A Six Sigma Case Study-Tutorial for IT Call Center

Part 1 of 6 – Focusing the Project

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IT services is a competitive field populated with companies that all deliver important online and call center support to a variety of customers. Most IT services businesses come to realize that their clients have choices and, within the same pricing range, they gravitate to the support organization where the service is best.

In this case study of an IT services business, benchmarking helped quantify what the business already knew – its competitive position was not totally secure. There are a number of ways the company might have responded to the challenge. While the company had built up a reasonable capability in Six Sigma, its management realized improvement was not as simple as forming a project team and turning them loose on the problem. Senior managers had learned that an important part of their responsibility as leaders is to find the issues that are well-enough defined and of a scope to be suitable for a Six Sigma DMAIC project team to take on.

After working through the benchmarks and other data and with the help of a Black Belt, they were able to distill enough clues and evidence in the top-level industry figures to select a DMAIC project they could sponsor with facts and supporting data.

Customer Satisfaction and Business Growth

Industry data was purchased from a clearinghouse that gathers a number of measures about customer satisfaction and call center technical and business performance. Comparing their company to the benchmark average and to a select best-in-class group, the company's management team could see that customer satisfaction with their support services (gathered by an unbiased industry source) was just average or a bit below.

Figure 1: Customer Satisfaction for the Company, 2001-2003

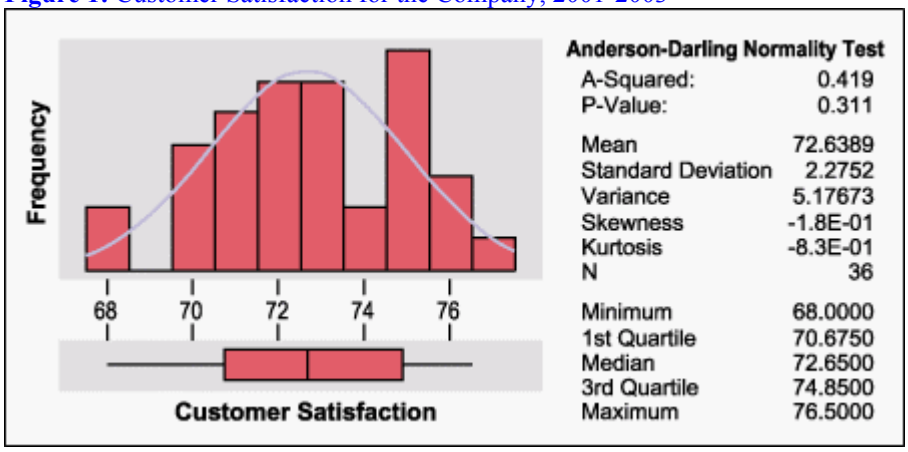


Figure 2: Customer Satisfaction for Average Companies, 2001-2003

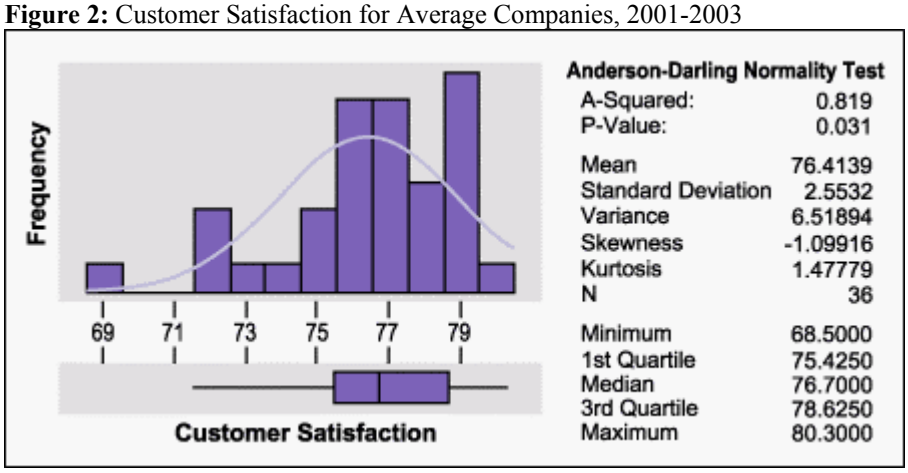
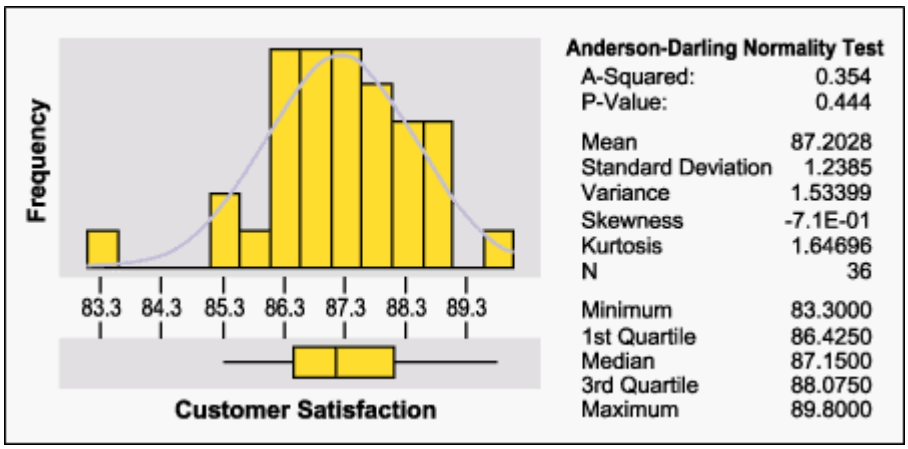
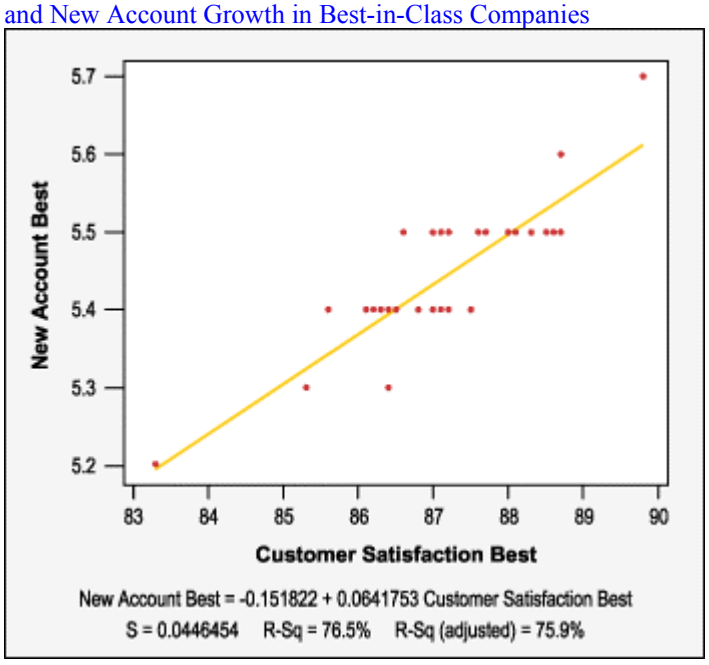


Figure 3: Customer Satisfaction for Best-in-Class Companies, 2001-2003



The comparison of the company's customer satisfaction ratings (73 percent on a 100 percent standardized score), with the "average" companies in the same sector (76 percent) and "best-in-class" competitors (87 percent) showed management it had work to do.
The evidence also supported the important business contention that customer satisfaction (CSat) can be a driver of new account growth. Figure 4 illustrates that the range of customer satisfaction ratings for best-in-class competitors tracked with about 75 percent of the changes in new account growth. That was evidenced by the R-sq. value in the linear regression that was plotted. Senior managers knew that the relationship didn't "prove causality" but, together with their business sense, they saw this as an indicator that customer satisfaction shows up on the bottom line

Figure 4: Relationship of Customer Satisfaction Ratings and New Account Growth in Best-in-Class Companies



Support Costs Per Call, Per Client

The benchmark data indicated customer satisfaction and business growth do not have a direct relationship to support costs per call. So the companies with the best customer satisfaction and best business growth do not spend the most on support costs per call. In fact, the support costs of $26 per call for the best companies and $30 for the average are lower than the case study company's cost per call of about $36 (Figure 5).
A model was built to check the feasibility of focusing a DMAIC project on call center service measures (Figure 6). In the figure, the Y, or NewAcct, is new account growth during the benchmark period (as a percent of sales). The Xs are:
Transfer = Average number of transfers (to different agents and help systems) during a service call.
Wait Time = Average wait time during a service call.
Service = Average service time during the call (the time spent getting the answer to the question, problem solving advice, etc.).
Obviously the company would like to have seen a better model-fit than the 62 percent R-Sq seen here. Realizing, though, that many factors play into account growth, the senior leadership felt that the model showed enough linkage to the process factors that pursuit of the project was feasible.
Figure 5: Support Costs Per Call

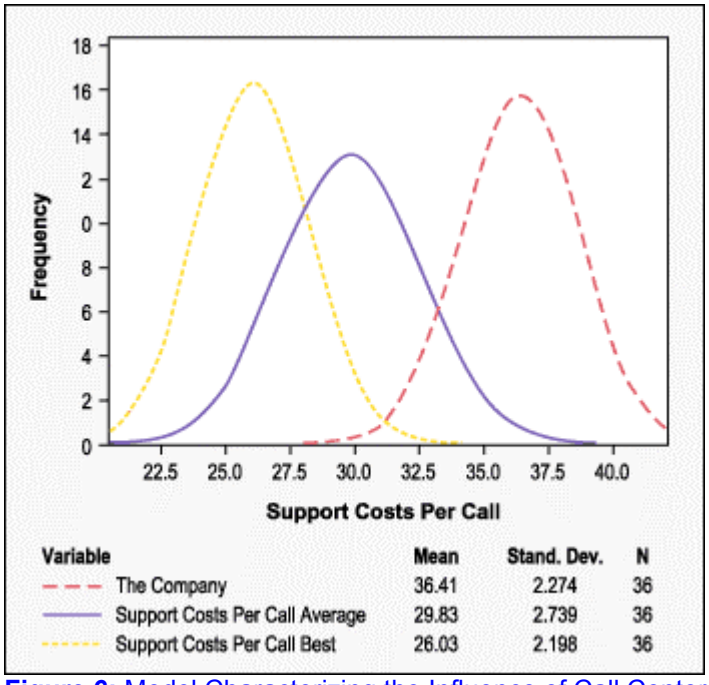


Figure 6: Model Characterizing the Influence of Call Center Process Factors on New Account Growth

Predictor	Coefficient	SE Ceofficient	T	P
Constant	6.1222	0.1927	31.76	0.000
Transfer	-0.01193	0.02974	-0.40	0.691
Wait Time	-0.07830	0.01085	-7.21	0.000
Service	-0.06921	0.02324	-2.98	0.006

New Account B-Best = 6.12 - 0.0119 Transfers B-Best - 0.0783 Wait Time B-Best - 0.0692 Service Time B-Best

S = 0.05848 R-Sq = 62.1% R-Sq (adjusted) = 58.6%

Obviously the company would like to have seen a better model-fit than the 62 percent R-Sq seen here. Realizing, though, that many factors play into account growth, the senior leadership felt that the model showed enough linkage to the process factors that pursuit of the project was feasible.

Since the company's senior managers had ready access to wait time benchmark data, they checked their company's performance against the industry (Figures 7, 8 and 9).

The wait time review indicated that, indeed, the company was behind the industry norms. This, and the model indication that wait time could be an influential factor in customer satisfaction and new account growth (Figure 5), helped the senior managers see that a DMAIC team focused on improvement in this area could be worthwhile.

Figure 7: Call Wait Times for the Company (Median 4.5)

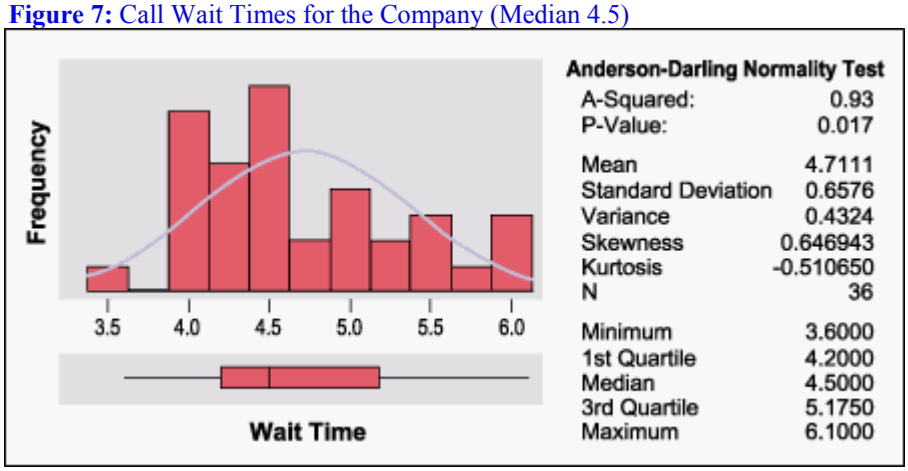


Figure 8: Call Wait Times for Average Companies (Median 4.0)

