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Characteristics that Influence the Adoption of Systems Improvement in Hospital Workgroups

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CHARACTERISTICS THAT INFLUENCE THE ADOPTION OF SYSTEMS IMPROVEMENT IN HOSPITAL WORKGROUPS

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ABSTRACT

This study presents the assessment of possible characteristics within workgroups that might be influencing the adoption of systems improvement initiatives at the Providence Veterans Medical Center (PVAMC). With the collection of data from a survey, hypotheses were elaborated in order to investigate the relationships between two workgroup characteristics: size and leadership-involvement, and the workgroup's readiness to adopt systems improvement initiatives. The ANOVA (Analysis of Variance) statistical procedure was used for the testing of such hypotheses. Based on results, there was a significant difference between the small and large workgroup size categories. These results signified that large workgroups are more involved in systems improvement initiatives and have more confidence when it comes to participating or continuing to participate in systems improvement initiatives compared to small workgroups. As for the results of the leadership-involvement characteristic, results showed that workgroups with involved leadership are more knowledgeable, involved, and confident of the systems improvement initiatives compared to the workgroups with uninvolved leadership. Reflections on the findings and recommendations on how to further develop systems improvement initiatives based on workgroup characteristics were made.

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1 CHAPTER I

INTRODUCTION

1.1 Background

Over the past years, the quality and cost of health care has been a major issue discussed in the United States. Although new technology is arising every day, which increases efficiency in the delivery of care, the costs of new tests and treatment are said to outweigh the savings (Garson, 2000). “Lowering healthcare spending and improving care outcomes will not only necessitate better application of existing medical insights at the point of care, but also require significant changes to the delivery system” (Yong & Olsen, 2010). The health care delivery system is composed of numerous basic components depending on the magnitude of services it provides. These components are made up of more components which are affected by many factors which may include: finance, culture, geography, and other influences that assist with the determination of the availability and effectiveness of those services (Ball et al., 2004).

With the goal of transforming the health care delivery system, quality improvement initiatives are being implemented as a combined effort to form part of the healthcare system, including healthcare professionals, patients and their families, researchers, payers, planners and educators (Batalden & Davidoff, 2007). These initiatives are implemented to reduce the gap between current practice and desired practice through a series of activities. For instance, the Providence Veterans Affairs Medical Center (PVAMC) has chosen to initiate a Lean transformation. Recent literature in health care quality improvement initiatives is showing an increase in the utilization of Lean tools and techniques due to its proven benefits in many segments of the manufacturing and automotive industries. Although the health care industry differs in the types of services provided from those in the automotive or manufacturing industry, it can be certain that all of these industries provide services to their customers. In the case of the healthcare industry, the customer is the patient.

As the PVAMC is proceeding with a Lean transformation, the role and influence of employees throughout the facility are crucial for the implementation of improvement initiatives and the change of culture in the organization. Any new improvement initiative being implemented needs to match the readiness of the targets of cultural change, in this case, the employees of the facility. Thus, to transform the PVAMC culture to a "Lean" Culture or "Culture of Improvement (COI)", employees must be willing to adopt improvement initiatives and continuously be representatives of such. More importantly, improvement initiatives and changes need to be effectively managed and communicated so that they are embraced rather than rejected and resources used during the process are exploited to their ultimate potential.

If the health care delivery system can be improved by implementing quality improvement initiatives such as Lean as shown by Kim et al. (2006), it is important to understand what features within the health care industry may be influencing the adoption of systems improvement initiatives. For instance, as a decentralized organization, the PVAMC is built around workgroups. Workgroups are built within health care organizations in order for employees to "work together, learn together, engage in clinical audit of outcomes together, and generate innovation to ensure progress in practice and service" (Borrill et al., 2001). However, different characteristics of workgroups may be producing an effect on the implementation of improvement initiatives. These characteristics include participation, commitment, lines of communication, roles, leadership, and even workgroup size. Hence, in order to transform to a Lean health care facility, the PVAMC needs to be able to understand the different features that constitute its facility. This will not only help with the effective implementation of improvement initiatives but it will help put into effect a culture of daily continuous improvement.

1.2 Problem Statement

This study is part of an Institutional Review Board (IRB) approved study titled "Assessing Climate for Systems Improvement Initiatives in Healthcare", which has an overall purpose of assessing the change in cultural climate at the PVAMC through a survey. The survey questionnaire has been administered to all PVAMC employees four times over the period of two years. Cultural climate, in this case, refers to the change in workplace environment of the employees and the facility over time. Through the implementation of improvement initiatives, it is expected that employees at the PVAMC will increase the rate of adoption and implementation of systems improvements methods and tools.

This study focuses on analyzing the surveys' responses with the main objective of assessing potential characteristics of workgroups that may be affecting the adoption of Culture of Improvement (also referred to as 'COI' or a 'Lean Culture'). There are many improvement initiatives which have structured the COI at the PVAMC. These include the formation of process improvement teams, allocation of improvement projects, organizing of improvement trainings, and provision of seminars, etc. Thus, this study will focus on two primary objectives:

1 To determine the impact of workgroup size and the adoption of improvement initiatives within workgroups.

2 To determine the impact of leadership's involvement and support of systems improvement initiatives and the readiness of the front line "hands on" employees to adopt and utilize process improvement tools and techniques.

1.3 Significance

As recently added to the Veterans Healthcare Administration (VHA), the Systems Redesign (SR) program, generally as a part of the Quality Management Department, along with its improvement initiatives "has developed significant traction in leading facility improvement in outpatient initially, recently inpatient, and has worked successfully with the VHA office and departments to align efforts" (Davies et al., 2008). These efforts constitute the creation of a "Learning Organization" which has been a VHA top priority. However, any new improvement initiative being implemented needs to match the readiness of the targets of cultural change, in this case, the employees of the facility. Hence, as the SR program continues to expose employees throughout the facility to improvement initiatives, it is essential to assess the possible characteristics of workgroups which may be affecting the adoption of such improvement initiatives. With the findings of this study, the SR program at the PVAMC will know how to further develop Systems Redesign improvement initiatives to become more effective in assisting employees with improving the processes of daily patient care. This systematic improvement will ultimately advance the patient care of the PVAMC Veteran population, increase worker satisfaction, and assist in improving hospital wide administrative practice.

2 CHAPTER II

REVIEW OF LITERATURE

2.1 Organizational Structure

Duncan (1979) explained that organizational structure is not just about organizing boxes on a chart: “it is a pattern of interactions and coordination that links the technology, tasks, and human components of the organization to ensure that the organization accomplishes its purpose”. According to Zinn & Mor (1998), the organizational performance of any industry is greatly influenced by the composition of their structural external and internal factors. External factors are said to be composed by the marketplace competition and other performance outcomes (Hofer & Schendel, 1988). On the other hand, the internal factors are said to involve the size of an organization, their mission, their ownership, their communication among departments, and their control structures which greatly affect the delivery of a product or care (Zinn & Mor, 1998).

An established organizational structure is critical in any industry as it helps address a clear form of operations, roles, power, and responsibilities for the employees in order to meet the organization’s goals. Having an established organizational structure also helps determine the “responsibilities for each job position and the relationships among those positions” (Madura, 2007). “Organizational structure determines the manner and extent to which roles, power, and responsibilities are delegated, controlled, and coordinated, and how information flows between levels of management” (Peyman et al., 2011). Determining the best type of organizational structure in an industry depends on the objectives and goals to be met by the employees of that organization.

2.1.1 Organizational Structure in Health Care

The healthcare organizational structure differs from other types of industries as it can be classified by ownership: private or government, voluntary (non-for profit) or investor owned (for-profit), and sectarian and nonsectarian (Ullrich & Wieland, 1980). Beside the ownership difference, the organizational structure in a health care setting can also differ in role, activity, and size. Some of the organizational structures of health care institutions include bureaucratic, functional, centralized, decentralized, and matrix.

1. Bureaucracy structure – where institutions have an excessive enforcement of rules. This structure is "designed to promote smooth operations within a large or complex group of people" (Booyens, 2007). Inefficiency could be seen in this type of structure due the many rules to follow. However, every organization is said to have some degree of this organizational structure where employees have proper duties with a degree of specialization within an established system of rules and regulations which oversee the employee's decisions and actions.
2. Functional Structure – where activities around the organization's goals/mission or clinical operations are organized. These activities are said to be "the most prevalent structures for single product/service and narrowly focused organizations" (Swayne et al., 2008). A functional organizational structure

generates a high degree of specialization and expertise within the many different functions or processes of an organization. Its main objective is to nurture efficiency, particularly when tasks are founded on routine basis and are repetitive (Swayne et al., 2008).

3. Centralized structure – where the power to make decisions is concentrated at the top layer of management. Centralized organizational structures are said to "fear any expectations, and rules are almost enforced" (Finkler & Ward, 1999). Moreover, information needs to be fed upwards in the organization and decisions must be fed downward through the organization with a minimum of lost time.
4. Decentralized structure – where employees are empowered through autonomy to make decisions. These decisions are made at the point of care regarding patient and practice environment. This is an organizational structure for which there is a degree of dispersion in responsibility (Zelman et al., 2009). The advantages and disadvantages of this structure can be seen in the following Figure 2.1-1.

Exhibit 11–1 Selected advantages and disadvantages of decentralization

Advantages	Disadvantages
Time	Loss of control
Information relevance	Decreased goal congruence
Quality	Increased need for coordination and formal communication
Speed	Lack of managerial talent
Talent	
Motivation and allegiance	

Figure 2.1-1: Pros and Cons of Decentralization
Source [Zelman et al., 2009]

2.1.2 Organizational Structure in the VHA

The Veterans Health Administration (VHA) is one third of the Department of Veterans Affairs, a federal agency which provides health care services at more than 14,000 sites throughout the U.S., employs a staff of 255,000 and maintains affiliations with over 107 academic healthcare systems (VA Organizational Briefing Book, 2010). As a federally funded and centrally administered agency, the VHA is responsible for supervising and executing a centralized program directing the different Veterans Medical Centers in which diverse programs and services are provided to Veterans and their families (VA Organizational Briefing Book, 2010).

As part of the cabinet-level Department of Veterans Affairs, the VHA operates in a highly politically charged environment and it is under a continuous close inspection by the General Accounting Office (GAO), the Congress, and the Office of Management and Budget (OMB) (Abramson & Lawrence, 2002). The VHA's management systems and culture was based on a command and control, military mindset, and its decision making rules and techniques are highly centralized and bureaucratic (Abramson & Lawrence, 2002). Hence, this centralized and bureaucratic decision making structure can often impede localized operating units from adjusting to local circumstances in a timely and effective manner in order to address operational challenges and address change. Additionally, "VHA's system for allocating resources to operating units, which was based largely on units' historical costs, did not provide incentives for the efficient and effective delivery of health care services to the patient population" (Abramson & Lawrence, 2002).

From around 1980 to the early 1990s, the VHA was not well synchronized with predominant developments in the delivery of care in the United States and was also facing significant budgetary funding cuts and potential competition from private-sector health care organizations (Abramson & Lawrence, 2002). At the same time, the VHA's "complex mission and highly centralized decision-making structure were substantial impediments to its ability to adapt to these external threats" (Abramson & Lawrence, 2002). The year of 1995 was the start of the VHA's large-scale transformation. The main objective for this transformation was to counter the various events and external trends which put the VHA in jeopardy of its future patient care and financial viability (Abramson & Lawrence, 2002). The reorganization of facilities and staff into Veterans Integrated Service Networks (VISNs) was one of the key organizational structural changes at the VHA at that time. This newly devised organizational structure reflected "a basic management approach of centralized policy direction, completed by consistent decentralized execution" (VA, Organizational Briefing Book, 2010).

2.1.2.1 Organizational Change in the VHA

In 1995, the VHA established 22 (now 21) regional Veterans Integrated Service Networks (VISNs) that represent organizational structures arranged according to a population health approach (Singh, et al., 2005). The creation of VISNs was a very drastic and important change at the VHA as is not only decentralized the VHA's bureaucracy but it also eliminated many layers of administration. Most importantly, this organizational change not only led staff closer to patient care, but it became a remarkable improvement step toward replacement of the "older, monolithic, military-style top-down organization" (Abramson & Lawrence, 2002).

Each VISN is in charge of "conducting daily operations and decisions affecting hospitals, clinics, nursing homes, and Vet Centers located within their regions" (VA, Organizational Briefing Book, 2010). The VHA's integrated service networks are based on the idea that "whoever controls and coordinates the supply, production, distribution, and marketing of service delivery will be a vastly more efficient producer than the non-integrated operator" (Abramson & Lawrence, 2002). The creation of VISNs not only transferred decision making from headquarters to the reorganized networks but to the localized planning and budgeting units as well. This brought a higher rate of asset and service utilization throughout the VHA system, thereby allowing the VISNs the opportunity to assist specific populations with uniform quality services at standardized prices (Abramson & Lawrence, 2002). The overall transformation of the VHA has been highly successful as the VISNs are a "revolutionary organizational form, based on patient referral patterns, hospitals, and other VHA assets" (Abramson & Lawrence, 2002). However, as any change is often difficult for any type of organization, certain problems emerged as changes were applied in this bureaucratic health care organization.

"The expression "this too shall pass" became a rallying cry for the VHA employees who opposed the transformation" (Abramson & Lawrence, 2002). As other change efforts were attempted in the past with and resulted in later abandonment of those changes, there were some VHA employees whom demonstrated behaviors which were counterproductive to change during this time of transformation. Another problem seen during this transformation was the emergence of new designs, ideas, and entrepreneurial activities produced by individual VISN directors as they were given substantial, local decision making authority (Abramson & Lawrence, 2002). The freedom of making decisions allowed VISN directors to implement ideas, or engage in decisions that were perhaps not in the best interest of the VHA, the VISN, the local medical centers, or the patients at the time. Moreover, as Abramson and Lawrence (2002) remarked, not all VISN directors nor lower-level managers were prepared for all of the sophisticated challenges necessary to address such as: the analysis for strategic and marketing plans, capital investment decisions, or contract negotiations with private-sector employees. Employees throughout the VHA also detected that the new structure did not provide the opportunity to share best practices among the VISNs as its communication links were not as effective as necessary to truly achieve the valuable asset of intra-organizational communication (Abramson & Lawrence, 2002). Although problems were seen during the transformation of the VHA structure, it can be certain that "this new operating system emphasized efficiency, collaboration and cooperation, and the quest for productivity by eliminating layers of bureaucracy and streamlining communications" (Abramson & Lawrence, 2002).

In 1998, another drastic change occurred in the VHA system which was the implementation of a data management system known as VistA (Veterans Health Information Systems and Technology Infrastructure). This system has been described as a provider of an "outstanding electronic medical record with practical user interface" (Rounds, 2010). VistA not only offers physicians the opportunity to view medical records such as those found in a paper chart, but also provides access to images files such as radiographs along with other important to-the-minute clinical data. The overall use of VistA has made it possible to “research on health care delivery; medical use, efficacy, complications, and outcomes of care” (Rounds, 2010). Most importantly, this management system enables the VHA, its VISNs, and its medical facilities and the staff of those facilities to implement corrective actions and monitor measures of performance and quality in patient care.

2.1.3 Organizational Structure at the PVAMC

Veterans Affairs Medical Centers (VAMCs) are the main clinical care centers of the VHA. VAMCs are hospitals that include services such as acute care, long-term care, rehabilitation, ambulatory care, and emergency care. Yih (2011) explained that the “specific scope of services and complexity of care available at any given VAMC may vary, leading to care arrangements that may require veterans to travel to another VA facility”. This could include the need for specialized surgical services as well as ambulatory surgery services. In order to match the delivery needs, selected VAMCs have undergone facility integration along with a common leadership structure (Yih, 2011). For instance, the Providence Veterans Medical Center (PVAMC) is both a primary and secondary health care facility integrated with Community Based Outpatient Clinics (CBOCs) in Middletown RI, New Bedford MA, Hyannis MA, and contract arrangements with facilities in Hope Valley, RI, Nantucket, MA, and Martha’s Vineyard, MA. The PVAMC staff consists of three main categories of specialized employees. There are clinical, administrative, and technical specialists (includes facilities management) which drive the day-to-day operations of the facility in order to provide patient care.

The PVAMC is one of the facilities compromising eight Joint Commission-accredited medical centers in the VISN known as VISN 1VA New Healthcare System. Detailed performance contracts with agreed upon goals and standardized measures to be met are given to the VISN 1 network director each fiscal year (VA Organizational Briefing Book, 2010). Similar contracts are given throughout all levels of the facilities from medical center directors to line managers. As seen in Figure 2.1-2, each performance measure has a performance target. If any VA facility within a VISN network does not meet the performance targets, the network director thereby fails to meet their prescribed performance measures (Baker et al., 2008).

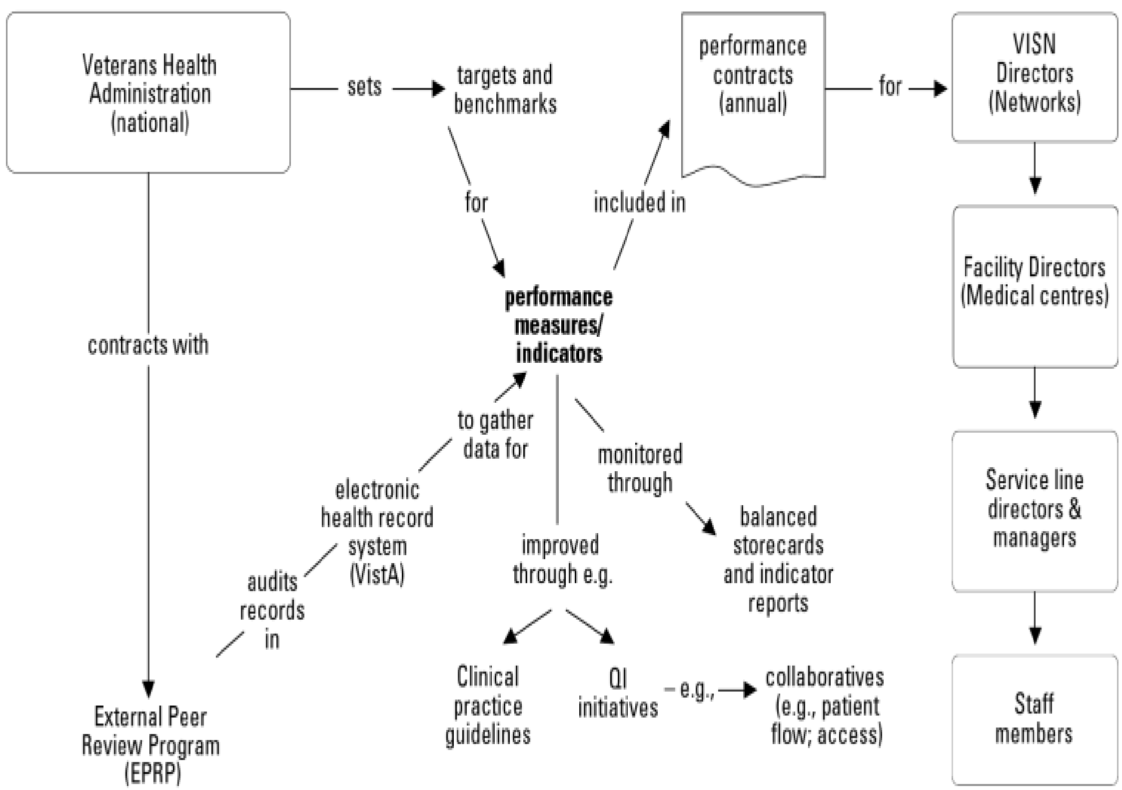


Figure 2.1-2: Linkages among performance measures, accountability, and improvement

These performances measures were developed to "serve as a framework for a variety of quality improvement and management accountability initiatives" (Nerenz &

Neil, 2001). This performance management system has a number of measures for which processes and outcomes of care are organized in ten dimensions which may include performance measures, patient type, admissions, etc. For instance, the VA's National Surgical Quality Improvement Program uses a "risk- and severity- adjusted functional status and mortality data to compare hospitals, track trends over time, and improve toward benchmark levels" (Nerenz & Neil, 2001). Performance measures can help understand how well an organization is doing, what and where changes might be needed in order to improve performance, and it allows for information to be shared with other facilities which can learn from such. Hence, understanding performance measures along with its dimensions is "critical to understanding the root of operational problems in any daily clinic operation" (Matta & Patterson, 2007).

2.1.4 Management versus Leadership

Ernst (2002) defines management as a match between organizational processes and managerial processes. Organizational processes are defined as (1) work processes where critical activities are needed to accomplish work and achieve set targets, (2) behavioral processes which are the ways of acting/interacting and shaping the way in which work is conducted and decisions are made, and (3) change processes which are the sequence of events over time that changes the organization according to its requirements (Ernst, 2002). On the other hand, managerial processes are defined as direction setting, negotiations, and selling, as well as monitoring and control process.

Any employee who has a managerial position has an official title assigned by the organization and may have subordinates. Managers are said to have a position of authority and subordinates work for them and frequently do as they are told. However, because managers have an authority role, many employees are reluctant to report errors, present ideas, or make suggestions, fearing a punitive culture. Hence, managers require leadership skills as well. For instance, as a complex and dynamic organization, the health care industry requires managers "to make certain that organizational tasks are carried out in the best way possible to achieve organizational goals and that appropriate resources, including financial and human resources, are adequate to support the organization" (Goldsmith, 2012). As explained by Parrish (2009), the main difference between managers and leaders is that "managers have subordinates while leaders have followers".

Leadership can exist anywhere throughout an organization without an official title given. Leaders tend to "create the direction, win the commitment of followers and other key stakeholders, and influence others to do what needs to be done to achieve future strategic vision" (Manion, 2005). In general terms, leaders are visible spokespeople of innovation, involvement, improvement, and opportunities within an organization which may influence and encourage other employees to do the same. In fact, as Parisi & Carew (2000) explained, leadership is "the capacity to influence others through a dynamic, reciprocal covenant aimed toward identifying and accomplishing collective purposes". Recent literature shows growing evidence that leadership and management, both combined, can help transform and improve health care safety and quality and ultimately bring nothing but success (Parisi & Carew, 2000; Manion, 2005; Parrish, 2009; Goldsmith 2012).

2.1.5 Leadership at the PVAMC

The PVAMC's leadership is structured upon an executive suite known as the "Quad" which consists of: a Medical Center Director, an Associate Director for Operations, a Chief of Staff, and an Associate Director for Patient Care/Nurse Executive. In a recent research interview with the Medical Center Director, the assertion of turning the current culture at the PVAMC into a Lean culture was expressed. The Medical Center Director believes that the Lean methodology fits the PVAMC organization very well. Reasons stated for the transformation included: root cause analyses of problems faced, engagement of the workforce from managers to front line staff, patient satisfaction, saving costs, etc.

As of today, the Medical Center Director ensures that all members of the Quad are involved in some kind of system improvement initiatives. However, it is known that even though senior management can make many improvements via a top-down structure, it is the front line staff working on day-to-day operations improvement that is going to be much more powerful in a bottom-up approach. Hence, the Medical Center Director, along with the Systems Redesign (SR) Improvement program within the PVAMC Quality Management Department, is leading and increasing the number of trainings and programs which encourage empowerment and engagement of the PVAMC's front-line employees.

The Medical Center Director's main goal within five years is to have an overall improvement percentage demonstrating 80% small day-to-day continuous improvement work and 20% larger, formalized systems improvement projects. In an effort to accomplish this balance, the PVAMC has invested in many resources and programs, including the SR program. It can be certain that the PVAMC senior leaders are very engaged and interested in the different methods and tools the medical center should implement in order to drive improvement and innovation to high peaks. With a formalized commitment of the PVAMC leadership, the director expects to transform the facility's culture to a Lean Culture with results such as improved patient quality, outcomes, cost effective care, and improved patient and staff satisfaction.

2.1.6 Team/Workgroups in Health Care

The delivery of health care has changed drastically over the years. As Mitchell et al. (2012) explained, health care was provided by an all-knowing doctor who not only lived in the community but was able to be contacted at any time. Whenever care was needed for any patient, a family member or a nurse who "lived in" was able to take charge during the needed time. Now, "a driving force behind health care practitioners' transition from being soloists to members of an orchestra is the complexity of modern health care, which is evolving at a breakneck pace" (Mitchell, et al., 2012). Each year new clinical practices and trials are published and new chronic conditions are seen for which different specialists, providers of diagnostic, pharmacy, and other services are required (Bodenheimer, 2008). Hence, a vital relationship between the clinical, administrative and technical configuration of a health care industry is necessary for successful outcomes.

Given the constantly changing demand in any organization, team-based structures are being created in order to provide the flexibility needed to respond in an effective, appropriate, and quick manner (Zaccaro et al., 2001). Besides teams being classified depending on the characteristics needed such as task type, team duration, purpose, interdependence, and autonomy, each team is also classified upon "the extent of team integration; that is, the extent to which members share a theoretical base and common language" (Lemieux-Charles & McGuire, 2006). Therefore, a right classification of health care teams is very important as it is an ongoing process of interaction between team members which work together to provide care to a patient. As Mitchell et al. (2012) stated, a high-performing team is recognized "as an essential tool for constructing more patient-centered, coordinated, and effective health care delivery system". Figure 2.1-3 shows the Integrated (Health Care) Team Effectiveness Model (ITEM) which highlights the essential features of a successful team.

