerations that need to be addressed, however, in the assumption that shorter wait times yield higher level of customer satisfaction. This relationship will, of course, be contingent on how well the outsourced call center is able to answer customer questions compared to employees from inside the company. If the call center has less subject expertise, then some of the goodwill garnered from reduced wait times may disappear as a result of less effective resolution of customer questions and concerns. Whether this happens is a topic for future research, as customer satisfaction data are currently unavailable. Perhaps a system of transferring questions needing more precise knowledge to a small in-house operation, while maintaining the bulk of simple questions for outsourcing, could be developed.

Another implication is that there is still room to reduce talk times and thereby yield additional savings. This research has revealed that the 2015 outsourced call center shows an improvement over the 2014 in-house call center, but also that the process will continue to be tracked to monitor effectiveness over time. Tracking customer calls, and having a display of answers ready for the most common questions, may help bring down talk times further, while simultaneously addressing the customer needs.

VII. Conclusion

In conclusion, MedicEd decided to outsource the call center. By using six-sigma processes MedicEd evaluated alternatives, developed a plan, and had a procedure in place to ensure that the results are measurable and easy to analyze and that improvements are being made and controlled. By completing this project and following these processes, the company expects the following results:

1. Customer wait times will decrease from over five minutes per call to less than one minute.
2. Call center staff costs will decrease from over $150,000 per year to less than $40,000 per year.
3. Customer satisfaction will increase due to highly trained customer service staff.
4. Although the customer service staff at OCC is highly trained in customer phone service, we have yet to determine whether their expertise in responding to questions requiring basic and more-than-basic knowledge of MedicEd will be sufficient to ensure customer satisfaction for most calls.

Thus, the evidence-based decision to outsource their call center is anticipated to save the company well over a million dollars in the next few years through decreased staff costs and increased customer satisfaction and loyalty. Although this research cannot determine the exact relationship between call center experience and customer retention, the staff cost alone will allow the company to focus on other processes to improve overall quality. By using a systematic process

and following the six-sigma principles, MedicEd should be able to reduce wait times, decrease annual expenses, and improve customer service. DMAIC has thus been demonstrated as a valuable resource in this case, as outlined through the benefits to MedicEd above, but it was also demonstrated to be a valuable tool BPI methodology for service industry business process considerations. The overall benefit is contingent on the ability of phone operators to answer questions comprehensively and to the customer's satisfaction. Callers who do not have their questions answered in enough detail may be dissatisfied, which may offset the benefits of reduced talk times. This remains to be determined by further study.

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