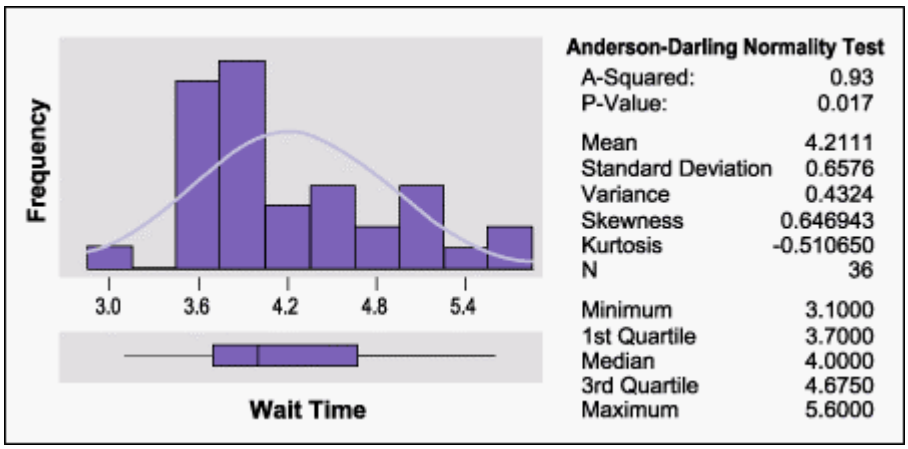
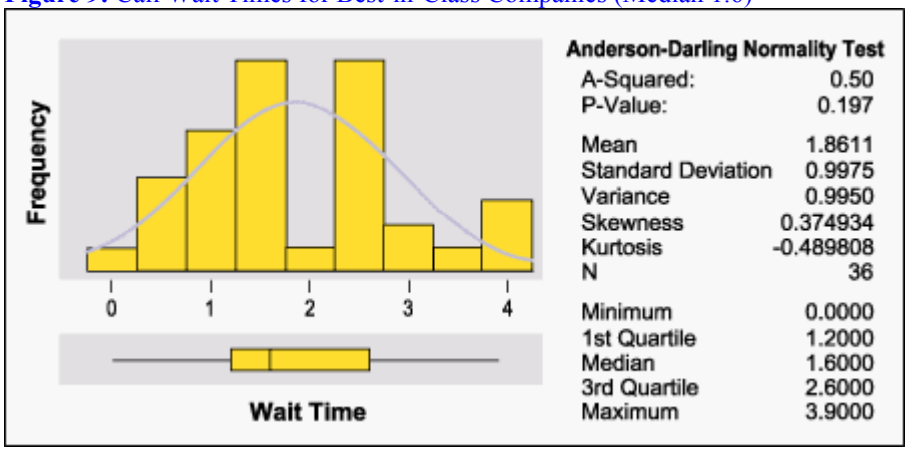


Figure 9: Call Wait Times for Best-in-Class Companies (Median 1.6)



The company could see a strong indication that a DMAIC project to reduce support costs should be quite doable – and should return significant dollars to the bottom line. Management also could see that the DMAIC team should look for the improved customer experience connected with reduced wait times and service times to improve new account growth – bringing dollars to the top line. The company assigned a Champion from its leadership team to take responsibility for the new project and identify a team leader and key team members. The team was given its top level goals and scope – to reduce support costs while improving new account growth. The work with the benchmark data was helpful in orienting the team to the project rationale. The team began working on their project charter.

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Part 2 of 6 – The Define Phase

The senior leadership of the IT services company completed the important pre-project work and found an area of the business worthy of attention by a DMAIC project team. The team then began work on understanding and articulating the project goals, scope and business case.
The DMAIC roadmap called for work in these areas during the Define phase:
D1. Project Charter: Spelling out the project's goal statement.
D2. Customer Requirements: Identifying all the internal and external customers who depend on the outputs of the process under study, the deliverables and measures connected with those outputs, and the process steps, process inputs and (as appropriate) the suppliers of those inputs.
D3. High Level Process Map: Showing the flow of information, materials and resources, from key process inputs, through process steps and decision points, to create the process outputs. The map describes the flow of what happens within the scope of the target process and it defines the boundaries of that scope.

D1. Project Charter

Here are some of the key elements of the project charter.
Problem Statement: "Competitors are growing their levels of satisfaction with support customers, and they are growing their businesses while reducing support costs per call. Our support costs per call have been level or rising over the past 18 months, and our customer satisfaction ratings are at or below average. Unless we stop – or better, reverse this trend – we are likely to see compounded business erosion over the next 18 months."
Business Case: "Increasing our new business growth from 1 percent to 4 percent (or better) would increase our gross revenues by about $3 million. If we can do this without increasing our support costs per call, we should be able to realize a net gain of at least $2 million."
Goal Statement: "Increase the call center's industry-measured customer satisfaction rating from its current level (90th percentile = 75 percent) to the target level (90th percentile = 85 percent) by end of the fourth quarter without increasing support costs."
The project team also developed its initial set of milestones, tasks, responsibilities, schedule and communication plan. After reviewing the charter with their Champion, team members began work on the next step – customer requirements.

D2. Customer Requirements

For many processes there are one or more customers who are obvious - the people who pay for products or services or those who visibly depend on the company, like employees. Often, though, there are internal and external customers and dependencies that are not so obvious. A SIPOC table (Suppliers, Inputs, Process, Outputs and Customers) develops a detailed view of all the important customers, their requirements, and the related process step and supplier dependencies.
SIPOC Table: The team developed a SIPOC table to help identify and report what it learned about key customers and their requirements. While processes flow in the SIPOC direction, the thought process used to build the table often begins with the customer, suggesting display in the COPIS (Customer, Output, Process Inputs and Suppliers) direction as shown in Figure 1.

Figure 1: SIPOC / COPIS Table – Captures Important Information About Customer-Process Dependencies

Customer	Output	Process	Inputs *(& Resources)*	Suppliers
Client	Call Engaged	(Automated) **Answer Call**	Active Phone Line	Phone Service Provider
			Internal Call Switch	IT Group
			Switching Software	
	Information in System	(Staff) **Gather Customer Information**	Available Representative	Call Center Management
			Call Management Software	IT Group
	Escalation Decision	(Staff) **Assess Ability to Resolve**	Database Available	
			Staff Experience/Training	Human Resources/ Training
	Next-Level Support Staff Engaged	(Staff) **Transfer Call**	Available Staff for Transfer	Call Center Management
	Resolution Information	(Staff) **Gather Resolution Information**	System Documentation	Documentation Group
			FAQ Database	IT Group
			Client Configuration Information	Call Center Staff
		(Staff) **Deliver Resolution Information**	Customer Availability (on Callback)	
Call Center Management	Call Data Logged to Customer File and FAQ	(Staff) **Log Call Data**	Call Management Software	
			Staff Availability	
			Staff Discipline	
	Documented Call Resolution	(Automated/Internet) **Confirm Resolution with Customer**	Web Monitor	IT Group (Web Monitor Application)
			(Customer) Internet Access	

Voice-of-Customer (VOC) Interviews: The SIPOC table highlighted some areas where more information about the process – as understood by customers and call center staff – would be helpful. Representative samples of the company's customers were involved in group interviews. The following are excerpts from individual customer responses and are representative of the data gathered. The answers are to the question: "**What influences your level of satisfaction with our services?"**

Group 1

A1. "Well, first and foremost I want the correct answer to my questions or issues. It makes me nuts when I'm told something that turns out later to be wrong or only part of the story."

A2. "I really like it when the person who answers the phone has a good attitude. Sometimes you can just tell they wish you'd just go away and stop bothering them with stupid questions."

A3. "Well I can sure tell you what I don't like. That voice response thing where they ask you to make 46 choices (and none match what you want) is a real pain – ends up taking a lot of my time and then they seem to ignore it all anyway and ask the same questions again. What's the point? Sometimes I wonder if they ever asked a real customer to test these things before they put them in."

A4. "I'm happy when my call gets answered quickly and the person I talk to knows their stuff and gives me an answer on the first call. When I have to wait for a call back and talk to someone else, repeating some of the same stuff – that's a real drag!"

A5. "I like it when the person on the phone can actually make a decision without putting me on hold while they get an ok from a supervisor. Seems like they spend 10 minutes to make a $5 decision. That just doesn't make sense to me. Seems like some control freak is running the show."

A6. "Follow-through is what really matters to me. I don't necessarily expect you'll always be able to resolve my issue immediately, but I do expect you'll call me back in a reasonable amount of time."

A7. "My hot button is getting someone who has enough patience to really solve my problem. Some of this stuff seems pretty technical to me, and I don't always know even the right question to ask. I like it when the person on the phone cares enough to get to the real solution, even when I can't explain exactly what I need."

A8. "I don't want to be transferred around. Last time I called I got transferred four times and ended up with the same person I started with. I'm too busy to put up with that!"

Group 2

A1. "Our big concern is speed. Our customers demand answers from us, and we in turn rely on you for some of that. That means you have to be adequately staffed to meet call volume."

A2. "What we most need from you is people who can answer complicated questions accurately and quickly – not just the easy stuff, we can do that ourselves."

A3. "We need you to have immediate access to up-to-date information about all of our accounts and transactions with all of your branches and locations. It creates huge problems for us when your records aren't accurate and timely. We can't sit on hold for 10 minutes."

A4. "I call 3 to 4 times a week, and the thing I find most frustrating is the lack of consistency. Sometimes my call gets answered in 2 minutes, which I can live with, and sometimes it's 10, which I can't. I also notice that there's a lot of variation in how long it takes to get answers to very similar issues. I call your competition all the time also, and they're a lot more consistent."

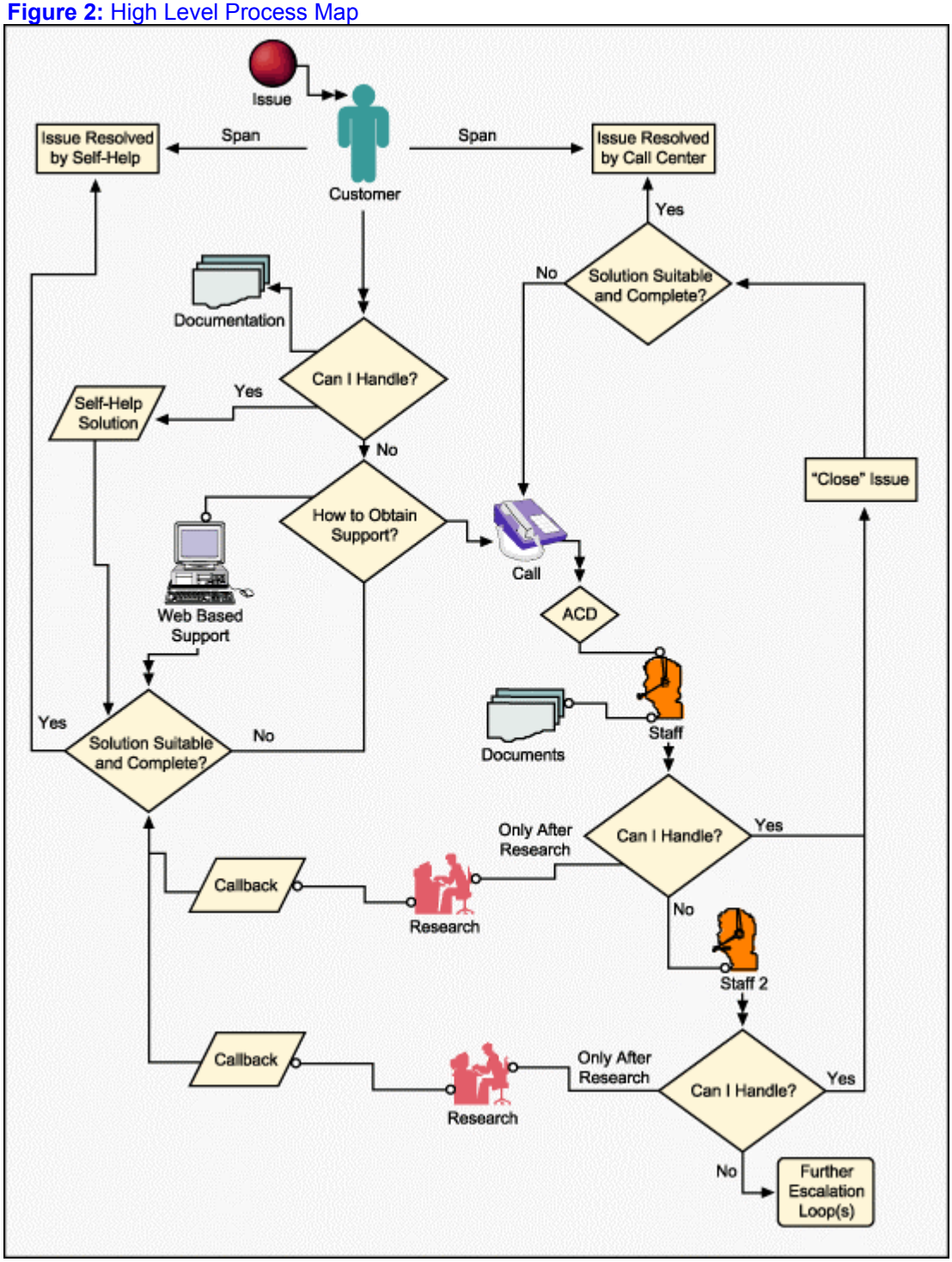
Summarizing Customer Requirements: The team began to summarize what it was learning about what's important to customers – in the form of requirement statements and measures.

Requirements	**Measures**
Quickly connect with a helpful person	Wait Time
Get the information I need	Transfers, Service Time
Apply the information, with help if needed	Customer Satisfaction, Support Cost
Understand how to avoid problems recurring	Days to Close

D3. High Level Process Map

The team mapped the process by which an initiating event (an issue encountered by a customer) moves into and through the resolution process (Figure 2).

Figure 2: High Level Process Map



The process map will be helpful during the Measure phase, as the project team considers how and where to gather data that will shed light on the root cause of the issues most pertinent to the project's goals.

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Part 3 of 6 – The Measure Phase

Having developed a good understanding of the project's business case and customer requirements (identifying the Y(s)), and the as-is process, the Six Sigma project team of the IT services business began to focus on the Measure phase. The team identified the measures and data collection plan for gathering the right amount of the right data to impel their learning about root causes and drivers that impact the project Y(s).

The DMAIC roadmap called for work in these areas during the Measure phase:

M1. Refine the Project Y(s): Getting even clearer about how the project's key outcome measure(s) will be defined, measured and reported.

M2. Define Performance Standards for the Y(s): Identifying how performance will be measured – usually somewhere on the continuum from capability measures like Cp and Cpk for "variables" data that is normally distributed to percentile or other capability metrics for "attribute" and other data that may be skewed in distribution.

M3. Identify Segmentation Factors for Data Collection Plan: Starting with the natural segmentation of project Y(s) and moving though consideration of prospective driving factors (x's), segmentation suggests the packets of data that should be collected in order compare and contrast segments to shed light on Y root causes and drivers.