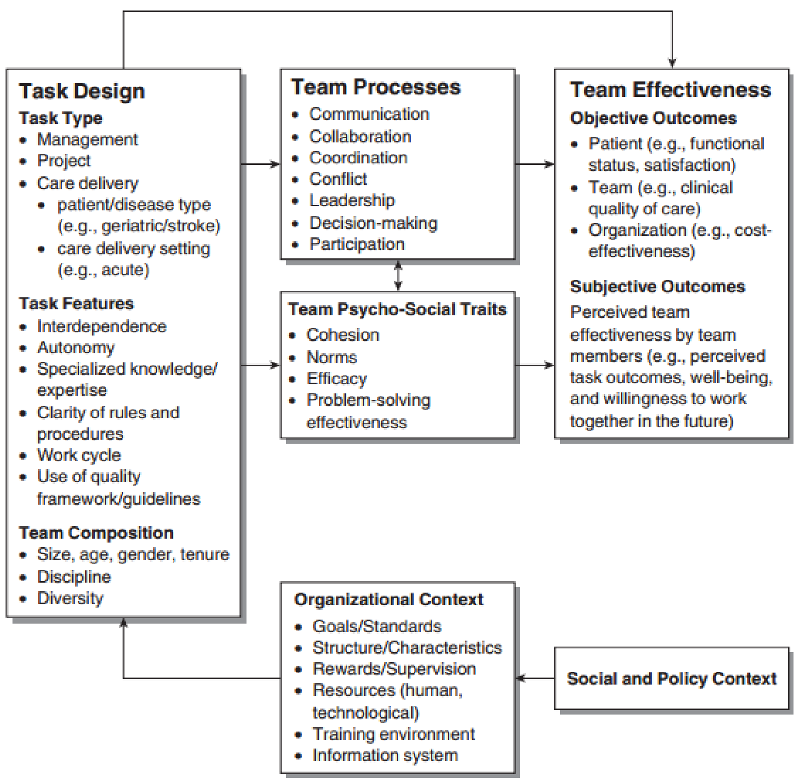


Figure 2.1-3: Integrated (Health Care) Team Effectiveness Model (ITTEM)
Source [Lemieux-Charles & McGuire (2006)]

Once a team is formed, team work comes into play. The General Medical Council (1999), from a medical perspective, states "The purpose of teamwork in medical practice, as of every professional activity by doctors and other health care workers, is to provide the best means of serving patients' interest". In fact, the importance of team working has been greatly emphasized by many studies, reports, and even policy documents on the National Health Service (NHS). "The best and most cost-effective outcomes for patients and clients are achieved when professionals work together, learn together, engage in clinical audits of outcomes together, and generate innovation to ensure progress in practice and service" (Adorian et al., 1990). However, it has proved very difficult to achieve successful team work due to a wide range of factors. These may include practice between doctors and nurses, multiple lines of management, organizational context, gender issues, leadership, team size, age, etc.

2.1.6.1 Team Size

Team size can be a critical factor in the success of team work. Research on larger teams shows cost savings through economies of scale and scope as well as quality improvement through the opportunity of specialization (Jones, 2004). For instance, "the larger size and more diverse composition of primary health care teams create opportunities for team working" (Jones, 2004). However, although there are benefits from larger teams, increasing the size of a team can be disadvantageous. As teams grow in size, they may experience increasing problems of not only communication but cooperation and coordination (Sundstrom, 1990). For example, as the number of members within the primary care team increases, the individual doctor-patient relationship as well as the continuity of care may be affected (Jones, 2004). Another drawback of a larger team reflects in the effectiveness of decision making.

Larger teams are considered generally slower to arrive at decisions. Janis (1972) defined this phenomenon as "groupthink" which is the "deterioration of mental efficiency, reality testing and moral judgment resulting in-group pressure". Moreover, groupthink may lead to anxieties concerning independence and autonomy (Jones, 2004). Overall, large teams may have the tendency to increase participation and involvement; however, they may also decrease the opportunity for effective communication and coordination.

Small teams have the propensity to increase the frequency and quality of communication as well as likely patient outcomes such as patient safety, including openness, understanding, and collaboration (Godon et al., 2011). Small teams bring efficient interaction not only between every team member but between the care giver and the patient.

In conclusion, team size is positively related to productivity, effectiveness, and employee satisfaction (Campion et al., 1993). Moreover, Magjuka and Baldwin (1991) found that team size is a highly significant predictor of team performance and employee involvement.

2.2 Business Process Re-Engineering (BPR) in Health Care

With technology being the most dynamic change in a healthcare industry, the methodology of service delivery to patients is always changing. Hence, as the National Academy of Engineering and the Institute of Medicine issued in a report "Building a Better Delivery System, A New Engineering/Health Care Partnership" (2005), systems engineering tools and related organizational innovations play a critical role in addressing the interrelated quality and productivity crises facing the health care system. Recommendations in the report included a broader diffusion of systems engineering tools in health care. There are many definitions for Business Process Reengineering (BPR). Davenport & Short (1990) have defined BPR as the analysis and design of work flows and processes within and between organizations. Petrozzo & Stepper (1994) defined BPR as the concurrent redesign of processes involving IT support systems in order to achieve radical improvement in time, cost, quality, and customer satisfaction. It can be certain that the many definitions of BPR reflect BPR's main goal which is the radical improvement of processes (O'Neill & Sohal, 1990). BPR's structured approach provides the fundamental techniques and tools to attain dramatic and sustained improvements not only in quality, but cost, service, lead time, flexibility and innovation as it focuses on the whole process (Gunasekaran & Kobu, 2002).

Research shows BPR is a method used to improve the organizational performance of an industry created by industry employees as their "fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality and speed" (Hammer & Champy, 1993). Thus, BPR is a change strategy that focuses on making modest, gradual, incremental improvements to any existing processes over a significant period of time (McNulty & Ferlie, 2002). Moreover, BPR is a technique used in settings where more than incremental change is required such as in the health care industry where continuous change is faced due to demand uncertainties and technological changes. Therefore, the health care industry uses BPR as a tool to engage organizational transformations towards a more customer-focused and cost-effective care system (Elkhuizen et al., 2006).

Main factors for hospitals to implement BPR include “delivery of improved service quality to external customers, reducing bottlenecks by improving service quality to internal customers, improve financial performance by cost cutting, improve clinical performance, reduce processing time of service delivery, adopt the positive experience of healthcare organizations abroad, pressure to comply with regulatory requirements, and to remain competitive with other healthcare organizations” (Gupta, 2008). Radhakrishnan and Balasubramanian (2008) recommended a seven step approach after analyzing various BPR methodologies done in the past: (1) project planning and launch, (2) current state assessment and learning from others, (3) solution design, (4) business case development, (5) solution development, (6) implementation, (7) continuous improvement.

BPR’s main goal of improving processes along with its conceptual design explaining its major components are seen in Figure 2.2-1. There are many methods that can be implemented with BPR including process visualization and flowcharting, process mapping/operational methods, organizational change, benchmarking, process and customer focus techniques, etc. (O'Neill & Sohal, 1990). Together, all of these tools and techniques along with the BPR’s approach can ensure that the best practices in an industry are in use. However, “BPR must be seen as a strategic, cross-functional activity that needs to be integrated with other aspects of management to deliver benefits to the organization” (O'Neill & Sohal, 1990). Consequently, it is necessary to examine the needs of the organization and perhaps apply not only BPR but other techniques that enhance improvement throughout an organization.

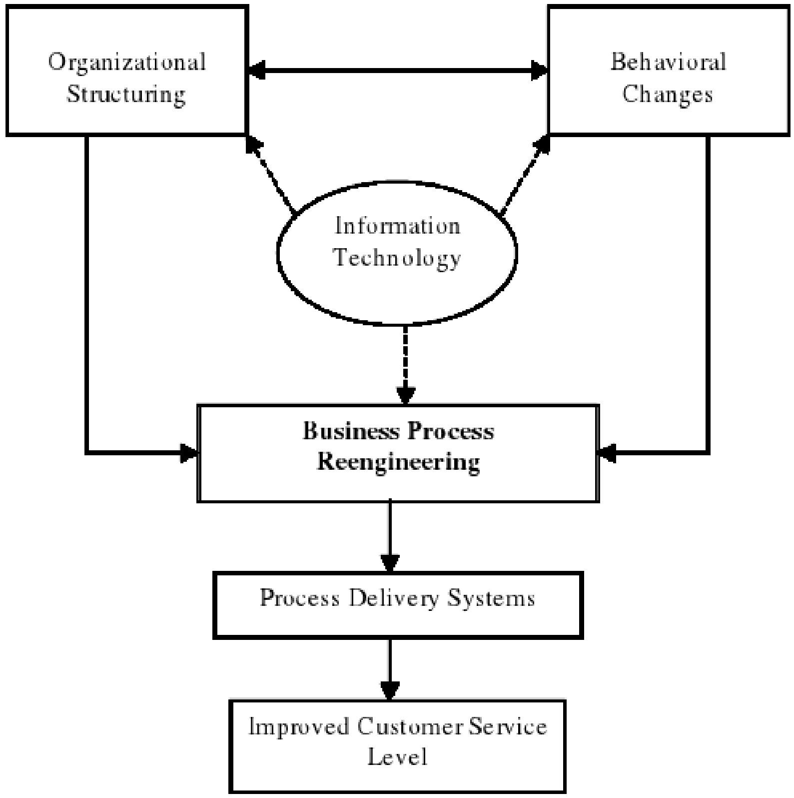


Figure 2.2-1: BPR Process
Source [O'Neill & Sohal, 1990]

2.3 Systems Redesign and Improvement

Although new technology is emerging every-day which increases efficiency in the delivery of care, the costs of new tests and treatment are said to outweigh the savings (Garson, 2000). Reducing costs of service while attracting and retaining highly dedicated and competent patient care and support employees are two strong imperatives for healthcare managers (Harmon et al., 2003). Moreover, “lowering healthcare spending and improving care outcomes will not only necessitate better application of existing medical insights at the point of care, but also require significant changes to the delivery system" (Yong & Olsen, 2010). This will be especially important as the United States considers how and where it will spend its limited resources in the future.

Many health care providers are developing different quality improvement strategies for optimizing their healthcare system; "some clinician/patient driven, others manager/policy maker driven" (Scott, 2009). The implementation of improvement initiatives are expected to lead to changes that will show "better patient outcomes (health), better system performance (care) and better professional development (learning)" (Batalden & Davidoff, 2007). These initiatives have been known to be successful in other industries such as general manufacturing and automobile production. Although the healthcare industry differs in the types of services provided from those in the automotive or manufacturing industry, it can be certain that all of these industries provide services to their customers. In the case of the healthcare industry, the customer is the patient.

Business Process Reengineering (BPR), Lean thinking, PDCA or PDSA (Plan, Do, Check/Study, Act) cycles, Six Sigma, and Microsystems are some improvement techniques seen in healthcare. The main objective for adopting such initiatives is "to develop procedures to improve patient flow, to provide timely treatment and maximum utilization of available resources" (Hall, 2006). However, many healthcare organizations are said to cycle through the multiple improvement initiatives without a clear vision of a sustained improvement in either process effectiveness or patient outcomes; "the result is often staff fatigue, a more stressful work environment, and increased patient care costs" Hagg et al., 2008). Hence, as Batalden and Davidoff

(2007) explained, these changes will only be effective when they become an intrinsic part of everyone's job, every day, in all parts of the system.

"The challenges of transitioning from the decision to utilize an innovation (adoption) to skilled and consistent use of an innovation (implementation) are well documented in health care and non-health care organizations" (Hagg et al., 2008). These challenges are said to include lack of leadership support, resource support, participation time from staff, development of measurement methods, insufficient data feedback systems, no incentive structures, and a resistance to change (Hagg et al., 2008). Nevertheless, as a branch of the Department of Veterans Affairs (VA), the VHA (Veterans Healthcare Administration) wants "all employees to understand that discovering and documenting ways to deliver services efficiently to Veterans is a critical element to his/her job" (VA, VATAMMCS Improvement Guidebook, 2011). Hence, the VHA started a national Systems Redesign (SR) program among all the VA facilities. The mission of SR is to offer every employee at the VA the opportunity to adopt the philosophy "Improving Our is Our Work". SR is founded under four guiding principles which include being patient centered, data driven, continuously improving and team based (VA, VATAMMCS Improvement Guidebook, 2011). To facilitate the adaptation of the SR program, the VHA is supporting thirty VA medical centers, including the Providence VAMC, with grants with a main purpose of not only implementing these improvement initiatives but also in creating a culture of continuous improvement.

To ease the implementation of improvement tools, the VHA started training programs based on Microsystems and lean methodology. An example of the improvement approaches the VHA has taken is the improvement framework of VA TAMMCS (Vision, Analysis, Team, Aim, Map, Measure, Change, Sustain, Spread), as seen in Figure 2.3-1, which encourages a culture of continuous process improvement. This framework promotes "the core values of feedback, engagement by employees, calculated experimentation, discipline, and standardization" (VA, VATAMMCS Improvement Guidebook, 2011).

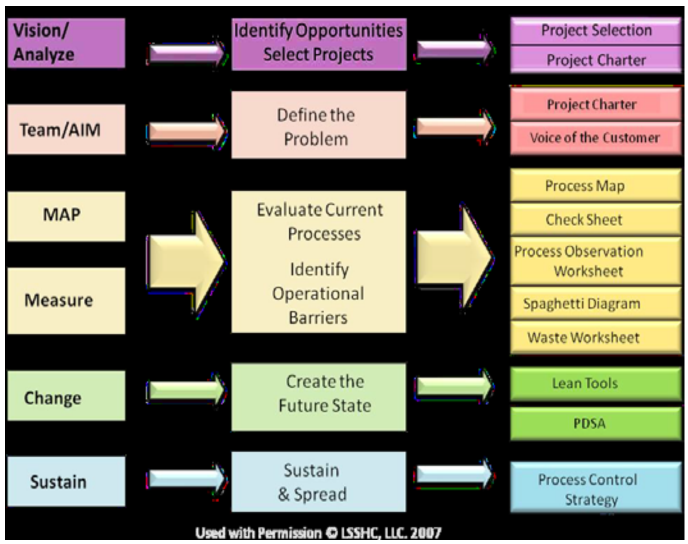


Figure 2.3-1: VA TAMMCS

2.4 Lean Techniques and Tools in Healthcare

The implementation of Lean in many manufacturing and automotive industries started with the publication of a seminal work on Lean Manufacturing entitled "The Machine that Changed the World" (Womack et al., 1990). Lean manufacturing is a projection of the Toyota Production System (TPS) that is focused on creating a process speed and efficiency in any process (Womack et al., 1990). Lean has gained popular attention in the health care industry as its foundational principle is the elimination of waste so that all activities associated with producing a product or service are value added. Zidel (2006) encouraged the implementation of Lean in

Healthcare to reduce waste which included defects, over-production, waiting, not using human potential, transportation, inspection & inventory, motion and an excess in processing. Moreover, Jimmerson et al. (2005) explained that the "ideal" notion of Toyota's state of error-free work could fit the "ideal" notion for healthcare (as shown in Figure 2.4-1).

IDEAL

- ☐ *Exactly what the patient needs, defect free.*
- ☐ *One by one, customized to each individual patient.*
- ☐ *On demand, exactly as requested*
- ☐ *Immediate response to problems or changes.*
- ☐ *No Waste*
- ☐ *Safe for patients, staff and clinicians: Physically, Emotionally, & Professionally*

Figure 2.4-1: A Notion of Ideal State for Health Care
Source [Jimmerson et al., 2005]

With hospitals struggling to produce a higher quality product, drive profitability, and to make a better work environment for their employees, many Lean healthcare tools and techniques have been considered for use. The use of these Lean tools and strategies can help manage many everyday barriers and obstacles that plague a patient care environment and drive the creation of a culture of continuous improvement. In fact, written reports show that the applications of Lean in different health care settings including, but not limited to emergency departments are now days seen. For example, an emergency department is able to use value stream maps to help identify and eliminate waste in the patient care process. In fact, value stream mapping has shown to improve patient flow and reduce overcrowding (King et al., 2006). The identification of waste has created opportunities for implementing improvement projects with outcomes such as the reduction of patient waiting time, reduction of costs, and most importantly, improving service quality.

While the benefits of lean are clearly seen throughout the literature, there are also a number of barriers to be overcome. Waring & Bishop (2010) conducted an ethnographic study of lean implementation in which potential sources of tension between clinicians and leadership were shown as possible implications for an unsuccessful Lean implementation. Waring & Bishop (2010) explained that "making healthcare services Lean is likely to be a highly contested process, as it becomes reinterpreted and reshaped by different social actors to ensure that it fits with their prevailing vision or aspirations for clinical practice". Furthermore, Radnor et al. (2012) mentioned that a difference between the numbers of fundamental 'organizational' and 'managerial' differences in a manufacturing and healthcare industry could limit the benefits of Lean. Results from this study showed a hindrance in the progress of Lean implementation from tool-based improvements such as Kaizen events to system-wide improvements. However, Lean is still a powerful concept for the improvement of processes (Radnor et al., 2012). If well managed, Lean could potentially be successfully implemented in a wide system scale such as the health care system. Lean tools include just-in-time, cellular flow, pull systems and kanban, poka-yoke, value stream mapping, visual management, 5S, and many more (as shown in Figure 2.4-2).

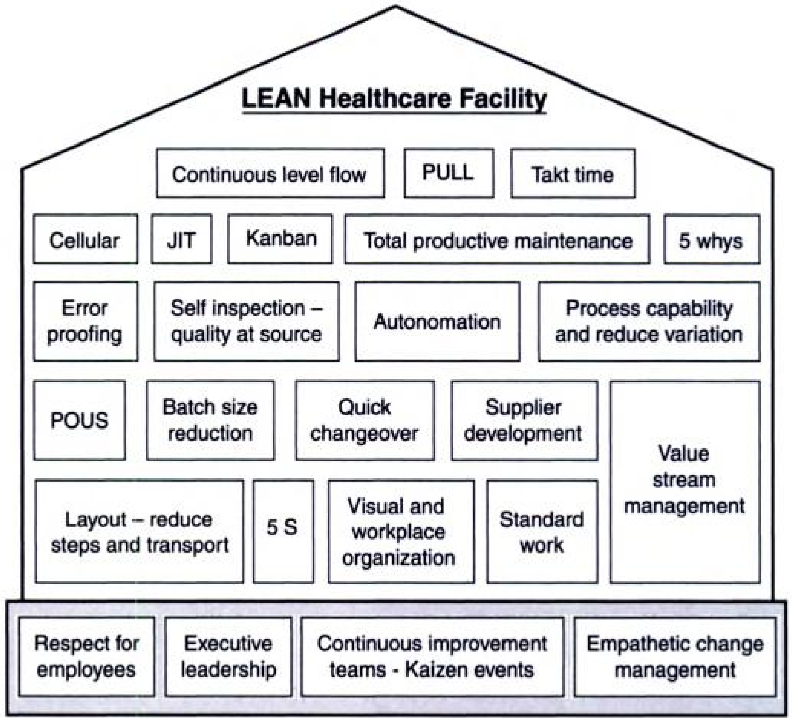


Figure 2.4-2: Lean Health Care Building Blocks
Source [Chalice, 2005]

2.5 Lean Techniques used at the PVAMC

As stated in many of their improvement systems proposals, the VA Medical Center has been trying to "improve quality, safety and value for veterans and other stakeholders by accelerating the pace of clinical and support service improvements" (PVAMC Improvement Capability Grant Proposal). In fact, Figure 2.5-1 shows the 5 lean concepts used at the PVAMC.

5 Lean Concepts (V-I-V-A-C)

Value is determined by the "end customer"	Patient/Veteran
Identify & eliminate waste	Anything that does not add value from the patient's perspective
Value flows without interruption	Identify ideal patient experience – streamline process and eliminate waste to achieve
Allow customer to pull value from process	Available when they want it – one piece flow
Continuous pursuit of perfection	Reliable and sustainable systems and process design

Figure 2.5-1: Lean Concepts (V-I-V-A-C)

With the implementation of Lean strategies and tools, the VAMC has been directed towards one clear goal; the elimination of waste. “Through this “Lean” lens, waste is seen as “any activity that does not serve the valid requirements of the customer” (Bush, 2007). The customer, in this case, is the individual or entity that pays for a healthcare service. The PVAMC uses the Taiichi Ohno method from the Toyota Production System for the definition of waste in healthcare. However, another type of waste was added to Taiichi Ohno’s original method to devise the “8 Wastes of Healthcare” known by the acronym (DOWNTIME):

1. Defects – medication errors; rework; incorrect charges/billing; surgical errors
2. Over-production – duplicate charting; multiple forms with same information; copies of forms sent automatically
3. Waiting – waiting for workers at meetings, surgeries, procedures, reports; patients waiting for appoitments, MD visitss, procedures
4. Not clear (Confusion) – same activities being performed in different ways by different people; unclear MD orders; unclear route for medicine administration; unclear system for indicating charges for billing
5. Transportation – delivery of medication/supplies
6. Inventory – overstocked medications on units; overtocked supplies on units and in warehouses
7. Motion – looking for information; looking for materials and people; materials, tools located far from the work
8. Excess Processing – clarifying orders; reduntant information gathering/charting; missing medications; regulatory paperwork

2.5.1 Value Stream Mapping

Once "MUDA" (waste) can be clearly defined following the "8 Wastes of Healthcare", the most common Lean technique used by the PVAMC is Value Stream Mapping (VSM). This technique forces workers to "walk the gemba" which means walking to "go to the work" by walking through/documenting every single step of the process as it exists giving the team "a visual representation of the material, work and information flow as well as the queue times between processes for a specific customer demand" (Tapping, 2009). This map includes all of the actions regardless of whether or not they are value added or non-value added to the process. This is a substantial technique allowing many heatlhcare clinical providers, administrative and technical support staff to use on the journey towards Lean thinking. This technique and its results represent the patient and the flow of goods and services in health care through a series of activities involved in providing value to the patient, ultimately producing the value stream map (Tapping, 2009). VSMs are composed of two types:

1. Current State Map – providing a visual representation of the current work being performed and patient flow.
2. Future State/Ideal Map – which is a visual representation of the current state map after lean tools have been applied. This serves "as a visual road map displaying how to eliminate waste identified in the current state" (Tapping, 2009).

2.5.2 Kaizen Events

In order to have a successful lean transformation the "simple lean tools require an organization's serious commitment to continuous improvement" (Manos, 2007).

Hirano (2006) described the Kaizen event as a primary vehicle for engaging the hearts and minds of any workforce. Hence, kaizen events help transform the mentality of any service industry to a Lean one. Hamel (2010) said that this method teaches “people how to see, think and feel within the context of Lean and, ultimately, how to rapidly and effectively deploy their improvement ideas to address high-impact opportunities”. Kaizen is said to be more about an idea flow where the big and small ideas are thought to flow along a scientific path and ultimately use them to obtain and sustain results (Hamel, 2010). Manos (2007) went on to say that reduced lead time or cycle time, shorter distance traveled, time saved, fewer steps in a process, and reduced inventory are all quantitative benefits of Kaizen events.

2.5.3 ‘5S’ Lean Tool

The 5S tool is said to be a systematic approach to the organizing, ordering, and cleaning of any workplace; thus, establishing and maintaining a quality environment within the workplace (Fabrizio & Tapping, 2006). Ahlstrom (2007) explains that with the use of a 5S approach, a work or production environment is positively affected with minimal expenditure and benefits such as 1) enhancing safety and reducing clutter 2) increasing productivity 3) fostering and promoting compliance with regulatory standards 4) reducing inventory and supply costs 5) recapturing valuable space and minimizing overhead costs 6) impacting the “how we feel” feeling about a workplace, organization and the employees. In order to apply the Lean 5S approach, employees need to be acquainted with its five components which include sort, set in order, shine, standardize and sustain (as shown in Figure 2.5-2)

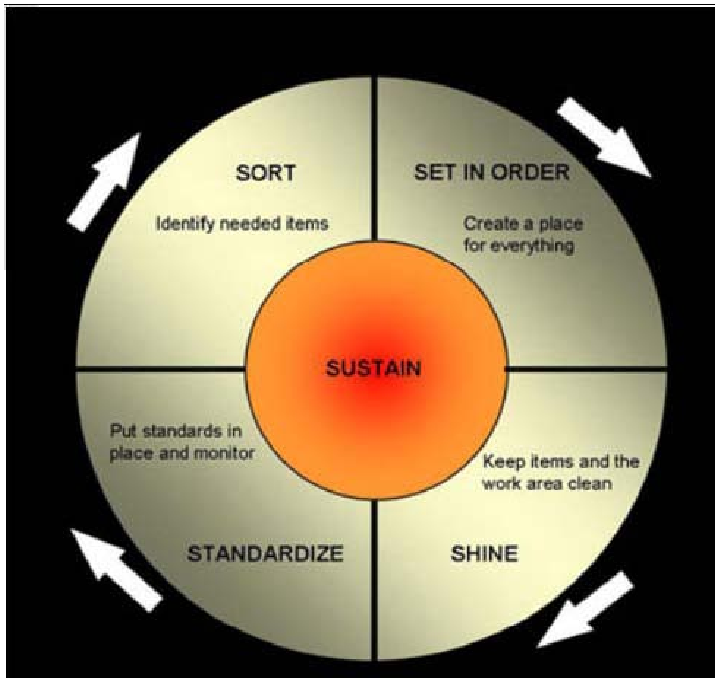


Figure 2.5-2: The 5S Approach
Source [Ahlstrom, 2007]

2.5.4 PDSA (Plan-Do-Study-Act) or PDCA (Plan-Do-Check-Act)

The PDSA model for improvement is a simple yet powerful tool for accelerating change/improvement on a small scale (Melnyk & Fineout-Overholt, 2010). It is a process for which continual improvement and continual learning is proposed. "This scientific method is a process of proposing a study, designing an experiment to collect evidence, arranging, and interpreting the results" (Speroff & O'Connor, 2004). As shown in Figure 2.5-3, this method stresses the establishment of a hypothesis for improvement based on three questions: "what are we going to accomplish? How will we know that a change is an improvement? What changes can we make that will result in an improvement?" These three questions help with the hypothesis development as they are built for data analysis purposes. Moreover, together these three questions "structure an active and disciplined way of pursuing change" (Grunow, 2012).

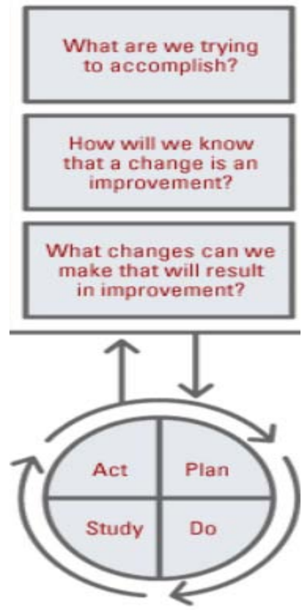


Figure 2.5-3: PDSA Cycle

Whenever an improvement method is being applied, it is important to include everyone that takes part in a process including the customer/patient. That way, they can all provide feedback about what is currently working well and vice versa. Hence, the PDSA method is meant to include everyone that takes part of the current manner for every stage. The 'Plan' stage refers to the identification of an opportunity, and plan for improvement. During this stage, the team is assembled, the aim statement is created, the examination of the current process is studied, and an improvement theory is developed (PDSA: Plan-Do-Study-Act, 2012). The 'Do' stage is the process of carrying on with the plan which includes: (1) the testing of the theory for improvement (2) the discharge of the plan developed (3) the collection, charting, and displaying of data and (4) the documentation of problems, unexpected observations, and side effects. (PDSA: Plan-Do-Study-Act, 2012). The 'Study' stage is where the examination of results occurs. The data collected in the previous stage is studied and linked to the hypothesis for matching of the theory and predictions. During this stage, trends and unintended effects are captured and an improvement opportunity is clearly perceived (PDSA: Plan-Do-Study-Act, 2012). The final stage of 'Act' refers to the refining of the change, based on what was learned from the past test. This is where the PDSA cycle takes its definition by being a continuous process. Revisions, adjustments, changes as well as sustaining steps for the preservation of gains are determined and a plan for the next test is developed during this step. (PDSA: Plan-Do-Study-Act, 2012).

