3.4.2 Data Analysis

The statistical analysis techniques used for this research included correlations, multiple regression analysis, equality of means, and cluster analysis. For Research Questions 1-3, Kendal's tau b correlations were used to examine whether or not significant relationships existed between the dependent and the independent variables. Where appropriate, General Linear Model for multiple regression analyses were performed to determine if regression equations could be found to relate one or more of the independent variables (employees trained in CI, number of departments involved in CI, total number of CI tools used, and CI tool focus) to the six dependent variables used to assess hospital performance.

For Research Question 4, descriptive statistics were used to characterize overall tool usage across the entire sample of hospitals. A Wilcoxon Sign Rank test was used to determine whether or not the average number of effectiveness tools used differed from the average number of efficiency tools used by the hospitals participating in the study.

For Research Question 5, Kendal tau b correlations were used as a screening device to assess whether or not any significant relationships emerged between individual tool usage and the six dependent variables related to hospital performance. Box plots were also created and studied to compare performance differences between hospitals that used a particular CI tool and those hospitals that did not use the same tool. In addition to the analyses conducted to address the defined request questions, follow-on analyses were completed, post hoc, to help provide additional insight into the results of the hypothesis testing completed.

As a result of the very low response rate to the web survey, follow-up telephone interviews were conducted. The telephone interviews or surveys included seven questions. These questions were directed to participants from nine of the seventeen responding hospitals.

These hospitals were selected based upon a stratified random sample ~~to represent~~ the proportion of hospitals, ~~i.e. large, medium, and small~~. The responses ~~to these seven questions~~ were ~~categorized and~~ summarized. Pie charts were ~~developed~~ to provide an overall ~~assessment~~ of the responses ~~given across all~~ nine ~~participants~~.

The final set of ~~post hoc~~ analyses were completed to examine the potential role of hospital size on the use and resulting impact of CI tools on hospital performance. Basic descriptive statistics were ~~calculated~~ for both the independent and dependent variables for each group of hospitals by size. A Wilcoxon Rank ~~Scale~~ was used to ~~examine the effect of~~ hospital size. ~~In~~ the final ~~set of post hoc~~ analyses completed, hierarchical cluster analysis was completed to determine whether ~~certain types of~~ usage patterns ~~emerged~~ for the set of hospitals participating in this study. A Wilcoxon Sign Rank test was used to determine ~~if~~ a significant difference occurred between the clusters.

4 Results

This chapter summarizes the results of the analyses of both the survey and interview data. The analyses are organized into four sections. The first section provides a summary of various characteristics of the hospitals participating in the study. This section includes descriptive statistics for demographic factors, e.g. number of beds, number of admits, etc. for CI implementation practices, e.g. the number of employees involved in CI, and for hospital performance, e.g. lab wait times. The second section provides a summary of the statistical analyses completed to address the five research hypotheses. The third section summarizes the results of the follow-up telephone survey administered to a subset of administrators from hospitals that completed the survey. The fourth section summarizes post-hoc analyses completed to investigate the role of hospital size in the use of CI practices.

To facilitate the presentation of the results, abbreviations were developed for the various independent and dependant variables. These abbreviations are summarized in Table 12. In addition to the abbreviations used for the independent variables, acronyms were developed for each of the CI tools included in the study. Table 13 summarizes the acronym used for each CI tool included in the survey.

Table 12: Abbreviations for Survey Items

Abbreviation	Survey Item
# of Beds.	Number of licensed beds
# Pat. admttd.	Patients admitted
% CMS.	Percent of patients Medicare/Medicaid
% uninsured.	Percent of patients uninsured
# ER Pat.	Patients seen in emergency department
FTE Eng. CI.	Full-time employees engaged in CI
# of Depts.	Departments engaged in CI
FTE. Trnd. CI.	Full-time employees trained in CI
Red. Pat. Cost.	Staff engaged to reduce patient cost (yes or no)
Avg. Pat. Cost/Day.	Average patient cost per day
Red. Lab. Wait Times.	Staff engaged in reducing wait time for lab. results (yes or no)
Avg. Lab. Wait. Times.	Average wait time for lab results
Red. Rm. Time.	Staff engaged in reducing average time to clean a room (yes or no)
Avg. Rm. Time.	Average time to prepare a room
Red. Errors.	Staff engaged to reduce reportable errors (yes or no)
Errors.	Number of reportable errors
Imp. Pat. Sat.	Staff engaged in CI to improve patient satisfaction (yes or no)
Pat. Sat.	Overall rating of patient satisfaction for hospital
Imp. Emp. Sat.	Staff engaged in improving employee satisfaction (yes or no)
Emp. Sat.	Overall rating of employee satisfaction for hospital

Table 13: Acronyms used for CI Tools

Acronym	CI Tools
5s	Shine, sort, standardize, store, sustain
5Y'S	5 why's
AD	Affinity diagrams
B	Benchmarking
CS	Customer surveys
CFT	Cross functional teams
CTA	Cycle time analysis
CRA	Customer requirements analysis
DPI	Delivery Performance Improvement
DMAIC	Define, measure, analyze, improve, control
DPI	Delivery performance improvement
FBD	Fishbone diagrams
FMEA	Failure mode effect analysis
FPG	Frequency polygons
H	Histograms
JIT	Just in time
KBS	Kanban system
LTA	Lead time analysis
NPET	New processes equipment technology
PA	Pareto analysis
PCA	Process capability analysis
PFP	Pay for performance
PM	Process mapping
POUS	Point of use stocking
PVA	Process variation analysis
PY	Poka-yoke
QC	Quality circles
SDWT	Self-directed work teams
SIPOC	Supplier inputs process output customer
SPC	Statistical process control
TTA	Travel time analysis
VAA	Value-added analysis
VSM	Value stream mapping
WC	Work cells

4.1 Descriptive Summary of Survey Responses

4.1.1 Response Rate Summary

There were 206 large, medium, and small hospitals in Oregon, Washington, and Idaho that were invited to participate in the study. A total of 17 hospitals completed the entire survey or a portion of the survey. The hospitals were categorized based upon the number of beds that each hospital was licensed for. Small hospitals were defined as those hospitals licensed for one to 99 beds, medium hospitals were defined as those licensed for 100-300 beds, and large hospitals were defined as those licensed for more than 300 beds. The largest number of surveys were returned from Oregon hospitals ($n_{Oregon} = 8$). Five surveys were returned from hospitals in Idaho, and four surveys were returned from hospitals in Washington. In terms of hospital size, only three large hospitals (all from Oregon) participated in the study. Five medium hospitals and nine small hospitals returned surveys. Response rates varied both by hospital size and by state. The overall response rates by size and by state are summarized in Table 14. Response rates for each state, by size are summarized in Table 15.

Table 14: Overall Survey Response Rates by Hospital Size and by State

	Size		
	Small	Medium	Large
Number Responding (n)	9	5	3
Target Population (N)	136	49	21
Response Rate by size	7%	10%	14%
	State		
	OR	WA	ID
Number Responding (n)	8	4	5
Target Population (N)	60	98	48
Response Rate by state	13%	4%	10%

Table 15: Response Rates by State

	Small	Medium	Large
Oregon			
Number Responding (n)	2	3	3
Target Population (N)	40	13	7
Response Rate	5%	23%	43%
Washington			
Number Responding (n)	3	1	0
Target Population (N)	58	29	11
Response Rate	5%	3%	0%
Idaho			
Number Responding (n)	4	1	0
Target Population (N)	38	7	3
Response Rate	11%	14%	0%

4.1.2 Descriptive Statistics for all Respondents

Each hospital was requested to provide data on implementation practices, tool usage, and performance for two years (2006 and 2007). In reviewing the responses provided, many hospitals did not provide complete data, therefore, it was decided to use only data from 2007 as representative of the data submitted.

Basic descriptive statistics were calculated using the 2007 data. Since not all items were completed by each hospital, the number of responses used to calculate summary statistics varies for survey items. In addition, one of the small hospitals responding to the survey completed only four of the requested items. As a result, all subsequent analyses were done with the remaining 16 responding hospitals. Average values, standard deviations, and the number of hospitals responding to each survey item are summarized in Table 17. The items have been grouped based on the research model defined for the study.

The first set of survey items summarized are those items describing general characteristics of each hospital, i.e. number of licensed beds, annual number of patients admitted, percent of Medicare and Medicaid patients, percent of uninsured patients, and the annual number of patients seen in the emergency department.

The second set of items summarized is the percentage of responding hospitals who indicated that they were engaged in CI activities to improve performance related to costs, room turn times, lab wait times, employee satisfaction, patient satisfaction, and/or error reduction. A total of 16 hospitals responded to these six survey items. This summarized information provides a high level view of what performance elements were being addressed through the application of CI tools at the hospitals participating in this study.

The third set of items summarized is the list of independent variables related to implementation practices, i.e. number of employees trained in CI, the number of departments involved in CI, and the number of CI tools used. The acronym TTU (Total Tools Used) was used for the calculated measure of tool usage for each hospital. To calculate TTU, each tool was given a value of either 0 (not used) or 1 (tool used) for each hospital. A sum of these values was then calculated. If no tools were used the TTU value would be 0. If every tool was being used by a hospital, the TTU value would be 33.

The fourth set of items summarized is the dependent variables included in the study, i.e. patient costs/days, lab wait times, room turn time, employee satisfaction, patient satisfaction, and errors. Costs are summarized using US dollars, lab wait times and room turn times are summarized in minutes, and satisfaction scores were reported on a 5 point likert scale. In this section of the survey, respondents were asked to provide actual performance data. This section of the survey had the lowest item response rate. As few as six hospitals provided data for some of the dependent variables of interest.

Table 16: Descriptive Statistics for Demographic Factors, Involvement Responses, Independent Variables, and Dependent Variables

Variable	Mean	Std Dev	n
Demographics			
# of Beds.	200	231	16
# Pat. Admttd.	5,018	7,339	16
%. CMS.	61	17	15
%. Uninsured.	11	17	11
# ER. Pat.	18,661	16,439	13
Involvement responses			
Red. Lab. Wait Time.	25%		16
Red. Pat. Cost.	33%		15
Red. Rm. Time.	19%		16
Red. Errors.	44%		16
Imp. Emp. Sat.	50%		16
Imp. Pat. Sat.	63%		16
Independent variables			
FTE Trnd. CI.	84	145	14
# of Depts.	11	10	12
TTU Efficiency	5	4.30	16
TTU Effectiveness	8	4.79	16
Dependent variables			
Lab. Wait. Times.	22	18	9
Pat. Cost/Day.	$2,485	$1,968	10
Time Prep. Rm.	43*	28*	6
Errors.	2	2	5
Pat. Sat.	1.8**	.7**	14
Emp. Sat.	1.9**	.5**	13

*In minutes
**Based on a rating scale of 1-5 with 1 = very poor 5 = excellent.