M4. Apply Measurement Systems Analysis (MSA): In any project, raw data is gathered and then converted into measures. That process comprises a "measurement system" that should be characterized and strengthened in terms of its accuracy and repeatability.

M5. Collect the Data: Gathering data, preserving its meaning and noting any departures from the discipline put in place under MSA.

M6. Describe and Display Variation in Current Performance: Taking an initial look at the data for its distribution, extreme values and patterns that suggest special variation.

M1. Refine the Project Y(s)

During this step the team conisdered exactly how the project Y(s) would be defined and measured

	Y(s)	Measurement
Primary	**Customer Satisfaction**	1. By industry standard monthly survey
		2. The project will require additional, more frequent, case-by-case customer satisfaction data. A measurement system that tracks with the industry survey will be devised and validated.
Secondary	**Support Cost (Per Call)**	The staff time connected with each call:
		- Call answering and discussion
		- Case research
		- Callback time
		will be loaded with a distribution of benefits and infrastructure costs to compute overall support cost per call.
Related / Of Interest	**Days to Close**	Time span from call origination through client indication that the issue is closed to their satisfaction.
	Wait Time	Automatically tracked for calls in queue. Summed for calls encountering multiple transfers.
	Transfers	Automatically tracked for each call moved to another extension.
	Service Time	Automatically tracked for time from staff call pickup until hangup or transfer.

M2. Define Performance Standards for the Y(s)

For each project Y, the current baseline and best-estimate target was documented. In some cases, the team found that good baseline data was unavailable. (Unfortunately that is a common occurrence in DMAIC projects.)

	Measure	Current Baseline	Target
Primary	Customer Satisfaction (Per Collins Industry Assessment)	90th Percentile / 70-80% Satisfied	90th Percentile / 85% Satisfied
Secondary	Support Cost Per Call	90th Percentile / $40	90th Percentile / $32

Related / Of Interest	Days to Close	Did Not Have Good Baseline Data	90th Percentile / 3 Days or Less
	Wait Time	Did Not Have Good Baseline Data	90th Percentile / 4 Minutes
	Transfers	Did Not Have Good Baseline Data	90th Percentile / 2
	Service Time	Did Not Have Good Baseline Data	Mean: < 8 Minutes St.Dev.: < 0.5 Minutes

M3. Identify Segmentation Factors for Data Collection Plan

The first question was: How is Y naturally segmented? Often Y data is organized by customer type, geographic region, product or service type, etc. Thinking about where the strongest "action" was for the dynamics under study, the team focused its initial data collection effort on the segment(s) that offered the most potential for the team's learning. This helped conserve the limited resources available for data collection and analysis. Instead of "measuring everywhere," the team started with a focused subset of all possible data. The data was naturally segmented by call center – with most of the traffic in one center. Data from that site was used for the initial data collection.

The next question was: What factors may be driving the Y(s)? Identifying these factors and gathering data on their behavior may shed light on the root causes and drivers for the Y(s). This is the planning part of the Six Sigma drill-down that is sometimes called "peeling the onion." While the fundamental interest is in the Y behavior, the idea is not to truly solve a problem by trying to "fix the Y." That approach might provide a temporary fix. Understanding the underlying drivers (the x's) offers the possibility of addressing the root cause, and fixing the problem so that it will stay fixed.

A Y-to-x tree depicts the array of lower level x's that may be driving a Y. Other tools with a similar thrust – cause-and-effect diagrams and cause-and-effect matrices (illustrated later) – can be helpful in identifying and prioritizing the prospective x's for data collection and study.

The team's Y-to-x trees for support cost and customer satisfaction are shown in Figures 1 and 2.

Figure 1: Y-to-x Tree for Support Cost

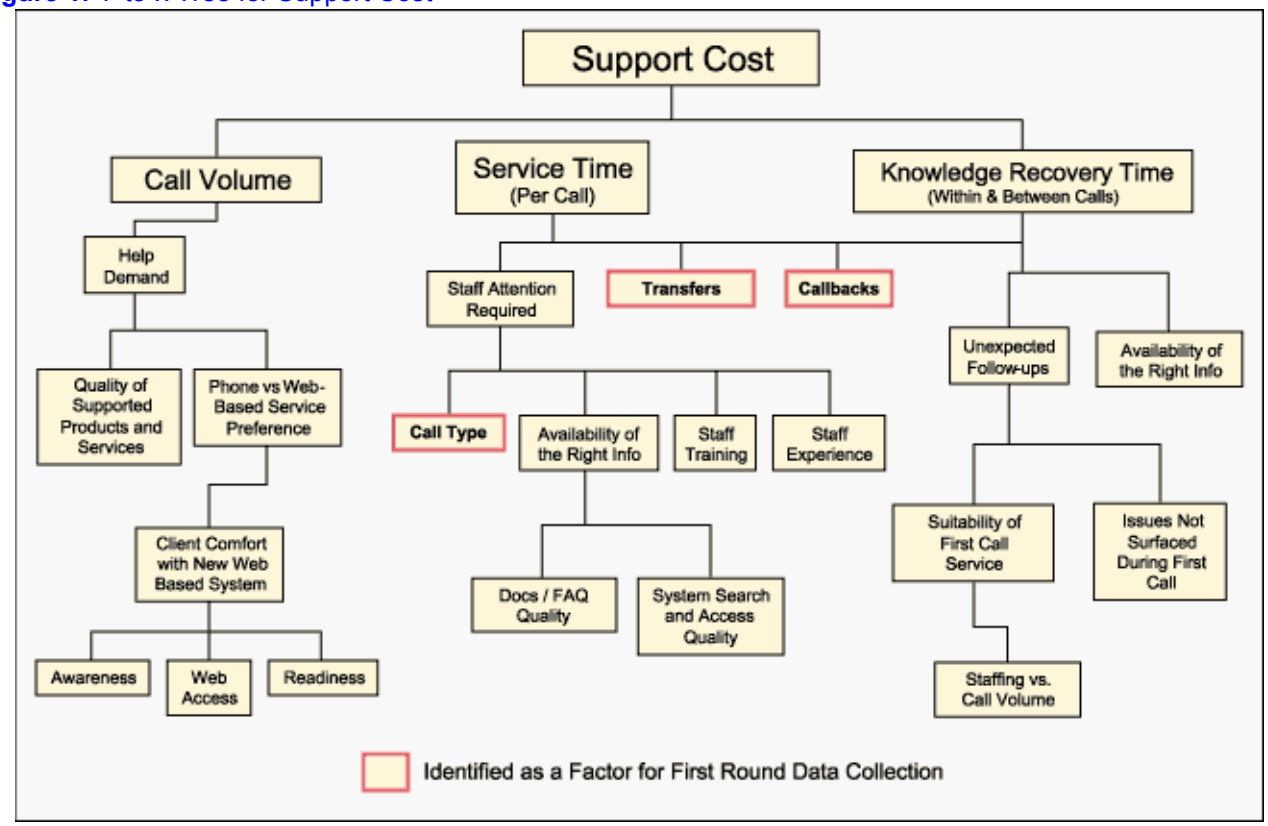
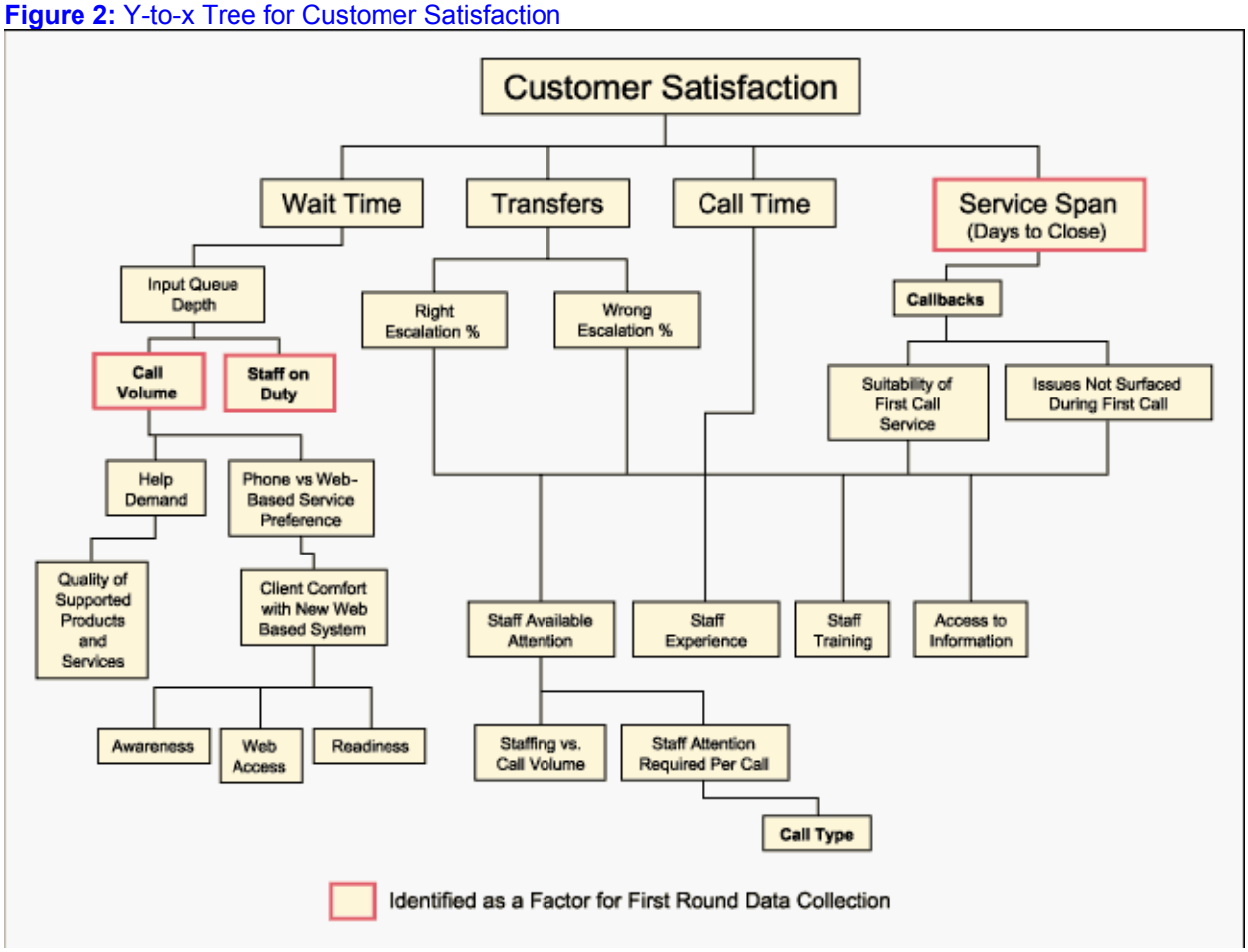


Figure 2: Y-to-x Tree for Customer Satisfaction



Input-Output Analysis

Building on the information developed in the SIPOC / COPIS table, the team reviewed process inputs and outputs, classifying each as "controlled" (with process provisions in place to measure and influence that input or output, if necessary) or "uncontrolled" (with no such provisions in place). See Figure 3.

Customer	Output	Controlled (C) Uncontrolled (U)	Process	Inputs *(& Resources)*	Controlled (C) Uncontrolled (U)	Suppliers
Client	Call Engaged	C	(Automated) Answer Call	Active Phone Line	U	Phone Service Provider
				Internal Call Switch	C	IT Group
				Switching Software	C	
	Information in System	C	(Staff) Gather Customer Information	Available Representative	C	Call Center Management
				Call Management Software	C	IT Group
	Escalation Decision	U	(Staff) Assess Ability to Resolve	Database Available	U	
				Staff Experience/Training	C	Human Resources/ Training
	Next-Level Support Staff Engaged	C	(Staff) Transfer Call	Available Staff for Transfer	U	Call Center Management
	Resolution Information	U	(Staff) Gather Resolution Information	System Documentation	C	Documentation Group
				FAQ Database	C	IT Group
				Client Configuration Information	C	
					U	Call Center Staff
		C	(Staff) Deliver Resolution Information	Customer Availability (on Callback)	U	
Call Center Management	Call Data Logged to Customer File and FAQ	C	(Staff) Log Call Data	Call Management Software	C	
				Staff Availability	C	
				Staff Discipline	U	
					U	
	Documented Call Resolution	C	(Automated/Internet) Confirm Resolution with Customer	Web Monitor	C	IT Group (Web Monitor Application)
				(Customer) Internet Access	U	
					U	

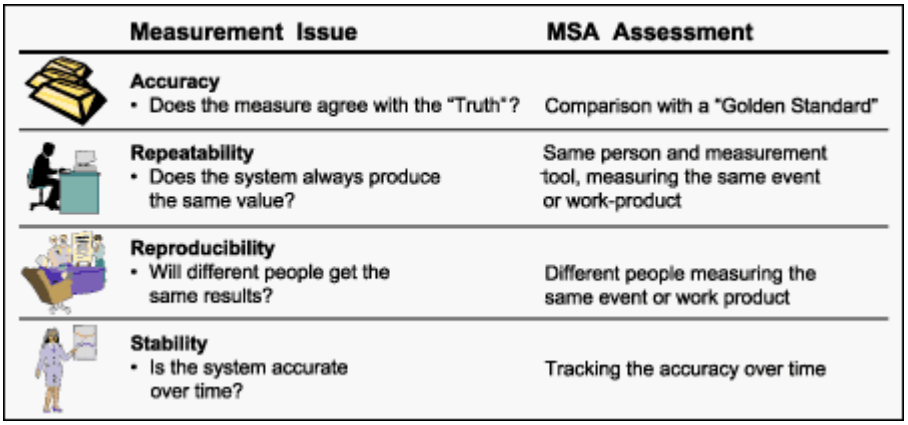
Cause-and-Effect Matrix

To further explore potentially influential factors, the team created a Cause-and-Effect Matrix (Figure 4). The high scoring items in this analysis were strongly considered for data collection. The highest, "Available Staff for Transfer," was included. The next highest scoring, "Staff Experience/Training" was not readily available in the historic database. (There had been reluctance to log personal data as part of the ongoing call logging.)