The basic concept of the PDSA cycle is to improve the quality of fundamental processes by creating a repetitive learning atmosphere. During a PDSA cycle, "intervention is replicated by segmenting its application within the same subject onto separate targets" (Speroff & O'Connor, 2004). Thus, by testing small interventions, the PDSA improvement method can help conduct larger improvements through successive cycles of rapid change.

All of the Lean tools and techniques noted above have been used effectively in the manufacturing as well as in the automotive industries for decades. Because of its concepts, tools, and methods, specifically designed to improve processes while eliminating waste, Lean has also gained popularity in the healthcare industries. As of today, many healthcare industries have undertaken a Lean transformation in order to drive out process improvements in quality, efficiency, cost, safety, and delivery of care (Kim et al., 2006).

2.6 Health Care as of 2012

As of 2012, the health care industry is going through high economic, regulatory, and political uncertainty (IOM, 2012). The rise of complexity of modern health care, unsustainable cost increases, and outcomes below the system's potential are major imperatives for health care industries to continuously keep improving delivery of care and reduce costs (IOM, 2012). As these challenges take place, emerging tools and techniques such as computing power, connectivity, team-based care, and systems engineering techniques are also arising (IOM, 2012). Some of these tools were not available in past times and as they are quickly emerging, they "make the envisioned transition possible, and are already being put to successful use in pioneering health care organizations" (IOM, 2012). As the Institute of Medicine (2012) explained, the application of these strategies are not only supporting the transition to a continuously learning health care system but they are producing the best care at lower cost by aligning science and informatics, patient-clinician partnerships, incentives and a culture of continuous improvement.

As explained in previous sections, Lean is one of the emerging strategies used as a breakthrough solution for process improvement in healthcare. The Lean transformation of the PVAMC started in October 2009 with the introduction of the Systems Redesign (SR) program. The mission of the SR program is to improve the PVAMC healthcare delivery system through Lean thinking. This program provides different trainings, workshops, and seminars that promote that use of Lean tools and techniques throughout the facility. SR also provides facilitation support during the execution of any improvement initiative. Moreover, a partnership with the University of Rhode Island (URI) was also established to not only create a diffusion of systems engineering tools throughout the facility but also to find ways to run operations faster, better, and more cost effective. URI Industrial and Systems engineering students have become an important part of transforming the PVAMC culture by leading many workshops teaching staff to apply Lean techniques to their day to day work. The SR team, along with the URI team, has also built a database of systems redesign projects and employee trainings in systems redesign methods. This database was created using Microsoft Access for the purposes of tracing, capturing, and organizing the details of all systems improvement activities an employee has been involved in such as training sessions and number of projects. With this systems redesign database and a survey, the PVAMC has been able to assess the change in its culture.

The survey, developed by a URI research team, "Assessing Climate for Systems Improvement Initiatives in Healthcare" was designed in order to assess climate change at the PVAMC. Historical data in the form of All Employee Survey (AES) responses from 2008-2010 were reviewed to help build a survey which captures not only the adoption of a new culture at the PVAMC but also demographic questions such as workgroup, age, length of service in the facility and level of supervisory responsibility. Survey responses collected during Spring 2011, Fall 2011, Spring 2012 and Fall 2012 have helped measure the change in culture over time. Responses have also helped assess the rate of adoption and implementation of improvement methods according to different departments or workgroups, different demographic groups, and different healthcare settings. The long term goal of this survey was to study the effectiveness of systems improvement initiatives, in an effort to identify the best practices and most effective methods.

The PVAMC has also created relationships with the Institute for Healthcare Improvement (IHI) and ThedaCare. IHI is a non-profit organization that promotes improvement in health care worldwide. This organization provides online courses, conferences, seminars, and web-based programs that allow the workforce, from executive leaders to front-line staff, achieve significant results in quality, safety, and innovation (Institute for Healthcare Improvement, 2013). ThedaCare, on the other hand, is a health system consisting of hospitals and clinics. As healthcare providers, ThedaCare is one of the leading organizations with a proven Lean transformation. This health care system was able to reduce the number of defects, improvement patient outcomes, eliminate waste, and reduce costs dramatically without layoffs. With such first-hand experience with Lean, ThedaCare offers many educational materials for other hospitals and health care providers to initiate their own Lean transformation. They also allow other health care providers to visit their facilities or access their healthcare value network to create “peer-to-peer relationships, share knowledge, conduct real-world experiments and access the best resources to accelerate their own organization’s lean transformation” (Healthcare Value Network, 2013).

2.7 Role of Surveys

A survey is said to be a “systematic method for gathering information from (a sample of) entities for the purposes of constructing quantitative descriptors of the attributes of the larger population of which the entities are members” (Groves et al., 2009). Quantitative descriptors are described as “statistics” which are summaries of observations on a set of the entities/elements being studied. Groves et al. (2009) also explained that the difference between surveys and other efforts to describe people or events lies in the two types of "statistics" obtained from a survey: descriptive statistics and analytic statistics. Descriptive statistics describe the main features of the data being collected. Analytic statistics, on the other hand, describe how much two or more variables are related to one another.

Surveys are used all around the world to collect people's preferences, knowledge, opinions, beliefs, behaviors, etc. Surveys are also used in "needs assessments and opinion polls, as well as to evaluate the process, outcomes and impacts of programs and policies" (Taylor-Powell & Hermann, 2000). Most importantly, surveys are used to see if there are any changes over time. Hence, as Groves et al. (2009) explained, "surveys are a crucial building block in a modern information-based society". With surveys, researchers are able to understand the way society works and test theories to ensure its efficient application. Moreover, nowadays, they are used more and more to collect feedback in order to improve a industry's operations. However, with a self reported mechanism, survey questionnaires have many challenges.

There are multiple threats to the validity of a self reported survey "which serve to weaken the intended substantive inferences to be drawn from such data" (Lance & Vanderberg, 2009). Since surveys ask respondents to report something about themselves without any supervision, the credibility of the data collected is an overarching problem. As Robins et al. (2007) explained, "Even when respondents are doing their best to be forthright and insightful, their self-reports are subject to various sources of inaccuracy". These may include self-aware forms in which exaggeration, faking and lying take place, and self-deception forms in which self-favoring bias, self-enhancement, defensiveness, and denial take place. (Robins et al., 2007). Although researchers know of this tendency, survey questionnaires are still a popular choice as it has a number of persuasive advantages including “easy interpretability, richness of information, motivation to report, casual force, and shear practicality” (Robins et al., 2007) .

In the case of a healthcare industry, surveys are used to improve a hospitals’ operations, conduct medical research, track patient satisfaction, track staff satisfaction, and much more. Through surveys, critical information about an employee, physician, and patient are provided with the intent to recommend improvement of medical facilities and their services from both a quality and cost perspective. Moreover, surveys offer many hospitals the ability to attain a realistic view of what is happening on a day to day basis. Hence, many hospitals are able to solve problems that come to light through survey collection and then apply solutions.

3 CHAPTER III

METHODOLOGY

3.1 Study Framework and Exploratory Hypotheses

The objective of this thesis was to investigate the characteristics of workgroups which might influence the adoption of system improvement initiatives at the PVAMC. The adoption of systems improvement initiatives means applying process improvement tools and techniques associated with Lean methodologies and related improvement methodologies. The adoption of improvement initiatives was captured by responses collected from a survey. These questions were specifically designed to help measure the implementation of improvement initiatives among all staff at the PVAMC. In the preceding chapters, organizational change, leadership, workgroup structure as well as different improvement initiatives have been explained in terms of theory and its relevance to organization studies and change. The purpose of this chapter is to examine how different workgroup characteristics can potentially impact the adoption and involvement of a workgroup in systems improvement initiatives. The workgroup characteristics to be analyzed, in this study, are workgroup size and leadership-involvement. Results of this examination will help explain if such characteristics ultimately affect workgroup readiness regarding the implementation of systems improvement initiatives.

3.1.1 Workgroup Size Hypothesis

<u>*Null Hypothesis (H_0)*</u>*: Workgroup size does not affect the adoption of systems improvement initiatives within a workgroup.*

Alternative Hypothesis (H_1): Workgroup size does affect the adoption of systems improvement initiatives within a workgroup.

As a decentralized organization, the PVAMC is structured around workgroups. Workgroups within health care organizations allow for employees to "work together, learn together, engage in clinical audit of outcomes together, and generate innovation to ensure progress in practice and service" (Department of Health, 1993). The size of a workgroup is very important in any organization. For instance, larger workgroups may experience greater strains on effective communication compared to small workgroups. On the other hand, smaller workgroups may suffer from fewer resources affecting their participation in systems improvement initiatives such as trainings, workshops, or seminars. Assessing the ability to adopt improvement initiatives based on workgroup size can assist management with Lean implementation at the PVAMC.

3.1.2 Leadership Hypothesis

Null Hypothesis (H_0): Leadership's involvement and support of systems improvement initiatives does not affect the readiness of front line "hands on" employees to adopt process improvement tools and techniques.

Alternative Hypothesis (H_1): Leadership's involvement and support of systems improvement initiatives affects the readiness of front line "hands on" employees to adopt process improvement tools and techniques.

According to Bewer, Wilson, & Beck (1194), leaders not only affect team performance but the relationship between leadership style and team effectiveness is considered to be strong. For instance, effectiveness of primary care teams in England has been highly rated whenever there is a strong leadership and involvement of all team members. In fact, the stronger the influence of leadership and involvement of all team members, the higher the rating for effectiveness (Eden, 1990). Leaders, in this study, are considered to be anyone who has a higher position within the organization such as team leader, first line supervisor, manager, and executive. Anyone with such a leadership role at the PVAMC exerts a significant influence on the front line employees' adoption of systems improvement initiatives. Therefore, the extent to which leaders are involved in the implementation of systems improvement initiatives is hypothesized to be positively associated with greater perceived impact on their workgroup involvement in systems improvement.

3.2 Study Setting

The setting was the Providence VA Medical Center (PVAMC) and the survey population included all of the employees working at the PVAMC. The Providence VA Medical Center is one of 8 hospitals in the VA New England Healthcare System. The medical center delivers a broad range of services in medicine, surgery, and behavioral sciences and is currently serving more than 30,000 patients/year, 4,000 discharges/year and 360,000 outpatient visits/year. Clinical services are organized by service lines including Mental Health, Specialty and Acute Care, and Primary Care. Employees range from physicians to nurses, technical specialists, therapists, medical assistants, pharmacists, dieticians, educators, accountants, social workers, executives, administrative assistants, janitors, etc. As a medical center, the PVAMC contains many different departments or service lines, each of which is run almost as a separate business or entity within the facility. Each service line is then divided into workgroups. The PVAMC also serves as a research teaching facility with affiliation with Brown University Medical School and other institutions.

Study Sample

There are approximately 1,100 full-time equivalent employees who were all invited to participate in this study. All of these employees complete the PVAMC health care delivery team of professional, technical, administrative, and support personnel. There was no additional criterion to select participants for the survey other than current PVAMC employment. The PVAMC currently has 51 workgroups that include dental service, mental health, nursing general, police, etc.

3.3 Measures

3.3.1 Questionnaire Survey

Since this study analyzes data obtained from the “Assessing Climate for Systems Improvement Initiatives in Healthcare” research, which uses a survey to assess change in climate in the organization, it is important to be familiar with the concept of change.

The model used in the survey is the Trans-theoretical Model of Change (TTM). This model “uses a temporal dimension, the stages of change, to integrate processes and principles of change from different theories of intervention” (Prochaska & Velicer, 1997). TTM was developed to focus on the phenomena of intentional change rather than developmental, social, or imposed change (Brinthaupt & Lipka, 1994). TTM has been used in studies assessing the readiness of individuals to make changes in behavior, such as smoking cessation, exercise programs, or healthy diets. The TTM has also been used in healthcare to study interventions which increase the ability of physicians to adopt continuous quality improvement (Levesque, Prochaska, Prochaska, Dewart, & Hamby, 2001).

TTM was used during the creation of the survey in the "Assessing Climate for Systems Improvement Initiatives in Healthcare" research with the purpose of assessing the change in behavior of employees while implementing improvement initiatives throughout the PVAMC. This was done by following the basic hypothesis of the TTM which states that organizational and individual change occurs in stages over time (Brinthaupt & Lipka, 1994). The theoretical concepts that were defined in the TTM model as essential to change are stage of change, decisional balance, self-efficacy, and process of change (Prochaska & DiClemente, 1983). With the TTM's theoretical concepts, the research team was able to develop a questionnaire survey that captures the ability of PVAMC's employees to adopt systems improvement initiatives during the transformation of their culture to a Lean culture.

3.3.1.1 Design of Questionnaire Survey

There were different sources used during the creation of this survey including 1) VHA All Employee Survey (AES), 2) VA quality improvement survey, and 3) University of Rhode Island (URI) Research team questions. The first source of research survey questions is the Department of Veterans Affairs All Employee Survey (AES), which has three segments: a) Job Satisfaction Index (JSI) (Nagy, 2002), b) Organizational Assessment Inventory (OAI) (Gowing & Lancaster, 1996), and c) Culture (Zamutto & Krakower, 1991; Shortell, Rousseau, Gillies, Devers, & Simons, 1991). The second source of research survey questions originate from a Quality

Improvement Survey developed by the VA Center of Excellence for Organization, Leadership, and Management Research (COLMR). The remaining questions were added by the research team for measuring climate change in the facility, based on the measures frequently used in TTM, applied to the current focus of systems improvement. The intention of adding questions was to look at TTM processes that were not captured by the items located in the existing survey instruments.

3.3.1.2 Survey Questions Breakdown

The following section is going to explain the structure of the survey. The survey consisted of 42 questions. These questions are divided into six segments: demographic questions, systems improvement questions, stages of change questions, decisional balance questions, self-efficacy questions, and processes of chance questions.

Demographics: Questions in the demographic segment asked participants to report their workgroup, shift, age, length of service, and their supervisory level responsibility. The response options of these questions, as seen in Figure 3.3-1, were determined based on the All Employee Survey administered at the PVAMC every year. These questions were designed to help determine what factors may influence a participant's response by enabling the cross-tabulation and comparison of subgroups. With such subgroups, the variation of responses between groups was able to be assessed. However, the responses collected for these questions were self-reported which could have had an impact on the results. As explained in Section 2.7, self-reported questionnaires can cause respondents to report answers based on the participant's social desirability.

Q.	Definition	Q.No.	Responses
1	Please select your work group from the list below.	1	Select Workgroup
2	What shift do you typically work?	2	Day (approximate start time between 6am and 9am) Evening (approximate start time between 3pm and 6pm) Night (approximate start time between 7pm and midnight)
3	What is your age?	3	Less than 20 20-29 30-39 40-49 50-59 60 or older
4	How long havfe you been with VA?	4	Less than six months Six months to one year One to three years Four to five years Six to ten years 11 to 20 years More than 20 years
5	What is your supervisory level?	5	None Team Leader First Line Supervisor Manager Executive

Figure 3.3-1: Demographics Questions

***Systems Improvement*:** Questions shown in Figure 3.3-2 were added by the research team for measuring climate change in the facility, based on the measures frequently used in TTM, applied to the current focus of systems improvement. These questions were specifically designed to help assess the adoption of improvement initiatives at the PVAMC.

Q.	Definition	Q.No.	Responses	Source	Category
6	At this point in time, how much have you... (SCALE 1 to 5, NOT AT ALL to COMPLETELY)	6a	been trained in at least one of the systems improvement techniques (Microsystems, Lean, PDSA, VA-TAMMCS).	Research Team	*Systems Improvement*
		6b	used PDSA or VA-TAMMCS tools in my work group.		
		6c	been involved in improvement projects or continuous improvement initiatives.		
		6d	incorporated continuous improvement into everyday work.		

Figure 3.3-2: Survey's Systems Improvement Section

Some questions were eliminated, added, or modified over time by the research team using Principal Component Analysis (PCA). The research team made use of this tool for each one of the scales to check if the validity of the scales changed over time. Hence, PCA was used to determine the number of components to retain before administering the next survey. For this reason, only the questions that appeared consecutively on all four surveys were analyzed during this study. The following is a brief explanation of TTM's theoretical concepts that were used during the development of the survey:

***Stages of Change*:** The TTM interprets change as a nonlinear but fluid process that implicates progress throughout a series of stages (Prochaska & Velicer, 1997). Using the question in Figure 3.3-3, participants were asked to report their involvement in the following stages:

Q.	Definition	Q.No.	Responses	Source	Category
7	Considering that being involved in systems improvement can include both specific improvement projects or everyday continuous improvement, are you involved in systems improvement?	7	NO, and I do not intend to in the next 6 months NO, but I intend to in the next 6 months NO, but I intend to in the next 30 days YES, I have been, but for less than 6 months YES, I have been for more than 6 months	Research Team	***Stages of Change***

Figure 3.3-3: Survey's Stages of Change Section

a) Pre-contemplation Stage – people are not ready to take action within the next 6 months. There is no intention whatsoever for changing a behavior because they are unaware, uninformed, abandoned, demoralized or resistant to change.

b) Contemplation Stage – people intend to take action within the next 6 months. This is the stage in which someone is considering change but may not be fully aware of what the change corresponds to or what kind of commitment is involved in it.

c) Preparation Stage – people intend to take action within the next month.

d) Action Stage – people have done specific modifications in their own styles of life for less than 6 months and thus they have engaged in the new behavior. This stage is where people understand the need to change and apply time and resources to do so.

e) Maintenance Stage – sustaining changes for at least 6 months after they have been applied. This is the stage where people consistently work to avoid relapse and really think about the value of the gains attained during the action stage.

Self-Efficacy**:** The survey questions in Figure 3.3-4 conceptualize the respondent's degree of confidence and conviction for maintaining the change being applied. This represents the belief that changes are having a positive impact and thus, change will be sustained and temptation to revert back will not be seen.

Q.	Definition	Q.No.	Responses	Source	Category
8	How confident are you that you could begin to participate or continue participating in systems improvement activities... (SCALE 1 to 5, NOT AT ALL CONFIDENT to EXTREMELY CONFIDENT)	8a	when unexpected problems arise during projects.	Research Team	***Self Efficacy***
		8b	when conflicts arise between team members.		
		8c	if meetings conflict with your regular job duties.		
		8d	when other employees are absent or leave the workgroup.		
		8e	if the project on which you are working concludes.		
		8f	if the systems improvement team is in need of a new leader.		
		8g	if you do not already have some of the necessary skills or training.		

Figure 3.3-4: Survey's Self-Efficacy Section

***Decisional Balance*:** The survey questions in Figure 3.3-5 measure the importance of reasons and concerns relating to change in behavior; the pros and cons of such change are balanced.

Q.	Definition	Q.No.	Responses	Source	Category
9	How important are the following reasons in your decision of whether or not to participate in systems improvement activities. (SCALE 1 to 5, NOT AT ALL IMPORTANT to EXTREMELY IMPORTANT)	9a	It would take a lot of effort.	Research Team	***Decisional Balance***
		9b	My co-workers would not respect my involvement.		
		9c	It would not directly benefit me.		
		9d	I would enjoy learning new skills and applying them.		
		9e	My job would become easier in the future.		
		9f	My work group would share information with other work groups.		
		9g	Veteran care and patient safety would improve.		
		9h	Employee turnover would go down.		
		9i	It would be difficult to continue improving after initial gains.		
		9j	My job satisfaction would increase.		
		9k	It would be difficult to get other people involved.		
		9l	I would not have time for my other job duties.		
		9m	The ideas I work on might never be implemented or acted on.		
		9n	I would not be sufficiently recognized or rewarded for my involvement.		
		9o	The quality of work my work group produced for others would improve.		
		9p	I would have better procedures for handling problems.		

Figure 3.3-5: Survey's Decisional Balance Section

***Processes of Change*:** The survey questions in Figure 3.3-6 represent a dimension of the TTM that allows the research team to understand the processes by which employees change. The implementation of different processes at each particular stage of change has shown successful self-changers (Levesque et al., 2001). The processes refer to the thoughts, feelings, and actions individuals engage as they attempt to change behavior or maintain behavior change.

Q.	Definition	Q.No.	Responses	Source	Category
10	Please indicate how much you agree or disagree with the following statements.	10a	My supervisor has helped me to rethink the way I do things.	Research Team	***Self-Revaluation***
		10b	Management is taking necessary improvement actions based on survey feedback from employees.	Research Team	***Social Liberation***
		10c	Facility leaders are strongly committed to systems improvement.	Research Team	***Social Liberation***
		10d	My immediate supervisor(s) establishes forums for and provides time and resources for participating in quality improvement activities.	Quality Improvement Survey (Q.7)	***Stimulus Control***
		10e	Employee ideas should be shared with supervisors to help improve the work.	Research Team	***Self Liberation***
11	Please indicate how satisfied you are with the following situations.	11c	How satisfied are you with the cooperation your fellow employees provide for improvement projects?	Research Team	***Social Liberation***
12	Please indicate how much you agree or disagree with the following statements.	12b	In this work group, there is time to reflect on how well our processes work for providing patient care.	Quality Improvement Survey (Q.3)	***Stimulus Control***
		12e	Until there is a situation of emergency, nothing is changed or improved.	Research Team	***Environmental Reevaluation***
		12f	Changes are made without talking to the people involved in those processes.	Research Team	***Self Reevaluation***
13	Please indicate how much you agree or disagree with the following statements.	13a	I have adequate information regarding the improvement projects in my work group.	Research Team	***Consciousness raising***
		13b	I understand how systems improvement can benefit patient care.	Research Team	***Consciousness raising***
		13c	I am comfortable with the way that I accomplish my daily tasks.	Research Team	***Dramatic Relief***
		13e	I am willing to change the way I work, if it improves the outcomes.	Research Team	***Environmental Reevaluation***
		13f	Systems improvement is important for this facility to cost effectively serve veterans.	Research Team	***Environmental Reevaluation***

Figure 3.3-6: Survey's Processes of Change Section

3.3.1.3 Authorization for the survey

Since this study uses human subjects, permission for the completion of the research was required from the Institutional Review Board (IRB) at both the University of Rhode Island and the PVAMC. It was determined that this research had minimum risk, as employees were able to decline their participation on the survey at any time. Each survey included a disclosure statement attached in Appendix A.

Though the responses collected from the survey were collected anonymously, based on the combination of demographics; it would have been possible to identify individual employees. To keep risk to a minimum, any combination of demographics that resulted in less than 10 responses was not reported to the management of the medical center.

Benefits of this study: Although there was no direct benefit to an employee for taking part in this study, the research team was able to learn more about the ways different healthcare departments implement system improvements and adopt them, problems that can occur and the change in climate that occurs due to system improvement activities. The research findings benefit the medical center in general and help improve processes that in turn benefit the day-to-day work of employees and patient care.

***Collaborators**:* The research team collaborated with the Systems Redesign Program at the Providence VA Medical Center to help carry out the research. Robert A. Harris, Systems Redesign Coordinator, managed the systems improvement initiatives across the medical center.

Costs to Subjects: There was no cost to subjects to participate in this study, other than their time needed to complete the survey questionnaires.

***Conflicts Of Interest**:* The Principal Investigator or the research staff or their immediate families did not have any financial interest that could have been affected by the outcome of the research protocol. The Conflict of Interest forms with the required signatures were submitted to the Providence VA Medical Center research office.

3.3.1.4 Survey Collection

Survey invitations were sent to all employees working at the PVAMC. Employees were asked to complete a web-based survey, using Survey Monkey as a tool, with no time limit over a period of three weeks. Paper copies were available in locations convenient to employees, or by request, for those who preferred a paper format. Employees were assured that their responses were not only confidential but anonymous as well. Table 3.3-1 shows the response rate for each survey administered over the period of two years. After collected, survey responses were coded by assigning numbers to each response.

Table 3.3-1: Response Rate

Survey	Response Rate	Total Number of employees
Spring 2011	516 (41.3%)	1250
Fall 2011	550 (44.0%)	1250
Spring 2012	549 (43.2%)	1273
Fall 2012	213 (16.7%)	1273

3.3.2 Database

Besides the survey data acquired from the "Assessing Climate for Systems Improvement Initiatives in Healthcare" research, the PVAMC provided this study with a database which helped in the organization of the data set:

1. ***Employees' database***: Every year, the PVAMC Human Resources department provides the research team with a list of different departments along with the number of employees working for each department based on the AES. This database was used to determine how many employees belonged to each workgroup analyzed during this study.

3.4 Hypotheses Analysis

3.4.1 Workgroup Size Hypothesis

3.4.1.1 Dependent Variables

At the conclusion of each survey, data collected from Survey Monkey was downloaded into a Microsoft Excel spreadsheet. A variable was assigned to each question and then coded for the purpose of analyzing the responses. All of the Likert-scale items were coded as seen in Table 3.4 -1.

Table 3.4-1: Coded Likert-Scale Items

Codes	Systems Improvement	Self-Efficacy	Decisional Balance	Stages of Change
1	Not at all	Not at All Confident	Not at All Important	Strongly Disagree
2	Slightly	Not Very Confident	Somewhat Important	Disagree
3	Somewhat	Moderately Confident	Moderately Important	Neutral
4	Moderately	Very Confident	Very Important	Agree
5	Completely	Extremely Confident	Extremely Important	Strongly Agree

The 5-point scale rating for each of the questions was used to measure dependent variables (DVs) during this study. As explained by Rosenthal & Rosnow (1991), “DV refers to the status of the ‘effect’(or outcome) in which the researcher is interested”. Hence, as the responses to the questions are the outcome for this study which were not manipulated, only observed and analyzed, all likert-scale ratings were employed as DVs.

3.4.1.2 Independent Variables

Independent variables (IVs), on the other hand, were manipulated for the pupose of testing each hypothesis. Independent variables are also called “explanatory or predictor vairables, because they are used to explain or predict the repsonse, outcome, or result” (Fink, 2003). Workgroup sizes categories were considered IVs during the testing of this hypothesis. The workgroup size categories (IVs) were coded as follow: ‘1’-Small, ‘2’-Medium, ‘3’-Large, and ‘4’-Extra Large.