Table 17 summarizes the analyses of the same set data, but the data are grouped by hospital size. This analysis enables a direct comparison between the responding hospitals based on size. For example, the mean and standard deviation for beds in large, medium and small hospitals are (623, 133), (210, 41), and (37, 22) respectively, with yearly admittance rates of 9,586 for large hospitals, 9,139 for medium hospitals, and 683 for small hospitals. The difference between the admittance rates for medium and large hospitals was not as great as the difference between small and medium hospitals or the difference between small and large hospitals. Medium-size hospitals had slightly more uninsured patients than large hospitals (37% versus 34%). Small hospitals had the lowest percentage of uninsured patients at 29 percent. These data suggest a greater similarity between medium and large hospitals and appear to set small hospitals apart.

Table 17 summarizes that the ratios of full time employees trained in CI to available beds. This ratio highlights a significant difference between small hospitals and the medium and large hospitals participating in the study. This ratio is 0.90 for large hospitals, 0.12 for medium hospitals, and 1.84 for small hospitals. Small hospitals participating in this study reported almost two times as many full time employees trained in CI per bed over the large hospitals and almost ten times as many employees trained in CI per bed than medium hospitals responding to the study.

The average patient cost per day for medium-size hospitals, responding to this survey, was $3,225. This is 16 percent higher than the average patient cost per day for large hospitals, and over 200 percent higher than patient costs per day for small hospitals. This difference in average patient cost per day again highlights the similarity between large and medium hospitals while emphasizing, at least from an operational perspective, the difference for small hospitals.

Patient and employee satisfaction scores were not all reported for the three large hospitals responding to the survey. However, the average satisfaction scores for medium and small hospitals were similar for both employee satisfaction and patient satisfaction. The average satisfaction scores for both sizes of hospitals were in the poor to very poor range.

Table 17: Descriptive Statistics by Hospital Size

	Hospital size					
	Large n=3		Medium n=5		Small n=8	
Demographics						
Item	Mean	SD	Mean	SD	Mean	SD
# of Beds.	623	133	210	41	36	29
# Pat. Admttd.	9,586	14,880	9,139	4,123	730	582
% CMS	38	8	54	10	71	15
% Uninsured.	34	40	5	5	6	5
# ER. Pat.	-	-	31,671	14,143	6,737	6,609
Independent variables						
Item	Mean	SD	Mean	SD	Mean	SD
FTE. Trnd. CI.	239	330	26	34	68	122
# of Depts.	11	14	7	12	13	8
TTU Efficiency	~~9.67~~ 10	~~4.04~~ 4.0	7	~~4.60~~ 4.6	~~2.80~~ 3	~~2.00~~ 2.0
TTU Effectiveness	~~11.3~~ 11	~~4.00~~ 4.0	10	~~5.00~~ 5.0	~~4.60~~ 5	~~3.50~~ 3.5
Dependent variables						
Item	Mean	SD	Mean	SD	Mean	SD
Lab. Wait Times	-	-	17*	15*	28*	21*
Pat. Cost/Day	$2,788	$2,192	$4,837	$2,245	$1,362	$798
Time Prep. Rm.	-	-	54*	10*	32*	38*
Errors.	-	-	2	3	1	1
Pat. Sat.	2.50**	.71**	1.60**	0.55**	1.7[illegible]**	0.76**
Emp. Sat.	-	-	2.00**	0.71**	~~1.86~~** 1.9	0.38**

Note. "–" Indicates information not reported by more than one hospital
*In minutes ** Based on a scale of 1-5 1 = very poor 5 = excellent.

Add TTU

I think this data is incorrect

For TTU use only 1 digit for mean & 2 digits for std dev.

for Pat & Employee satisfaction up 2 digits for mean, but only 1 after decimal pt & 2 digits (to hundredths) for S.D.

4.2 Research Questions and Hypotheses Analyses and Results Summary

This section presents a summary of the results obtained when analyzing the data based on the research questions and hypotheses developed for this study. Many previous studies either reviewed the effectiveness of training for CI implementation (Palo & Padhi, 2003) or studied the effects of CI projects on single performance criteria, e.g. wait times. The focus of this study was to examine the effects of multiple independent variables individually against six different hospital performance measures. The research goal was to determine a predictive equation for each dependent variable based on the existing levels of CI implementation as defined by the number of employees trained in CI, the number of departments engaged in CI, and total tool usage. As a first step in this analysis, the level of association between each independent variable (FTE Trnd. CI, # of Depts., and TTU) and each of the six dependent variables representing hospital performance was calculated using Kendall tau b correlations. Because not all hospitals provided data for both the independent and dependent variables included in the study, the number of responses for each correlation ranged from a low of six to a high of 14. The results of this correlation analysis are summarized in Table 18. The independent variables are located in the first column of the table, and the dependent variables are specified in the first row of the table using the abbreviations and acronyms summarized in Tables 12 and 13, respectively. A letter designation is included next to each dependent variable based consistent with the individual hypothesis associated with each dependent variable.

Table 18: Kendall tau b correlation results

	Lab wait times (a)	Pat. cost/day (b)	Time prep rm. (c)	Errors(d)	Pat. Sat. (e)	Emp. Sat. (f)
FTE Trnd. CI (H1)	0.354 n=8	0.429 n=7	0.222 n=5	0.471 n=5	0.124 n=11	-0.116 n=12
# of Depts. (H2)	0.077 n=8	0.036 n=8	-0.105 n=5	0.183 n=4	-0.028 n=10	-0.219 n=10
TTU. (H3)	-0.243 n=9	0.405 n=10	0.552 n=6	0.447 n=15	-0.098 n=14	-0.182 n=13

4.2.1 Summary of Analyses and Results for Hypotheses 1, 2, and 3

Based on the correlations between the independent variables and the dependent variables, there was no support for any of the hypotheses

There does not appear to be support for the hypotheses developed for this study linking the number of departments engaged in CI and total tool usage to hospital performance when a simply correlation between these variables and hospital performance is conducted. The lack of significant association between the independent variables and the six chosen measures of hospital performance is not consistent with some previous research, e. g. Argyris & Schon, 1996; Emison, 2004; Ishikawa, 1985; Kantor & Zangwill, 1991; Middel et al., 2006; Murray & Chapman, 2003; Rajagopalan, 1998; Zangwill & Kantor, 1998.

The data distribution from this study was analyzed using Minitab software to ascertain the shape of the distribution. If the distribution of the data were normal then parametric analysis would be pursued, and if not then a non-parametric option would be executed. It was determined that the data was not normally distributed and thus for this and the remaining analysis of the data from this study non-parametric statistics would be used. For this section on regression analysis, the General Linear Model (GLM) for statistics was chosen over factorial ANOVA or

Table 19: Summary of GLM Regression Model Coefficients for Employee Satisfaction

Descriptive Analysis

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	Emp. Sat.	9	1.00	3.00	2.00	.50
Covariate	Dept	9	.00	25.00	11.00	10.10
	FTE	9	1	315	56.78	100.21
	TTU	9	3.00	29.00	11.56	7.38

Summary of GLM Regression Model Coefficients For Employee Satisfaction

	B	Std. Error	95% Wald Confidence Interval Lower	Upper	Hypothesis Test Wald Chi-Square	df	Sig.
(Intercept)	**1.481**	.238	1.015	1.948	38.754	1	**.000**
FTE	-.103	.072	-.243	.037	2.082	1	.149
Dept	**.251**	.073	.107	.394	11.748	1	**.001**
TTU	**.135**	.029	.078	.191	21.647	1	**.000**
Dept * FTE	.001	.003	-.005	.008	.183	1	.668
FTE * TTU	.004	.005	-.005	.014	.861	1	.354
Dept * TTU	**-.032**	.008	-.048	-.016	14.862	1	**.000**
Dept * FTE * TTU	.000	.000	.000	.001	.355	1	.551

The equation generated from the analysis for employee satisfaction is:

$$Employee\ Satisfaction = 1.481 + .251(No.\ of\ Departments\ Involved\ in\ CI\ Projects) + .135(Total\ Tools\ Used)$$

Within the analysis a combined factor was also produced $-.032(No.\ of\ Departments\ Involved\ in\ CI\ Projects)(Total\ Tools\ Used)$. Thus it appears that there was an interaction effect occurring between no. Departments Involved in CI Projects and total Tools Used, but this second order factor does not effect the equation.

Hierarchical Regression Analysis. Factorial ANOVA Analysis was not suited based upon the type and amount of data gathered in this study, and Hierarchical Regression Analysis was designed for normal data which we have investigated and proven that this data is not.

GLM was used to investigate the hypotheses $H_{1a\text{-}f}$ through $H_{3a\text{-}f}$ and determine support along with the identification of a regression equation. The results produced one equation supporting two hypotheses. The hypotheses H_{2f} and H_{3f} were the only hypotheses that were associated with a dependent variable, i.e. employee satisfaction. Table 19 displays the summary of the descriptive analysis and the non-parametric coefficients for the regression equations. In addition, the regression model is also represented within the body of the table.

Thus it appears that the majority of the hypotheses were not supported by the data from this study. Therefore it appears that the number of full time employees trained in CI tools and techniques, the number of departments involved in CI projects, and the total tools used in CI projects has no effect on wait times for lab result, patient costs per day, time to prepare a patient's room, reportable errors, or patient satisfaction. In addition, it also appears that the number of departments involved in CI projects and the total number of tools used in CI projects has no effect on these same dependent variables. These results do not support previous research (Cua, et.al., 2001; Sha, et. al., 2001, Locke, 1979; Shingo, 1985). The question of why there is no support for these previous works is explored in greater depth in the responses to the questions in the section on the telephone survey.

4.2.2 Summary of Analysis and Results for Hypotheses 4 and 5

This section discusses the research question and analyses completed to study hypothesis 4. H_4 was focused on determining whether the entire group of responding hospitals tended to favor the use of one type of CI tool (effectiveness tools or efficiency tools) over the other. Table 20 summarizes overall usage by tool number and name for the 16 hospitals responding to the tool usage portion of the survey. Tools have been sorted by frequency of use for the 16 hospitals completing this portion of the survey. The most-used tool by the participating hospitals was Benchmarking (B), with approximately 88% of the hospitals indicating that benchmarking was used in 2007. The tools with the least usage were KBS, SIPOC, TTA, PCA, QC, and WC, all had a usage rate of 12% each.

Table 20: Percentage of Hospitals Reporting Use of Individual CI Tools

Tool number	Tool abbreviation	Percent of hospitals using tool
27	B	88
3	NPET	75
26	CS	75
19	FPG	69
29	CFT	69
10	PM	63
17	PA	63
18	H	63
20	FBD	63
23	FMEA	56
5	CTA	50
21	DMAIC	50
16	SPC	44
32	PFP	44
34	PVA	44
8	VAA	38
24	5Y'S	38
6	POUS	31
22	AD	31
4	JIT	25
9	VSM	25
12	LTA	25
25	CRA	25
28	SDWT	25
1	5S	19
13	DPI	19
7	KBS	12
11	SIPOC	12
14	TTA	12
15	PCA	12
30	QC	12
31	WC	12

Note: two tools had one response or less and subsequently removed from the list.