	Rating of Importance to Customer	7	10	8	5	
		1	2	3	4	
	Requirements >	Quickly Connect with a Helpful Person	Get the Information or Results I Need	Apply the Information, with Help if Needed	Understand How to Avoid the Issue Recurring	
Process Step	**Process Inputs**					**Total**
Answer Call		9				63
	Active phone line	5				35
	Internal call switch	5				35
	Switching software	5				35
Gather Customer Information		3	9	5	5	176
	Available Representative	5	9	5	3	180
	Call Management Software	5	3	5	9	150
Assess Ability to Resolve		9	9	5	3	208
	Database Available		5	3	5	99
	Staff Experience/Training	9	9	5	5	218
Transfer Call (Optional)		9	9	1	1	166
	Available Staff for Transfer	5	9	9	5	222
Gather Resolution Information			8	8	9	189
	System Documentation		7	5	7	145
	FAQ Database		9	9	9	207
	Client Configuration Info		9	7	7	181
Deliver Resolution Information			9	8	5	179
	Available Customer (On Callback)		7	7	5	151
Log Call Data					9	45
	Call Management Software				3	15
	Staff Availability				5	25
	Staff Discipline				7	35

M4. Apply Measurement Systems Analysis (MSA)

To prepare for the measures to be collected in the next step, the team reviewed the measurement systems. In transactional processes, any activity that gathers raw data and converts it into counts, classifications, numbers or other forms of measure is a "measurement system." While the statistical methodology connected with MSA is beyond the scope of this article (see other references under iSixSigma tools) , Figure 5 depicts the four questions that are usually posed for measurement systems in transactional processes. Viewed simply, the intent of MSA is to strengthen a measurement system so that it is suitably accurate, repeatable, reproducible and stable. A fifth issue, "linearity" (the accuracy of the system over the range of mesaured values), is sometimes considered.



M5. Collect the Data

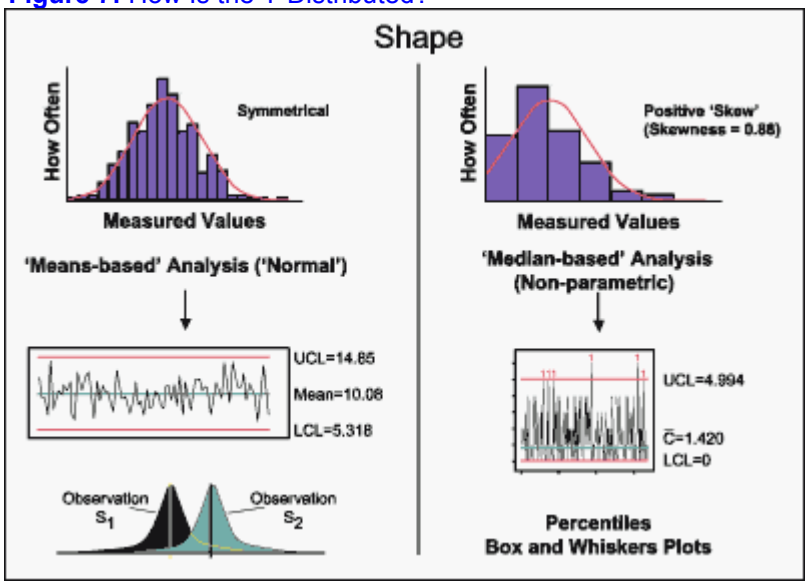
A plan was formulated to gather data from the past year's database. This required retrieving call data, as well as tracing call resolution times, staffing levels, call volume levels and relevant follow-up events. For each call sampled, the team rebuilt information about staffing, call type, number of transfers, wait time, etc. (Figure 6)

Call	Qtr	Week	Day	Staffing	Call Volume	Call Type	Transfers	Wait Time	Service Time	Callbacks	Days to Close	Web Help Volume	Support Cost ($)
1	1	1	M	49	1100	Problem	4	8.6	15.6	1	6	341	46.9
2	1	1	M	49	1100	Problem	0	4.7	16.2	2	5	341	42.6
3	1	1	M	49	1100	Complaint	0	4.7	11.1	0	0	341	15.6
4	1	1	M	49	1100	Complaint	1	5.5	6.0	0	1	341	12.3
5	1	1	T	59	976	Question	3	4.4	5.7	0	1	340	16.0
6	1	1	T	59	976	Problem	3	3.8	12.8	0	2	340	27.9
7	1	1	T	59	976	Change	0	3.5	11.7	3	3	340	37.4
8	1	1	T	59	976	Change	2	4.3	8.5	1	0	340	20.9
9	1	1	W	58	962	Question	1	4.4	4.0	0	2	344	11.6
10	1	1	W	58	962	Problem	1	3.9	11.1	0	1	344	19.5
11	1	1	W	58	962	Change	1	3.7	13.1	0	0	344	20.4
12	1	1	W	58	962	Complaint	0	3.5	9.7	0	1	344	15.6
13	1	1	Th	59	964	Question	0	3.4	10.1	2	2	344	28.2
14	1	1	Th	59	964	Change	2	4.2	5.5	1	3	344	22.7

M6. Describe and Display Variation in Current Performance

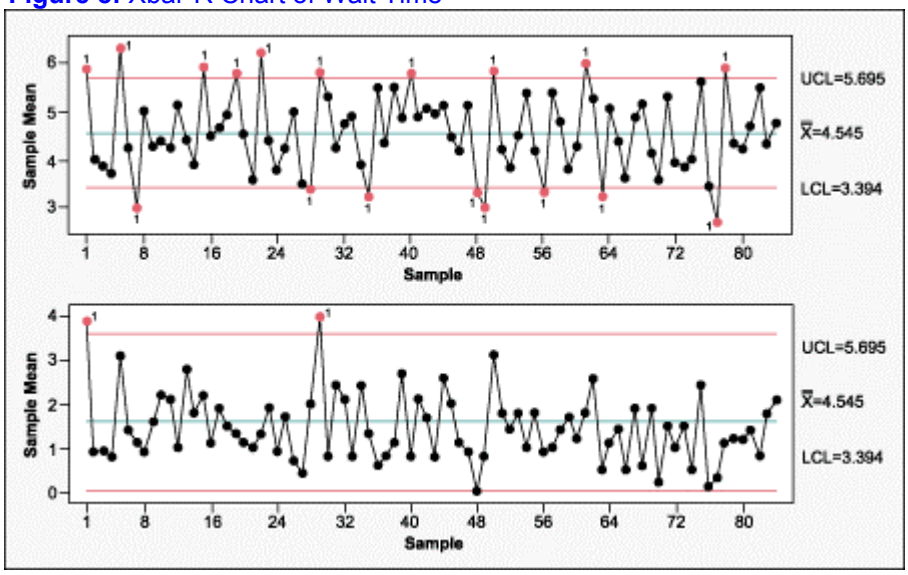
A first look at the data coming in provided the team insights about extreme values and patterns suggesting problems with the measurement system. With the information, the team began to forecast what the Analyze phase would reveal. The team's question at this point was: How is the Y Distributed? The team looked for the layout of measured values collected – for symmetry and for extreme values. This suggested the kinds of graphical and statistical analysis that would be appropriate (Figure 7).

Figure 7: How Is the Y Distributed?



Data on the call center x measures was graphed and charted a number of ways. Figure 8 shows the variation in customer Wait Times on an Xbar-R control chart. Variation above and below the chart's control limits suggested that there were "special causes" in play – worth understanding in more detail by the team in the Analyze phase

Figure 8: Xbar-R Chart of Wait Time



A Six Sigma Case Study-Tutorial for IT Call Center

Part 4 of 6 – The Analyze Phase

Having refined the project's key outcome measures, defined performance standards for project Y(s), identified segmentation factors and defined measurement systems, the Six Sigma project team of the IT services business began to focus on the Analyze phase. The DMAIC roadmap called for work in these areas during the Analyze phase:

A1. Measure Process Capability: Before segmenting the data and "peeling the onion" to look for root causes and drivers, the current performance is compared to standards (established in step M2 of the Measure phase).

A2. Refine Improvement Goals: If the capability assessment shows a significant departure from expectations, some adjustment to the project goals may need to be considered. Any such changes will, of course, be made cautiously, supported with further data, and under full review with the project Champion and sponsors.

A3. Identify Significant Data Segments and Patterns: By segmenting the Y data based on the factors (x's) identified during the Measure phase – the team looks for patterns that shed light on what may be causing or driving the observed Y variation.

A4. Identify Possible x's: Asking why the patterns seen in A3 are as observed highlights some factors as likely drivers.

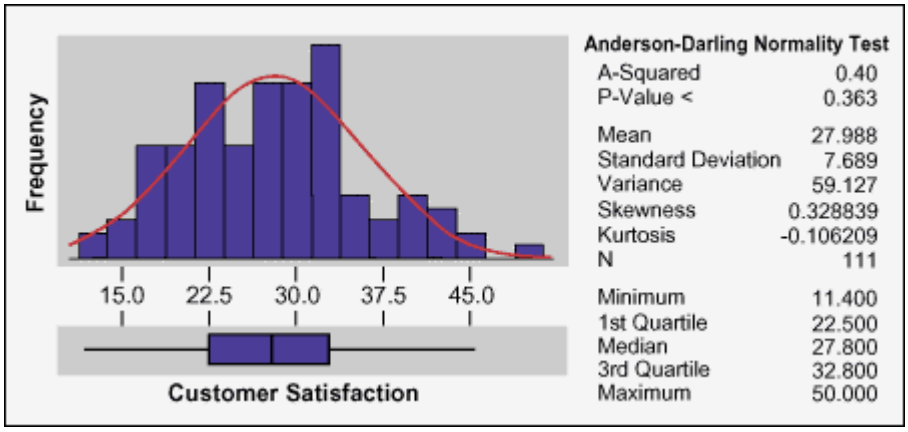
A5. Identify and Verify the Critical x's: To sort out the real drivers from the "likely suspects" list built in A4, there is generally a shift from graphical analysis to statistical analysis.

A6. Refine the Financial Benefit Forecast: Given the "short list" of the real driving x's, the financial model forecasting "how much improvement?" may need to be adjusted.

A1. Measure Process Capability

The team first looked at the distribution of each Y data set. For those with symmetrical shapes close enough to a normal distribution (the bell-shaped curve in Figure 1) means-based measures (e.g. mean, sigma, or Cp and Cpk) were used to describe capability. For skewed distributions (the histogram in Figure 1, and any cases where the Anderson-Darling test P-value was below about 0.05) a median-based capability measure was used (e.g. median, quartile, percentile).

Figure 1: Distribution Check for Support Costs



While the graphical summary in Figure 1 shows median-based capability to the detail of quartiles (1st Quartile: 25%, Median: 50%, and 3rd Quartile: 75%), the team applied a macro to generate a more detailed percentile view, summarized in the list below.

75th Percentile = $32.80 90th Percentile = $39.44
80th Percentile = $33.36 95th Percentile = $42.68
85th Percentile = $35.42 98th Percentile = $44.73

The support cost 90th percentile capability is $39.44. Call volume, of course, indicates that this was a very costly gap. The results of these and other capability checks, as done at the outset of the Analyze phase, are summarized and compared to established targets in the table below.

Measure	Capability	Target
Customer Satisfaction (Per Collins Industry Assessment)	90th Percentile = 75% Satisfaction	90th Percentile = 85% Satisfaction
Support Cost Per Call	90th Percentile = $39	90th Percentile = $32
Days to Close	90th Percentile = 4 Days	90th Percentile = 3 Days or Less
Wait Time	90th Percentile = 5.8	90th Percentile = 4 Minutes

	Minutes	
Transfers	90th Percentile = 3.1	90th Percentile = 2
Service Time	Mean: 10.5 Minutes	Mean: <= 8 Minutes
	StDev: 3 Minutes	StDev: <= 0.5 Minutes

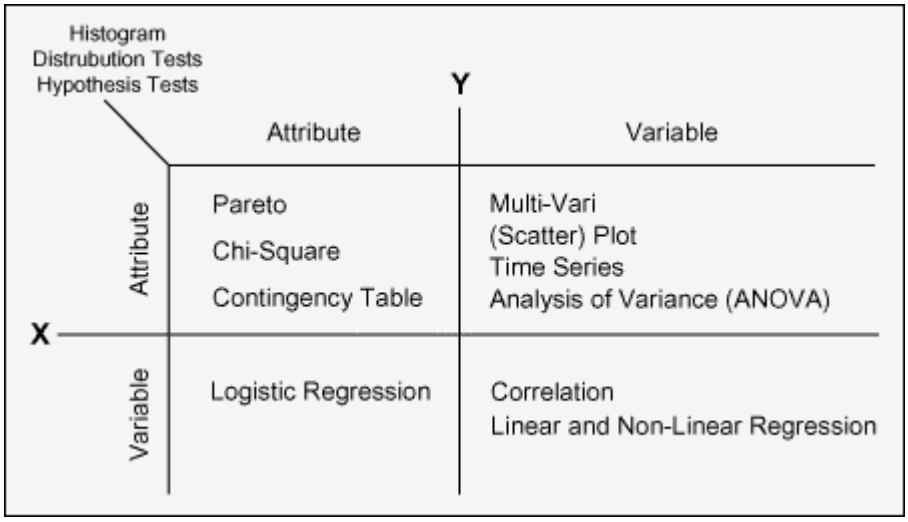
A2. Refine Improvement Goals

Reviewing the data in the table, the team felt that the project targets were still in line and did not require a change at that time. Had there been a surprise or a show stopper, that would have been the time to flag it and determine the right action.

A3: Identify Significant Data Segments and Patterns

While planning for data collection (during the Measure phase), the team had done some hypothetical cause-and-effect analysis to identify potentially important x's. At this step, it prepared to use the data to confirm or reject those earlier hypotheses, and to discover other x's that may have been missed.
Figure 2 outlines some of the common tools for finding patterns in the data. Since most tools are suited for certain kinds of data, a chart like this can be helpful. Like many teams, during A3 this team favored graphical tools, which give quick views of many "cuts" on the data. The team found multi-vari charts were especially flexible in that regard. Later, when refined distinctions were called for (in step A5), the statistical tools like ANOVA, regression, and Chi-Square were brought into play.