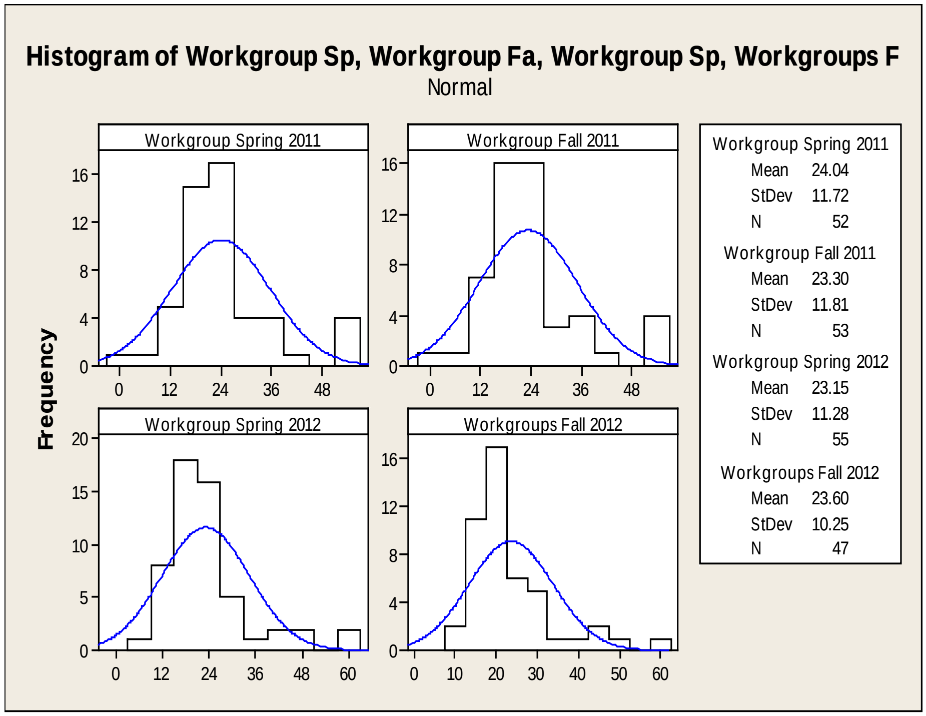


Figure 3.4-1: Graphical Summary of all workgroups per survey

The quantity of employees per workgroup was determined through the employee database. A graphical summary of the data set, using the statistical software of Minitab, was then developed as seen in Figure 3.4-1.

After analyzing each survey's distribution of the data set and the shape of its frequency histogram, workgroups were clustered into quartiles. This was done because the data set presented non-normality and a skewed shape where most of the data set fell within the left hand side of the histogram. As explained by Walpole, Myers & Myers (2007), as a useful measure of spread data, quartiles calculated by using the median tend to be much less affected by outliers or a skewed data set than the corresponding measures of the mean and standard deviation. Therefore workgroups were categorized according to the first, second, third, and fourth quartiles as seen in Table 3.4-2.

Table 3.4-2: Workgroup Categorization

Quartiles	Spring 2011	Fall 2011	Spring 2012	Fall 2012	Workgroup Category
1st	0-17	0-17	0-17	0-17	Small
2nd	18-21	18-21	18-21	18-22	Medium
3rd	22-27	22-26	22-25	23-25	Large
4th	28-57	27-57	26-61	26-61	Extra-Large

3.4.1.3 Data Analysis

The following steps were taken when analyzing the results:

Step 1: Developed an analysis of variance (ANOVA) table for the randomized complete blocks design (RCBD) using Minitab.

This analysis was conducted in order to compare the responses of four surveys administered at the PVAMC. Although the questions in all four surveys remained the same over time, these surveys were administered sequentially which captured the effects of different improvement initiatives which were implemented during the elapsed time between survey periods. These initiatives included various facility-wide and targeted trainings, seminars, improvement projects, etc. Thus, a difference in the responses between each survey was anticipated.

Surveys' responses helped investigate two types of factors: a blocking factor and a main factor, often called a treatment. Block factors as explained by Walpole et al. (2007), are homogenous units which are randomly assigned to one treatment. The meaning of homogeneous refers to the fact that the units are likely to have similar values of the response when given identical treatment. Hence, blocks are used in order to reduce unexplained variation and error. Main factors or treatments are randomly assigned to units within the blocks (Walpole et al., 2007). Each treatment is said to appear once in each block. An analysis conducted in this manner is called a randomized complete blocks design (RCBD).

A RCBD was performed during the analysis of this hypothesis. The RCBD layout is shown in Table 3.4-3 in which the main factor is the survey and the blocking factor is workgroup size. Workgroup size categories were used as blocks because it is suspected that each workgroup size category is homogeneous with respect to their responses to each treatment. The units to be analyzed are the responses of surveys.

Table 3.4-3: Analysis Factors and Levels

	Factors	Levels
Main Factors	Surveys	Spring 2011, Fall 2011, Spring 2012, Fall 2012
Blocking Factors	Workgroup Size Categories	Small, Medium, Large, Extra-Large

Having established the main and blocking factors, the RCBD statistical model of this analysis is:

$$R_{ij} = \mu + S_i + W_j + \epsilon_{ij}$$

Where

R_{ij} = Response to survey i from workgroup size category j;

μ = Overall mean response;

S_i = Survey (i = 1, 2, 3, 4);

W_j = Workgroup Size Category (j = 1, 2, 3, 4);

ϵ_{ij} = Error;

An analysis of variance (ANOVA) provided statistical computations to perform a significance of difference between the means. Hence, hypotheses were elaborated for each one of the questions being analyzed. The hypotheses of interest were:

Main Effect (Survey Effect):

$$H_0: S_1 = S_2 = S_3 = S_4 = 0$$

$$H_1: \text{At least } S_i \neq S_j \text{ for one pair of i, j;}$$

$$\text{Reject } H_0 \text{ if p-value} < \alpha$$

Blocking Effect (Workgroup Size Category Effect):

$$H_0: W_1 = W_2 = W_3 = W_4 = 0$$

$$H_1: \text{At least } W_i \neq W_j \text{ for one pair of i, j;}$$

$$\text{Reject } H_0 \text{ if p-value} < \alpha$$

Table 3.4-4 shows the response rate of the total number of employees belonging to each workgroup size category collected during the administration of the four surveys.

Table 3.4-4: Response Rate of Workgroup Size Categories (Number of employees per category)

Workgroup Size Category	Surveys			
	Spring 2011	**Fall 2011**	**Spring 2012**	**Fall 2012**
Small	70 (42.17%)	21 (11.05%)	116 (85.93%)	40 (21.05%)
Medium	146 (45.63%)	45 (13.31%)	108 (33.75%)	91 (26.07%)
Large	116 (38.93%)	19 (8.68%)	155 (96.88%)	30 (20.41%)
Extra-Large	184 (39.48%)	61 (12.5%)	170 (32.69%)	52 (12.29%)

Step 2: Extracted p-values from the ANOVA test results and highlighted any rejected null hypothesis (H_0).

The p-value provided in the ANOVA table results lead to the decision about whether to reject or not reject the null hypotheses of equal means. As a threshold value used to judge whether a test if statistically significant, the alpha value of 0.05

represented acceptable probability of the Type I error – rejection of the null hypothesis when it is true – during this study. The value of 0.05 was chosen as a pre-significance level because it is the most popular alpha value used by many researchers in the scientific field as well as in the TTM procedure (Fisher, 1956; Bross, 1971; Prochaska, 1983). Hence, if the p-value of a hypothesis test was less than or equal to the alpha value, it was considered to be statistically significant. For example, if a p-value resulted in a value of 0.01, the null hypothesis would be rejected, leading to a conclusion that the means are not all equal.

Step 3: Conducted a Tukey test and created graphical visualization for any rejected hypotheses with respect to the blocking effect.

When a null hypothesis was rejected, further analysis was done in order to identify where exactly differences existed. Since more than two blocking factors (4 workgroup size categories) were analyzed, a Tukey test was performed. The Tukey test is "described as the simplest and quickest significance test for comparing independent samples" (Basler and Smawley, 1968). As a paired comparison method, this test helps determine which means amongst the set of means differ from the rest. For instance, as there were six pairs of comparisons for the blocking factor (1 vs. 2, 1 vs. 3, 1 vs. 4, 2 vs. 3, 2 vs. 4, and 3 vs. 4), the Tukey method helped analyze the difference between each comparison by assigning a letter. Means which did not share the same letter were considered to be significantly different.

A graphical visualization of the data was also created in order to show specific characteristics of the data (responses) set. Box-plots, in this case, were used to interpret results. A Box Plot is a 5-number graphical summary of the data set which shows the minimum and maximum range values, along with the upper and lower quartiles and the median, as shown in Figure 3.4-2. All data points that go beyond these limits are considered to be outliers and they are plotted individually (Potters et al., 2010).

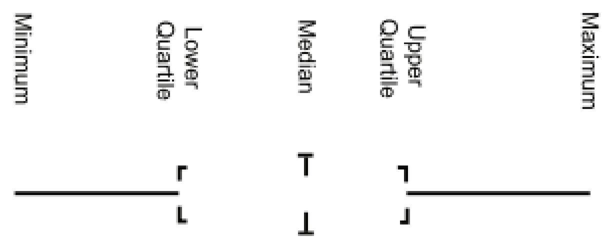


Figure 3.4-2: Box-plot Description

The box-plot graphical visualization of the rejected hypotheses helped understand different measures such as (1) Location – the median line, (2) Dispersion – the length of the box and the distance between the upper and lower whiskers, and (3) Skewness – the asymmetry of the upper and lower portions of the box (Mitchell, 2012).

3.4.2 Leadership Hypothesis

3.4.2.1 Dependent Variables

When testing whether leadership-involvement in systems improvement initiatives had an effect on the front-line employees' involvement in systems improvement initiatives, the stages of change (SOC) question, in the survey, played a big role. As explained in Section 3.4-5, the SOC question requested participants to report their involvement in systems improvement initiatives according to the TTM's stages of change which were coded as seen in Table 3.4-5.

Table 3.4-5: Coded Stages of Change Items

Involvement	Code	Stages of Change	Scale on Survey
Uninvolved	1	Pre-contemplation	No, and I do not intend to in the next 6 months
	2	Contemplation stage	No, but I intend to in the next 6 months
	3	Preparation stage	No, but I intend to in the next 30 days
Involved	4	Action stage	Yes, I have been, bur for less than 6 months
	5	Maintenance stage	Yes, I have been for more than 6 months

As a dependent variable, the SOC scale was employed to determine the involvement of leaders at the PVAMC. However, since this hypothesis is testing the involvement of leadership and not their 'intention', the SOC scales were grouped together into two categories: (1) Uninvolved – for which coded stages of change 1, 2, and 3 represented the lack of involvement of leadership in systems improvement initiatives and (2) Involved – for which coded stages of change 4 and 5 represented the leadership's involvement in systems improvement initiatives. Hence, the responses of the groups corresponding to the 'Uninvolved' and 'Involved' categories were employed as DVs for the testing of this hypothesis.

3.4.2.2 Independent Variables

Independent variables for the testing of this hypothesis were able to be manipulated as the survey included self-reported demographic questions such as which workgroup an employee belongs to and if they have a supervisory level. Leadership, as explained in Section 3.1.2, was composed of employees who had a supervisory level of team leader, first line supervisor, manager, and executive. The answers of the survey respondents who self-reported a leadership role were then filtered and the SOC question was analyzed. Employees who belonged to workgroups with leaders who answered 'Involved' to the SOC question were grouped and coded as

1. Conversely, employees who belonged to workgroups with the leaders who answered 'Uninvolved' to the SOC question were grouped together and coded as 0. However, since workgroups may have two or more leaders, workgroups which fell within both categories were consequently eliminated from the analysis in order to reduce any potential bias in the results as seen in Figure 3.4-3. For example, if an employee with a supervisory level responsibility of executive reported being uninvolved in improvement initiatives during the SOC question, the workgroup they belonged to was then studied. If this 'executive' leader belonged to a 'primary care' workgroup, the 'primary care' workgroup was considered to be under an uninvolved leadership. Hence, the IVs for this hypothesis were composed of two groups: workgroups under the leadership 'Involved' and workgroups under the leadership 'Uninvolved'.

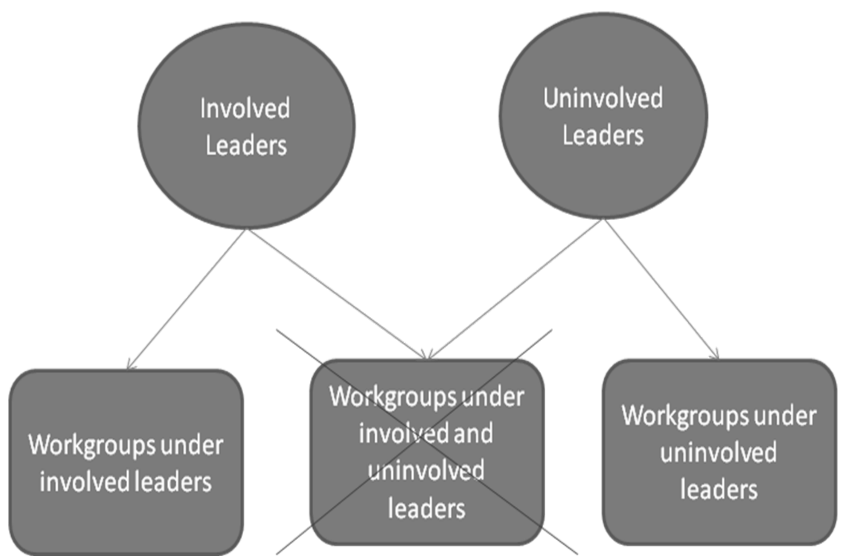


Figure 3.4-3: Leadership Breakdown

3.4.2.3 Data Analysis

This hypothesis tested whether two independent groups ('No' and 'Yes') differ from one another. Therefore, a 2-Sample T-test was chosen, as a means of analysis.

However, two assumptions needed to be tested before proceeding with the 2-Sample T-test. The following steps were taken when analyzing the results:

Step 1: Test assumption 1- two samples are randomly selected in an independent manner from two populations.

Participants individually responded to the questions through a web-based survey instrument provided by Survey Monkey. Surveys were also available as paper copies to those participants who preferred it that way. It is known that samples were independent of one another. A single participant's responses to the independent questions did not directly impact the responses of other participants' survey questions. Therefore the first assumption before proceeding with a 2-Sample T-test was satisfied.

Step 2: Test assumption 2 - the variances for the two distributions are equal.

Due to the significant difference between the total number of responses between the 'No' and 'Yes' groups, a preliminary evaluation for the assumption of equal variances was performed. As explained by Horsnell (1953), the assumption of equal variances is critical if the sample sizes are markedly different to compare variability and ensure valid results. Therefore, an assumption of equal variances hypothesis was elaborated for this step and the p-value was observed in order to make a decision:

Variances between 'No' and 'Yes' groups are equal:

$$H_0: \sigma_{yes} = \sigma_{no} \text{ versus } H_1: \sigma_{yes} \neq \sigma_{no}$$

Note: An assumption of equal variances test was established for each question or group of questions.

If the p-value resulted to be less than the alpha value, in this case 0.05, then, the null hypothesis H_0 was rejected. This meant the assumption of equal variances was rejected. Thus, when a 2-Sample T-test was performed, there was no assumption of equal variances.

Step 3: Completed a 2-Sample T-test.

After analyzing *Hypothesis 2.1* for each question in the survey, the 2-Sample T procedure was done. According to Walpole (2007), the 2-Sample T-test is used to determine if there is a significant difference between the means of two groups or if the observed difference is due instead to random chance. Since this hypothesis is testing if the 'Yes' and 'No' groups are different from each other, a two-tailed 2-Sample T-test hypothesis was elaborated for each question:

$$H_0: \mu_1 - \mu_2 = 0 \quad \text{versus} \quad H_1: \mu_1 - \mu_2 \neq 0$$

where μ_1 and μ_2 are the means of the responses for group 'Yes' and group 'No' respectively and 0 is the hypothesized difference between their means. An alpha value of 0.05 was also used during the testing of this hypothesis. Hence, if the p-value of a test resulted to be equal or less than the alpha value, it is considered to be statistically significant.

Step 4: Created box-plots for the graphical visualization of the group's responses for any rejected hypothesis.

This chapter explained how this study was conducted and why the different methods used were chosen. In chapter 5, the collected data will be analyzed. Even though, the adoption of systems improvement initiatives is assessed by questions under the *Systems Improvement* questionnaire section only, all questions in the survey were analyzed.

4 CHAPTER IV

FINDINGS

This study examined the relationships between characteristics of workgroups and their influence over the implementation of systems improvement initiatives. All PVAMC employees were surveyed over the period of two years (Spring 2011, Fall 2011, Spring 2012, and Fall 2012). This chapter presents the results of this study.

4.1 Workgroup Size Hypothesis Findings

In this section, a summary of the results will be provided. As stated in the methodology chapter, different steps were taken for the analysis of the workgroup size hypothesis:

Step 1: Developed an analysis of variance (ANOVA) table for the randomized complete blocks design (RCBD) using Minitab.

ANOVA tables for each question were produced to show the results of the RCBD statistical model. During this step, the adequacy of the model was also tested. A normality test was first done to determine if the response variables followed a normal distribution. A normal probability plot was created with Minitab to check on the normality of the data set. However, because surveys' responses were based on a Likert-scale, responses were not normally distributed - the graph in Figure 4.1-1 exhibits an S-shape distribution instead of a straight line distribution. For instance, a Likert-scale question with 5 or more possible answers cannot possibly possess a normal probability distribution. This is because the range of answers is discrete, not continuous (a participant was not allowed to answer 2.5 or 3.6) (Singh, 2010). Hence, the assumption for normality was not satisfied during the analysis of these Likert-scale surveys. However, histograms with frequency results of the questions were plotted showing a mound shaped as seen in Figure 4.1-2 which approximated the normal distribution of the responses (Singh, 2010).

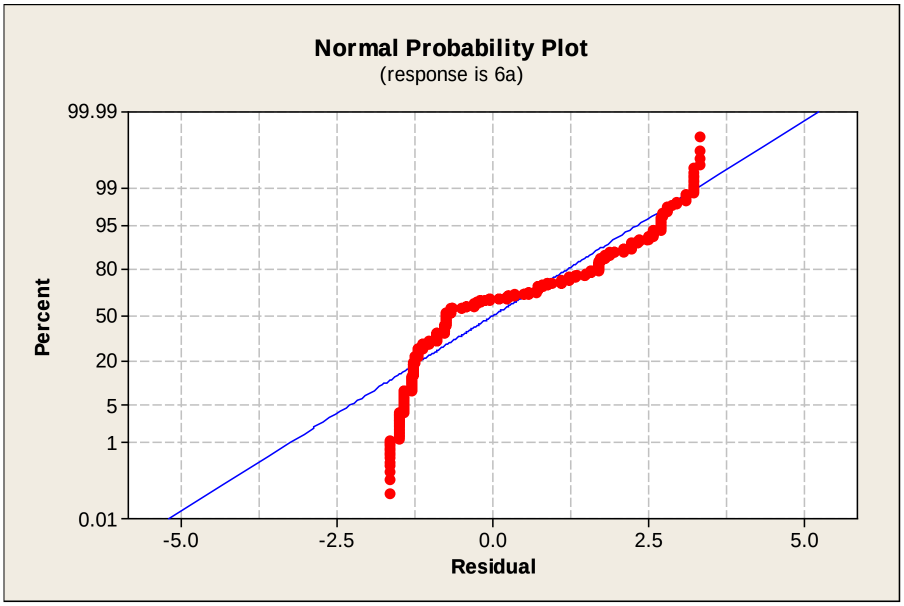


Figure 4.1-1: Normal Probability Plot of the residuals for Question 6a

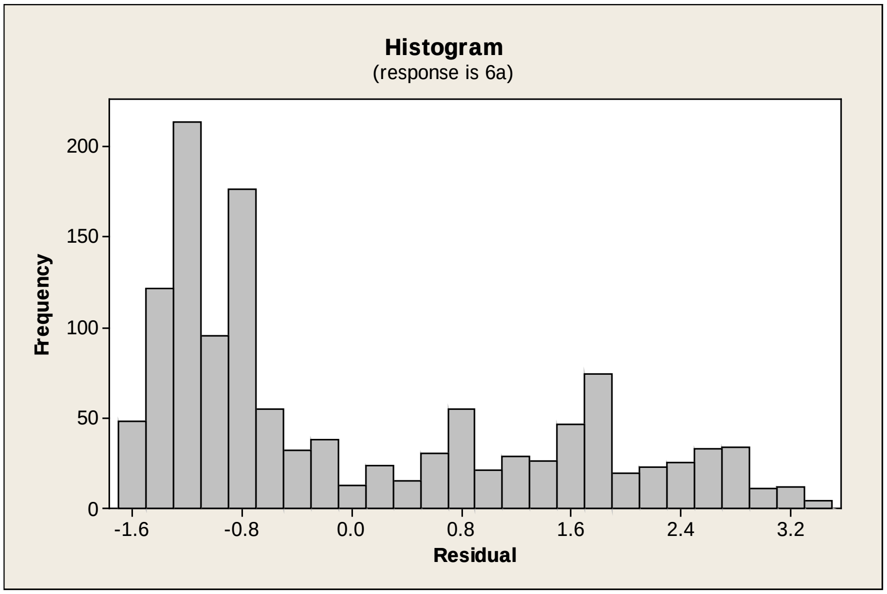


Figure 4.1-2: Histogram of the residuals for Question 6a

Residuals plots were also created to provide a "diagnostic that may detect violations of assumptions" (Walpole et al., 2007). In these plots, residuals are plotted separately for each treatment and for each block. Points in these plots should generally be scatter with no signs of patterns or outliers. In the case of the RCBD statistical model, this will indicate that constant variance assumptions are satisfied. An assumption of constant variance means that when individual errors are plotted against the predicted value, the variance of the error should be constant. Figures 4.1-3 and 4.1-4 did not show any sign of inequality of variance. Hence, this statistical model was valid and appropriate for the testing of this hypothesis. For a full view of the ANOVA results, please refer to APPENDIX B.

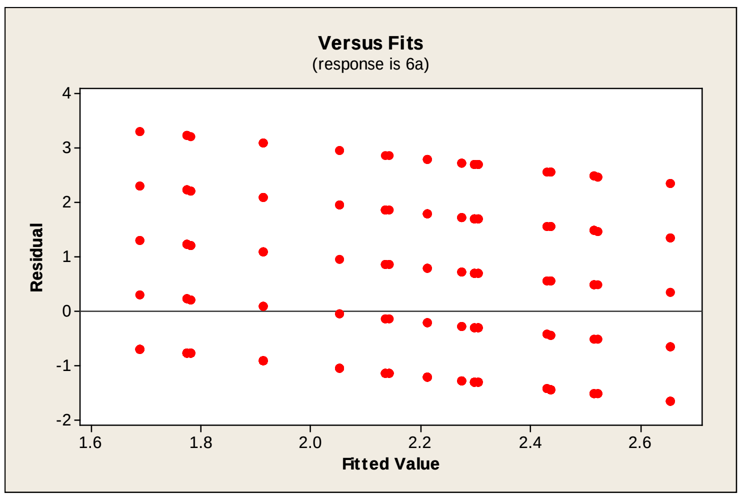


Figure 4.1-3: Plot of the residuals versus fitted values

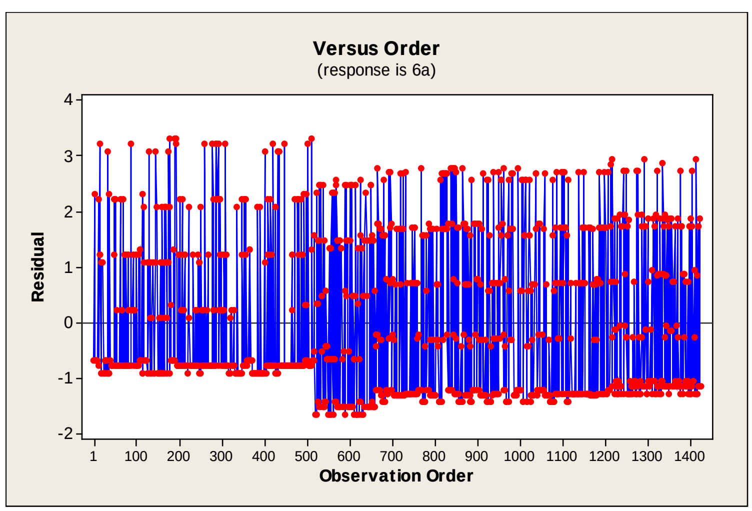


Figure 4.1-4: Plot of residuals versus observation order

<u>Step 2</u>: Extracted p-values from ANOVA table results and highlighted any rejected null hypothesis (H_0). Recall the hypotheses of interest:

Main effect (Survey Effect)	**Blocking effect (Workgroup Size Category Effect)**
H_0: $S_1 = S_2 = S_3 = S_4 = 0$	H_0: $W_1 = W_2 = W_3 = W_4 = 0$
H_1: At least $S_i \neq S_j$ for one pair of i, j;	H_1: At least $W_i \neq W_j$ for one pair of i, j;
Reject H_0 if p-value < α	Reject H_0 if p-value < α

Table 4.1-1: ANOVA's P-values for the RCBD of Hypothesis 1

Q#	Survey Response/Question	Main (Survey) P-Value	Block (Workgroup Size Category) P-Value
6a	been trained in at least one of the systems improvement techniques (Microsystems, Lean, PDSA, VA-TAMMCS).	***<u>0.000</u>***	0.299
6b	used PDSA or VA-TAMMCS tools in my work group.	***<u>0.000</u>***	0.210
6c	been involved in improvement projects or continuous improvement initiatives.	***<u>0.000</u>***	***<u>0.028</u>***
6d	incorporated continuous improvement into everyday work.	***<u>0.008</u>***	***<u>0.008</u>***
7	Response	***<u>0.000</u>***	***<u>0.044</u>***
8a	when unexpected problems arise during projects.	0.092	***<u>0.008</u>***
8b	when conflicts arise between team members.	***<u>0.003</u>***	***<u>0.000</u>***
8c	if meetings conflict with your regular job duties.	***<u>0.042</u>***	0.177
8d	when other employees are absent or leave the workgroup.	0.193	0.056
8e	if the project on which you are working concludes.	***<u>0.027</u>***	***<u>0.001</u>***
8f	if the systems improvement team is in need of a new leader.	0.053	***<u>0.003</u>***
8g	if you do not already have some of the necessary skills or training.	***<u>0.013</u>***	***<u>0.002</u>***
9a	It would take a lot of effort.	0.576	0.557
9b	My co-workers would not respect my involvement.	0.085	0.403
9c	It would not directly benefit me.	0.697	0.596
9d	I would enjoy learning new skills and applying them.	0.514	***<u>0.029</u>***
9e	My job would become easier in the future.	0.333	0.171
9f	My work group would share information with other work groups.	0.467	0.180
9g	Veteran care and patient safety would improve.	0.199	0.800
9h	Employee turnover would go down.	0.913	0.421

9i	It would be difficult to continue improving after initial gains.	0.400	0.448
9j	My job satisfaction would increase.	0.928	***0.048***
9k	It would be difficult to get other people involved.	0.935	0.323
9l	I would not have time for my other job duties.	0.312	0.913
9m	The ideas I work on might never be implemented or acted on.	0.774	0.635
9n	I would not be sufficiently recognized or rewarded for my involvement.	0.560	0.235
9o	The quality of work my work group produced for others would improve.	0.940	0.072
9p	I would have better procedures for handling problems.	0.502	0.519
10a	My supervisor has helped me to rethink the way I do things.	0.188	0.259
10c	Management is taking necessary improvement actions based on survey feedback from employees.	***0.001***	0.489
10d	Facility leaders are strongly committed to systems improvement.	***0.000***	0.355
10f	My immediate supervisor(s) establishes forums for and provides time and resources for participating in quality improvement activities.	***0.013***	0.069
12d	In this work group, there is time to reflect on how well our processes work for providing patient care.	***0.000***	0.617
12h	Until there is a situation of emergency, nothing is changed or improved.	***0.000***	0.189
12j	Changes are made without talking to the people involved in those processes.	***0.000***	0.199
13a	I have adequate information regarding the improvement projects in my work group.	***0.000***	***0.023***
13b	I understand how systems improvement can benefit patient care.	***0.000***	0.207
13c	I am comfortable with the way that I accomplish my daily tasks.	***0.000***	0.399
13f	I am willing to change the way I work, if it improves the outcomes.	***0.000***	0.884
13g	Employee ideas should be shared with supervisors to help improve the work.	***0.000***	0.971
13h	Systems improvement is important for this facility to cost effectively serve veterans.	***0.000***	0.772
16e	How satisfied are you with the cooperation your fellow employees provide for improvement projects?	0.685	0.480

Note: Italic, bolded and underlined p-values correspond to the rejected hypothesis.