The next analysis examined differences in usage between effectiveness tools and efficiency tools. Effectiveness tools are CI tools associated with quality initiatives and focused on improving the quality and/or reliability of product or process. Efficiency tools are those tools that are focused on producing improvements in the time to complete a task, the movement of people or things, the operation of teams, or the overall process efficiency. To avoid biasing the respondents, the CI tools were not grouped or categorized on the survey as efficiency or effectiveness tools.

The CI tools included in the survey were evenly divided between effectiveness and efficiency tools, with 16 tools classified as effectiveness tools and 16 tools classified as efficiency tools. Table 21 summarizes the usage of CI tools by category (efficiency and effectiveness) for the hospitals participating in this study. The tools are listed by hospital for efficiency and effectiveness. Overall, the usage of effectiveness tools appeared to be more prevalent for the responding hospitals. There were 121 uses of effectiveness tools; whereas only 89 uses of efficiency tools were observed. A Wilcoxon Rank test was used to compare the efficiency to effectiveness tool usage by hospital. Again, the Wilcoxon Rank test was chosen over the MannWhitney U test because of the type of data which was dependent paired data from the same sample which was more suited to the traditional Wilcoxon Rank test. The ManWhitney U test is more suited to independent samples of data or the McNair test which is used for matched pairs of data.

The results of this analysis are included in Table 22. The results indicate that the two distributions are significantly different. In other words, hospital employees, as reported by representatives from hospitals within this study, are more likely to use tools from the effectiveness grouping than those from the efficiency tool group, and thus hypothesis H4 is not supported.

Table 21: Total Number of Hospitals Reporting Effectiveness and Efficiency Tool Usage

	Effectiveness	Efficiency

Hospital No.	No. of uses	No. of uses
15	12	10
17	7	6
7	15	14
16	15	15
1	10	5
10	2	5
8	10	2
3	13	9
14	5	4
13	9	3
5	3	0
4	9	5
6	0	1
9	3	6
11	1	2
2	7	2
Total	121	89

Table 22: Wilcoxon Rank Test of Effectiveness and Efficiency Tool Usage by Hospital

Test Statistics

	Effectiveness - Efficiency
Z =	-2.17
Asymp. Sig. (2-tailed)	.030

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Effectiveness	16	7.56	4.87	.00	15
Efficiency	16	5.56	4.41	.00	15

The hypotheses associate with Research Question 5 explored the relationship between specific tool usage and hospital performance. Kendall tau b correlations were calculated next to examine whether or not significant relationships existed between the use of individual tools and the six dependent variables related to hospital performance. This analysis was completed to ascertain if the usage of particular CI tools was associated with higher or lower performance levels. Table 23 summarizes all of the significant correlations resulting from this analysis. In some cases, the number of hospitals using a tool and/or providing performance data was small. The significant correlations included in Table 23 are only for those CI tools used by three or more hospitals.

Table 23: Kendall tau b Correlations for Individual Tools and Hospital Performance Metrics

Individual tools used	Lab. Wait Times (a)	Pat. Cost/Day (b)	Time Prep. Rm. (c)	Errors (d)	Pat. Sat. (e)	Emp. Sat. (f)
JIT (Effic)	-	**.606***	-	-	-	-
PA (Effec)	-.667*	-	**.775***	-	-	-
H (Effec)	-.671*-	-	**.775***	-	-	-
FBD (Effec)	-	**.626***		-	-	-
AD (Effec)	-	-	-	-	-	**-.679***
CRA (Effec)	-	-	-	-	**-.608***	**-.679***
POUS (Effec)	-.661*-	-		-	-	-
PFP (Effic)	-	**.671***	-	-	-	-
PVA (Effec)	-	-	**.775***	-	-	-

*Correlation is significant at the 0.05 level 2-tailed

There were significant correlations between two different efficiency and seven different effectiveness tools and five measures of hospital performance. There was no significant correlation between any of the CI tools and the number of reported errors. Box plots for these data are shown in Figures 4 – 8.

There were six negative correlations identified between CI tool usage and three of the dependent variables wait times for lab results, patient satisfaction, and employee satisfaction. Wait times for laboratory results were negatively correlated to Pareto analysis (PA), Histograms

(H), and Point Of Use Stocking (POUS). Figure 4 shows that those participants that reported using Pareto Analysis, Histograms, and Point Of Use Stocking had shorter wait times than those participants that were not using the same tools. Patient satisfaction and employee satisfaction were negatively correlated with customer requirements analysis (CRA). In addition, employee satisfaction was negatively correlated to the use of affinity diagrams (AD).

The use of just in time (JIT), fishbone diagrams (FBD) and pay for performance (PFP) was positively correlated with average patient costs/day. Pareto analysis (PA), histograms (H), Pay for Performance (PFP) and process variation analysis (PVA) were positively correlated with the average room turnover time. Figure 5 illustrates the relationship between FBD, PFP, and JIT and average patient cost/day. The results indicate that those participants who reported using FBD, PFP, and JIT had higher average patient costs per day than those participants that did not use these tools. Figure 6 illustrates the relationship between the time to prepare a room and the usage of three different CI tools: PA, H, and PVA. The average time to prepare a room was longer for those hospitals that were not using these tools than for those hospitals who reported using these tools.

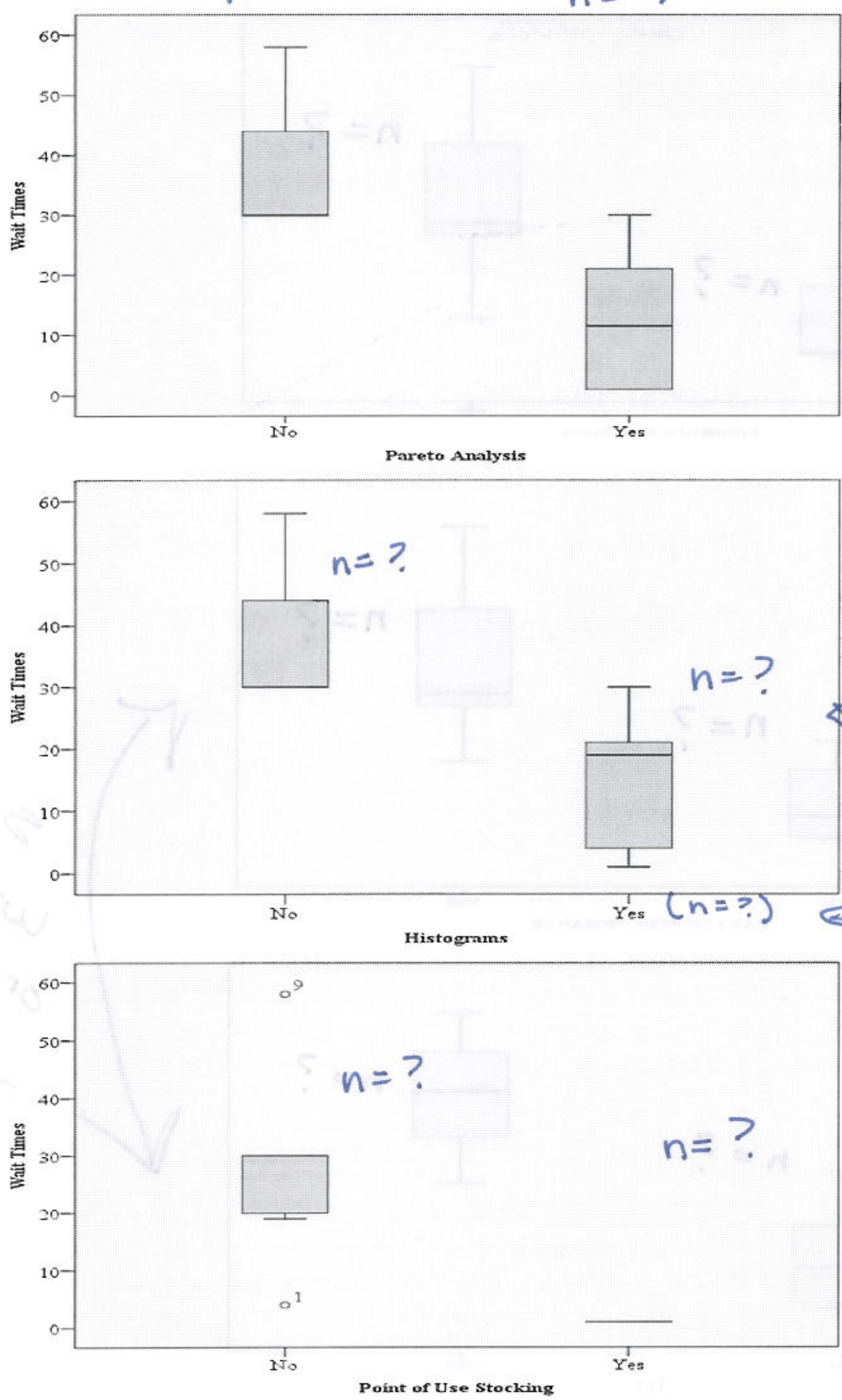
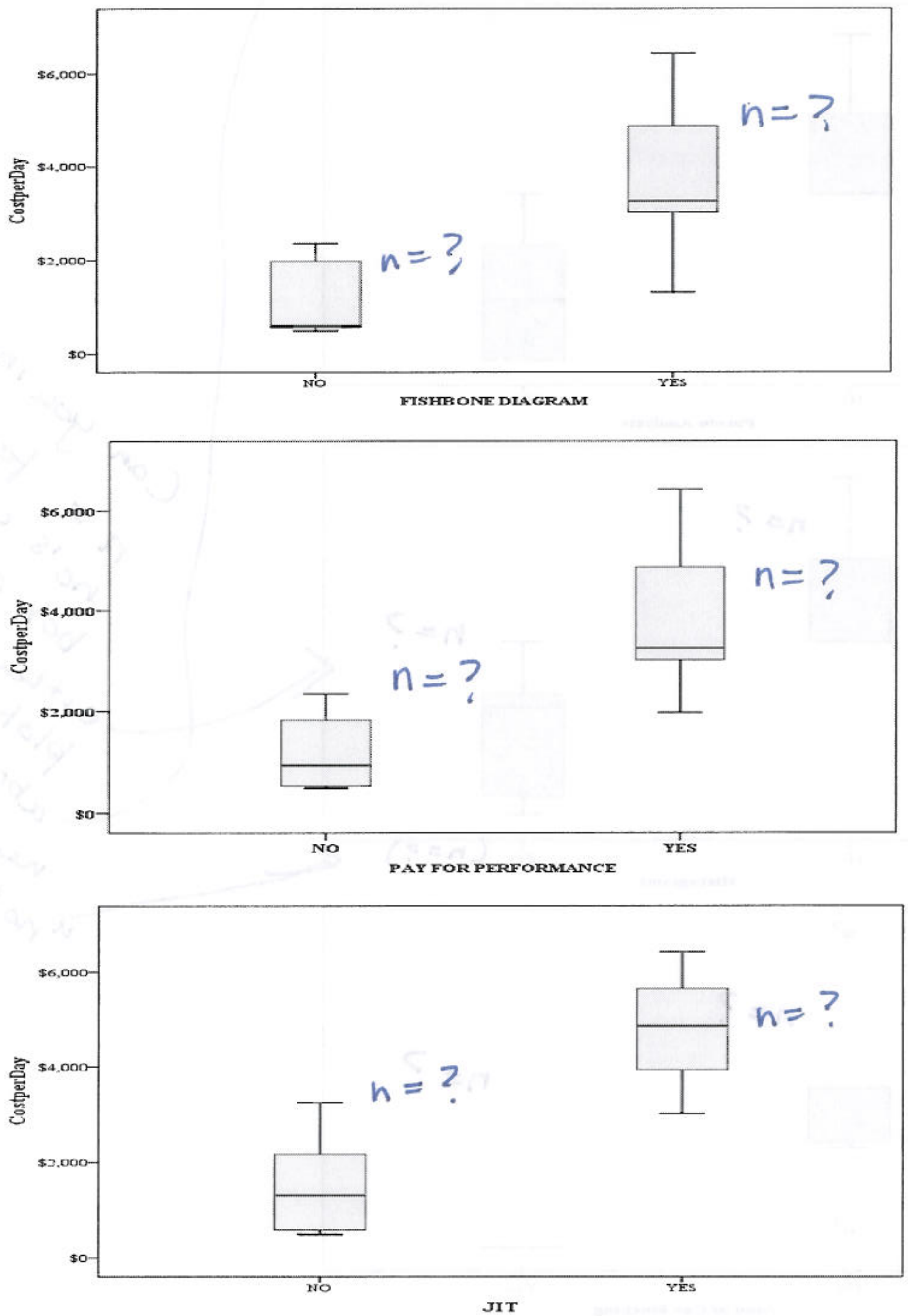