Figure 2: Some Key Analysis Options



Numerous cuts of the data were reviewed with the goal of shedding light on root causes and drivers underlying variation in the project Y(s). A few of those are summarized in Figures 3 and 4. Figure 3 shows that Problems and Changes look more expensive to service than other types of calls. Figure 4 reveals an added signature in the pattern – Mondays and Friday stand out as being more costly.

Figure 3: Multi-Vari for Support Costs by Call Type

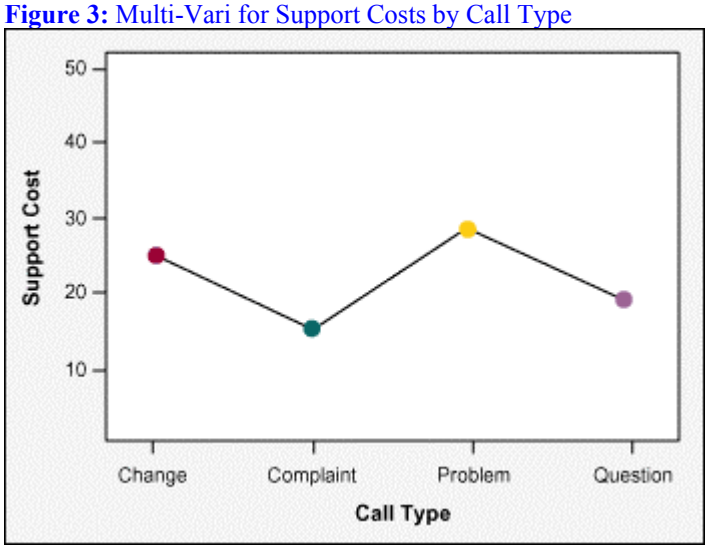
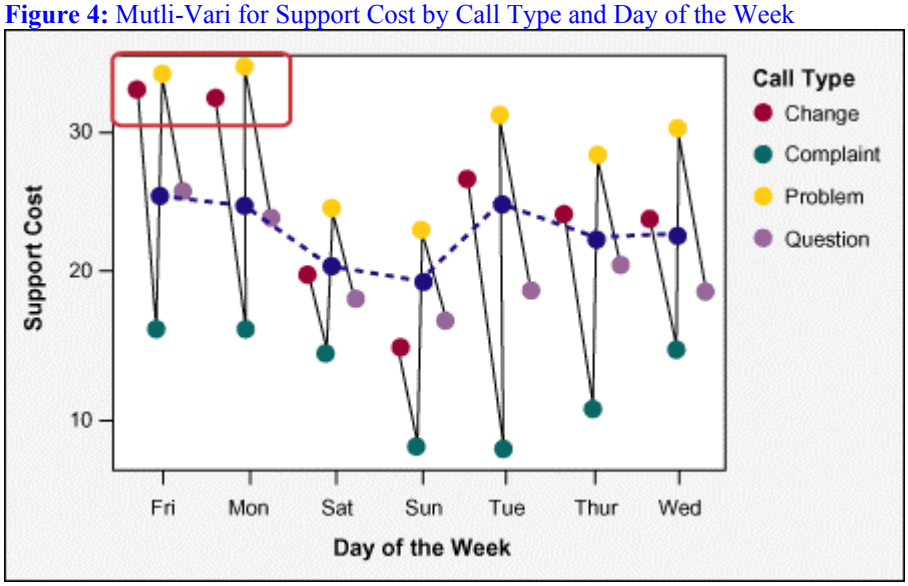


Figure 4: Mutli-Vari for Support Cost by Call Type and Day of the Week



A4: Identify (Refined/More Detailed List of) Possible x's

Collecting the findings that came out of A3, the team posed strongest in the form of "why" questions:

- Why do Problems and Changes cost more than other call types?
- Why are calls processed on Mondays and Fridays more expensive?
- Why do transfer rates differ by call type? (higher on Problems and Changes, lower on others)
- Why are wait times higher on Mondays and Fridays and on Week 13 of each

The team reviewed the fishbone diagrams, Y-to-x trees, and cause-and-effect matrices that it had built during the Measure phase. At this step, with the benefit of the data and insight gained during A3, the team was ready to get closer to what was really driving the Y(s). Figures 5, 6 and 7 trace the team's thinking as it moved through this step. Figure 5 highlights questions about the driving influence of staff availability – and why it may vary so widely on Mondays and Fridays. Figure 6 highlights the issue of staffing/call volume as a ratio. The initial data had looked at these factors individually. Figure 7 raises questions about several factors that were not measured initially – but the data may suggest these as realistic lower-level x's that should be studied using a sample of follow-on data.

Figure 5: Fishbone Diagram

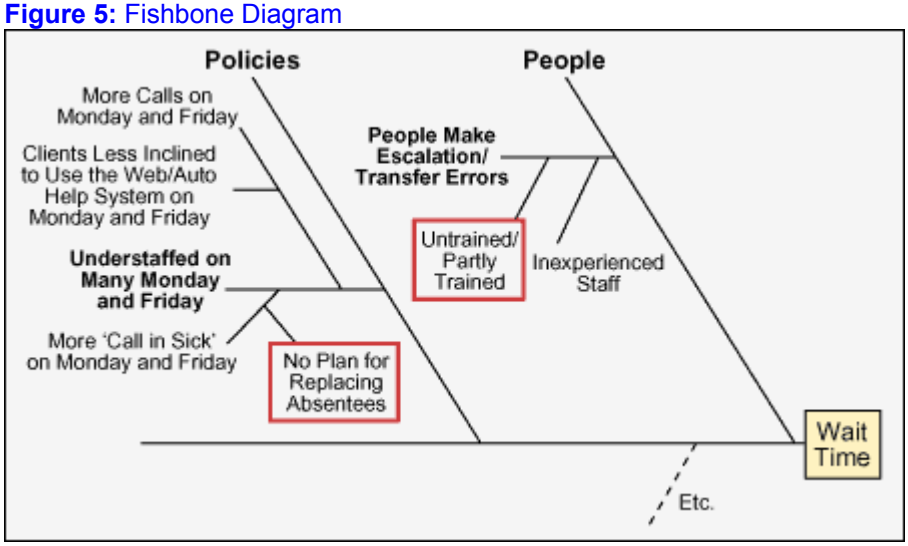


Figure 6: Y-to-x Tree

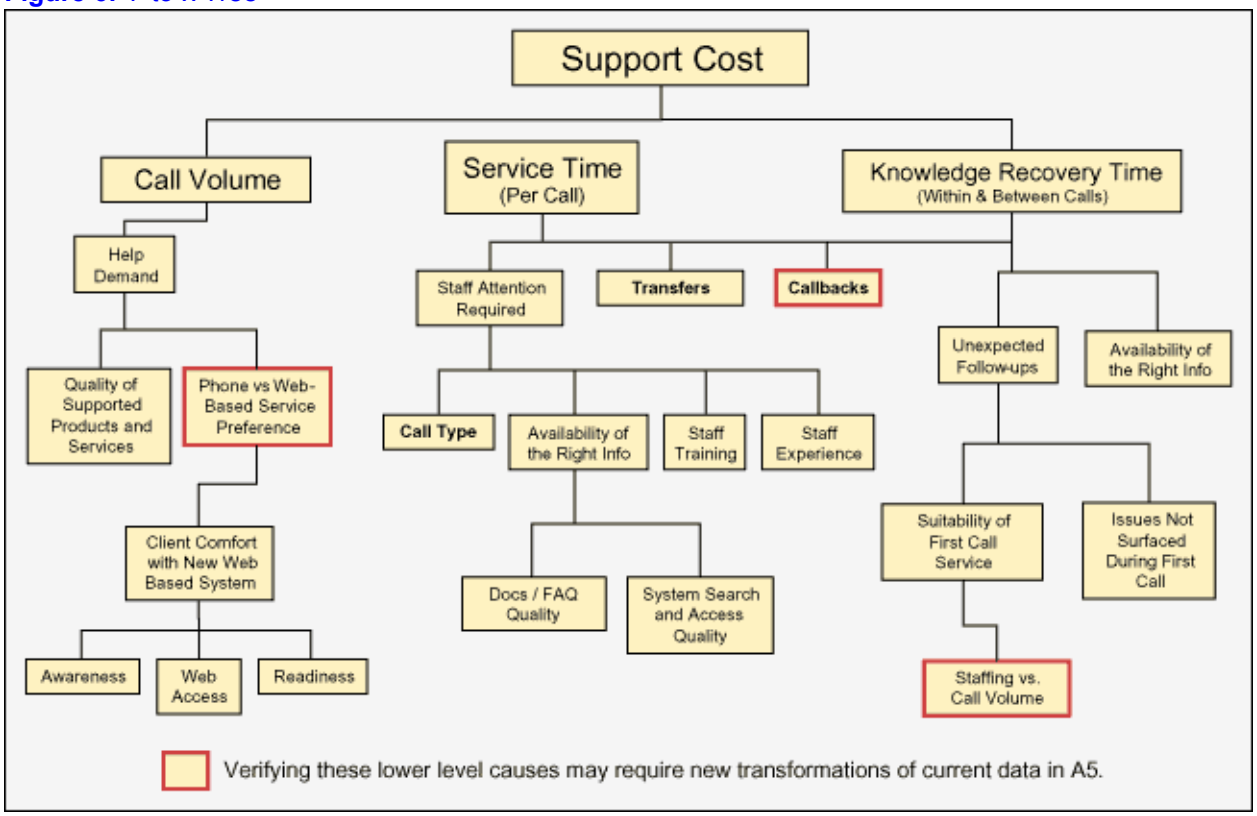
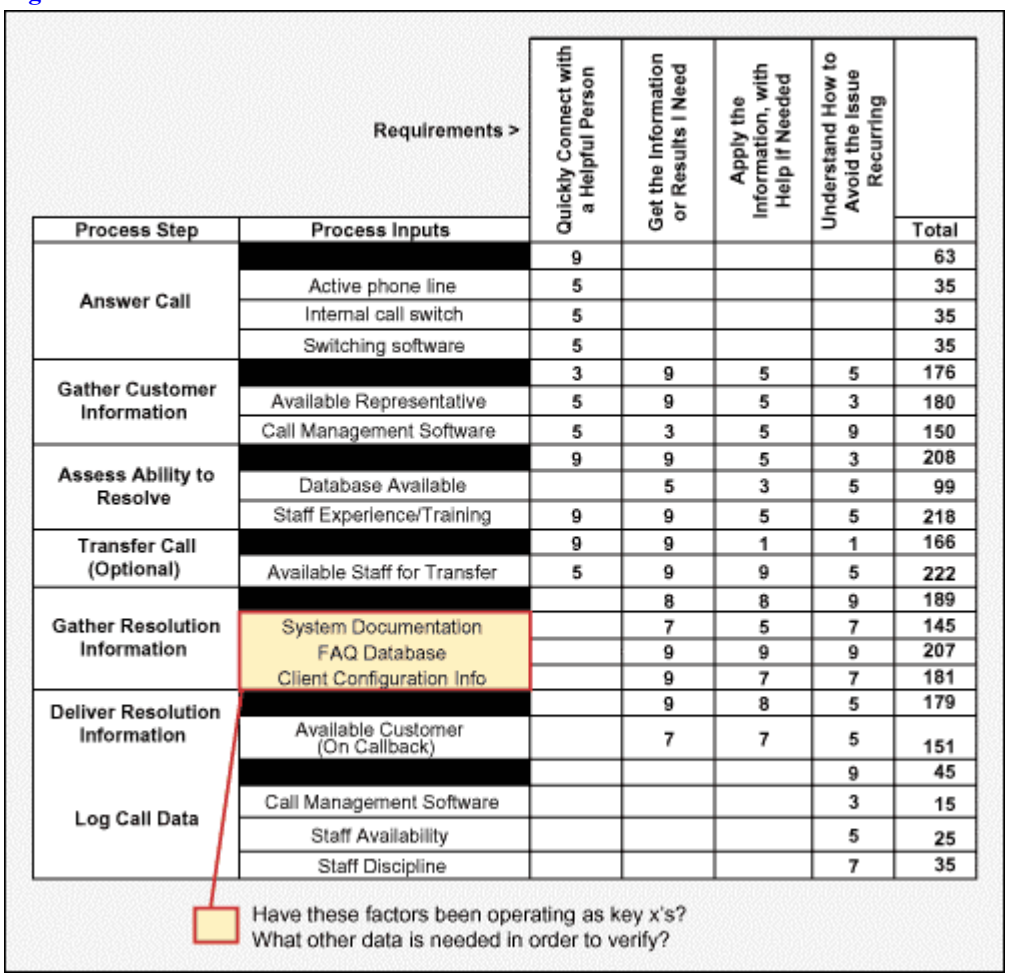


Figure 7: Cause-and-Effect Matrix



Process Step	Process Inputs	Quickly Connect with a Helpful Person	Get the Information or Results I Need	Apply the Information, with Help If Needed	Understand How to Avoid the Issue Recurring	Total
	Requirements >					
Answer Call		9				63
	Active phone line	5				35
	Internal call switch	5				35
	Switching software	5				35
Gather Customer Information		3	9	5	5	176
	Available Representative	5	9	5	3	180
	Call Management Software	5	3	5	9	150
Assess Ability to Resolve		9	9	5	3	208
	Database Available		5	3	5	99
	Staff Experience/Training	9	9	5	5	218
Transfer Call (Optional)		9	9	1	1	166
	Available Staff for Transfer	5	9	9	5	222
Gather Resolution Information			8	8	9	189
	System Documentation		7	5	7	145
	FAQ Database		9	9	9	207
	Client Configuration Info		9	7	7	181
Deliver Resolution Information			9	8	5	179
	Available Customer (On Callback)		7	7	5	151
Log Call Data					9	45
	Call Management Software				3	15
	Staff Availability				5	25
	Staff Discipline				7	35

The work represented in the previous figures motivated the next round of analysis, step A5, to check the deeper relationships hypothesized. As is often the case, the team had identified some new data that could be useful. Further, it had uncovered some new ways to "torture" the current data to reveal more root cause insights:

- Volume to staffing ratio – Call volume and staffing had not revealed much when looked at separately. Their ratio may be more interesting.
- Web-to-phone issue call traffic ratio could be computed from the initial data – potentially revealing more insight.