As seen in Table 4.1-1, using $\alpha = 0.05$, it was concluded that the main factor (surveys) affected the responses for 21 out of the 42 questions. As explained in Section 3.4.1.3, these results were expected as different improvement initiatives were being implemented during the elapsed time between each treatment. However, since this study focuses on the effect of the blocking factor (workgroup size category) in the responses, a Tukey comparison test was performed along with the creation of box-plots for the 11 out of the 42 rejections of the hypotheses corresponding to the main factor.

Step 3: Tukey test and Box-plots

As explained in Section 3.5.1.1, even though the ANOVA results provide sufficient evidence that the means of the main factor differ from one another, these results cannot give a certainty of which workgroup size categories in fact differ from one another. For this reason, the Tukey test results along with the creation of box-plots were used for a clear interpretation of any rejected hypotheses shown in Table 4.1-1. Figure 4.1-5 shows an explanation of the Tukey results output as well as the definitions of the Box-plot used during this analysis.

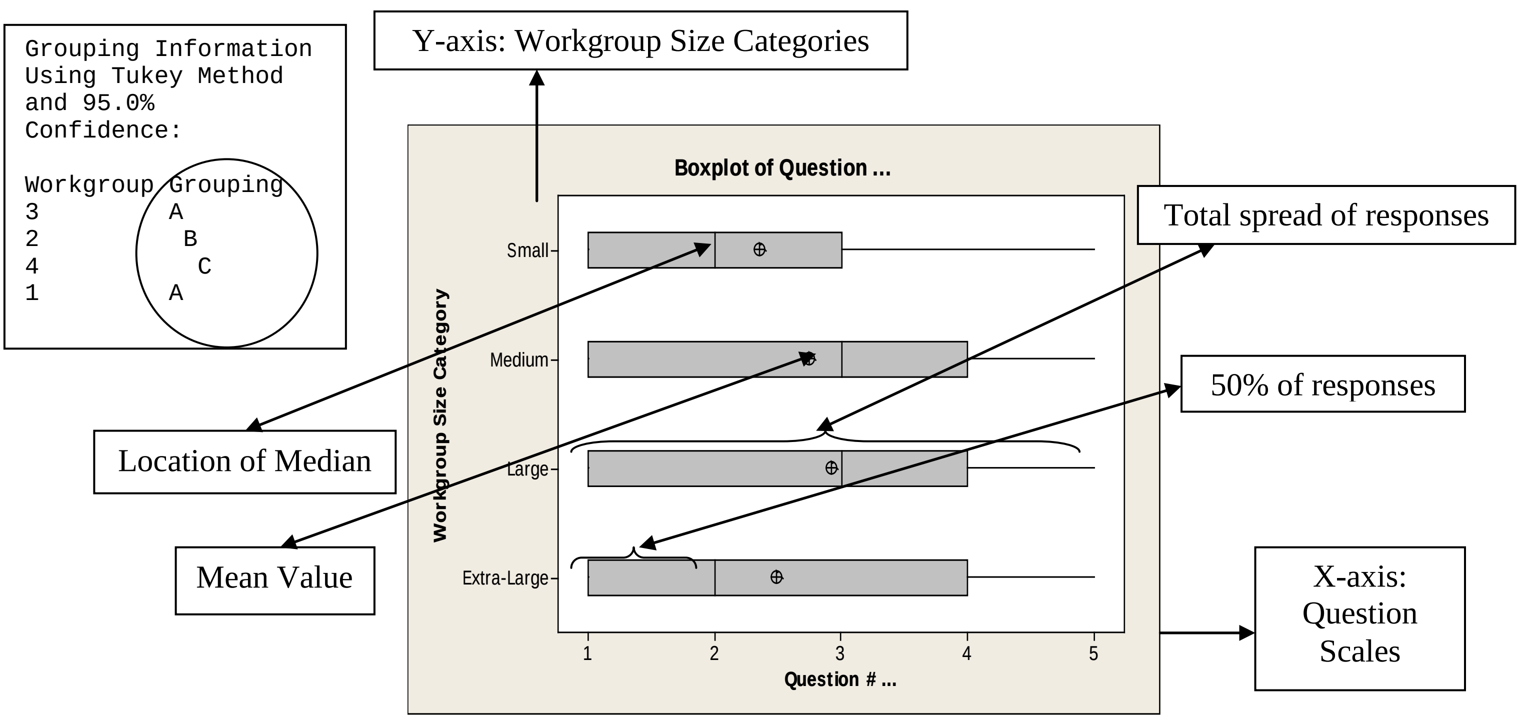


Figure 4.1-5: Minitab's Tukey and Box-plot Outputs

In the following, detailed analysis of the rejected hypotheses shown in Table 4.1-1 will be provided. The turkey grouping and the graphical view of the responses as well as a detailed explanation will be given

<u>Rejected Question 6c:</u> At this point in time, how much have you been involved in improvement projects or continuous improvement initiatives? Coded Scales: ‘1’-Not at all, ‘2’-Slighlty, ‘3’-Somewhat, ‘4’- Moderately, ‘5’- Completely.

Tukey’s grouping results for the blocking factor show a difference between large (3) and small (1) workgroups as they do not share the same letter (A vs. B). As seen in Figure 4.1-6, the spread of responses for all workgroup size categories ranged on a scale from 1-5. However, the location of the median and mean for the small workgroups greatly differs from the other workgroup’s location of medians and means placing itself at scale 2 compare to scale 3. Based on the Tukey results and location of the means, it can be concluded that large workgroups are more involved in improvement projects or continuous improvement initiatives than small workgroups.

Grouping Information Using Tukey Method and 95.0% Confidence

Workgroup Size Category	N	Mean	Grouping
3	286	3.049	A
2	345	2.959	A B
4	419	2.845	A B
1	215	2.671	B

Means that do not share a letter are significantly different.

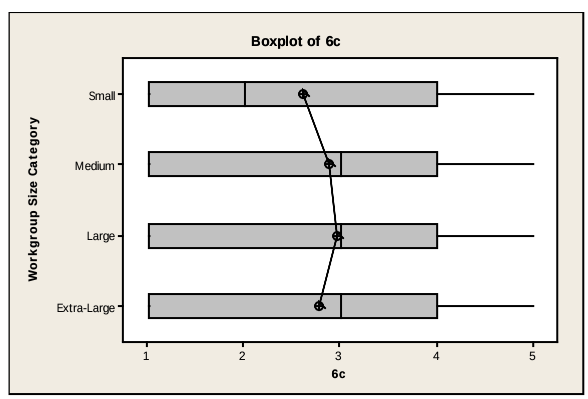


Figure 4.1-6: Box-plots for Question 6c

Rejected Question 6d: At this point in time, how much have you incorporated continuous improvement into everyday work? Coded Scales: '1'-Not at all, '2'-Slighlty, '3'-Somewhat, '4'- Moderately, '5'- Completely.

Tukey's grouping results of the blocking factor for Question 6d shows a difference between large (3) and small (1) workgroups (A vs. B) as well as large (3) and extra-large (4) workgroups (A vs. B). As seen in Figure 4.1-7, all workgroups show a similar spread of data ranging from scales 1-5. The mean location of the large workgroups also differs from the rest placing itself at the highest mean scale. According to these results, large workgroups have incorporated more continuous improvement into everyday work than medium, extra-large and small workgroups.

Grouping Information Using Tukey Method and 95.0% Confidence

Workgroup Size Category	N	Mean	Grouping
3	283	3.497	A
2	344	3.276	A B
4	416	3.164	B
1	212	3.120	B

Means that do not share a letter are significantly different.

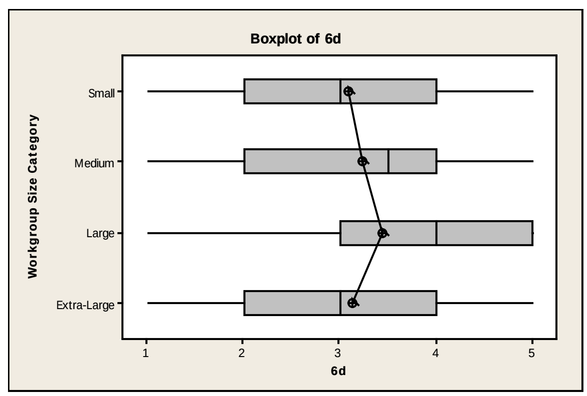


Figure 4.1-7: Box-plots for Question 6d

Rejected Question 7: Considering that being involved in systems improvement can include both specific improvement projects and everyday continuous improvement, are you involved in systems improvement? Coded Scales: '1'-No, I do not intend to in the next 6 months, '2'- No, but I intend to in the next 60 days, '3'- No, but I intend to in the next 30 days, '4'- Yes, I have been, but for less than 6 months, '5'- Yes I have been for more than 6 months.

Tukey’s results show a difference between large (3) and small (1) workgroups as they do not share the same letter (A vs. B). Figure 4.1-8 shows the same spread of responses for all workgroups ranging from scales 1-5 with a median location at scale 4. However, most of the responses for large workgroups ranged from scales 2-5 compared to scales 1-5 for small, medium, and extra-large workgroups. According to these results, large workgroups have been more involved in systems improvement initiatives than rest of the workgroup size categories.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category     N   Mean  Grouping
3          284  3.624  A
4          422  3.376  A B
2          343  3.351  A B
1          209  3.203    B

Means that do not share a letter
are significantly different.
```

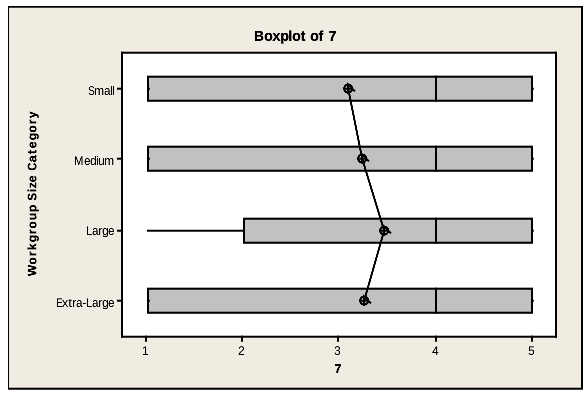


Figure 4.1-8: Box-plots for Question 7

Rejected Question 8a: How confident are you that you could begin to participate or continue to participate in systems improvement activities when unexpected problems arise during projects? Coded Scales: ‘1’- Not at all confident, ‘2’- Not very confident, ‘3’- Moderately confident, ‘4’- Very confident, ‘5’- Extremely confident.

Tukey’s comparison test results show a significant difference between large (3) and small (1) workgroups (A vs. B). Box-plots in Figure 4.1-9 shows the same spread of responses for all workgroups ranging from scales 2-5. Outliers are also seen in the spread of responses for all workgroup. However large workgroups show a fewer amount of outliers than the other workgroups. The means of the different workgroup size categories show a slightly different location on the box-plots. From these results, it can be concluded that large workgroups were more confident to begin to participate or continue to participate in systems improvement initiatives, even when unexpected results arise during projects, compared to the medium, extra-large, and small workgroups.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category     N   Mean  Grouping
3          265  3.549  A
2          324  3.482  A B
4          398  3.368  A B
1          198  3.241    B

Means that do not share a letter
are significantly different.
```

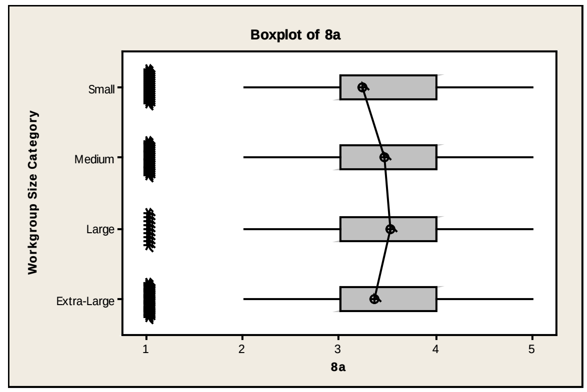


Figure 4.1-9: Box-plots for Question 8a

Rejected Question 8b: How confident are you that you could begin to participate or continue to participate in systems improvement activities when conflicts arise between team members? Coded Scales: ‘1’- Not at all confident, ‘2’- Not very confident, ‘3’- Moderately confident, ‘4’- Very confident, ‘5’- Extremely confident.

Tukey’s comparison test results for Question 8b show a significant difference between large (3) and extra-large (4) workgroups (A vs. B), large (3) and small (1) workgroups (A vs. B), medium (2) and extra-large (4) workgroups (A vs. B), and medium (2) and small (1) workgroups (A vs. B). Box-plots in Figure 4.1-10 show the same spread of responses for all workgroups ranging from 2-5, including outliers for all workgroups. However, large workgroups appeared to have fewer outliers than the rest of the workgroup size categories. In conclusion, according to the Tukey’s results and mean values, large and medium workgroups felt slightly more confident to begin to participate or continue participating in systems improvement initiatives, even when conflicts arise between team members, than small and extra-large workgroups.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category     N   Mean  Grouping
3          263  3.583  A
2          322  3.493  A
4          395  3.283    B
1          198  3.244    B

Means that do not share a letter
are significantly different.
```

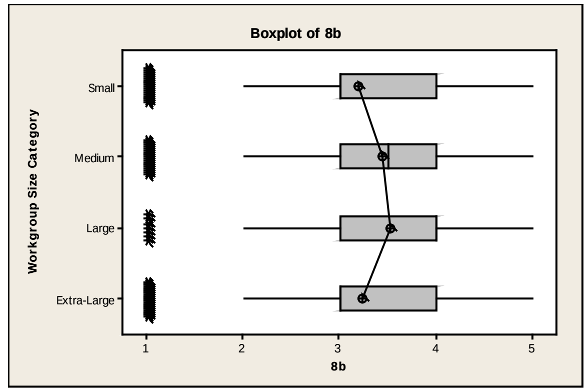


Figure 4.1-10: Box-plots for Question 8b

Rejected Question 8e: How confident are you that you could begin to participate or continue to participate in systems improvement activities if the project on which you are working concludes? Coded Scales: '1'- Not at all confident, '2'- Not very confident, '3'- Moderately confident, '4'- Very confident, '5'- Extremely confident.

Tukey's grouping results of the blocking factor for Question 8e show a significant difference between large (3) and small (1) workgroups (A vs. B) as well as large (3) and extra-large (4) workgroups (A vs. B). Figure 4.1-11 show a same spread of responses between all workgroups; expect that the large workgroups exhibit fewer outliers. According to the Tukey's results and the means for each workgroup size category, large workgroups revealed slightly more confidence to begin to participate or continue participating in systems improvement initiatives, even if the project on which they are working concludes, compared to the rest of the workgroup size categories.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category      N   Mean  Grouping
3           262  3.620  A
2           318  3.430  A B
4           393  3.318    B
1           196  3.312    B

Means that do not share a letter
are significantly different.
```

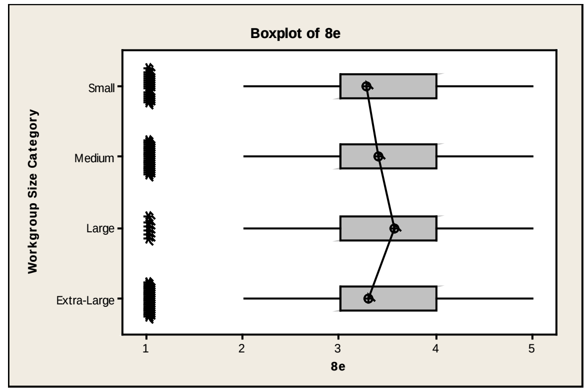


Figure 4.1-11: Box-plots for Question 8e

Rejected Question 8f: How confident are you that you could begin to participate or continue to participate in systems improvement activities if the systems improvement team is in need of a new leader? Coded Scales: '1'- Not at all confident, '2'- Not very confident, '3'- Moderately confident, '4'- Very confident, '5'- Extremely confident.

Tukey's grouping results of the blocking factor for Question 8f show a significant difference between large (3) and small (1) workgroups (A vs. B) as well as large (3) and extra-large (4) workgroups (A vs. B). Figure 4.1-12 show the same spread of responses ranging from scales 2-5 for medium and large workgroups, including outliers. On the hand, small and extra-large workgroups share the same spread of data ranging from scales 1-5. Most of the responses for medium and large workgroups ranged from scales 3-4 compared to 2-4 from small and extra-large workgroups. Box-plots for small and extra-large workgroups also share the same median location at the scale of 3. In summary, according to the location of the medians, spread of responses, mean values and length of the box-plots, it can be concluded that large workgroups followed by medium workgroups felt more confident to begin to participate or continue participating in systems improvement initiatives, even if the systems improvement team is in need of a new leader, than small and extra-large workgroups.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category      N   Mean  Grouping
3           263  3.397  A
2           322  3.268  A B
4           394  3.072    B
1           198  3.050    B

Means that do not share a letter
are significantly different.
```

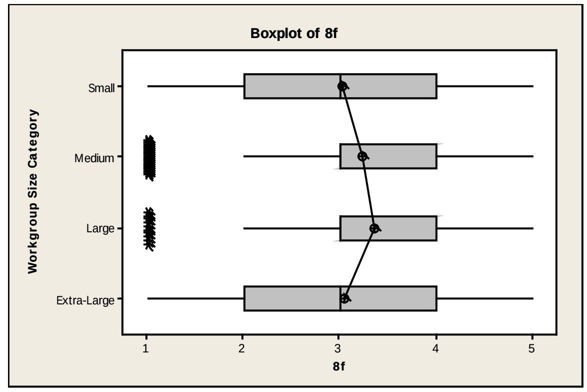


Figure 4.1-12: Box-plots for Question 8f

<u>Rejected Question 8g:</u> How confident are you that you could begin to participate or continue to participate in systems improvement activities if you do not already have some of the necessary skills or training? Coded Scales: ‘1’- Not at all confident, ‘2’- Not very confident, ‘3’- Moderately confident, ‘4’- Very confident, ‘5’- Extremely confident.

Tukey’s grouping results for Question 8g show a significant difference between large (3) and small (1) workgroups (A vs. B) as well as large (3) and extra-large (4) workgroups (A vs. B). Figure 4.1-13 show the same spread of responses (from scales 2-5) for medium and large workgroups, including outliers. On the hand, small and extra-large workgroups share the same spread of data ranging from scales 1-5 with a median location at scale 3. Most of the responses for medium and large workgroups ranged from scales 3-4 compared to 2-4 from small and extra-large workgroups. In conclusion, large workgroups followed by medium workgroups felt more confident to begin to participate or continue participating in systems improvement initiatives, even if they do not already have some of the necessary skills or training, compared to small and extra-large workgroups.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category     N   Mean  Grouping
3          264  3.279  A
2          316  3.176  A B
1          198  3.017    B
4          394  2.993    B

Means that do not share a letter
are significantly different.
```

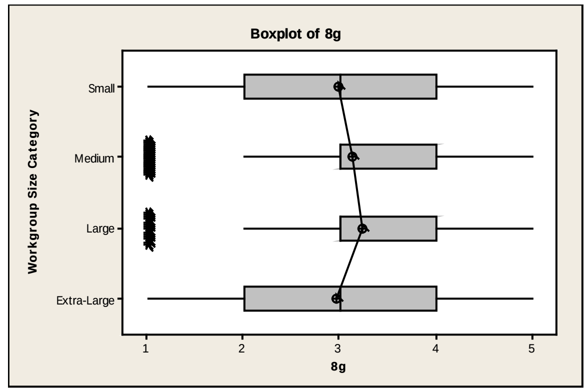


Figure 4.1-13: Box-plots for Question 8g

<u>Rejected Question 9d:</u> How important is the following reason in your decision of whether or not to participate in systems improvement activities: I would enjoy learning new skills and applying them. Coded Scales: ‘1’- Not at all important, ‘2’- Somewhat important, ‘3’- Moderately important, ‘4’- Very important, ‘5’- Extremely important.

Tukey’s comparison test results show a significant difference between large (3) and small (1) workgroups (A vs. B). Box-plots in Figure 4.1-14 exhibit a clear difference between small workgroups and the rest of the workgroup size categories. The spread of responses for small workgroups ranged from scales 2-5 compared to 1-5 from the rest of the workgroup size categories. Although small workgroups show some outliers at scale 1, these do not affect the conclusion since they cannot be compared to most of the responses for all other workgroup size categories. However, box-plots results show that learning new skills and applying them is a very important reason which could influence the participation in systems improvement initiatives for most of the workgroup size categories.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category      N   Mean  Grouping
3           252  3.841  A
2           306  3.771  A B
4           381  3.753  A B
1           189  3.553    B

Means that do not share a letter
are significantly different.
```

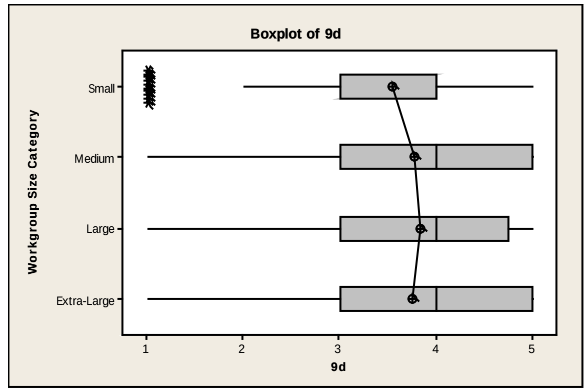


Figure 4.1-14: Box-plots for Question 9d

Rejected Question 9j: How important is the following reason in your decision of whether or not to participate in systems improvement activities: My job satisfaction would increase. Coded Scales: ‘1’- Not at all important, ‘2’- Somewhat important, ‘3’- Moderately important, ‘4’- Very important, ‘5’- Extremely important.

Although the p-value extracted from ANOVA table resulted to be less than α for Question 9j, results from the Tukey comparison test did not show a significant difference between workgroup size categories. Box-plots in Figure 4.1-15 exhibit a clear difference in the spread of responses between small workgroups and the rest of the workgroup size categories. Although small workgroups show some outliers at the scale of 1, these do not affect the conclusion since they cannot be compared to most of the responses for all other workgroup size categories. According to the box-plots, job satisfaction is a very important reason for all workgroups size categories to decide whether or not to participate in systems improvement initiatives. However, medium, large, and extra-large workgroups show a slightly high rating of importance than small workgroups.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category      N   Mean  Grouping
4           382  3.896  A
2           305  3.774  A
1           189  3.688  A
3           253  3.682  A

Means that do not share a letter
are significantly different.
```

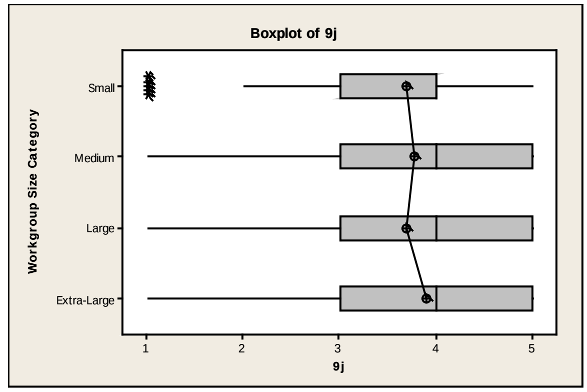


Figure 4.1-15: Box-plots for Question 9j

<u>Question 13a</u>: Please indicate how much you agree or disagree with the following statements: I have adequate information regarding the improvement projects in my workgroup. Coded Scales: ‘1’- Strongly disagree, ‘2’- Disagree, ‘3’- Neutral, ‘4’- Agree, ‘5’- Strongly agree.