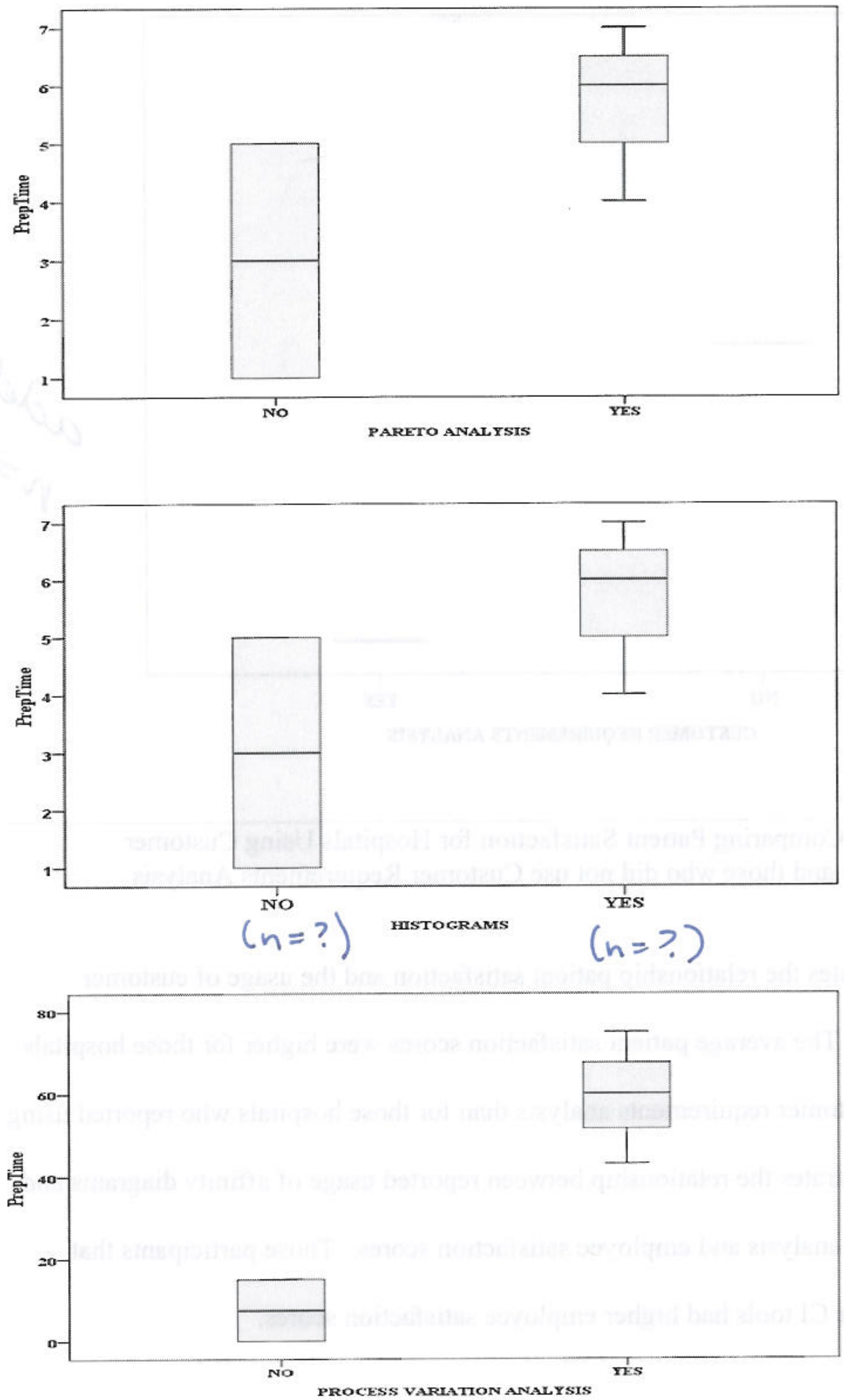
Figure 4: Box Plot Comparing Wait Times for Hospitals Using Pareto Analysis, Histograms, and Point of Use Stocking with those who did not use Pareto Analysis



Switch use same order as Table 23

Figure 5: Box Plot Comparing Patient Costs/Day for Hospitals Using Just In Time, Fishbone Diagrams, and Pay for Performance and those who did not use these CI Tools

not the same As Figure 4. Use a similar caption for Figures 4-8



Add n=

Figure 6: Box Plot Comparing Room Prep Time for Hospitals Using Pareto Analysis, Histograms, and Process Variation Analysis and those who did not use these CI Tools

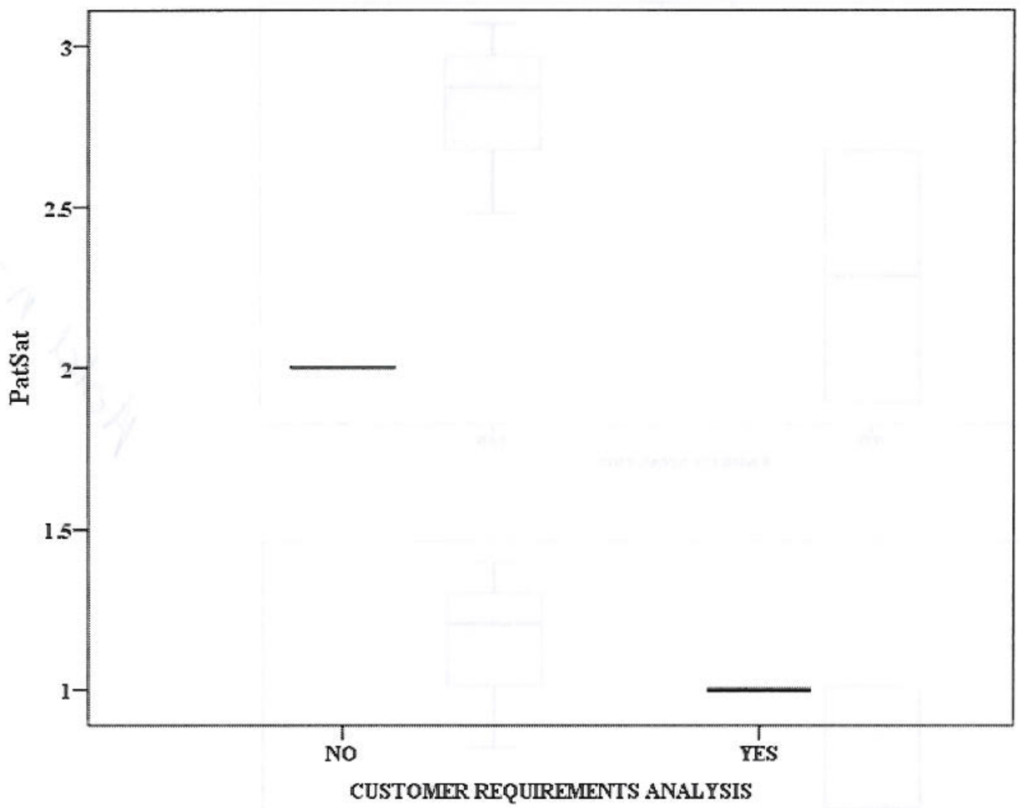


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Figure 7: Pat Box Plot Comparing Patient Satisfaction for Hospitals Using Customer Requirements Analysis and those who did not use Customer Requirements Analysis

Figure 7 illustrates the relationship patient satisfaction and the usage of customer requirements analysis. The average patient satisfaction scores were higher for those hospitals that were not using customer requirements analysis than for those hospitals who reported using this tool. Figure 8 illustrates the relationship between reported usage of affinity diagrams and customer requirements analysis and employee satisfaction scores. Those participants that reported not using these CI tools had higher employee satisfaction scores.