A5: Identify and Verify the Critical x's

The team made the computations and comparisons suggested by its cause-and-effect work. During this step, there was a leaning toward the statistical tools, to make the verification of driving x's more fact-based and convincing. Figures 8 and 9 illustrate a few elements in that work. Figure 8 shows that some days can be understaffed (Fridays and Mondays) and others (especially Sundays) can be overstaffed. Figure 9 shows that the influence of callbacks on a call's wait time (graphed during A3) is statistically significant (indicated by the P of less than 0.05 in the Callback row of the ANOVA table).

Figure 8: Multi-Vari with Computed Ranges Overlaid

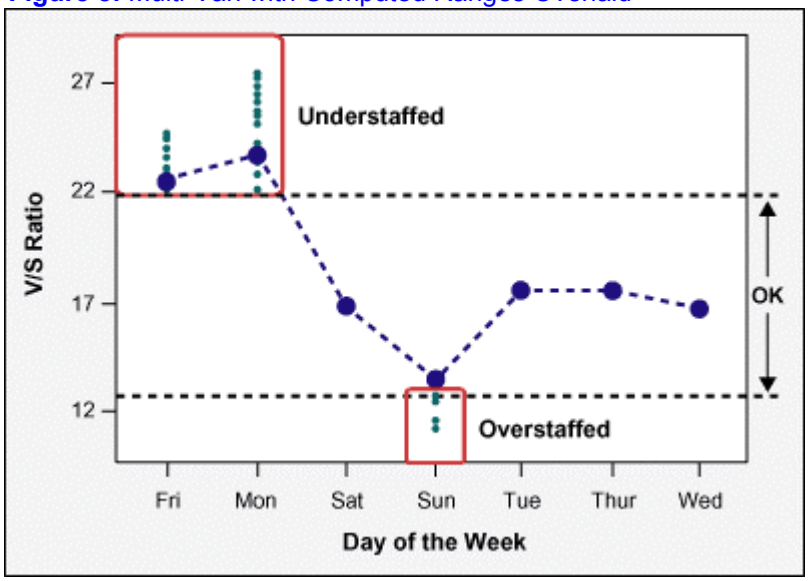


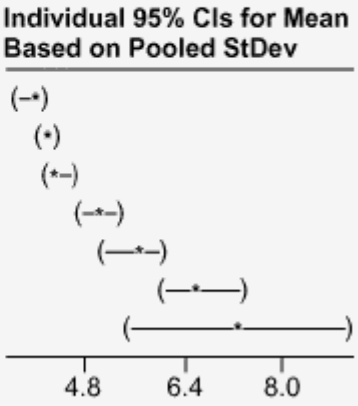
Figure 9: ANOVA Output

Analysis of Variance for Wait Time

Source	DF	SS	MS	F	P
Callback	6	140.334	23.389	24.18	0.000
Error	329	318.301	0.967		
Total	335	458.635			

Level	N	Mean	StDev
0	70	3.6143	0.9875
1	125	4.0352	0.9434
2	77	4.2247	1.0309
3	43	5.0140	1.0150
4	12	5.5833	1.0582
5	8	6.7625	0.7836
6	1	7.3000	0.0000

Pooled StDev = 0.9836



A6: Refine the Financial Benefit Forecast

In its charter, the team had signed up to reduce support costs per call from the current level (as high as $40) to $32. Given the team's analysis on factors driving support cost, the members still thought this was possible, and left the forecast unchanged.

The team was pleased to see that the key support cost drivers (the delays and interruptions during call servicing) were the same as those known to drive down customer satisfaction – so a win-win seemed to be possible.

A Six Sigma Case Study-Tutorial for IT Call Center
Part 5 of 6 – The Improve Phase

Having identified and verified ways that support cost is driven by staffing ratios, process factors like transfers and callbacks, and the proportion of phone and web traffic, the Six Sigma project team of the IT services business began identifying and selecting among solutions. It had entered the Improve phase. The DMAIC roadmap called for work in these areas during the Improve phase:
I1. Identify Solution Alternatives to Address Critical x's: Consider solution alternatives from the possibilities identified earlier and decide which ones are worth pursuing further.

I2. Verify the Relationships Between x's and Y(s): What are the dynamics connecting the process x's (inputs, KPIVs) with the critical outputs (CTQs. KPOVs)?

I3. Select and Tune the Solution: Using predicted performance and net value, decide what is the best solution alternative.

I4. Pilot / Implement Solution: If possible, pilot the solution to demonstrate results and to verify no unintended side effects.

I1. Identify Solution Alternatives to Address Critical x's

Work done during the Analyze phase identified several areas of prospective improvements that could deliver project results. The solution alternatives were:

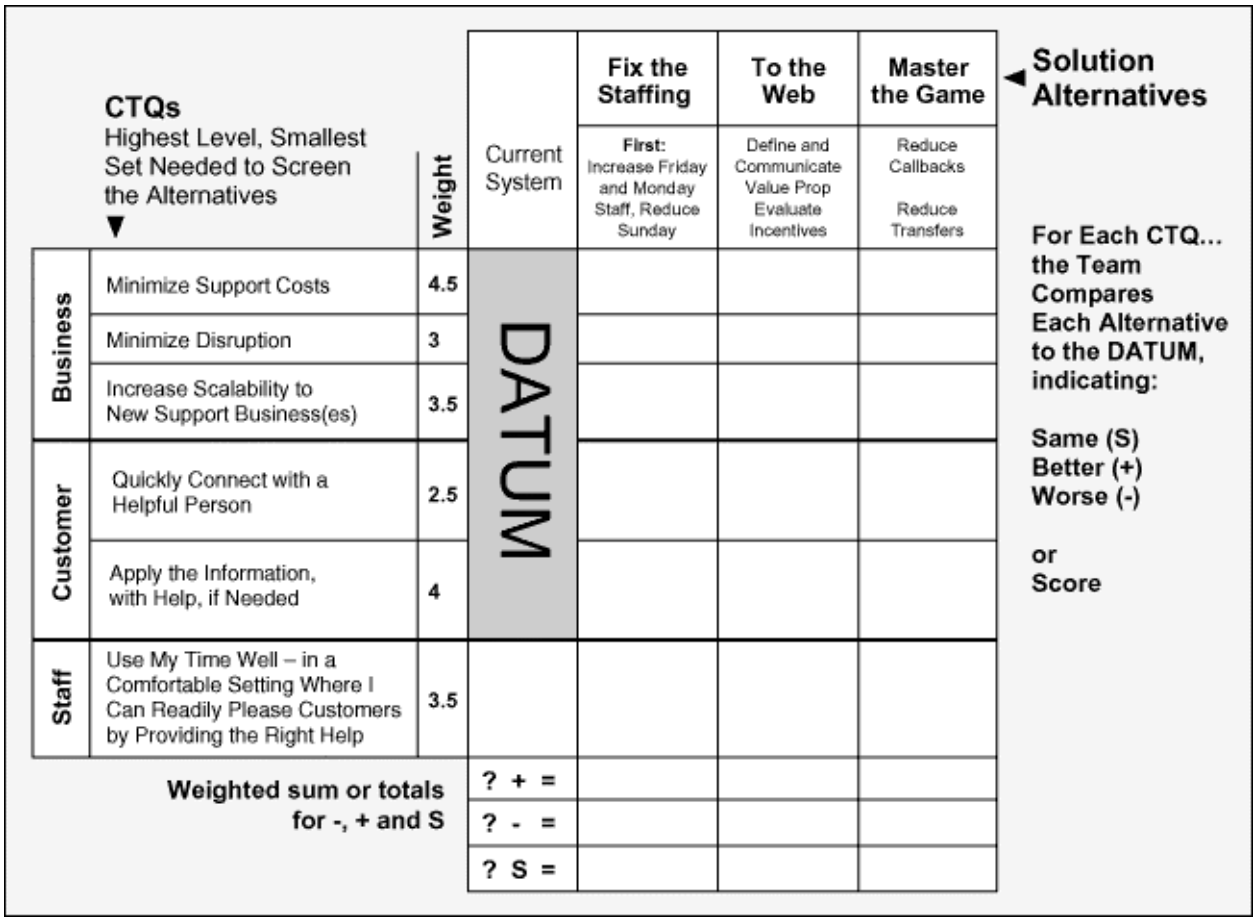
Driving Xs (from Analyze phase)	Solution Alternatives
Staffing	+ Add staff Mondays and Fridays, reduce staff on Sundays
	+ Develop staffing model
	+ Create on-call list to fill-in for absentees
Web Service Percentage	+ Focus on services that can be done best on the Web
	+ Define and communicate the value prop to customers
	+ Evaluate incentives to move traffic to the Web
Transfers and Callbacks	+ Improve call center processes to reduce transfers and callbacks without impacting customer satisfaction

The team began to think through how each of these alternatives would work – how it would compare/contrast with the current state, and what the costs, benefits and risks are regarding each CTQ for each of the following stakeholders?

Business: Net value = ($$Benefit – $$Cost) and other benefits and risks.
Customers: Functionality and value.
Employees (as appropriate): Working conditions, interesting work and growth opportunities.

To understand and compare each solution alternative, the team realized it would need to describe and characterize each of them with respect to the key requirements. The characterization work is the core of step I2, and the population and work-through of the selection matrix is the main activity in I3. A solution selection matrix (Figure 1), empty of evaluations during I1, formed the basis of the team's planning for the characterization work. (The matrix is an extract or simplified view of the "real thing.")

Figure 1: Solution Selection Matrix Drives the Characterization Work in I2



I2. Verify the Relationships Between x's and Y(s)

For each solution alternative, a sub-team worked through a series of comparisons and characterizations in order to check and quantify the key x-Y relationships that could be exploited for that alternative. Each group began by determining the magnitude of the potential business benefit. To do that, it was necessary to know the x-Y relationship, known as the "transfer function." If the potential benefit appeared to be significant, then the group had to evaluate how the improvement might be implemented, and what it would cost. Obviously the alternative passed if benefits meaningfully exceeded the likely cost of the improvement. If not, it was eliminated.
The staffing option is an illustration of the process used. To examine the other options, the team followed similar thought processes, but perhaps applied a somewhat different combination of tools. To evaluate the staffing option, the team asked this series of questions:

1. Which variables will be impacted, and by how much? Wait time, support cost, volume/staff (v/s) ratio.

2. How will the benefit be measured? Value of account growth minus the cost of additional staff.

3. What chain of analysis will be used to show the connection between additional staff and account growth? By definition, staffing drives v/s ratio. Does v/s ratio drive wait time? Does wait time drive account growth? How many staff might be added? How would that impact wait time? How much benefit would that staffing level produce? What would it cost?

Using regression analysis with the data collected, the team saw that the variation in wait time seemed in part to be related to the v/s ratio. (Figure 2) While this did not prove causality and there clearly were other influentialing factors, the team suspected a meaningful connection (subject to stronger proof later) and decided to pursue this clue further.

Figure 2: Wait Time vs. V/S Ratio

The Regression Equation Is:
Wait Time = 0.630 + 0.215 v/s

Predictor	Coef	SE Coef	T	P
Constant	0.6300	0.2314	2.72	0.007
v/s	0.21521	0.01251	17.21	0.000

S = 0.7744 R-Sq = 47.0% R-Sq (Adj) = 46.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	177.57	177.57	296.06	0.000
Residual Error	334	200.32	0.60		
Total	335	377.89			

Next, the team wanted to know if wait time was driving account growth – and, if so, by how much. The team again applied regression analysis. (Figure 3) It appeared that 61 percent of the variation in account growth could be attributed to wait time. Again, this was not conclusive proof, but wait time was a worthy suspect.

Figure 3: New Accounts vs Wait Time

The Regression Equation Is:
NewAcct = 1.06 - 0.0315 Wait Time

Predictor	Coef	SE Coef	T	P
Constant	1.05535	0.02005	52.64	0.000
Wait Time	-0.031501	0.004216	-7.47	0.000

S = 0.01640 R-Sq = 62.2% R-Sq (Adj) = 61.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0.015019	0.015019	55.84	0.000
Residual Error	34	0.009145	0.000269		
Total	35	0.024164			

To understand the number of staff that might be added or reduced, the team considered each day separately. The team decided to see what would happen, on paper, if the volume/staff ratio for each day was adjusted to the overall average – i.e., increase staff on Mondays and Fridays to get to the average v/s ratio, decrease staff to get to the average v/s ratio on Sundays. The team found that meant adding 14 people to the call center staff on Mondays. Combining what it had learned about the wait time-v/s ratio connection (Figure 2), the team forecast a 1.18-minute reduction in wait time on Mondays. The team used the following calculations:

As Is = .63 + (.215 x 23) = 5.57 Minutes
To Be = .63 + (.215 x 17.5) = 4.39 Minutes
5.57 – 4.39 = 1.18-Minute Wait Time Reduction

The team then evaluated the likely impact of wait time on new account growth using information from Figure 3.

As Is = 1.06 – (.0315 x 5.575) = 0.884%
To Be = 1.06 – (.0315 x 4.3925) = 0.921%
.921 – .884 = 0.037% New Account Growth

The accounting department was asked to provide some of the facts needed to find out the incremental value of the projected new account growth. They reported that there were 1,484,000 accounts and the average annual profit per account was $630. With this information and what the team already knew, it could calculate the financial impact.

0.037% New Account Growth x 1,484,000 Existing Accounts = 549 New Accounts
*549 Accounts x $680 Average Profit Per Account = **$345,870 Incremental Annual Profit***

Next the team calculated the additional staffing cost and the net benefit to the business.