Tukey’s comparison test results show a significant difference between medium (2) and small (1) workgroups (A vs. B). Box-plots in Figure 4.1-16 exhibit a difference in the spread of responses: small and extra-large workgroups have the same spread of responses between scales 2-4 with a median location at scale 3 while medium and large workgroups have the same spread of responses between scales 3-4 with outliers at scale 1. Although medium and large workgroups show some outliers at the scale of 1, these do not affect the conclusion since they cannot compared to the most of the responses of small and extra-large workgroups. From these results, it can be concluded that medium and large workgroups have more information about the improvement projects that go on in their workgroup compare to small and extra-large workgroups.

```
Grouping Information Using Tukey
Method and 95.0% Confidence

Workgroup
Size
Category     N   Mean  Grouping
2          292  3.292  A
4          375  3.160  A B
3          247  3.127  A B
1          187  2.977    B

Means that do not share a letter
are significantly different.
```

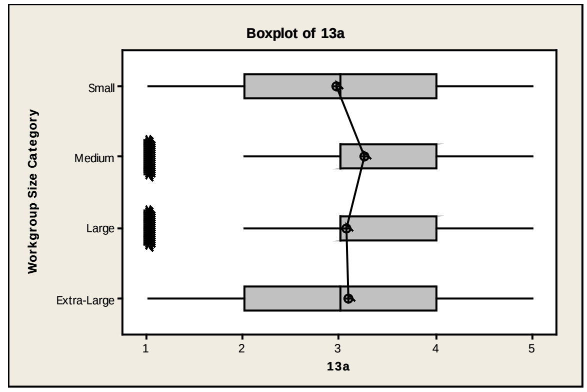


Figure 4.1-16: Box-plots for Question 13a

Sources of error for Workgroup Size hypothesis

Factors which could have influenced the error factor for this hypothesis are: the availability of the sample, as well as the response rate. For instance, survey data collection over the course of the two year survey period increases the risk of not getting participants from the same workgroup to respond to all four surveys. In fact, we can prove that the number of employees for each workgroup who answered the first survey did not remain the same throughout time. This is due to the fact that employees within workgroups may have been recruited, hired, promoted, or transferred. Also, different employees elected to complete the survey each time. Hence, these factors created a possibility of measurement error.

As explained in Section 2.7, as a self-report survey, there are many possible issues that could lead to questioning the validity of the data collected. For instance, research has revealed a tendency for participants in a survey to answer questions in a socially desirable way (Hadaway et. al, 1993). Hence, another potential source of error with this hypothesis is employees may have answered questions in a positive way due to a feeling of intervention on behalf of the organization's request to complete the survey.

4.2 Leadership Hypothesis Findings

In this section, a summary of the results will be provided. As stated in the methodology chapter, different steps were taken for the analysis of the leadership hypothesis:

<u>Step 1:</u> Performed an assumption for equal variances test.

An assumption of variances test was done before the 2-sample T-test procedure. The Table 4.2-1 exhibits the p-values collected from Minitab in order to reject or not the null hypotheses for equal variances:

$$H_0: \sigma_{yes} = \sigma_{no} \text{ versus } H_1: \sigma_{yes} \neq \sigma_{no}$$

Table 4.2-1: P-values for the Assumption of Equal Variances Test

Q. No	Spring 2011 P-value	Fall 2011 P-value	Spring 2012 P-value	Fall 2012 P-value
6a	0.072	Identical	0.570	***0.000***
6b	0.207	Identical	0.609	***0.000***
6c	0.359	0.435	0.909	0.237
6d	0.502	0.689	0.780	0.941
7	0.264	0.632	0.351	0.971
8a	***0.040***	0.428	0.231	0.078
8b	0.052	0.897	0.051	0.073
8c	0.060	0.322	0.479	0.328
8d	0.248	0.596	0.028	0.545
8e	0.196	0.686	***0.831***	0.157
8f	0.165	0.677	0.340	0.198
8g	0.067	0.963	0.444	0.978
9a	0.249	0.508	0.977	0.196
9b	0.187	0.144	0.627	0.478
9c	0.243	0.967	0.322	***0.041***
9d	0.179	0.648	***0.048***	0.202
9e	0.188	0.983	0.389	0.394
9f	0.984	0.55	0.000	0.150
9g	0.482	0.826	0.296	0.277
9h	0.424	0.486	0.802	0.915
9i	0.630	0.907	***0.040***	0.095

Q. No	Spring 2011 P-value	Fall 2011 P-value	Spring 2012 P-value	Fall 2012 P-value
9j	0.609	0.556	0.040	0.420
9k	***0.007***	0.982	0.881	0.226
9l	0.059	0.818	0.671	0.212
9m	0.473	0.539	0.856	0.923
9n	0.486	0.584	0.509	0.715
9o	0.413	0.573	0.094	0.496
9p	0.557	0.63	***0.037***	0.937
10a	0.457	0.819	0.848	0.968
10c	0.430	0.692	0.443	0.067
10d	0.132	0.313	0.733	0.972
10f	0.537	0.484	0.874	0.523
12d	0.730	0.897	0.061	0.715
12h	0.892	0.537	0.201	0.348
12j	0.726	0.55	0.583	0.186
13a	0.656	0.283	0.765	0.844
13b	0.738	0.586	0.226	0.308
13c	0.746	0.651	0.055	0.475
13f	0.200	0.839	***0.000***	0.210
13g	0.655	0.905	***0.010***	0.849
13h	0.463	0.77	***0.026***	0.754
16e	0.176	0.773	0.078	0.674

Note: Italic, bolded and underlined p-values correspond to the rejected hypothesis.

Step 2: Completed a 2-Sample T-test.

Once results for the equal variances test were found, an equal assumption of variances was considered for any of the hypotheses that were not rejected. The 2-Sample T-test was then performed to test whether there is a difference between the 'Yes' group - employees that fall under a leadership involved in systems improvement initiatives and 'No' group-employees that fall under a leadership with no involvement in systems improvement initiatives. The following hypothesis was elaborated in order to determine if there is a significant difference between the means of each group:

$$H_0: \mu_0 - \mu_1 = 0 \quad \text{versus} \quad H_1: \mu_1 - \mu_2 \neq 0$$

Where μ_0 and μ_1 are the population means for 'Yes' and 'No respectively and 0 is the hypothesized difference between the two population means. For a full view of the 2-Sample T-test results, please refer to Appendix C. Table 4.2-2 exhibits the p-values obtained when testing the null hypotheses established for each question.

Table 4.2-2: P-values for the 2-Sample T-test

Q#	Survey Response/Question	Spring 2011 P-Value	Fall 2011 P-Value	Spring 2012 P-Value	Fall 2012 P-Value
6a	been trained in at least one of the systems improvement techniques (Microsystems, Lean, PDSA, VA-TAMMCS).	0.266	Identical	0.283	***0.003***
6b	used PDSA or VA-TAMMCS tools in my work group.	0.346	Identical	0.167	***0.002***
6c	been involved in improvement projects or continuous improvement initiatives.	0.803	0.847	0.110	***0.007***
6d	incorporated continuous improvement into everyday work.	0.770	0.786	0.982	0.282
7	Response	0.870	0.586	***0.038***	0.317
8a	when unexpected problems arise during projects.	0.815	0.285	0.997	0.304
8b	when conflicts arise between team members.	0.833	0.323	0.662	0.784
8c	if meetings conflict with your regular job duties.	0.789	0.494	0.741	0.746
8d	when other employees are absent or leave the workgroup.	0.467	0.361	0.962	0.515
8e	if the project on which you are working concludes.	0.784	0.463	0.390	0.395
8f	if the systems improvement team is in need of a new leader.	0.146	0.372	0.797	0.196

8g	if you do not already have some of the necessary skills or training.	0.091	0.974	0.589	0.227
9a	It would take a lot of effort.	0.221	0.245	0.575	0.210
9b	My co-workers would not respect my involvement.	0.153	0.113	0.969	0.353
9c	It would not directly benefit me.	0.249	0.392	0.510	0.239
9d	I would enjoy learning new skills and applying them.	0.542	0.366	0.583	0.188
9e	My job would become easier in the future.	0.055	0.977	0.351	0.270
9f	My work group would share information with other work groups.	0.424	0.463	0.578	0.765
9g	Veteran care and patient safety would improve.	0.465	0.283	0.475	0.665
9h	Employee turnover would go down.	0.295	***<u>0.021</u>***	0.561	0.751
9i	It would be difficult to continue improving after initial gains.	0.227	0.446	0.851	0.905
9j	My job satisfaction would increase.	0.779	0.131	0.133	0.550
9k	It would be difficult to get other people involved.	0.698	0.653	0.942	0.271
9l	I would not have time for my other job duties.	0.609	***<u>0.041</u>***	0.125	0.405
9m	The ideas I work on might never be implemented or acted on.	0.592	***<u>0.031</u>***	0.075	0.341
9n	I would not be sufficiently recognized or rewarded for my involvement.	0.622	0.224	0.212	0.751
9o	The quality of work my work group produced for others would improve.	0.374	0.465	0.277	0.510
9p	I would have better procedures for handling problems.	0.786	0.432	0.227	0.223
10a	My supervisor has helped me to rethink the way I do things.	0.200	0.725	0.913	0.601
10c	Management is taking necessary improvement actions based on survey feedback from employees.	0.141	0.403	0.324	0.491
10d	Facility leaders are strongly committed to systems improvement.	0.922	0.782	0.963	0.557
10f	My immediate supervisor(s) establishes forums for and provides time and resources for participating in quality improvement activities.	0.108	0.658	0.862	0.811
12d	In this work group, there is time to reflect on how well our processes work for providing patient care.	0.890	0.533	0.890	0.452
12h	Until there is a situation of emergency, nothing is changed or improved.	0.410	0.319	0.363	0.423
12j	Changes are made without talking to the people involved in those processes.	0.603	0.247	0.483	0.285
13a	I have adequate information regarding the improvement projects in my work group.	0.352	0.761	0.454	0.602
13b	I understand how systems improvement can benefit patient care.	0.139	0.579	0.706	0.831
13c	I am comfortable with the way that I accomplish my daily tasks.	0.613	0.267	0.310	0.793
13f	I am willing to change the way I work, if it improves the outcomes.	***<u>0.026</u>***	0.975	0.551	0.617
13g	Employee ideas should be shared with supervisors to help improve the work.	0.519	0.589	0.092	0.962
13h	Systems improvement is important for this facility to cost effectively serve veterans.	0.156	0.853	0.173	0.639
16e	How satisfied are you with the cooperation your fellow employees provide for improvement projects?	0.445	0.612	0.673	0.168

Note: Italic, bolded and underlined p-values correspond to the rejected hypothesis.

Step 3: Created box-plots for a graphical visualization of the distribution for each of the group's responses of any rejected hypothesis.

Rejected Question 6a: At this point in time, how much have you been trained in at least one of the systems improvement techniques (Microsystems, Lean, PDSA, VA-TAMMCS)? Coded Scales: '1'-Not at all, '2'-Slighlty, '3'-Somewhat, '4'- Moderately, '5'- Completely.

From the box-plots seen in Figure 4.2-1, a significant difference between the spread of responses between the 'Uninvolved' and 'Involved' groups can clearly be seen. However, the median location for both groups is shown at the scale of 1. Based on the spread of responses, it can be concluded that most workgroup under an involved leadership have been trained in at least one of the systems improvement techniques. On the other hand, most workgroups under a leadership who is not involved in systems improvement initiatives have not been trained at all in systems improvement techniques.

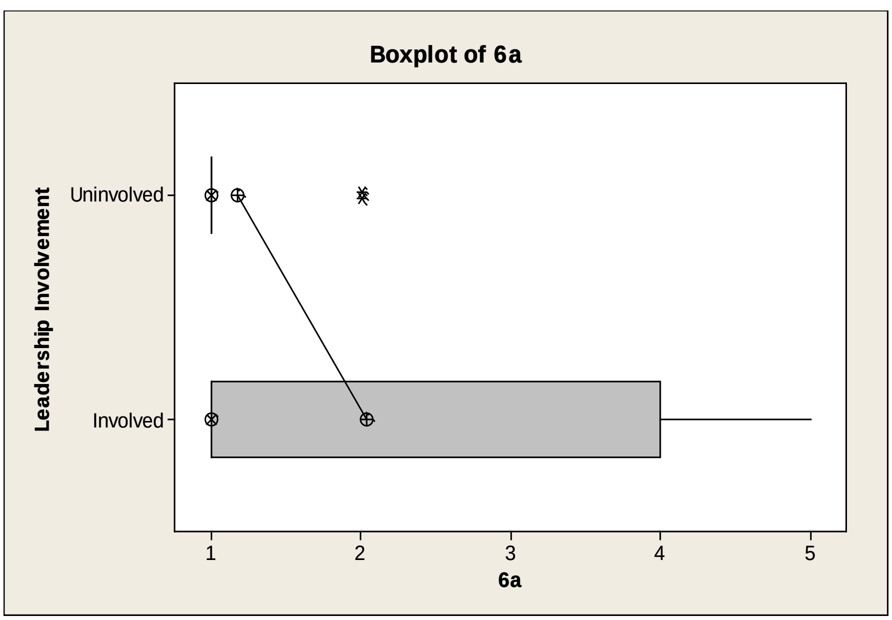


Figure 4.2-1: Box-plots for Question 6a

Rejected Question 6b: At this point in time, how much have you used PDSA or VA-TAMMCS tools in my workgroup? Coded Scales: '1'-Not at all, '2'-Slighlty, '3'-Somewhat, '4'- Moderately, '5'- Completely.

Box-plots seen in Figure 4.2-2 are very similar to the box-plots in Figure 4.2-2. A clear significant difference between the spread of responses between the 'Uninvolved' and 'Involved' groups can be seen. The mean location for both groups is also different from one another. Based on the spread of responses, it can be concluded that most workgroups under an involved leadership have used more of the PDSA or VA-TAMMCS tools than most workgroups under a leadership who is not involved in systems improvement initiatives.

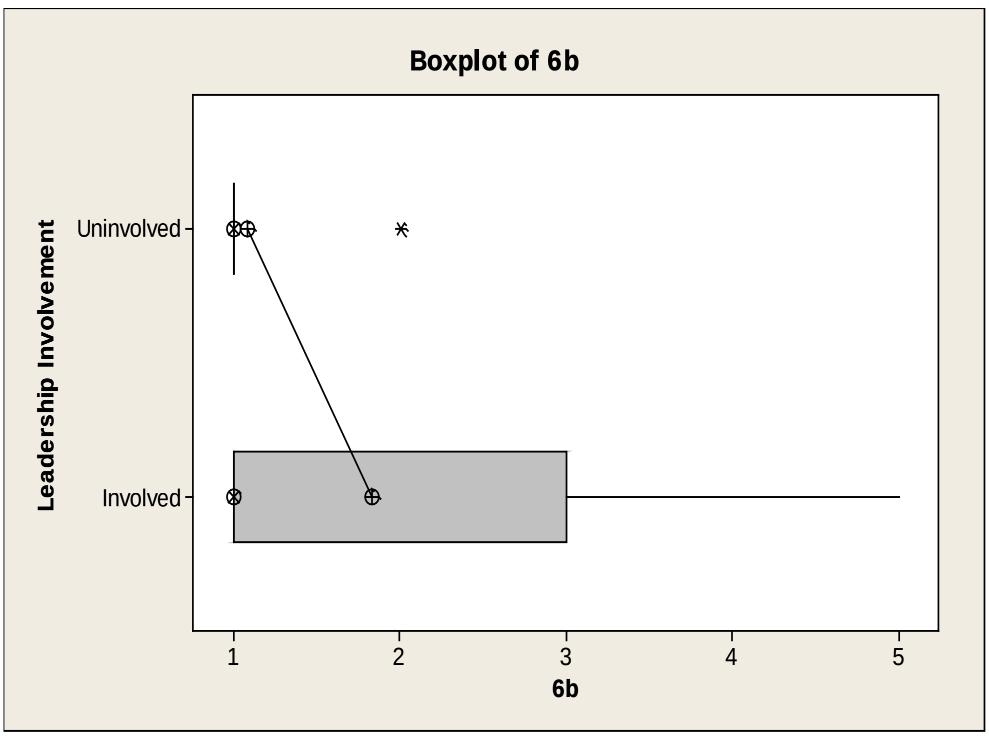


Figure 4.2-2: Box-plots for Question 6b

Rejected Question 6c: At this point in time, how much have you been involved in improvement projects or continuous improvement initiatives? Coded Scales: ‘1’-Not at all, ‘2’-Slighlty, ‘3’-Somewhat, ‘4’- Moderately, ‘5’- Completely. The responses for the ‘Uninvolved’ and ‘Involved’ groups, as seen in Figure 4.2-3, show a difference in their spread. Most of the responses for workgroups under the ‘No’ leadership approximately ranged from scales 1-3 while most of the responses for workgroups under the ‘Yes’ leadership ranged from 2-4. Based on the mean location, it can be concluded that workgroups under an involved leadership have been more involved in improvement projects or continuous improvement projects than workgroups under a leadership who is not involved in systems improvement initiatives.

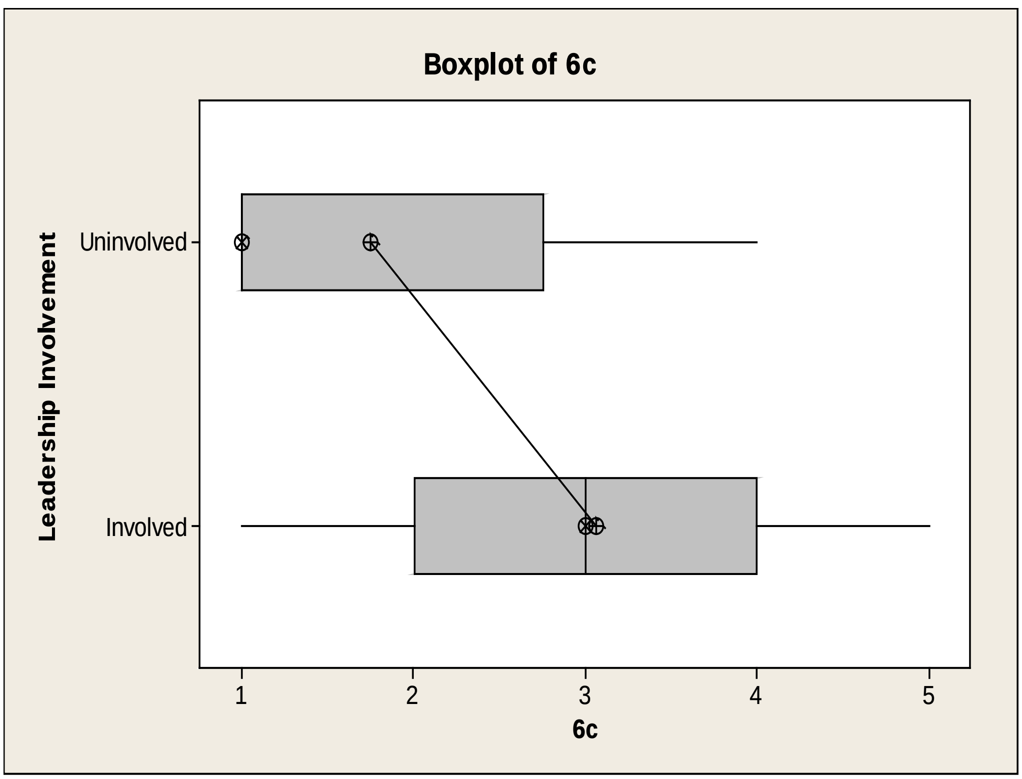


Figure 4.2-3: Box-plots for Question 6c

Rejected Question 7: Considering that being involved in systems improvement can include both specific improvement projects and everyday continuous improvement, are you involved in systems improvement? Coded Scales: '1'-No, I do not intend to in the next 6 months, '2'- No, but I intend to in the next 60 days, '3'- No, but I intend to in the next 30 days, '4'- Yes, I have been, but for less than 6 months, '5'- Yes I have been for more than 6 months.

Based on the spread of data and mean location seen in the box-plots (Figure 4.2-4), it can be concluded that most workgroups under an involved leadership are moderately involved in improvement projects or everyday continuous improvement. On the other hand, most workgroups under a leadership who is not involved in systems improvement initiatives are not as involved in improvement initiatives as the workgroups who are under an involved leadership.

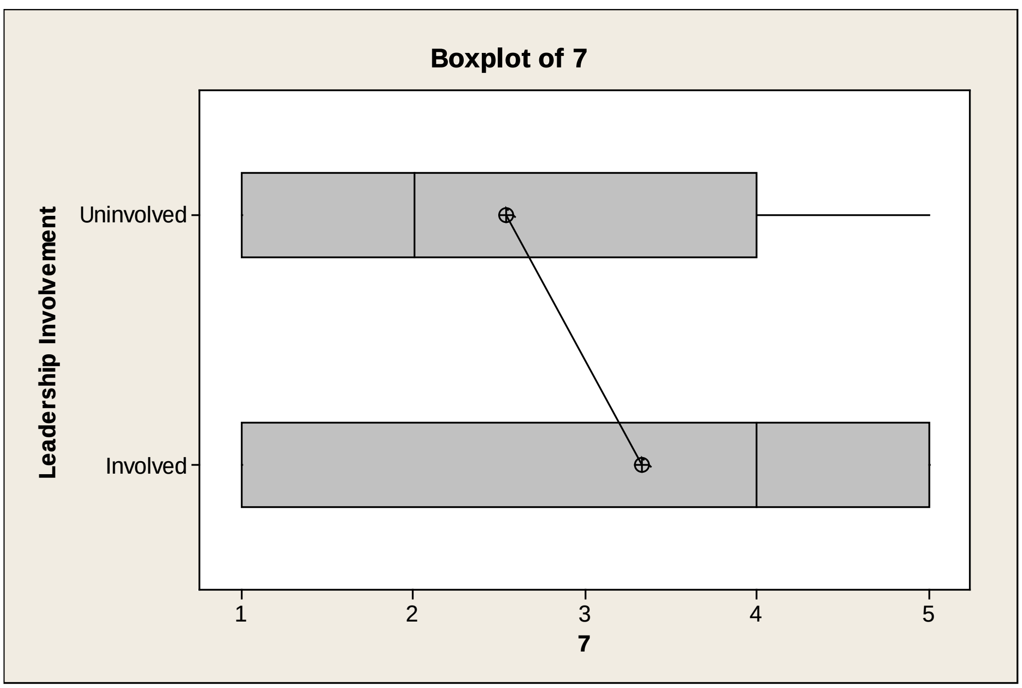


Figure 4.2-4: Box-plots for Question 7

<u>Rejected Question 9h:</u> How important is the following reason in your decision of whether or not to participate in systems improvement initiatives? -Employee turnover would go down. Coded Scales: '1'- Not at all important, '2'- Somewhat important, '3'- Moderately important, '4'- Very important, '5'- Extremely important.

Results from Figure 4.2-5 show a significant difference between groups under the 'Involved' and 'Uninvolved' leadership categories. The spread of data for each group is very different as they do not overlap. Most of the responses for the 'Uninvolved' leadership fall in between scale 4-5 while most of the responses under the 'Involved' leadership fall in between scale 2-4. The spread of responses between the 'Uninvolved' and 'Involved' leadership also show a significant difference ranging from 3-5 and 1-5, respectively. It can be concluded that workgroups under an involved leadership believe the decision of whether or not to participate in systems improvement initiatives is in between somewhat important to very important if employee turnover was to go down. Conversely, employees under a leadership who is not involved in systems improvement initiatives believe the decision of whether or not to participate in systems improvement initiatives is in between very important and extremely important if employee turnover was to go down.

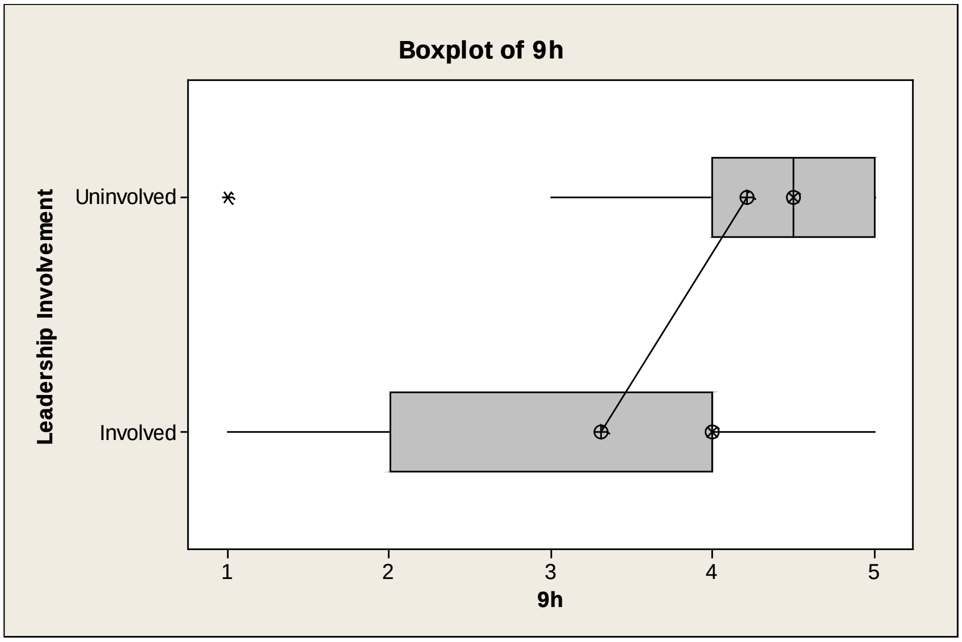


Figure 4.2-5: Box-plots for Question 9h

Rejected Question 9l: How important is the following reason in your decision of whether or not to participate in systems improvement initiatives? - I would not have time for my other job duties. Coded Scales: '1'- Not at all important, '2'- Somewhat important, '3'- Moderately important, '4'- Very important, '5'- Extremely important.

From Figure 4.2-6, the spread of data between the 'Uninvolved' and 'Involved' group overlap. The median location for the 'Uninvolved' group can be seen at the scale of 4 while the median location of the 'Involved' group is at scale 3. Based on the spread of responses and the location of the mean, it can be concluded that workgroups under leadership who are not involved in systems improvement initiatives feel the decision of whether or not to participate in systems improvement initiatives is very important if it implicates not having time to do other job duties. On the contrary, workgroups under an involved leadership believe the decision to whether or not to participate in systems improvement initiatives is moderately important if it implicates not having time to do other job duties.