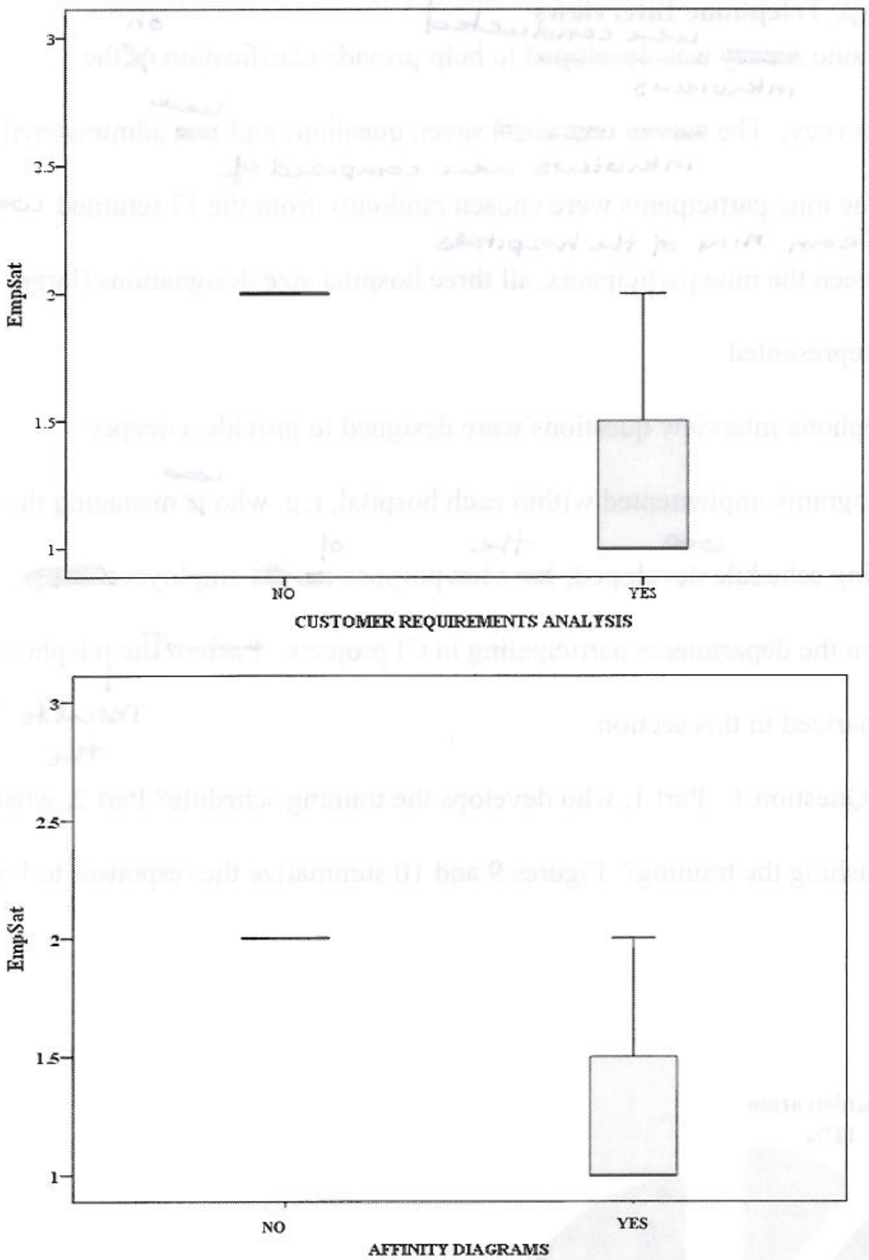

Figure 8: Box Plot Comparing Employee Satisfaction for Hospitals Using Affinity Diagrams and Customer Requirements Analysis and those who did not use these CI tools

The box plots provide a clear visual comparison of hospital performance for those hospitals using particular CI tools and those not using these CI tools.

4.3 Summary of Follow-up, Telephone Interviews

A follow-up, telephone survey was developed to help provide clarification of the quantitative results of the survey. The survey contained seven questions and was administered to nine of the participants. The nine participants were chosen randomly from the 17 returned quantitative surveys. Between the nine participants, all three hospital size designations (large, medium, and small) were represented.

The follow-up, telephone interview questions were designed to provide a deeper understanding of the CI programs implemented within each hospital, e.g. who is managing the programs, how is the training schedule developed, for what purpose are the employees being trained, as well as details on the departments participating in CI projects. Each of the telephone survey questions are summarized in this section.

Telephone Survey Question 1: Part 1, who develops the training schedule? Part 2, what is the strategy for accomplishing the training? Figures 9 and 10 summarize the responses to Part 1 and Part 2.

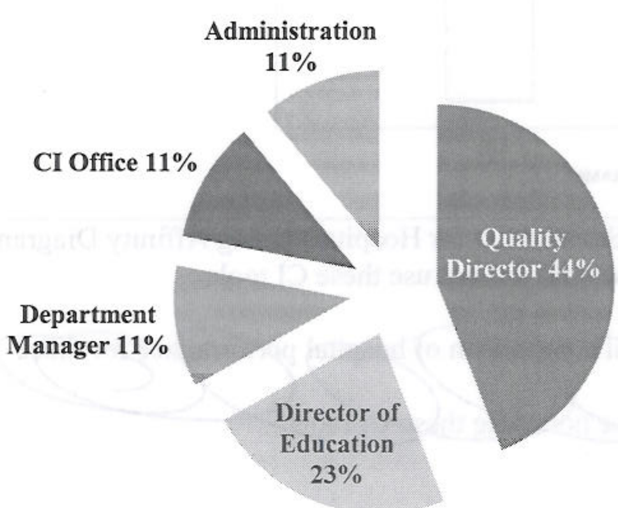

Figure 9: Responses to the Question: "Who develops the training programs?"

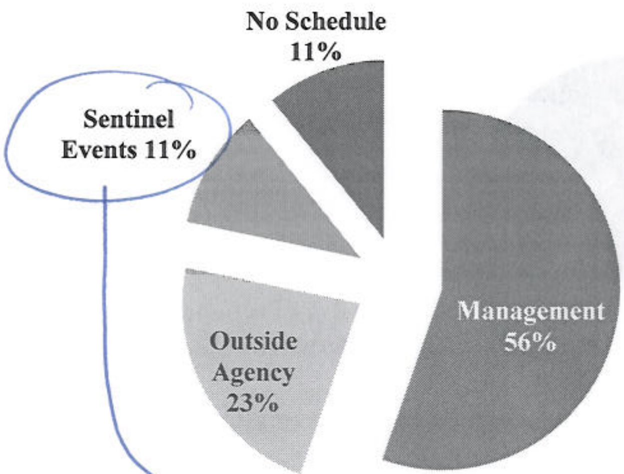

Figure 10: Responses to the Question: "What is the strategy for accomplishing training?"

Telephone Survey Question 2: Please describe the relationship, as you see it, between employees trained in CI tools and techniques and the number and complexity of CI projects? Only slightly over half (56%) of the respondents felt that there was a relationship between the number of employees trained in CI and the number of CI projects undertaken by the organization.

Telephone Survey Question 3: Part 1, which CI projects use more tools than others? Part 2, can you describe the outcome when more tools are used? Figure 11 summarizes responses to Part 1. All of the participants felt that there was no difference in outcomes, regardless of the number of tools used in a particular CI project.

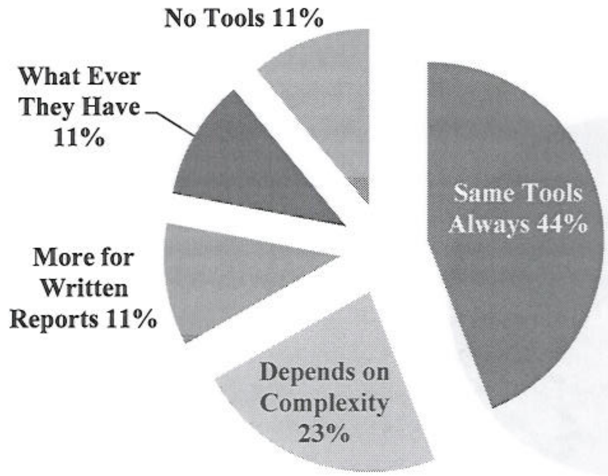

Figure 11: Responses to the Question: "Which CI projects use more tools than others ?"

Telephone ~~Survey~~ Question 4: Part 1, of the CI tools used, which tools are used most often? Part 2, have you noticed tool usage associated with one department or group more than other groups and why? Figure 12 summarize responses to Part 1. Of the interviewed participants, 33% stated that nursing was the department that used CI tools more than other departments. The remaining participants said that tools were used equally across departments.

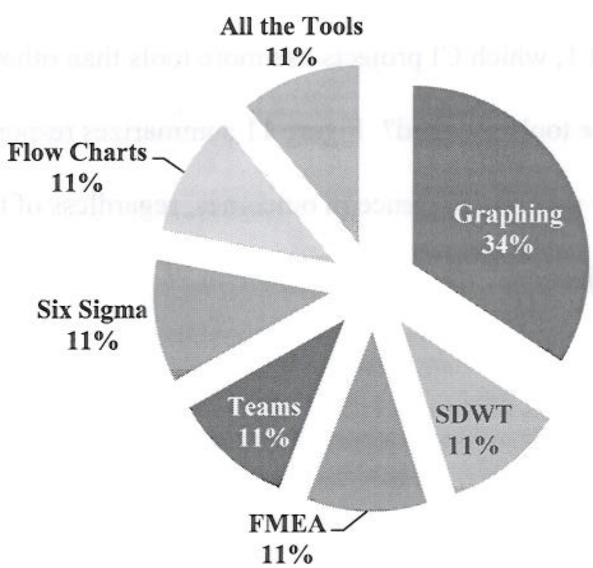

Figure 12: CI Tools Used Most Often

Telephone Survey Question 5: How did you decide upon which CI tools to use for each CI project? Figure 13 summarizes the responses.

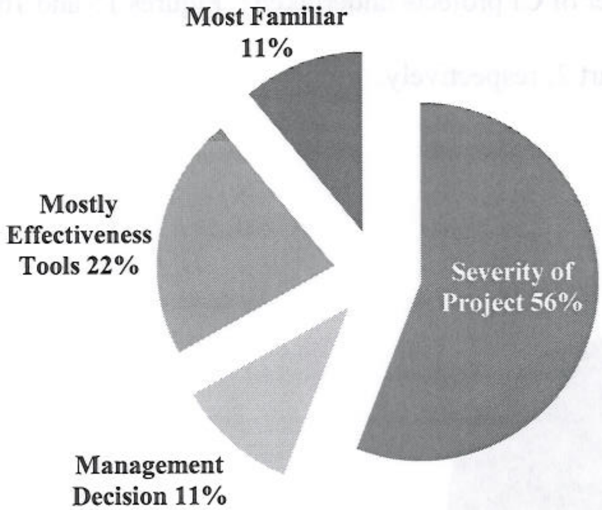

Figure 13: Decision for Choosing CI Tools

Telephone Survey Question 6: Which departments participate in CI projects? Figure 14 summarizes the responses.

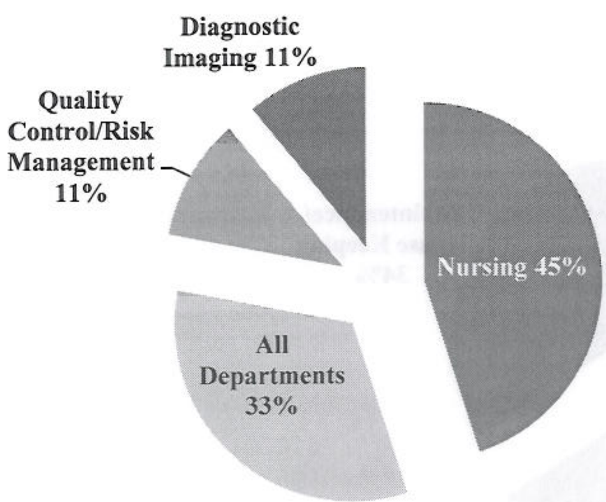

Figure 14: Department Participation in CI Projects

Telephone Survey Question 7: Part 1, if you had to rank the participation amongst the departments, which would rank the highest in the number of CI projects undertaken? Part 2, which would rank the lowest in the number of CI projects undertaken? Figures 15 and 16 summarize the responses for Part 1 and Part 2, respectively.