Staff Cost = 14 People x 8 Hours x $30 Per Hour = $4,480 x 50 Weeks = $168,000
$345,870 Incremental Profit – $168,000 Staff Cost = $177,870 Project Net Benefit to Business

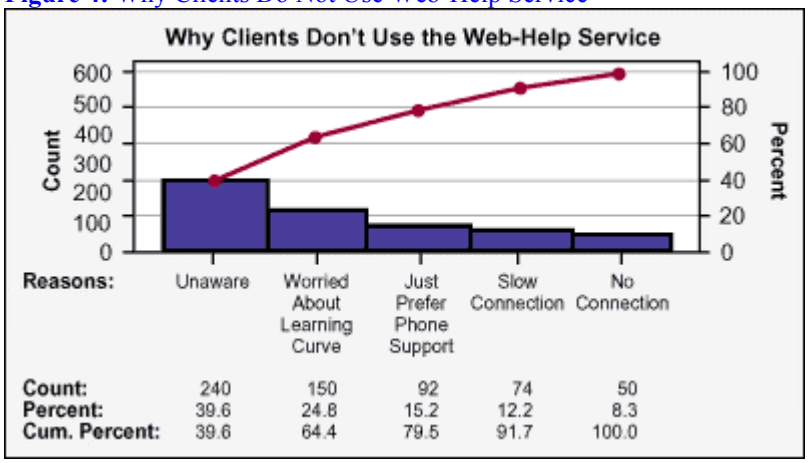
The team completed a similar quantitative analysis of each of the options. Included among them were one on web service and one on transfers and callbacks. An improvement summary was written for each.

Web Service Implementation Summary

Benefit: $280,080 (savings of $1,167 x 240 days per year).

Approach: Increase client awareness about web service and help clients see how easy it is to use. (Figure 4)
Risks: Verify that the web system can handle increased volume. Verify that customer satisfaction does not slip.
Method: Insert in upcoming mailings describing web services and interface. Announcement on the phone router switch that answers all calls.

Figure 4: Why Clients Do Not Use Web-Help Service



Transfer and Callback Implementation Summary
Benefit: $143,293 (annual savings of $104,233 + additional profit of $39,060).
Approach: In a focus group session with current staff, it was learned that almost half had not be trained on policy and system changes implemented nine months before. The data was stratified by those trained and those not. A t-test was used to compare transfer and callback percentages. The comparison showed that the untrained were more than three times as likely to have high percentages (p=.004). The conclusion was provide training.
Risks: No way to calculate how quickly the training will drive the percentage down. There may be a learning curve effect in addition to the training. Also making staff available for training is an issue because training is only done on the first Monday of each month.
Method: Considering risks, the decision was made to train 50 percent of those in need of training and evaluate the impact in a three-month pilot program. If that worked, the second half would be trained in the following quarter.
Costs: One day of training for approximately 15 people in the pilot program = cost of training ($750 per student x 15) + cost of payroll (8 hours x $50 x 15) = $14,850. If fully effective immediately, this penciled out to about half of the potential benefit. Discounting for risk, the team projected a first quarter gross (before costs) benefit of approximately $50,000.

When the team had completed a similar quantitative analysis of each of the options, it prepared a summary comparison and was ready to make recommendations for the next steps.

I3. Select and Tune the Solution

The team did not pursue tuning the solution in the context of this project, although it recognized there might be opportunities to further optimize performance of the web component.
Based on everything the team had learned, it recommended:

- Start with Staffing (the "quick fix"). It is the fastest and surest way to stem the erosion of business growth. ("We recognize it is costly and not highly scalable (to other centers, other languages, etc.). This should be a first step, with the hope that it can be supplanted as the solution elements in other recommendations reduce staff needs.)
- Web Service Percent. Begin right away tracking the call volume and customer satisfaction with this service mode.
- Transfer and Callback reduction. Start right away. This is a "no brainer" net benefit that should work well in parallel with the first two solution elements.

Before moving into the pilot phase, the team decided to meet with one of the Master Black Belts to get a sanity check on its work to that point.

MBB Review/Critique and Champion's Reaction

The Master Black Belt reviewed the team's work through I3 and raised strong concerns about the forecasts it had made for the increased staffing option. He pointed out that weaknesses in the measurement system feeding values into their regression analysis, together with the wide prediction interval around the team's estimates (which had been treated as precise point values) put considerable risk around the expectation that projected benefits would be realized.

Although the Master Black Belt's feedback was a bit sobering, the team still felt it wanted to go ahead with the pilot program. But it decided to do an interim review with the Champion first, including briefing him on the MBB's perspective. Here's a snippet of the Champion's reactions to the review:

"First let me say I think this team has done a fine job so far – you've found potentially substantial savings, you've got good supporting factual information, and you've pointed out the risks and uncertainties brought out by your MBB.

"While I don't at all dispute the issues brought out by the MBB, my perspective is a little different than his. The CEO has told me in no uncertain terms that he wants our account growth to match the competition, and soon. He made it clear this is a strategic imperative. Customers have lots of choices, and we could lose out big time if we don't turn this around right away. It has been let slide for too long as it is. So, in spite of the issues raised by the MBB, I'm prepared to spend some money to pilot this because if it works, we will get quick results. It is evident that adding staff will help us more quickly than any of the other options. We can always cut back staff later as these other improvements take hold. Turnover in this area is high anyway, so reducing staff will be painless when the time comes."

I4. Pilot / Implement Solution

The team developed a plan for the pilot program in staff training that addressed the practical considerations for success.

- Preparation and deployment steps for putting the pilot solution in place.
- Measures in place to track results and to detect unintended side effects.
- Awareness of people issues.

Details of the plan for the Monday staffing pilot program included the following elements:

- X's to adjust: Staffing level (add five for pilot, full increment to wait for evidence plan works)
- Y(s) to measure for impact and unintended side effects:
    - o Wait time, v/s ratio, customer satisfaction, transfers, callbacks, service time.
    - o Compare "new staff" versus "old staff" (hypothesis test).
    - o Measure monthly to observe learning curve effect, if any.
- Measurement system issues: Revise existing sampling plan and data collection process to distinguish new staff from old staff.
- Because the current customer satisfaction sampling gives only 1 data point per month (not enough to see a change), arrange a special sample – five per day for the first 60 days of the pilot (80 percent from existing staff, 20 percent from new staff).
- People and logistics issues: Communicate what is happening and why. Emphasize evaluation is not of individuals, only overall impact.

The team then conducted the pilot program and evaluated the results. The objective was to do before/after analysis (hypothesis tests to evaluate significance of outcomes), ask what was learned, refine the improvement if indicated and confirm or revise the business case. A number of significant questions needed to be answered in the results of the pilot program. Among the most important questions and answers were:

1. Did the additional staffing, and the resulting change in v/s ratio, impact wait time as expected? The team looked at the results month by month to see if there was a learning curve effect with the new staff. There was an effect, but the new staff nearly caught up by the end of the third month. During the first month, "new staff" calls took 7 minutes longer than "old staff" calls. During the second month, the difference was down to 2.5 minutes. And by the third month, the difference was about 1 minute. (Figures 5, 6 and 7)

Figure 5: Two-Sample T-Test for Call Length – Month 1 New & Old

	N	Mean	StDev	SE Mean
M1 New	16	16.95	4.63	1.2
M1 Old	16	10.71	3.74	0.93

Difference = mu (M1 New) - mu (M1 Old)
Estimate for Difference: 6.23750
95% CI for Difference: (3.19750, 9.27750)
T-Test of Difference = 0 (vs not =): T-Value = 4.19 P-Value = 0.000 DF = 30
Both Use Pooled StDev = 4.2102

Figure 6: Two-Sample T-Test for Call Length – Month 2 New & Old

	N	Mean	StDev	SE Mean
M2 New	16	14.70	3.61	0.90
M2 Old	16	12.16	3.51	0.88

Difference = mu (M2 New) - mu (M2 Old)
Estimate for Difference: 2.53750
95% CI for Difference: (-0.03358, 5.10858)
T-Test of Difference = 0 (vs not =): T-Value = 2.02 P-Value = 0.053 DF = 30
Both Use Pooled StDev = 3.5608

Figure 7: Two-Sample T-Test for Call Length – Month 3 New & Old

	N	Mean	StDev	SE Mean
M3 New	16	12.38	4.13	1.0
M3 Old	16	11.28	4.03	1.0

Difference = mu (M3 New) - mu (M3 Old)
Estimate for Difference: 1.10000
95% CI for Difference: (-1.84490, 4.04490)
T-Test of Difference = 0 (vs not =): T-Value = 0.76 P-Value = 0.452 DF = 30
Both Use Pooled StDev = 4.0785

2. Did wait time decrease as expected? Wait time was lower by 10 percent – just what was expected when the staff was increased by 10 percent.

Figure 8: Two-Sample T-Test for Wait Time & New Wait Time

	N	Mean	StDev	SE Mean
Wait Time	48	5.558	0.978	0.14
New Wait Time	48	5.002	0.823	0.12

Difference = mu (Wait Time) - mu (New Wait Time)
Estimate for Difference: 0.556250
95% CI for Difference: (0.189893, 0.922607)
T-Test of Difference = 0 (vs not =): T-Value = 3.01 P-Value = 0.003 DF = 94
Both Use Pooled StDev = 0.9039

3. Did the new staff have any impact on transfers? New staff had slightly more transfers, but the number was not statistically significant.

Figure 9: Two-Sample T-Test for Transfers – Month 1 New & Old

	N	Mean	StDev	SE Mean
M1 New Transfers	48	1.44	1.25	0.18
M1 Old Transfers	47	1.17	1.01	0.15

Difference = mu (M1 New Transfers) - mu (M1 Old Transfers)
Estimate for Difference: 0.267287
95% CI for Difference: (-0.196471, 0.731045)
T-Test of Difference = 0 (vs not =): T-Value = 1.14 P-Value = 0.255 DF = 93
Both Use Pooled StDev = 1.1381

4. Did the new staff have any impact on callbacks? New staff had 1.5 times more callbacks. This was a concern. The team needed to determine if this was a learning curve issue, and if not, how the additional callbacks can be controlled.

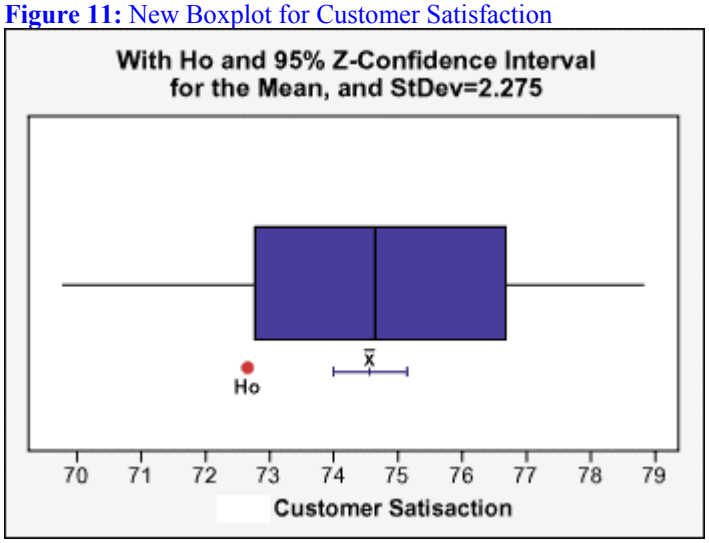
Figure 10: Two-Sample T-Test for Callbacks & New Callbacks

	N	Mean	StDev	SE Mean
Callbacks	48	0.625	0.789	0.11
New Callbacks	48	2.19	2.64	0.38

Difference = mu (Callbacks) - mu (New Callbacks)
Estimate for Difference: -1.56250
95% CI for Difference: (-2.35186, -0.77314)
T-Test of Difference = 0 (vs not =): T-Value = -3.93 P-Value = 0.000 DF = 94
Both Use Pooled StDev = 1.9476

5. What happened to customer satisfaction? New data on customer satisfaction after the pilot program confirmed the team's expectation of improvement. The company moved from less than 73 percent to about 74.5 percent.

Figure 11: New Boxplot for Customer Satisfaction



After the pilot program on staffing was complete, the team was ready for the Improve tollgate review with the project Champion. Here is what the team reported on the staffing issue during the review:

- Wait time was reduced by ~ 10 percent (to 5 minutes).
  - Volume/staff ratio was reduced to 1100/54 = 20.37 (versus. 23 before).
  - Predicted wait time = .63 + (.214 x 20.37) = 5.0 (agrees with actual).
- New staff had longer service time initially, but reached group average in three months (reflects learning curve).
- New staff had slightly more transfers, but not statistically significant.
- New staff had an average of about 1.5 more callbacks. This may need to be addressed, but is likely related to learning curve.
  - If transfers are the same as before and callbacks increase by
    [.10 x 1.5 = .015 the impact on wait time = 3.68 + (.643 x 1.23) + (.139 x .505)] = 5.41
    (i.e. negligible impact, as before the change the number was 5.40)
- Customer Satisfaction had increased, and the change was significant.
- Conclusion: The Monday staffing pilot program was a success and the team recommended full implementation.

A Six Sigma Case Study-Tutorial for IT Call Center
Part 6 of 6 – The Control Phase

The Six Sigma project team reached the final step in making significant improvements to the operation and profitability of the call center of the IT services business. After the company's senior leadership did the pre-project work, the team followed the first four steps of the Define-Measure-Analyze-Improve-Control methodology and entered the final phase. The DMAIC roadmap called for work in these areas during the Control phase:
C1. Develop Control Plan: Include both management control dashboards that focus on Y(s) and operational control indicators that monitor the most significant process variables, focusing on the x's.
C2. Determine Improved Process Capability: Use the same measures from Define and Measure in order to provide comparability and monitor impact in a consistent way.
C3. Implement Process Control: Create, modify and use data collection systems and output reports or dashboards consistent with the control plan.
C4. Close Project: Prepare the implementation plan, transfer control to operations, conduct project post-mortem, and archive project results.