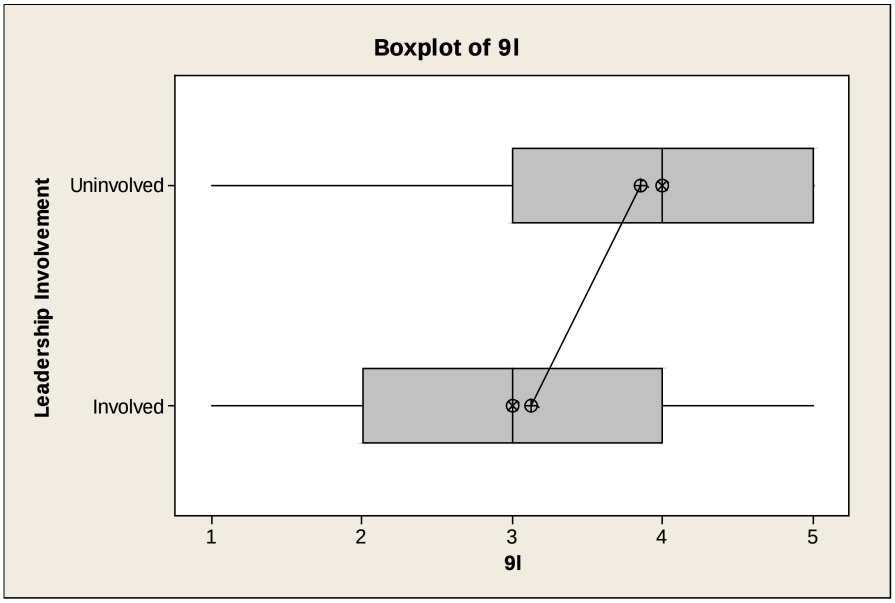


Figure 4.2-6: Box-plots for Question 9l

Rejected Question 9m: How important is the following reason in your decision of whether or not to participate in systems improvement initiatives? - The ideas I work on might never be implemented or acted on. Coded Scales: '1'- Not at all important, '2'- Somewhat important, '3'- Moderately important, '4'- Very important, '5'- Extremely important.

The box-plots in Figure 4.2-7 display a difference in the spread of responses between 'Involved' and 'Uninvolved' groups. Based on the spread of responses and mean location, most workgroups under an involved leadership believe the decision of whether or not to participate in systems improvement initiatives is moderately important if the ideas they work on might never get implemented or acted on. On the other hand, most workgroups under a leadership who is not involved in systems improvement initiatives believe the decision of whether or not to participate in systems improvement initiatives is very important if the ideas they work on might never get implemented or acted on.

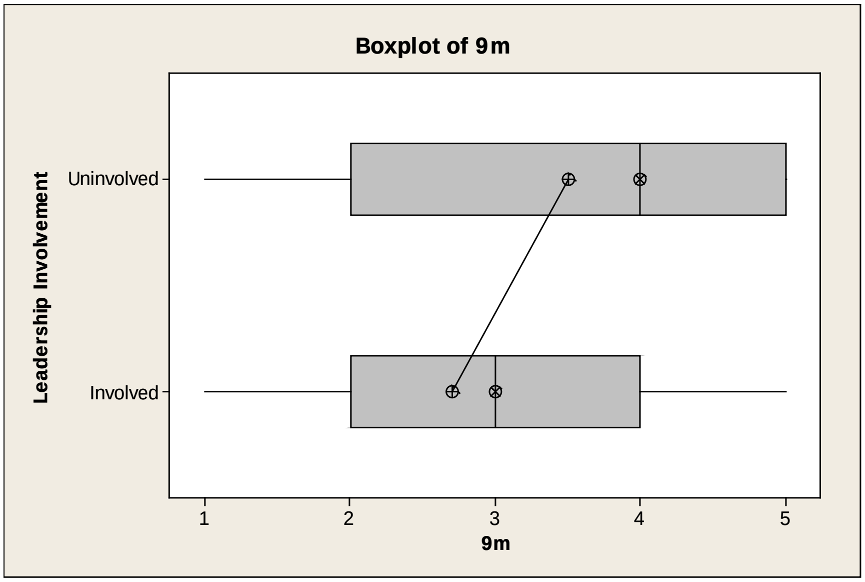


Figure 4.2-7: Box-plots for Question 9m

Rejected Question 13f: Please indicate how much you agree or disagree with the following statement: employee ideas should be shared with supervisors to help improve the work. Coded Scales: '1'- Strongly disagree, '2'- Disagree, '3'- Neutral, '4'- Agree, '5'- Strongly agree.

As seen in Figure 4.2-8, results from the 'Involved' group greatly differ from the 'Uninvolved' group. The spread of responses for the 'Uninvolved' group ranged from 1-1.5 while the spread of responses for the 'Involved' group ranged from 1-4. From the mean location of the 'Involved' group, it is clear that most workgroups under an involved leadership fairly agree that employee's ideas should be shared with supervisors to help improve the work. On the other hand, based on the mean, median location and the spread of data, most of the workgroups under an uninvolved leadership in systems improvement initiatives disagree with the statement that employee's ideas should be shared with supervisors to help improve the work.

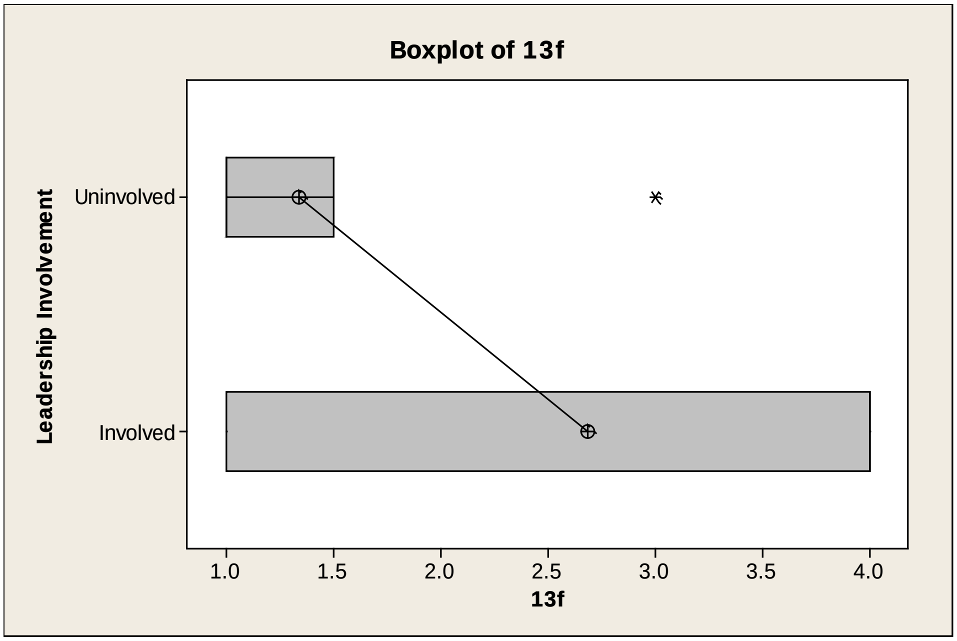


Figure 4.2-8: Box-plot for Question 13f

Sources of Error for Leadership Hypothesis

This study was based on a self-reported survey; there was no interference between the research team and the respondent. Thus, it is believable that respondents may have selected a supervisory level based upon their personal perspective, opinion, and in reference to the different tasks they perform on a daily basis and not their official title. On the other hand, the involvement of an employee in systems improvement initiatives tends to be less accurate due to self-reporting. It is known that employees try to work and improve every day by implementing different improvement initiatives or completing different improvement projects, but not necessarily like to communicate or track them. This could be due to different cultural factors which may include: lack of time for reporting, reluctance to talk about problems, perceived benefit for communicating projects, doing it, or no leadership expectation of communicating projects.

5 CHAPTER V

CONCLUSION

Transitional culture of change initiatives are complex for any organization in any industry. The successes in the automotive and manufacturing industries have served as an example in the adoption of Lean methodologies and tools in the healthcare industry. However, the process of revolutionizing and transforming the PVAMC culture to a Lean Healthcare culture is impacted by the readiness of employees as well as how they are being assisted and influenced by their leadership. With the PVAMC's organization structured around workgroups, the readiness of employees for adopting improvement initiatives could be influenced by characteristics of their workgroups. Hence, this study aimed to assess characteristics of workgroups which may be affecting the adoption of a Lean Culture at the PVAMC. This final chapter discusses and summarizes the findings and knowledge achieved from this study.

The method used to obtain results involved assessing two workgroup characteristics: size and leadership-involvement. The size characteristic was associated with the belief that different sizes of workgroups respond differently to the implementation of systems improvement initiatives. For instance, larger workgroups may struggle with areas of improvement or may experience difficulty in effective communication compared to smaller workgroups. Smaller workgroups may struggle with areas of improvement and must rely on fewer resources affecting their participation in systems improvement initiatives compared to larger workgroups. The leadership-involvement characteristic was primarily concerned with the effect of leaders on a workgroup's involvement in systems improvement initiatives. Results reported in this study provide a better understanding of how characteristics within healthcare workgroups can possibly influence the adoption of improvement initiatives.

There were 42 hypotheses related to workgroup size tested in this study, each of which consisted of a null hypothesis and an alternative hypothesis. Null hypotheses stated that the means of responses to the questions were all the same for all workgroup size categories. The alternative hypotheses stated that at least one of the means was different from the others. As seen in Section 4.1, 11 out of the 42 null hypotheses for the workgroup size hypothesis were rejected. These rejections lead to the conclusion that at least one of the workgroup size categories responded significantly different from the others. In order to discover which workgroup size category differed from the others, a Tukey comparison test was performed. Tukey's results revealed that out of the 11 rejected hypotheses, 9 of them reflected a significant difference between large and small workgroups. Moreover, in 9 out of the 11 rejected hypotheses, large workgroups placed on top with the most positive highest mean value while small workgroups placed last with the lowest negative mean value as seen in Table 5-1.

Table 5-1: Significant Results from the Workgroup Size Hypothesis Testing

Differences	Mean Responses	
	Small Workgroup	Large Workgroups
Involvement in improvement projects or continuous improvement initiatives	2.617	3.049
Incorporation of continuous improvement into everyday work	3.120	3.497
Confidence to begin or continue to participate in improvement activities	3.241	3.549

Results shown in Table 5-1 show that large workgroups are more involved in systems improvement initiatives and have more confidence when it comes to participating or continuing to participate in systems improvement initiatives compared to small workgroups. These findings are supported in the literature review which reflected that the size of a workgroup is positively related to productivity, effectiveness, performance, and employee involvement (Campion et al., 1993; Magjuka and Baldwin, 1991).

Recommendations include increasing the involvement of all workgroup size categories in systems improvement initiatives, and specifically targeting small workgroups. This could be done by (1) doing more training on systems improvement initiatives, (2) creating team building events to boost the confidence of small workgroups, (3) interviewing small workgroups to identify ways to increase participation in improvement initiatives, thereby capturing the voice of the small workgroups, (4) utilize staff from large workgroups to assist small workgroups, and (5) building protected time for improvement activities during the work schedule.

Results from the analysis of the leadership hypothesis displayed a rejection of 7 out of the 42 null hypotheses analyzed for each survey. The ANOVA table results for the 7 rejected hypotheses revealed significant mean differences between workgroups which were under leadership who were involved in systems improvement initiatives when compared to workgroups with uninvolved leadership. Leadership involvement in systems improvement initiatives was related to significantly higher or more positive scores across the largest number of scales used, as shown in Table 5-2.

Table 5-2: Significant Results from the Leadership Hypothesis Testing

Differences	Mean Responses	
	Uninvolved Leadership	**Involved Leadership**
Trained in at least one of the improvement techniques (Lean, PDSA, etc)	1.167	2.030
Involvement in improvement projects or continuous improvement initiatives	1.750	3.060
Employees ideas should be shared with supervisors to help improve the work	1.333	2.685

Results from Table 5-2 show a significant difference between the means of workgroups under an involved and uninvolved leader. Workgroups under an involved leadership have used systems improvement tools or have been trained in systems improvement techniques more than workgroups under an uninvolved leadership. Workgroups under an involved leadership are also more knowledgeable of the systems improvement techniques used at the PVAMC than those workgroups under an uninvolved leadership. Another important result shown when testing the leadership hypothesis was that workgroups under an involved leadership agreed that sharing ideas with supervisors is important in order to help improve the work. Hence, as supervisors are more involved in systems improvement initiatives, employee motivation to share ideas is increased. Such findings of the leadership hypothesis are supported by the literature review which shows that involvement and leadership within an organization can highly influence and encourage other employees to do the same (Manion, 2005; Parisi and Carew, 2000).

Recommendations include increasing the involvement of leaders who are not yet engaged in systems improvement initiatives by (1) getting the leadership into new habits and skills – especially targeted to improvement initiatives, (2) reviewing survey results with leaders to reinforce the importance of their involvement in improvement initiatives, (3) developing targeted training for leaders not fully engaged, (4) including 'participation improvement activities' in job description and performance review, and (5) evaluating candidates approaches to improvement initiatives during job interview.

Reflecting upon these findings of both hypotheses, the Systems Redesign program, as part of the Quality Management Department at the PVAMC, should consider the degree to which they expose and engage small workgroups into systems improvement initiatives. Additional attention should be paid to workgroups under an uninvolved leadership as they are not being provided with the encouragement or support they need to implement improvement initiatives that could potentially improve their day-to-day work.

Transformation of a healthcare organization's culture to a Lean healthcare culture is a difficult and complex process to undertake. This process has been undertaken in private healthcare organizations such as ThedaCare, Virginia Mason, and Baptist Healthcare and in government/public healthcare organizations including various VA Medical Centers, but is noted to take a long time for full implementation (Womack, 2005). Employees have been working at PVAMC for years with the culturally accepted mindset that how they are doing things right now is how things should be done – "this is the way it has always been done". However, with the introduction of Lean in healthcare at the PVAMC, many of the employees are adopting Lean techniques which create a more sustainable and continuously improving culture. With the knowledge gained from this study, the Systems Redesign Program will be able to further develop the systems improvement initiatives utilized at the PVAMC, based on workgroup characteristics. Thus, the PVAMC healthcare organization will become more effective in supporting employees as they improve the processes of daily patient care.

APPENDIX A: Disclosure Form for Research

Prov*idence VA Medical Center, 830 C*halkstone Avenue, Providence, RI 02908
Department of Mechanical, Industrial and Systems Engineering,
University of Rhode Island, 203 Wales Hall, Kingston RI 02881
Project Title: Assessing Climate for Systems Improvement Initiatives in Healthcare

DISCLOSURE FORM FOR RESEARCH

Description of the project: You are invited to take part in a study that deals with climate change and systems improvement initiatives in different healthcare settings. If you have questions please contact Associate Professor Valerie Maier-Speredelozzi at 401-874-5187. You must be at least 18 years old to take part in this research project.

What will be done: If you decide to take part in this study, you will be asked to complete surveys for research purposes approximately twice per year through the year 2013, in addition to the annual All Employees Survey. Each survey about systems improvement initiatives and workplace climate should take approximately 30 minutes.

Risks or discomfort, and decision to quit at any time: There is not any foreseeable risk or discomfort associated with the study. The decision to take part in this study is entirely voluntary and your employer will not know what you decide. Your responses will not be reported with your name or any identifying information other than your workgroup code. Combinations of demographic groups with less than 10 employees will not be identified. You may skip any question. If you decide to take part in the study, you may quit at any time.

Benefits of this study: Although there is no direct benefit to you for taking part in this study, the researcher may learn more about the ways that different hospital departments implement system redesign and problems that can occur. Thus, the research findings will benefit the hospital in general and may help to improve processes and patient care.

Confidentiality: Your participation in this study is confidential. None of the information will identify you by name. The researchers will not be able to access your email or IP address in Survey Monkey. You are encouraged to read the privacy agreement of Survey Monkey before participating. Data will be analyzed and kept on password protected computers in locked offices at the University of Rhode Island and in restricted folders at Providence VA Medical Center that are only accessible to the project investigators. Data will only be reported in aggregate, and any groups with less than 10 respondents will not be reported.

Rights and Complaints: If you are not satisfied with the way this study is performed, you may discuss your concerns with Associate Professor Valerie Maier-Speredelozzi at 401-874-5187, anonymously, if you choose. In addition, you may contact the office of the Vice President for Research, 70 Lower College Road, Suite 2, University of

Rhode Island, Kingston, Rhode Island, telephone: (401) 874-4328, or you may contact the VA Research Office at 401-273-7100 ext. 3066.

If you have read and understand this consent form, and now agree to participate in this study, please indicate your consent by clicking the button below to begin the survey.

If you prefer to complete the survey on paper, please print the attached file or call 401-874-5187 to request a paper copy. All completed surveys should be placed in a sealed envelope, marked “Systems Improvement Survey” and sent to mail code 00-SRC.

APPENDIX B: ANOVA Results (Workgroup Size Hypothesis)

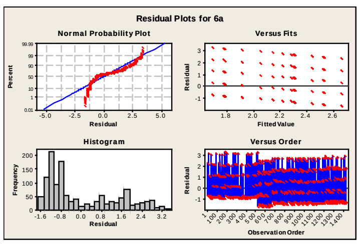
General Linear Model: 6a versus Survey, Workgroup Size Category

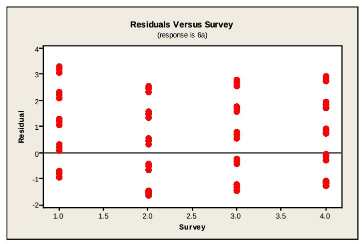
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

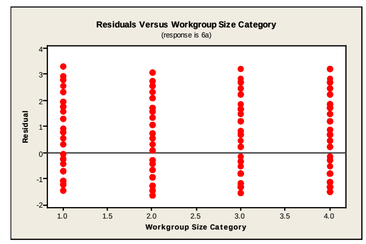
Analysis of Variance for 6a, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	87.596	89.987	29.996	15.14	0.000
Workgroup Size Category	3	7.292	7.292	2.431	1.23	0.299
Error	1265	2506.036	2506.036	1.981		
Total	1271	2600.924				

S = 1.40750   R-Sq = 3.65%   R-Sq(adj) = 3.19%







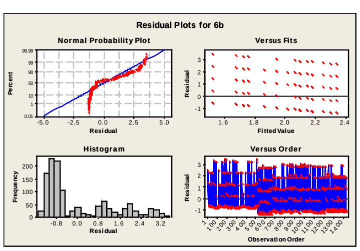
General Linear Model: 6b versus Survey, Workgroup Size Category

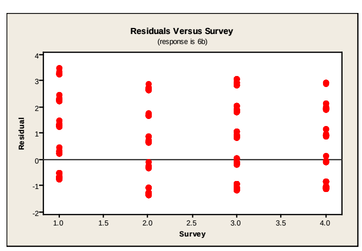
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

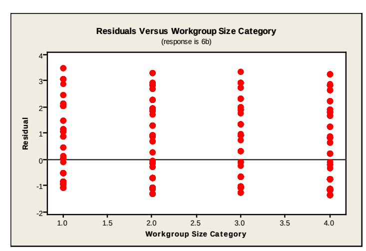
Analysis of Variance for 6b, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	52.557	55.066	18.355	10.17	0.000
Workgroup Size Category	3	8.179	8.179	2.726	1.51	0.210
Error	1223	2206.761	2206.761	1.804		
Total	1229	2267.497				

S = 1.34327   R-Sq = 2.68%   R-Sq(adj) = 2.20%







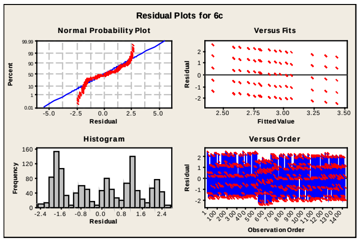
General Linear Model: 6c versus Survey, Workgroup Size Category

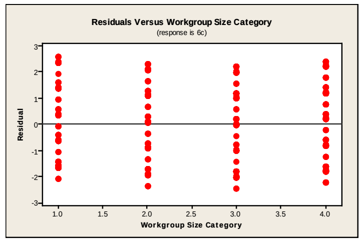
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

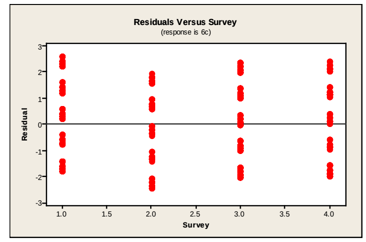
Analysis of Variance for 6c, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	40.887	43.661	14.554	6.66	0.000
Workgroup Size Category	3	19.966	19.966	6.655	3.05	0.028
Error	1258	2748.491	2748.491	2.185		
Total	1264	2809.344				

S = 1.47811   R-Sq = 2.17%   R-Sq(adj) = 1.70%







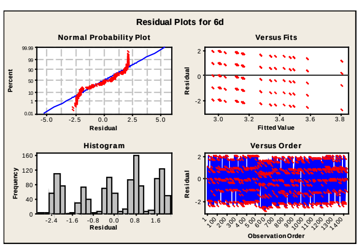
General Linear Model: 6d versus Survey, Workgroup Size Category

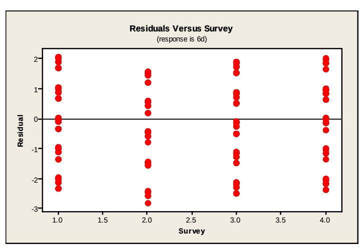
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 6d, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	21.607	23.706	7.902	3.93	0.008
Workgroup Size Category	3	23.868	23.868	7.956	3.95	0.008
Error	1248	2511.867	2511.867	2.013		
Total	1254	2557.342				

S = 1.41870   R-Sq = 1.78%   R-Sq(adj) = 1.31%





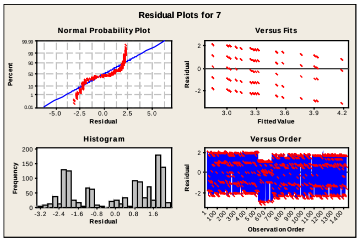
General Linear Model: 7 versus Survey, Workgroup Size Category

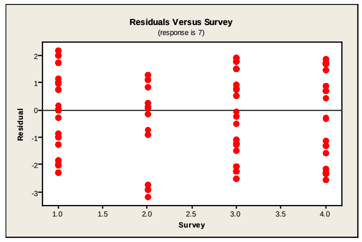
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

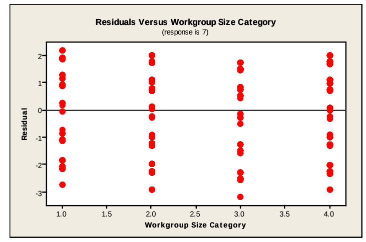
Analysis of Variance for 7, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	78.316	83.038	27.679	9.73	0.000
Workgroup Size Category	3	23.160	23.160	7.720	2.71	0.044
Error	1251	3559.710	3559.710	2.845		
Total	1257	3661.186				

S = 1.68686   R-Sq = 2.77%   R-Sq(adj) = 2.31%







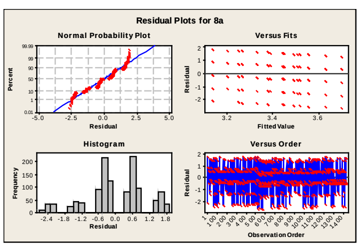
General Linear Model: 8a versus Survey, Workgroup Size Category

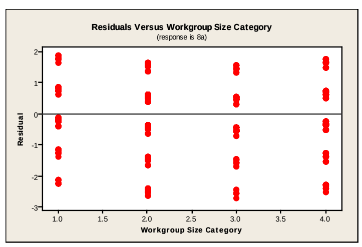
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

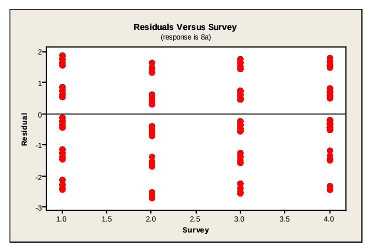
Analysis of Variance for 8a, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	5.864	7.003	2.334	2.15	0.092
Workgroup Size Category	3	13.007	13.007	4.336	3.99	0.008
Error	1178	1279.444	1279.444	1.086		
Total	1184	1298.316				

S = 1.04217   R-Sq = 1.45%   R-Sq(adj) = 0.95%







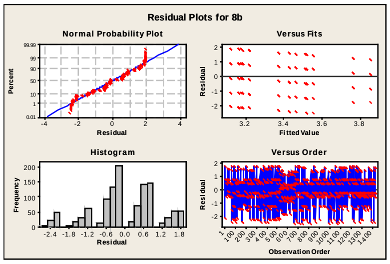
General Linear Model: 8b versus Survey, Workgroup Size Category

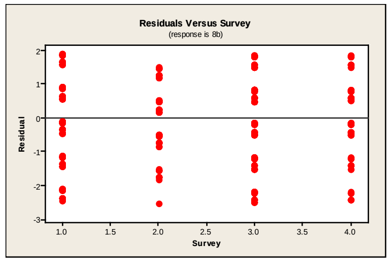
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 8b, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	12.693	14.828	4.943	4.64	0.003
Workgroup Size Category	3	21.711	21.711	7.237	6.80	0.000
Error	1171	1246.592	1246.592	1.065		
Total	1177	1280.996				

S = 1.03177   R-Sq = 2.69%   R-Sq(adj) = 2.19%





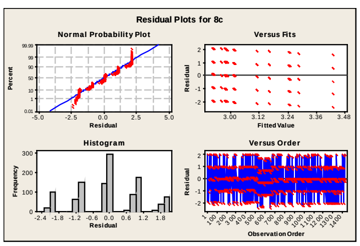
General Linear Model: 8c versus Survey, Workgroup Size Category

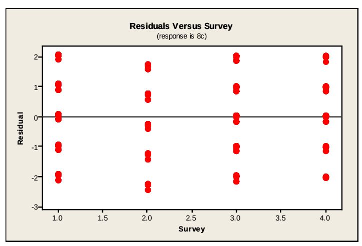
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

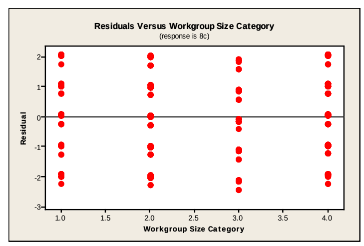
Analysis of Variance for 8c, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	8.934	10.059	3.353	2.74	0.042
Workgroup Size Category	3	6.050	6.050	2.017	1.65	0.177
Error	1157	1417.500	1417.500	1.225		
Total	1163	1432.485				

S = 1.10687   R-Sq = 1.05%   R-Sq(adj) = 0.53%







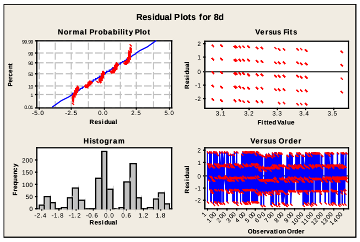
General Linear Model: 8d versus Survey, Workgroup Size Category

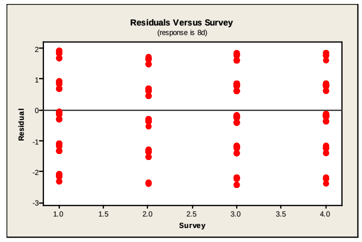
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