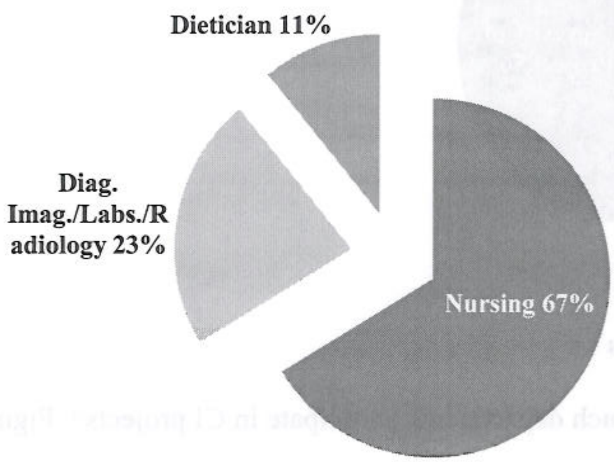

Figure 15: Departments Undertaking the Most CI Projects

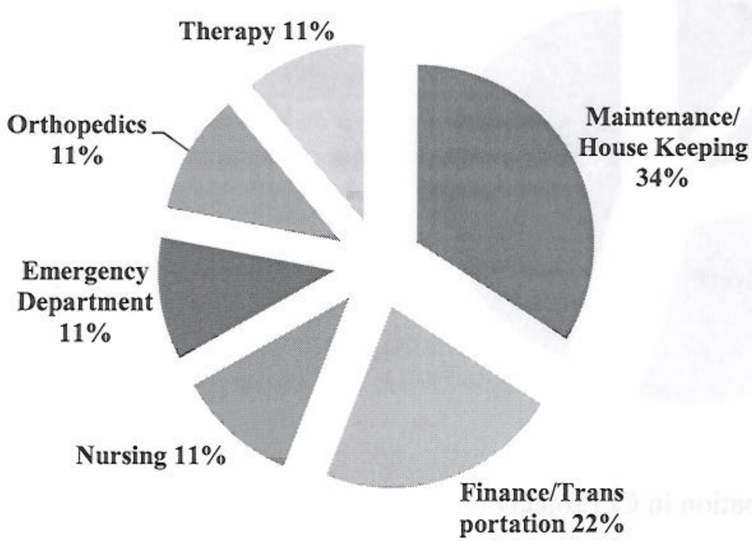

Figure 16: Departments Undertaking the Fewest CI Projects

Overall, it appears that management plays a significant role in establishing training schedules and curriculum. Over half of the participants identified a relationship between employees trained in CI tools and techniques and the number of CI projects undertaken at a hospital. When asked about the type of CI tools used, it became clear that for most hospitals the same tools were used no matter what type of CI project was undertaken.

The tool most used as reported as being used during the telephone survey was graphing. The second part of question 4 asked if tools were associated with specific departments, and the majority of respondents said that this was not the case. When asked how they decided upon which CI tool to use for a project, the majority answered that it depended upon the urgency of the project. This is not entirely consistent with responses from question 3, where the majority of participants stated that in general, the same tools were used for all projects. When asked which departments participated in CI projects, nursing was the answer most often given. When asked to rank the departments with the highest and lowest level of participation in CI projects based on the number of projects, nursing was identified as the department with the greatest number of projects. Both maintenance and housekeeping were identified as the departments with the fewest number of CI projects.

4.4 Post Hoc Analysis Related to Hospital Size

Some previous researchers have found that the impact of CI projects on performance was moderated by the size of the hospital. In this study, three different groups of hospitals were categorized based on the number of beds. Consistent with other research, large hospitals were defined as having more than 300 beds. Medium hospitals were defined as those hospitals with 100-299 beds, and small hospitals were defined as those hospitals with 1-99 beds. The three hypotheses dominating in previous research are: 1) CI projects in small hospitals produce superior results, 2) CI projects in large hospitals produce superior results, 3) Factors other than hospital size are important in the effectiveness of CI projects.

The first series of studies suggested that smaller facilities were more in touch with problems, more agile, less reliant on internal divisions, and better able to work cross-functionally (Guisinger & Gorashi, 2004; Lawrence & Hottenstein, 1195; Ramalingram, 1996; White et al., 1999). The researchers in these studies found that larger organizations tend to function in departmental silos with centralized organizational structures, which tended to produce organizations that were slower and less agile in decision-making.

The next grouping of research findings diametrically opposed the first grouping of studies. The results from this second set of studies found that larger institutions were better able to implement CI projects as a result of having more human and financial resources (Ismail et al., 1998; Poole, 1997; Shah & Ward, 2001). Functional organizational structures were identified as playing a necessary role in providing membership for cross-functional teams. These cross-functional teams were hypothesized to produce superior results over teams formed with participants from only one department.

The third group of researchers found that the size of the facility was irrelevant. Other factors, such as leadership, size of the CI project, number of employees involved in CI projects, and number of CI tools used were found to have a larger impact on change within an organization (Rodwell &Shadur, 1997; Sadikoglu, 2004; Taylor& Wright, 2003).

Table 24 displays total tool usage for each participating hospital, order from the hospital using the most tools to the hospital using the fewest tools. Hospital participant numbers were assigned to each participating hospital, to maintain anonymity.

since you have a list of all hospitals with participant # is appendix there is no anonymity.

Table 24: Tool Usage by Hospital Ranked From Most to Least Tools Used

Participant number	Hospital size	Licensed beds	Proportion total tools used	Percent of total tools used
16	Medium	250	30/33	91%
7	Large	503	29/33	88%
15	Large	766	22/33	67%
3	Medium	152	22/33	67%
1	Medium	246	15/33	45%
5	Small	25	14/33	42%
17	Large	600	13/33	39%
8	Medium	188	12/33	36%
13	Small	62	12/33	36%
14	Small	97	9/33	27%
9	Small	19	9/33	27%
2	Small	16	9/33	27%
10	Medium	215	7/33	21%
4	Small	25	3/33	9%
11	Small	19	3/33	9%
6	Small	22	1/33	3%

The greatest number of tools was used by a 250 bed medium-size hospital, participant number 16. This hospital used 30 tools out of the 33 tools included on the survey, which equates to 91 percent of the total tools. The highest tool user from the small hospitals was a 25-bed hospital. Hospital participant number 5 used 14 tools out of 33 tools or 42 percent of the tools included in the survey. This percentage is higher than one large, 600-bed hospital and higher than two medium hospitals. A Wilcoxon Rank test was completed to compare total tool usage by large, medium, and small hospitals. No significant difference was found to exist between the large, medium and small hospitals.

Cluster analysis was undertaken next to determine if hospitals could be clustered based on tool usage patterns. This clustering was created and analyzed to determine if there was

So this is not consistent with 4.2.2 where you do have paired data.

This test would not be paired data, so be sure to use the correct non-parametric test, i.e. independent samples.

evidence size or other identifying characteristic of the hospital playing a role in the selection of CI tools used. In this cluster analysis, each hospital from the study was a single case with specific tool usage data. The hierarchical analysis results indicate evidence for two clusters, one with four hospitals and the second cluster with the remaining 12 hospitals. Table 26 summarizes total tool usage and the breakdown of effectiveness and efficient tools for each hospital by cluster. The dendrogram from this cluster analysis is shown in Figure 17.

Table 26: Descriptive Analysis of Two Cluster Groups

	Participant Number	Hospital size	Total tools	Effectiveness	Efficiency
Cluster 1	15	Large	22	12	10
	7	Large	29	15	14
	16	Medium	30	15	15
	3	Medium	22	13	9
	Total		103	55	48
Cluster 2	17	Large	13	7	6
	1	Medium	15	10	5
	10	Medium	7	2	5
	8	Medium	12	10	2
	14	Small	9	5	4
	13	Small	12	9	3
	5	Small	14	9	5
	4	Small	1	0	1
	9	Small	9	3	6
	11	Small	3	1	2
	2,	Small	9	7	2
	Total		107	66	41

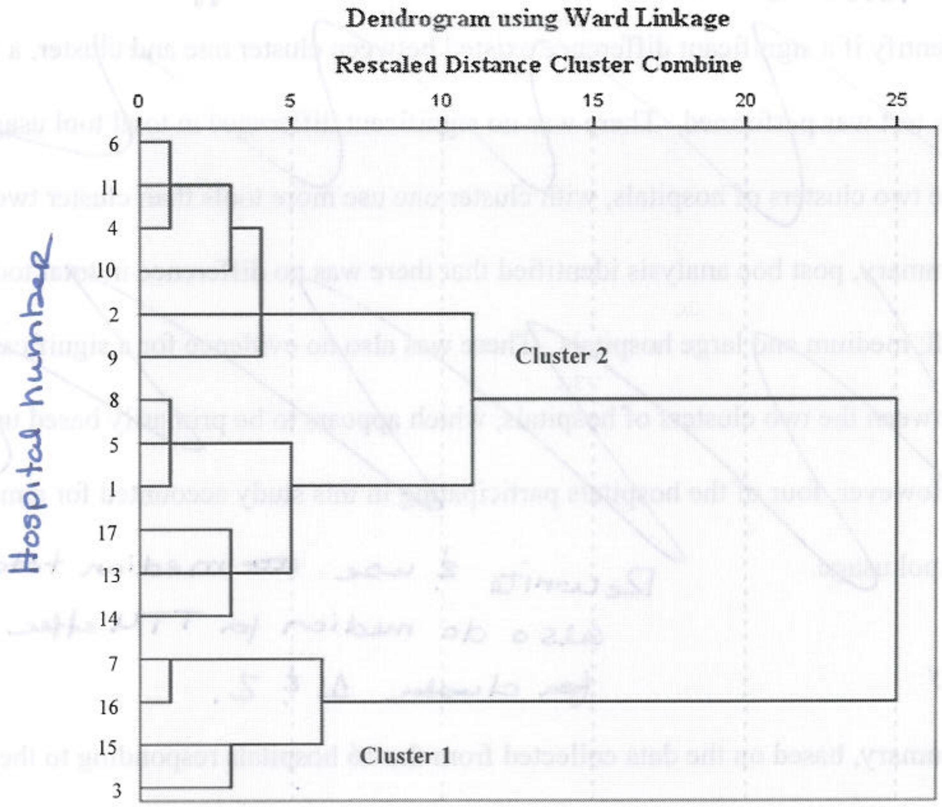

Figure 17: Dendrogram of Hierarchical Cluster Analysis of Tool Usage by Hospital Clusters

To identify if a significant difference existed between cluster one and cluster, a Wilcoxon Signed Ranks test was performed. There was no significant difference in total tool usage between these two clusters of hospitals, with cluster one use more tools than cluster two.

In summary, post hoc analysis identified that there was no difference in total tool usage between small, medium and large hospitals. There was also no evidence for a significant difference between the two clusters of hospitals, which appears to be primarily based upon total tool usage. However, four of the hospitals participating in this study accounted for almost half of the reported tool usage.

4.5 Summary

In summary, based on the data collected from the 16 hospitals responding to the web survey, there was support for the following hypotheses, H_{2f}, H_{3f}, H_{5abef}. However, all other hypotheses remain unsupported. There was statistically significant difference in the adoption of effectiveness and efficiency tools by the hospitals participating in this study. TTU does appear to be unrelated to hospital size. While small, medium, and large hospital total tool usage was not statistically different. In the next and final chapter, the results are discussed in the context of previous research, and where possible, conclusions are drawn from these results. Implications for hospital administrators are also discussed, and possible future research areas are identified.