C1. Develop Control Plan

The Control plans addressed two views – one concerned with management control and the other with operational control. Management control includes a focus on the Y(s) or outcomes of the process and often some of the x's as well. The level of detail was decided upon based on the interests of the specific managers concerned – some want a lot of detail, some much less. Hence, the management control plan needed to consider individual preferences so as to deliver enough – but not too much – information.
The operational control plan was more concerned with the x's that are predictive of outcome Y(s). Operational control information included both controllable and "noise" variables. Operational control information was provided more frequently than management control information.
Both types of control information pertinent to this case study are illustrated in step C3.

C2. Determine Improved Process Capability

The team linked the capability of the improved process to the baselines and targets identified during Define and Measure. It was important to use the same measures. (If it was necessary to change the measures, then baselines and targets would have had to been restated in those terms to enable comparison.) Many different statements of capability were considered, including mean/median, variance, Cp, Cpk, DPMO, sigma level, percentile rank, etc. The team knew that to a great extent these alternate characterizations are equivalent and the choice is largely one of preference. However, the team made its choices so that all concerned could have a common understanding of the meaning of the measure. The table below is the way the team chose to present the following data.

Measure	Baseline	Target	Current
Business Growth	1%	3%	Requires More Time to Measure
Customer Satisfaction	90th Percentile = 75% Satisfaction	90th Percentile = 85 Satisfaction	Need More Data
Support Cost Per Call	90th Percentile = ~ $40	90th Percentile = $32	~ $35
Days to Close	95th Percentile = 4 Days	95th Percentile = 3 Days or Less	3 Days
Wait Time	90th Percentile = 5.8 Minutes	90th Percentile = 4 Minutes or Less	4.4 Minutes
Transfers	90th Percentile = 3.1	90th Percentile = 2 or Less	1.9
Service Time	Mean: 10.5 Minutes StDev: 3.3 Minutes	Mean: <= 8 Minutes StDev: <= 0.5 Minutes	Mean: ~ 8.8 Minutes StDev: ~ 0.9 Minutes

The first current performance values were prepared from the pilot program results with plans for updating monthly or quarterly thereafter. To determine the initial values, the team considered the following:
Customer Satisfaction Percentile – The pilot data indicated an improved customer satisfaction at about 77.5 versus a baseline estimated to have been 70 to 80 percent. The team recognized this was a very small sample, so it decided not to make a claim on this until more time elapsed.
Support Cost – Using the analysis below, the team determined that the 95 percent confidence interval for support cost per call in the improved process was $33.50 to $33.90 versus about $37.00 for the baseline. The p-value indicated this change is significant. The team used Minitab to calculate the 90th percentile value as $34.94.

Support Cost Baseline	Support Cost Improved
$37.50	$33.40
$36.00	$34.00
$38.40	$33.50
$40.00	$33.90
$39.90	$33.50

Two-Sample T for
Support Costs Baseline vs. Support Costs Improved Process

	N	Mean	StDev	SE Mean
Support Costs Ba	45	37.84	1.84	0.27
Support Costs Im	45	33.722	0.983	0.15

Difference = mu (Support Costs Baseline) - mu (Support Costs Improved Process)
Estimate for Difference: 4.11333
95% CI for Difference: (3.49307, 4.73359)
T-Test of Difference = 0 (vs not =): T-Value = 13.24 P-Value = 0.000 DF = 67

Support Cost Per Call Improved Process Percents Calculated By Minitab Percentiles Macro	75 Percent	$34.60
	80 Percent	$34.76
	85 Percent	$34.90
	90 Percent	$34.94
	95 Percent	$35.14

Days to Close – Using the macro illustrated above, the team determined the 95th percentile value for the improved process days to close during the pilot was 3 days.

Wait Time – Although the data to determine the baseline value was not initially available, it was determined based on additional data collected and analyzed during the Measure and Analyze phases. The baseline was 90th percentile = 5.8 minutes, and the improved capability 90th percentile was 4.4 minutes.

Transfers – The team determined the 90th percentile baseline to have been 3.1 or less and the improved process value was 1.9 transfers.

Service Time – Baseline mean service time was 10 minutes with a 95 percent confidence interval of 9.7 to 10.4 minutes, while the improved mean was 8.8 minutes with a 95 percent confidence interval of 8.6 to 8.9 minutes.

Figure 1: Summary for Service Time Baseline

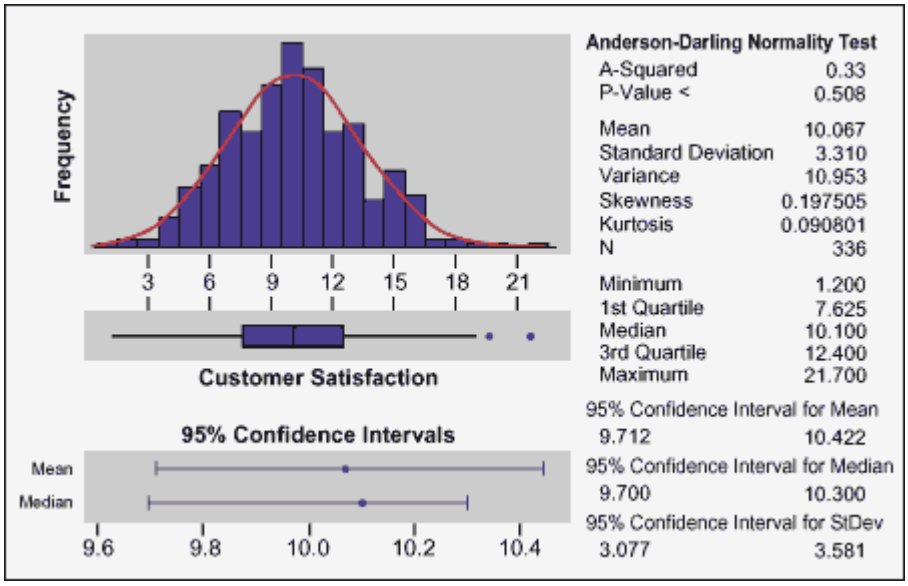
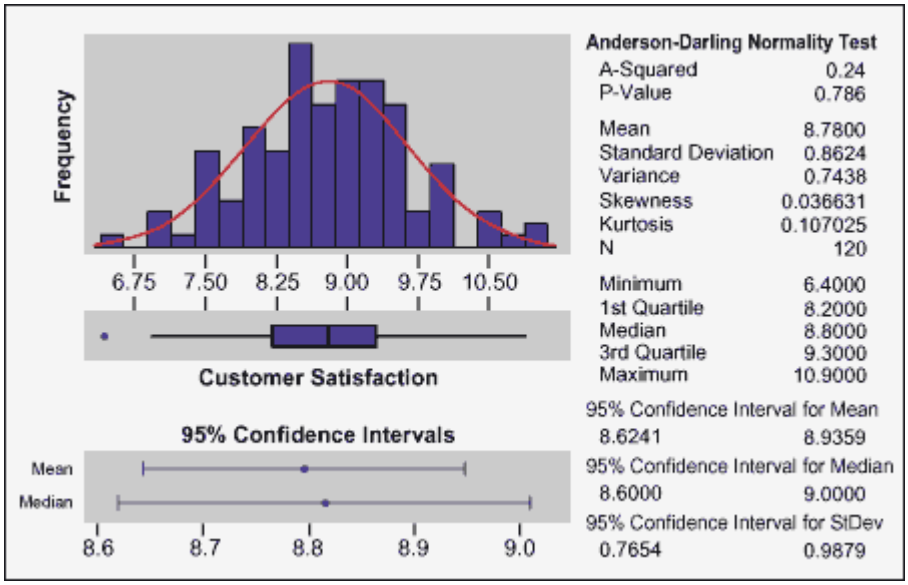


Figure 2: Summary for Service Time Improved Process



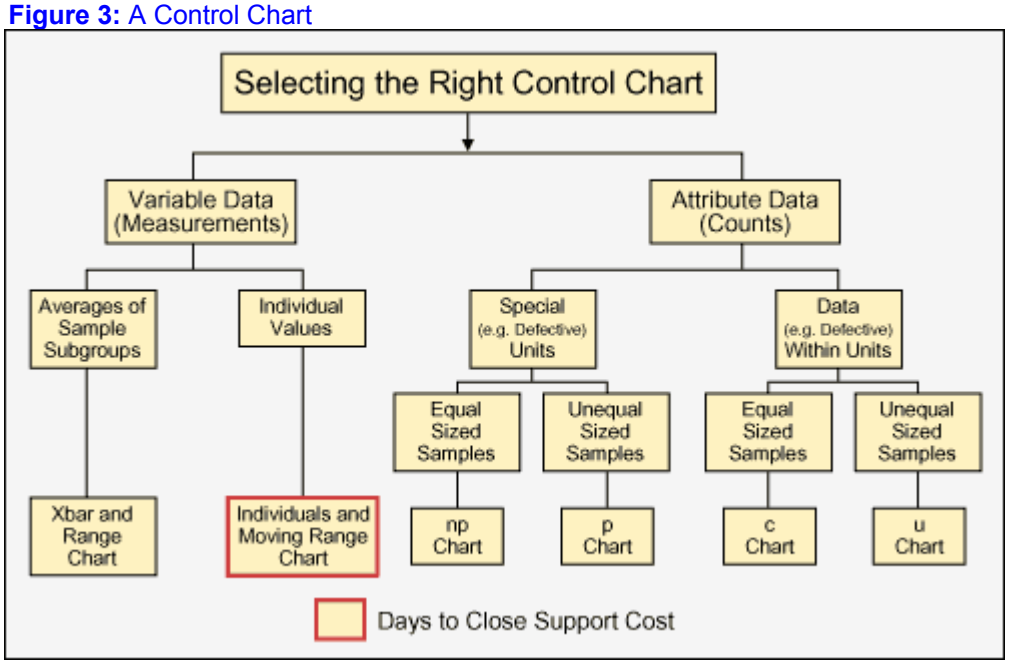
C3. Implement Process Control

The team began by planning the data collection process to be used, including preparing operational definitions for each data element and automated tools whenever possible to minimize expense and effort. Heeding W. Edward Deming's message to "drive out fear," the team was careful to prepare a well-thought-out communication plan to ensure the staff knew how the data was to be used and to address any concerns about punitive uses of the data. The team recognized that if members of the staff thought the data would be misused, they might be tempted to distort the data.

The team also verified that the process was under procedural control – i.e., standards and documentation were up-to-date and the staff understood and followed the intended process. In preparation for implementing control charts on some of the process variables, the team recognized the segmented some of the data, such as "issue type." Significant variations were expected across, but not within, issue types (e.g., "problem" versus "question").

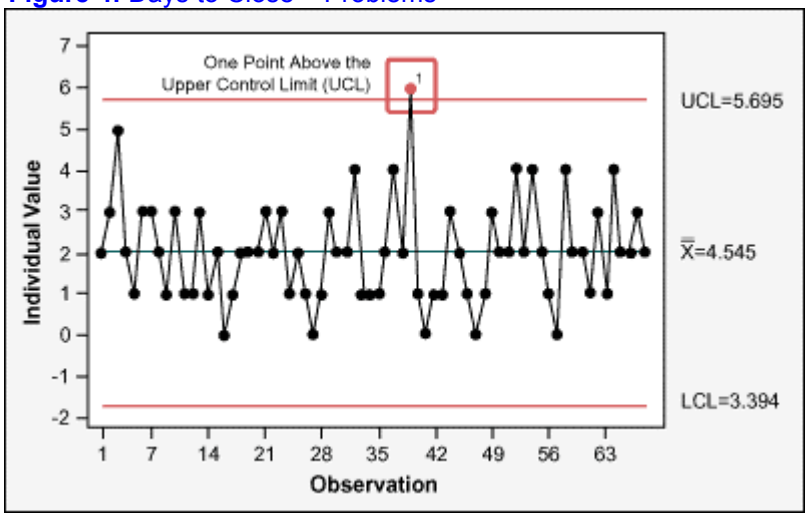
The team selected the appropriate form of control chart to suit each situation to be monitored. (Figure 3)

Figure 3: A Control Chart



One of the control charts the team implemented (Figure 4), monitored days to close for issue type = Problems. Similar charts were prepared for other issue types and for support cost.

Figure 4: Days to Close – Problems



Implementing process control means more than preparing control charts. The team also defined a process for analyzing the output in order to help the operations group determine the right course of action when an out of control situation is encountered. One of the tools they used was the Minitab "data brush." This tool isolates potential "special cause" data.

The team deployed a full set of control charts that monitored all of the variables of interest, but it also recognized a need for an overview to give a broader perspective without all of the detail. To satisfy that need, the team designed two "dashboards" for use by executive management and the call center. These dashboards overlap somewhat.

The team knew that new account growth and customer satisfaction were important to the senior vice president who runs the business unit served by this call center. The team recommended changes that were expected to impact these outcomes, so the vice president wanted to monitor what actually happened. He also wanted to see how these changes were impacting the cost structure.

The dashboards, one for the vice president and one for the call center manager, reflected both x's (leading indicators) and Y(s) (trailing indicators).

C4. Close Project

The team's final effort was aimed at wrapping up the project and transferring control to the call center group. This last step included:

- Developing and executing a plan to implement the improved process, including any necessary training.
- Developing and executing a communication plan that informed all those affected by the change.
- Conducting a transition review with key managers and staff, making adjustments and improvements they suggested.
- Establishing the timeline and responsibilities for the transfer, and executing the transition process.
- After an agreed interval, validating the financial benefits in conjunction with a representative of the finance department.
- Conducting a project post-mortem from multiple perspectives – the team, the Champion/sponsor, and the financial results. (Emphasis on process improvement, not critiques of individual performance.)
- Archiving in an accessible repository what the project team learned so other teams can benefit from it. (Special emphasis on items that have potential for re-use, and a "road-show" or poster presentation to communicate project results.)
- **Celebrating!** …along with well-deserved acknowledgment of team contributions (both the Six Sigma project team and the operations team).

About the Author

Gary A. Gack is a managing partner in Six Sigma Advantage which is headquartered in Narragansett, R.I. He has an MBA from the Wharton School and is a PMI-certified project management professional and an ASQ-certified software quality engineer. During his 40-year career in the software and IT industry, he has managed a variety of large-scale software projects and has consulted with dozens of Fortune 1000 firms. Mr. Gack can be reached at ggack@6siga.com.