5 Discussion

Chapter 5 is divided into five sections: summary of the study, findings, conclusions, implications for administrators, and future research. The summary is comprised of three sections, the research problem, a review of ~~the~~ related previous research, and ~~the listing~~ a summary of the research questions. The next section presents the findings from this dissertation. The conclusion section highlights three key findings resulting from this study. The implication for administrators section summarizes three results relevant to practicing administrators relative to the use of CI tools in hospitals. The final section is devoted to suggestions for future research, focusing on four specific areas identified as a result of the data analysis completed for this study.

5.1 Summary of the Study

The overarching ~~research question~~ driver for this study was, "Why has health care had not made the same scale of progress in reducing errors, holding down costs, improving patient throughput i.e. wait times, and increasing employee and patient satisfaction, in comparison with other industries, e.g. the automotive industry specifically the Toyota Motor Company. Crossing the Quality Chasm (2001) outlined 13 areas of concern and made recommendations for needed improvements within health care. Of those 13 areas of concern, five were considered in this study and formed the basis for the selection of six dependent variables. The dependent variables, identified for use in this study as measures of hospital performance were:

1. wait time for lab results
2. patient costs/day
3. time to prepare a room
4. reduction in number of reportable errors
5. overall rating for patient satisfaction for the hospital
6. overall rating for employee satisfaction for the hospital

The independent variables chosen for this study were derived from a review of previous research on organizational performance, taken from both the academic literature as well as practitioner literature in both healthcare and manufacturing. The five independent variables determined to be relevant from this review of the literature were the number of employees trained in CI tools, the number of departments involved in CI projects, the total number of CI tools used in CI projects, sole of effectiveness or efficiency tools, and the specific CI tool used. From this same review of literature, two types of CI projects and tools emerged.

The first type of tools and projects were associated with TQM/Six Sigma and included CI tools focused on improving organizational effectiveness tool. Many of these tools developed out of the writings of Deming, Juran, and Shingo. The second type of tools and projects were associated with Lean Manufacturing and included CI tools focused on improving organizational and process efficiency. Many of these tools developed from work at Toyota and descriptions of these work summarized by researchers such as Womak and Jones and Ohno.

The literature review produce the foundation for understanding the research problem and which ultimately lead to the generation of the five research questions:

1. Does the number of full-time employees trained in CI tools effect the hospital's performance?

2. Does the number of departments involved in CI projects effect the hospital's performance?

3. Does the number of tools used in a CI project effect the hospital's performance?

4. Do hospitals only use either effectiveness or efficiency tools in CI projects?

5. Does the use of a particular CI tool in a CI project effect the hospital's performance?

5.2 Summary of the Findings

A total of 206 hospitals from three states (Idaho, Oregon, and Washington) were invited to participate in this study. The data for the study was were collected using a custom-developed web survey. There were six fully-completed and 11 partially-completed surveys returned. Of the return of 17 surveys only 16 were included in the data analysis which corresponds to a response rate of less than 8 percent. Performance and tool usage data from 2007 were used in all analyses. The only three large hospitals to respond to the request for participation were located in Oregon. The largest number of surveys was returned from hospitals in Oregon. The section of the web survey with the highest rate of completion was the section that elicited responses about different reasons for using CI projects. The section of the written survey with the lowest rate of completion was the section requesting actual performance data. A similarity between responses in both dependent and independent variables was noted between responding medium and large hospitals. This similarity provided an early indication that hospital size might be a relevant factor.

5.2.1 Summary of Results Related to Hypotheses 1 - 3.

The testing began with Kendal tau b correlations between the independent variables and the dependent variables. The only significant correlation found as related to H_{1e}, relating the number of FTE's trained in CI tools with patient satisfaction. General Linear Model produced the regression analysis resulted in Equation 1:

$$Employee\ Satisfaction = 1.481 + .251(No.of\ Departments\ Involved\ in\ CI\ Projects) + .135(Total\ Tools\ Used)$$

This equation provides a statistically significant relationship between employee satisfaction and number of departments involved in CI projects and the total tools used on CI projects. This equation suggests that the fewer number of departments involved and the fewer tools used the more satisfied the employee is. Thus administrators should keep this equation in mind when planning CI projects. However this is only for employee satisfaction and says nothing about costs, wait times room prep times or errors. All of which have been shown in previous research to benefit from a wider range of tool usage and greater involvement by all departments related to the problem resolution (Rodwell & Shadur, 1997; Sadikoglu, 2004; Taylor & Wright, 2003; Zangwill & Kantor, 1998).

Overall, it appears that the number of trained employees had no practically significant relationship with any of the six dependent variables. These findings do not support results from previous studies in healthcare, which showed a relationship between training and employee satisfaction and other performance measures, e.g. turn times of rooms (Poole, 1997), error reduction (Carman et al., 1996), and customer satisfaction and employee satisfaction (Ramalingam, 1996).

This result runs counter to previous research and the prevailing body of knowledge regarding CI improvement, e.g. Argyris & Schon, 1996; Emison, 2004; Ishikawa, 1985; Kantor & Zangwill, 1991; Middel et al., 2006; Mizumo, 1998; Murray & Chapman, 2003, Rajagopalan, 1998; Rodwell & Shadur, 1997; Sadikoglu, 2004; Taylor & Wright, 2003; Zangwill & Kantor, 1998. The limited number of returned surveys could have produced these anomalous responses. Biasing occurring from only interested parties returning the surveys could have been the reason for this unusual and atypical outcome.

5.2.2 Summary of Results Related to Hypothesis 4.

H_4 examined tool usage patterns by hospitals. Based on the analyses completed, there is evidence that for the 16 hospitals participating in this study that a significant preference exists for using effectiveness tools. The distribution of tool usage indicated that even with the preference for effectiveness tools all of the hospitals reported using efficiency tools in conjunction with effectiveness tools. Previous research has found that using a mixture of effectiveness and efficiency tools is advantageous (George, 2002; Wedgewood, 2007). The results of this study support that the sixteen hospitals who participated were indeed using a mixture of CI tools.

5.2.3 Summary of Results Related to Hypothesis 5.

The analysis of $H_{5a\text{-}f}$ was undertaken next. These hypotheses were developed to test the effect of individual CI tools on various aspects of hospital performance, as measured by the six dependent variables included in this study. With the exception of wait times for lab results, the findings from this study were contrary to previous research in the manufacturing and healthcare domains. For example, patient cost per day was correlated to just "in" time, pay for performance, and fishbone diagrams, in such a way that indicated that as the usage of these tools increased so did the patient costs per day. In one previous study, for example, Cua et al. (2001) found that higher levels of manufacturing performance could be expected when the different practices and basic techniques of TQM, JIT, and TPM were implemented together. Further, they were able to show that jointly, these combined practices or techniques were responsible for significant improvements, including cost reduction, conformance to quality, volume flexibility, and on-time delivery. Although these manufacturing metrics are closely related to hospital metrics used for this study, the findings from this study were not similar.

Overall, while there was evidence for significant relationships between tool usage and hospital performance, the direction of the findings do not support previous research. In general, the findings from this study indicated that hospitals not using CI tools performed better than those who did use certain tools. Thus, support was found for all of the hypotheses with the exception of reduction in reportable errors, which did not have significant relationship to any of the CI tools listed in this study. Given the small number of respondents who provide performance data it could be that the hospitals using tools are currently doing so because of poor performance in a particular area.

In addition, this response group may not be representative of the population of hospital clinical staff in the US. Since most of the respondents were from small hospitals, and small hospitals have fewer resources and personnel, this group might be in the early stages of adoption and of understanding CI tools and practices. As a result, they may not be fully trained and experienced enough to provide reliable answers. Since the study was not longitudinal, it is not possible from the data collected to know how long these tools have been used or to what specific end.

5.2.4 Summary of Results from Follow-On Telephone Interviews.

Analysis of the data from the telephone interviews provided some interesting insight and helped characterize overall usage patterns in the participating hospitals. Some of the key insights were that there was, in general, a lack of involvement by employees in the decision process for training and scheduling of training in these hospitals. Management was most often cited as being responsible for establishing the training schedule and determining who and what was trained. Further, there appeared to be no relationship between specific types of training and specific CI projects.

The singling out of a one department that was most often involved in CI projects evidenced the lack of general involvement by a broad cross-section of employees. The departments most frequently engaged in CI projects were the clinical departments of nursing, laboratory, and imaging, with nursing being cited most often as the department most involved in CI projects. In addition, the lack of involvement by over half of the employees was illustrated in the responses which highlighted that non-clinical departments appeared to be the least involved in CI projects with housekeeping, maintenance, and accounting being the most frequently identified as not involved with CI projects.

5.2.5 Summary of Results Related to the Impact of Hospital Size.

The last analysis undertaken was to ascertain if response patterns were the same or different for large, medium, and small hospitals. Wilcoxon Signed Rank test results did not support a significant difference in the number of CI tools used between small medium, and large hospitals. These findings are consistent with previous research in manufacturing organizations that have found that size of organizations have no effect other factors such as leadership, size of the project, number of employees, and number of practices have a greater effect (Rodwell & Shadur, 1997; Sadikoglu, 2004; Taylor & Wright, 2003).

Continuing to investigate further, a hierarchical cluster analysis by hospital was performed and two clusters were identified. The cluster group containing four hospitals was composed of two large and two medium hospitals, while the second cluster group contained mostly small hospitals. A Wilcoxon Signed Rank test was then performed to ascertain if there was a significant difference between the two clusters. The results indicated that no significant difference in average total tool usage existed. These results provide some additional confirmation that size may not play a role in tool usage, at least from the number of tools used. The next section presents the conclusions derived from these significant findings.

5.3 Conclusions

There are four discussion points from this study. Point number one, hypotheses $H_{1a\text{-}e}$, $H_{2\,a\text{-}e}$, and $H_{3a\text{-}e}$, were not supported by the data from this study. Only hypotheses H_{2f},and H_{3f}, were supported by the data from this study. Thus, the number of full time employees trained in CI tools, the number of departments involved in CI projects, and the number of CI tools used in CI projects appeared to have no effect on wait time for lab results, time to prepare a patient's room, number of reportable errors, and patient satisfaction, as determined from the data of this study. These results do not support previous research (Carmen et.al., 1996; Cua et. al., 2001; Juran, 1988; Locke and Lathum, 1990; Secof, 2004; Shingo, 1981). This may be an artifact produced by the voluntary responses from the 16 respondents included in the data analysis. The data could be biased and not representative of the population since only approximately 8% returned surveys.

In addition, hospitals are not similar to factories. Hospitals are more similar to repair station or depots. Like repair depots, hospitals receive damaged products (patients) that come in with incomplete histories know by the staff. Both resort to problem solving diagnostics to understand and correct the problems, and both rely on established mental models to approach problem resolution. When these models fail both have to resort to a different problem solving approach requiring sufficient knowledge. It is in this stage that it appears that hospital clinical staff did not have the necessary knowledge of CI tools and practices to resort to, but rather stayed with their original mental rules based solution, which appears to be very strong but also could be very wrong.

Alternatively, it could be that because most of the respondents were from small hospitals, which might have produced a biasing that was undetected in the data analysis, which would lead small hospitals to have separate behavioral patterns regarding theses three hypothesized variables.

Point number two, hospitals participating in this study used both effectiveness and efficiency tools on CI projects, with a biasing towards the use of effectiveness tools. Thus, it could be concluded that hospital personnel appear to prefer a mixture of efficiency tools and effectiveness tools regardless of the types of CI projects and/or performance improvements being sought. This phenomenon may reflect that for some hospitals, the use of CI tools and the selection of CI tools is not done as a strategic process, but rather is based on individual manager preferences or previous experiences with tools. In addition, there appears to be an apparent lack of employee involvement in planning and training of employees. Management performed all the training topics and the scheduling of CI training. Also, there is a lack of relationship between CI training and CI projects. In addition, most of the respondents answered that they used the tools they were most familiar with and did not necessarily select CI tools with a specific purpose in mind. Thus, point four illustrates the need for comprehensive training and understanding both in tool usage but also in efficacy of usage particularly within the hospital setting. It may be that the lack of progress is not just a lack of training but possibly a lack of sensitivity of the trainer to the specific needs and circumstances that the clinical employees face. It may be that a specific tool set be established for clinical needs, which may combine tools from both efficiency and effectiveness or just effectiveness. Whatever the cause, it is apparent that training in specific tool usage is needed.

The results of the telephone survey clearly indicated a controlling of training and project selection by management. It is possible that only some employees anre trained and not all employees. In addition, it is possible that since management is choosing the projects only those projects that are important to management are receiving attention and support. Further, it is also possible that management is not making a clear one to one correspondence between clinician CI tool and practices skills and the CI project. Therefore, it is not too hard to believe that clinicians without the proper training and tool set to produce the ultimate success are completing some projects. This may be the reason for the strange correlations and the use of effectiveness tools significantly more than efficient tools even when the project may be best undertaken with efficiency tools.

Point number three, the results indicated that with the exception of pareto analysis, histograms and point of use stocking methods and their positive effect on wait time for lab results, those participants who did not use CI tools had superior results. These results may be symptomatic of a more generalized lack of understanding in the use of CI tools or incomplete knowledge of CI practices. The data collected does not allow for determining the sequence in which CI tools were adopted. Early adoption of effectiveness tools may be one reason for the identified pension towards using known tools rather than branching out and using the better tools for the job, which could explain their anomalous usage patterns as born by data analysis. Human behavior dictates that when confronted with a new experience, humans will tend to retreat to solutions that require the use of known commodities in this case CI tools, which they have used before and are comfortable using and understanding (Bandura, 1969).

In summary, the data from this study appears to suggest limited effect of the independent variables on the dependent variables. Second it appears that hospital personnel prefer to of effectiveness tools. Respondents also may lack a clear understanding of selecting tools for specific uses or strategically selecting tools to support overall performance goals. Finally, it appears that with management selecting the projects the match between tool knowledge and projects needs maybe not the perfect alignment that they could be causing anomalous responding to occur.

5.4 Implications for Administrators

There are three salient points that emerged from this study that are important to administrators of hospitals. The first point comes from the apparent lack of involvement in CI projects by both clinical and non clinical staff. Nowhere was this more evident than in the results of the telephone survey. Nursing was identified as the group most often involved in CI projects. However, of the six dependent variables used to estimate hospital performance, only patient satisfaction and reportable errors are directly linked to nursing functions. Reportable errors are not the sole responsibility of nursing, pharmacy, laboratory, and physician also play important roles in this important metric.

Of the other four dependent variables, departments other than nursing have a major role in determining the outcome of any improvement activities, e.g. accounting, has the talent and skill base to provide meaningful insight into reducing patient costs/day. However, these departments were reported to be least involved in CI projects. Nursing cannot be responsible for all of the improvements needed in a hospital, thus involvement by other departments and personnel are required.

The second point relevant to administrators gained from this research is the establishment of a professional training program. The apparent lack of understanding of the relationship between tool usage and CI projects was evident in both web survey and telephone portions of the study. The fact that four hospitals used almost half of all of the tools reported to be used is significant. Training needs to involve the employees in deciding when and what is to be trained but the training program should be professionally executed.

In addition, a team of individuals should accomplish the selection of the package of tools used within clinical settings of hospitals. This team should include but not limited to: management, clinician, and a professional trainer (one who knows both efficiency and effectiveness tools and practices). Once the tool package has been selected all of the clinical staff should be trained in the tool usage and practices in order to provide the necessary basic knowledge that they will need to trouble shoot and resolve problems and not rely on a mental model that may not be correct for the current situation.

This same effort should then be repeated this time with the non-clinical staff in order to improve their involvement in using CI tools and practices to solve problems. There should be no expectation that the tools package for clinical and non-clinical sides of the hospital are going to be the same. In fact if they are there may be a problem in finding the optimum solution and moving health care forward to improving conditions for staff and patients.

The third point is related to the lack of response from hospitals even with repeated requests for information. Of the 17 hospitals out of 206 that chose to respond, many hospitals chose to not respond to the request for reportable error data. Crossing the Quality Chasm was a call for more open and honest communication within healthcare. One of the many suggestions that came out of this monograph was for the lack of blaming to foster a more open dialogue within and between hospital personnel. The death rate is over 98,000 each year due to preventable errors within hospitals each year (IOM, 2001). Administrators should take the first steps within their organizations and between hospitals to share information. It is only through the sharing of successes and failures that an organization can move from single loop to double loop learning which transcends learning based within the individual to learning that becomes inculcated within the organization (Argyris and Schon, 1996).

5.5 Future Research

Four areas for future research have been identified. The first area identified as a stimuli for additional research is from the telephone survey questions seeking to establish an understanding of CI activities. The results suggested a lack of understanding of CI activities that were occurring within the respondents' respective hospitals. This suggests a lack of engagement or involvement on the part of the respondents. The lack of involvement appears to also affecting the full time employees as well as management as indicated in the lack of other departments outside of nursing identified as completing CI projects. Is the lack of involvement associated with the type of patients, number of patients, location of the hospital i.e. rural as opposed to urban?

The second point needing additional studies is to understand if hospitals have a different average CI tool usage. This opens other questions such as: Could tool usage be the difference that separates hospitals i.e. large, medium, and small hospitals? If it is only CI tool usage that separates hospitals, what is the reason for that difference? Is the difference in tool usage linked to number of departments, organizational structure, or patient population?

The third area of interest is the lack of engagement observed in clinical and non-clinical departments to CI projects. Why have other departments not adopted CI tools and techniques the way that nursing was reported to have adopted these tools? What is the difference between nursing and other clinical departments that makes nursing involved in CI projects and other departments to be disengaged?

The fourth area of interest is the level of engagement in CI activities of other clinical departments and its effect on reportable error reduction. Does the level of engagement from clinical departments vary from hospital to hospital and does the level of engagement by clinical departments have an effect of reduction of reportable errors?

The selection and the successful implementation of CI tools in health care presents health care managers and industrial engineering professionals with a challenge. In addition to identifying a performance area to address, organizations must also develop a process for identifying the CI tool or sets of CI tools that will have the most significant impact and develop a process for deploying the tools in the best way possible within the organization. This study adds to the existing body of knowledge related to the use of CI tools and implementation practices, by looking at how hospitals in the states of Idaho, Oregon, and Washington have navigated these challenges. In addition, this study also contributes to the existing literature by providing a summarized set of data to characterize the usage and deployment of CI tools in hospitals. The last contribution to the body of knowledge is the study of the interaction within and between independent variables. Previous studies have primarily focused on studying one independent variable at a time. Through a serial investigation of independent variables, it is possible, if not highly probable, that any interactions taking place between the independent and dependent variables will go unobserved. The loss of these possible interactions could prolong or delay significant reforms.

~~This study was unique in that many if not all of the data gathered indicated little or no support for previous research or the prevailing body of knowledge for continuous improvement.~~ This research suffered from lack of participation, which greatly limited the ability to generalize ~~this data~~. Thus, ~~any~~ future research investigating CI in hospital settings with increased response rate ~~could~~ add greatly to the information gathered in this study.

PARAMETRIC VS. NON-PARAMETRIC STATISTICS

GLM GENERALIZED LINEAR MODELS	LINEAR REGRESSIION
DOES NOT ASSUME DATA IS NORMALLY DISTRIBUTED	ASSUMES DATA IS NORMALLY DISTRIBUTED
BOTH DO THE SAME TYPE OF ANALYSIS	

KENDAL TAU	SPEARMAN RHO	PEARSON R
NON PARAMETRIC	NON PARAMETRIC	PARAMETRIC
DATA ASSUMED ~~NOT~~ TO BE NORMALLY DISTRIBUTED	DATA ASSUMED NOT TO BE NORMALLY DISTRIBUTED	DATA ASSUMED T TO BE NORMALLY DISTRIBUTED
NEEDS INTERVAL DATA OR BETTER ??	NEEDS INTERVAL OR BETTER DATA	NEEDS INTERVAL OR RATIO DATA
CONVERTS DATA TO RANKS	CONVERTS DATA TO RANKS	
PROBABILITY OF BEING IN RANK	USES PROPORTION OF VARIANCE LIKE PEARSON	USES PROPORTION OF THE VARIANCE
CONCORDANT AND DISCORDANT VALUES ?		
NOT UNDUELY INFLUENCED BY OUTLIERS	**UNDUELIY** INFLUENCED BY OUTLIERS	
USES Z TEST FOR DETERMINING SIGNIFICANCE LEVEL	USES T-TEST FOR SIGNIFICANCE LEVEL	USES T-TEST FOR SIGNIFICANCE LEVEL

not

WILCOXON	MANNWHITNEY	T-TEST
NON-PARAMETRIC	NON-PARAMETRIC	PARAMETRIC
DOES NOT ASSUME DATA TO BE NORMALLY DISTIRBUTED	DOES NOT ASSUME DATA TO BE NORMALLY DISTIRBUTED	DOES ASSUME DATA TO BE NORMALLY DISTIRBUTED
SINGLE SAMPLE MULTIPLE RESPONSES	TWO SAMPLES INDEPENDENT	ONE OR TWO SAMPLES DEPENDENT OR INDEPENDENT
Z TEST FOR SIGNIFICANCE	T-TEST FOR SIGNIFICANCE	
	KRUSKAL WALLIS TEST SIMILAR TO MANNWHITNEY ORDINAL DATA	
	McNEMARS DICOTOMOUS ONLY DATA NONPARAMETRIC CHECKS THE MARGINAL FREQUENCIES OF TWO BINARY OUTCOMES.	

YELLOW/SHADED = CHOSEN STATISTICAL METHOD TO BE USED.

Which of these are paired

I don't know that this is really correct. ~~Do you~~ Specify indep, dep, residual, error terms