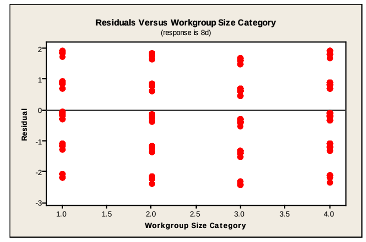
Analysis of Variance for 8d, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	4.636	5.350	1.783	1.58	0.193
Workgroup Size Category	3	8.568	8.568	2.856	2.52	0.056
Error	1167	1320.326	1320.326	1.131		
Total	1173	1333.530				

S = 1.06367   R-Sq = 0.99%   R-Sq(adj) = 0.48%







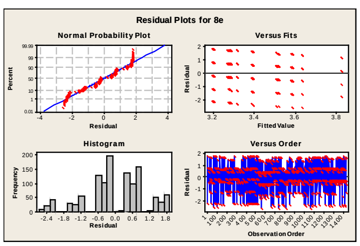
General Linear Model: 8e versus Survey, Workgroup Size Category

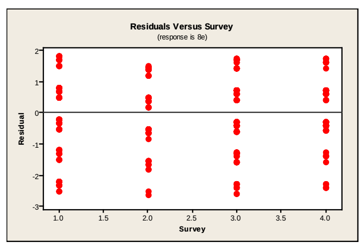
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

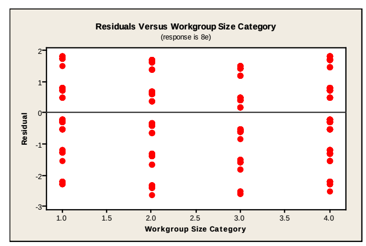
Analysis of Variance for 8e, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	7.786	9.645	3.215	3.08	0.027
Workgroup Size Category	3	16.682	16.682	5.561	5.33	0.001
Error	1162	1213.171	1213.171	1.044		
Total	1168	1237.639				

S = 1.02178   R-Sq = 1.98%   R-Sq(adj) = 1.47%







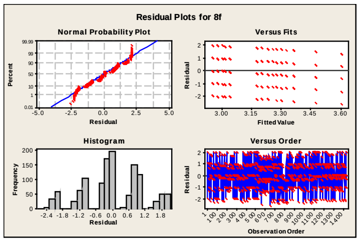
General Linear Model: 8f versus Survey, Workgroup Size Category

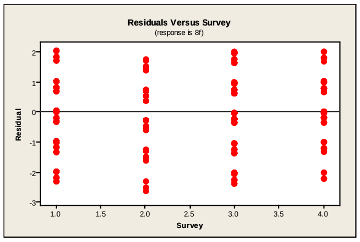
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 8f, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	7.126	8.955	2.985	2.57	0.053
Workgroup Size Category	3	22.403	22.403	7.468	6.44	0.000
Error	1170	1357.078	1357.078	1.160		
Total	1176	1386.607				

S = 1.07698   R-Sq = 2.13%   R-Sq(adj) = 1.63%





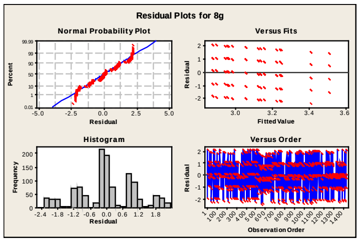
General Linear Model: 8g versus Survey, Workgroup Size Category

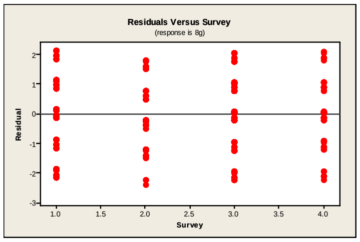
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

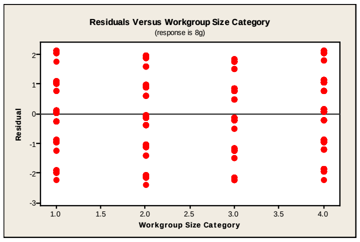
Analysis of Variance for 8g, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	10.112	11.949	3.983	3.61	0.013
Workgroup Size Category	3	15.919	15.919	5.306	4.81	0.002
Error	1165	1285.040	1285.040	1.103		
Total	1171	1311.072				

S = 1.05026   R-Sq = 1.99%   R-Sq(adj) = 1.48%







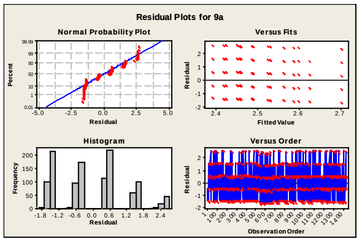
General Linear Model: 9a versus Survey, Workgroup Size Category

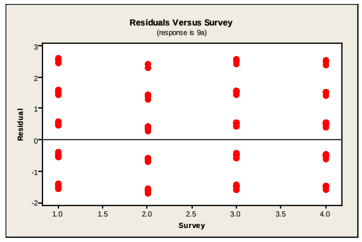
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 9a, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	2.404	2.871	0.957	0.66	0.576
Workgroup Size Category	3	3.000	3.000	1.000	0.69	0.557
Error	1130	1634.511	1634.511	1.446		
Total	1136	1639.916				

S = 1.20269   R-Sq = 0.33%   R-Sq(adj) = 0.00%





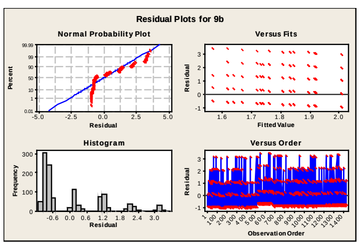
General Linear Model: 9b versus Survey, Workgroup Size Category

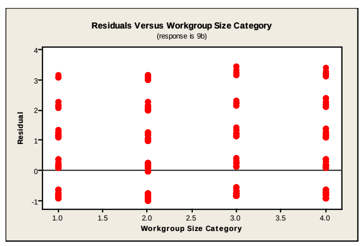
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

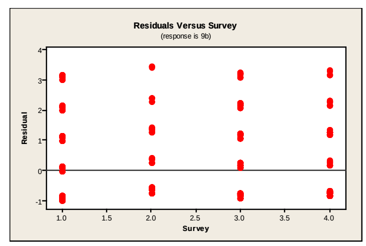
Analysis of Variance for 9b, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	7.726	8.712	2.904	2.22	0.085
Workgroup Size Category	3	3.841	3.841	1.280	0.98	0.403
Error	1126	1475.128	1475.128	1.310		
Total	1132	1486.695				

S = 1.14458   R-Sq = 0.78%   R-Sq(adj) = 0.25%







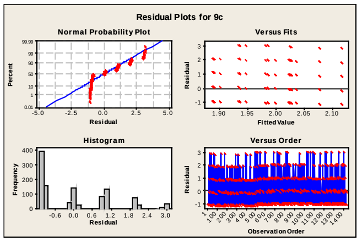
General Linear Model: 9c versus Survey, Workgroup Size Category

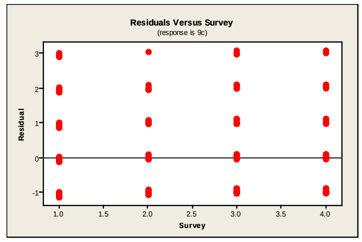
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 9c, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	2.341	2.001	0.667	0.48	0.697
Workgroup Size Category	3	2.628	2.628	0.876	0.63	0.596
Error	1116	1554.023	1554.023	1.392		
Total	1122	1558.992				

S = 1.18004   R-Sq = 0.32%   R-Sq(adj) = 0.00%





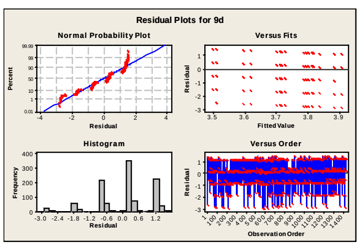
General Linear Model: 9d versus Survey, Workgroup Size Category

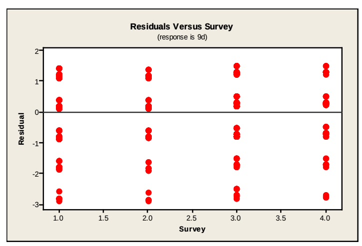
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 9d, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	2.932	2.412	0.804	0.76	0.514
Workgroup Size Category	3	9.510	9.510	3.170	3.01	0.029
Error	1121	1179.408	1179.408	1.052		
Total	1127	1191.850				

S = 1.02572   R-Sq = 1.04%   R-Sq(adj) = 0.51%





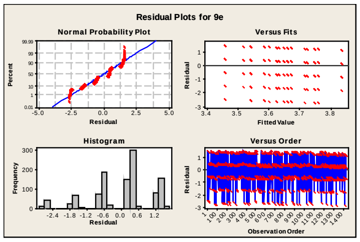
General Linear Model: 9e versus Survey, Workgroup Size Category

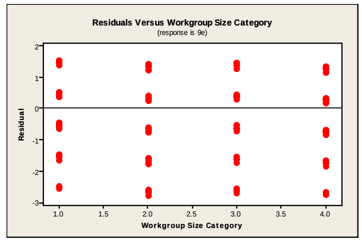
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

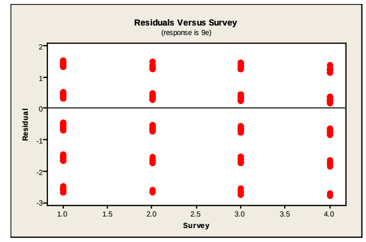
Analysis of Variance for 9e, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	3.459	3.858	1.286	1.14	0.333
Workgroup Size Category	3	5.681	5.681	1.894	1.67	0.171
Error	1129	1277.472	1277.472	1.132		
Total	1135	1286.612				

S = 1.06372   R-Sq = 0.71%   R-Sq(adj) = 0.18%







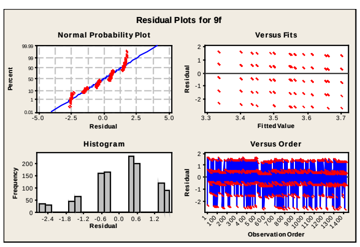
General Linear Model: 9f versus Survey, Workgroup Size Category

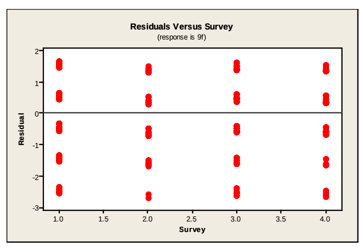
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

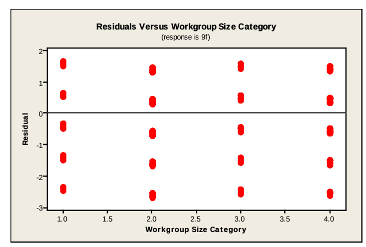
Analysis of Variance for 9f, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	3.302	2.948	0.983	0.85	0.467
Workgroup Size Category	3	5.670	5.670	1.890	1.63	0.180
Error	1123	1300.622	1300.622	1.158		
Total	1129	1309.594				

S = 1.07618   R-Sq = 0.69%   R-Sq(adj) = 0.15%







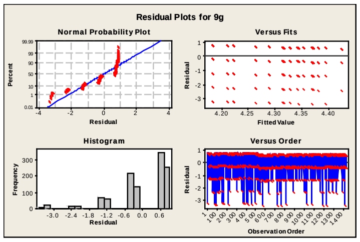
General Linear Model: 9g versus Survey, Workgroup Size Category

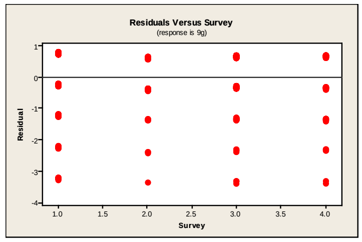
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

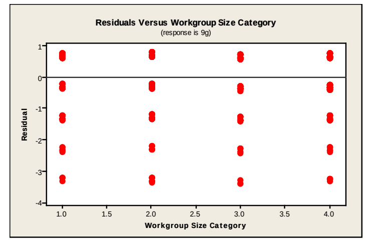
Analysis of Variance for 9g, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	3.8376	4.0209	1.3403	1.55	0.199
Workgroup Size Category	3	0.8663	0.8663	0.2888	0.33	0.800
Error	1129	974.3234	974.3234	0.8630		
Total	1135	979.0273				

S = 0.928976   R-Sq = 0.48%   R-Sq(adj) = 0.00%







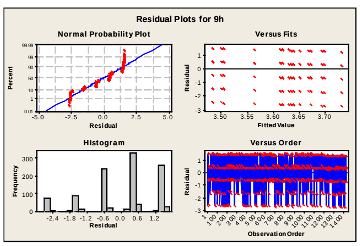
General Linear Model: 9h versus Survey, Workgroup Size Category

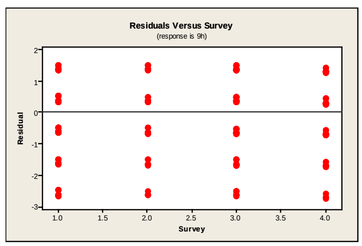
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 9h, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	1.137	0.740	0.247	0.17	0.913
Workgroup Size Category	3	3.974	3.974	1.325	0.94	0.421
Error	1122	1582.740	1582.740	1.411		
Total	1128	1587.851				

S = 1.18770   R-Sq = 0.32%   R-Sq(adj) = 0.00%





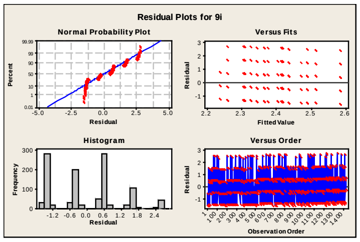
General Linear Model: 9i versus Survey, Workgroup Size Category

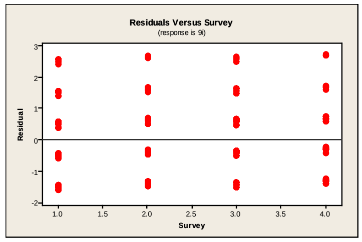
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

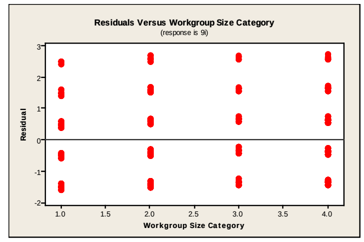
Analysis of Variance for 9i, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	3.341	4.012	1.337	0.98	0.400
Workgroup Size Category	3	3.611	3.611	1.204	0.88	0.448
Error	1106	1504.327	1504.327	1.360		
Total	1112	1511.279				

S = 1.16626   R-Sq = 0.46%   R-Sq(adj) = 0.00%







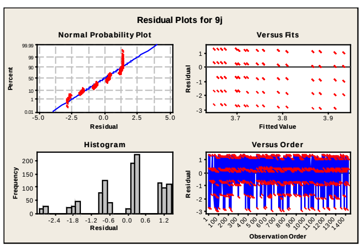
General Linear Model: 9j versus Survey, Workgroup Size Category

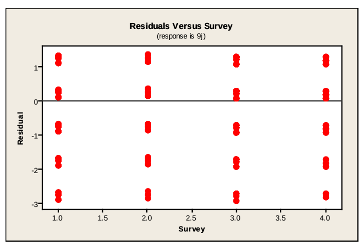
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

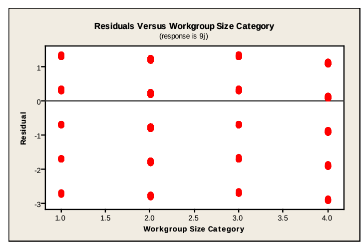
Analysis of Variance for 9j, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	0.268	0.524	0.175	0.15	0.928
Workgroup Size Category	3	9.100	9.100	3.033	2.64	0.048
Error	1122	1289.031	1289.031	1.149		
Total	1128	1298.399				

S = 1.07185   R-Sq = 0.72%   R-Sq(adj) = 0.19%







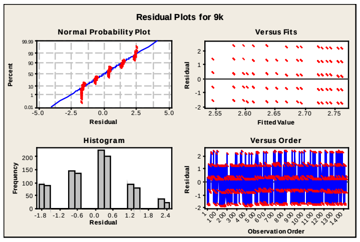
General Linear Model: 9k versus Survey, Workgroup Size Category

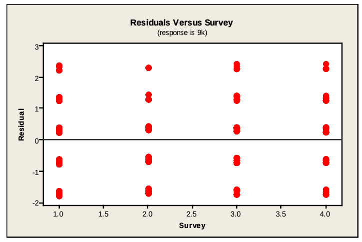
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 9k, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	0.612	0.499	0.166	0.14	0.935
Workgroup Size Category	3	4.118	4.118	1.373	1.16	0.323
Error	1116	1317.309	1317.309	1.180		
Total	1122	1322.039				

S = 1.08645   R-Sq = 0.36%   R-Sq(adj) = 0.00%





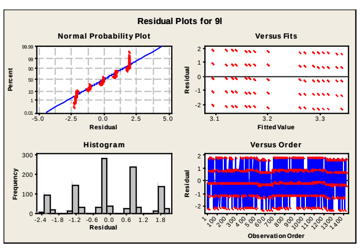
General Linear Model: 9l versus Survey, Workgroup Size Category

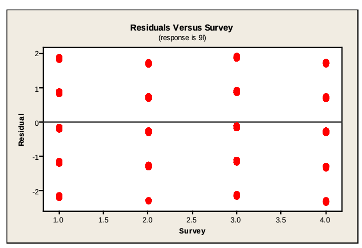
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

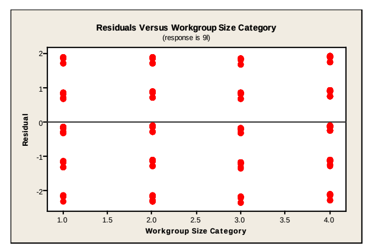
Analysis of Variance for 9l, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	4.960	5.187	1.729	1.19	0.312
Workgroup Size Category	3	0.764	0.764	0.255	0.18	0.913
Error	1116	1618.581	1618.581	1.450		
Total	1122	1624.305				

S = 1.20430   R-Sq = 0.35%   R-Sq(adj) = 0.00%







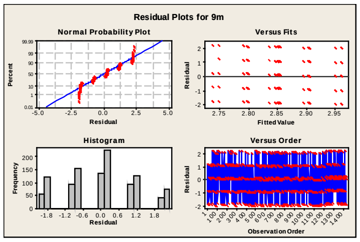
General Linear Model: 9m versus Survey, Workgroup Size Category

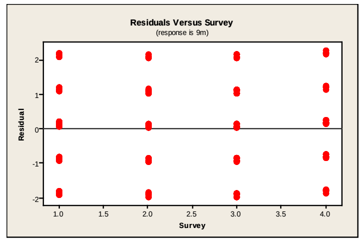
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 9m, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	1.493	1.613	0.538	0.37	0.774
Workgroup Size Category	3	2.477	2.477	0.826	0.57	0.635
Error	1104	1598.507	1598.507	1.448		
Total	1110	1602.477				

S = 1.20330   R-Sq = 0.25%   R-Sq(adj) = 0.00%





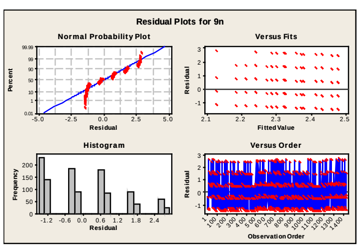
General Linear Model: 9n versus Survey, Workgroup Size Category

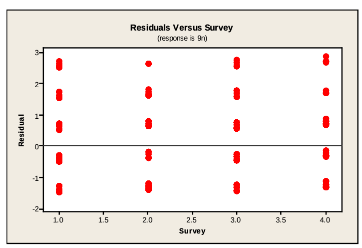
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

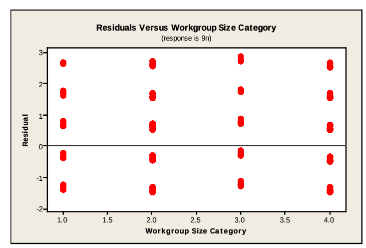
Analysis of Variance for 9n, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	2.608	3.221	1.074	0.69	0.560
Workgroup Size Category	3	6.665	6.665	2.222	1.42	0.235
Error	1125	1758.256	1758.256	1.563		
Total	1131	1767.529				

S = 1.25016   R-Sq = 0.52%   R-Sq(adj) = 0.00%







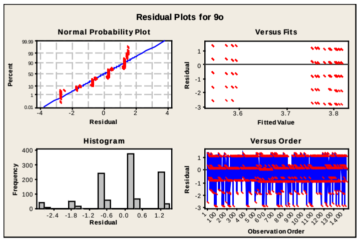
General Linear Model: 9o versus Survey, Workgroup Size Category

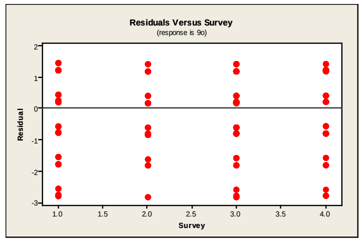
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

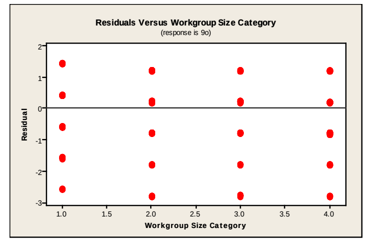
Analysis of Variance for 9o, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	0.244	0.421	0.140	0.13	0.940
Workgroup Size Category	3	7.348	7.348	2.449	2.34	0.072
Error	1124	1177.094	1177.094	1.047		
Total	1130	1184.686				

S = 1.02335   R-Sq = 0.64%   R-Sq(adj) = 0.11%







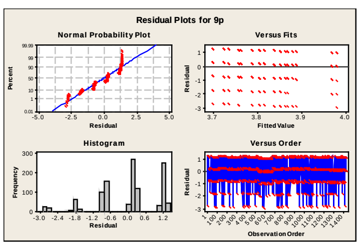
General Linear Model: 9p versus Survey, Workgroup Size Category

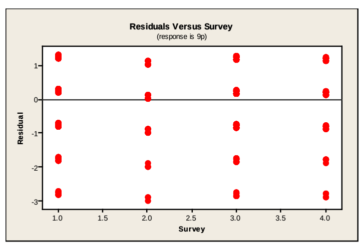
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

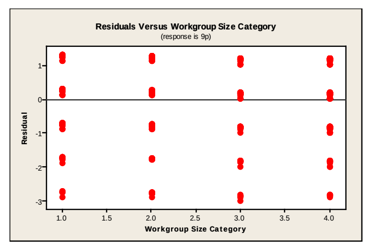
Analysis of Variance for 9p, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	2.357	2.619	0.873	0.79	0.502
Workgroup Size Category	3	2.523	2.523	0.841	0.76	0.519
Error	1121	1246.375	1246.375	1.112		
Total	1127	1251.254				

S = 1.05444   R-Sq = 0.39%   R-Sq(adj) = 0.00%







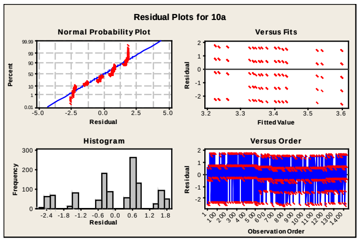
General Linear Model: 10a versus Survey, Workgroup Size Category

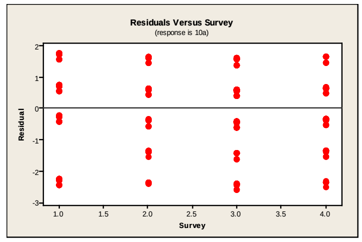
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 10a, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	7.574	6.597	2.199	1.60	0.188
Workgroup Size Category	3	5.543	5.543	1.848	1.34	0.259
Error	1153	1587.227	1587.227	1.377		
Total	1159	1600.344				

S = 1.17329   R-Sq = 0.82%   R-Sq(adj) = 0.30%





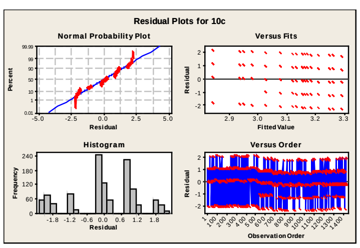
General Linear Model: 10c versus Survey, Workgroup Size Category

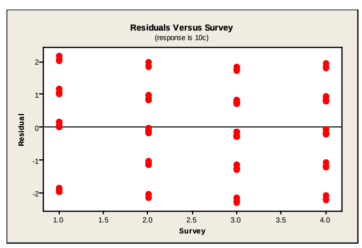
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

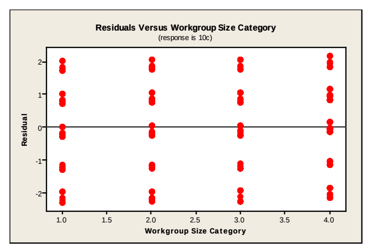
Analysis of Variance for 10c, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	22.409	21.149	7.050	5.37	0.001
Workgroup Size Category	3	3.184	3.184	1.061	0.81	0.489
Error	1137	1492.586	1492.586	1.313		
Total	1143	1518.178				

S = 1.14575   R-Sq = 1.69%   R-Sq(adj) = 1.17%







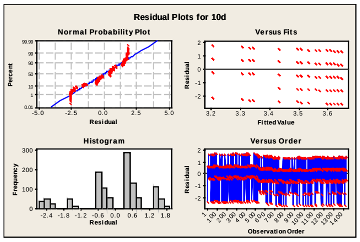
General Linear Model: 10d versus Survey, Workgroup Size Category

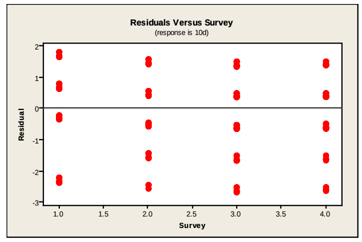
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 10d, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	23.149	21.881	7.294	6.13	0.000
Workgroup Size Category	3	3.873	3.873	1.291	1.08	0.355
Error	1152	1371.816	1371.816	1.191		
Total	1158	1398.839				

S = 1.09124   R-Sq = 1.93%   R-Sq(adj) = 1.42%





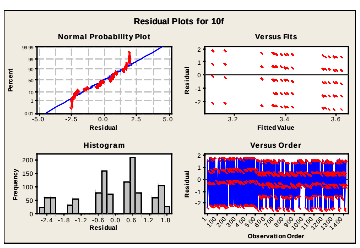
General Linear Model: 10f versus Survey, Workgroup Size Category

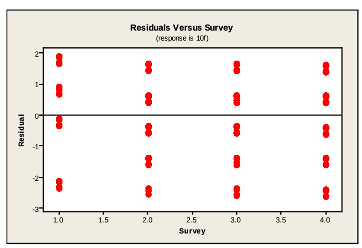
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

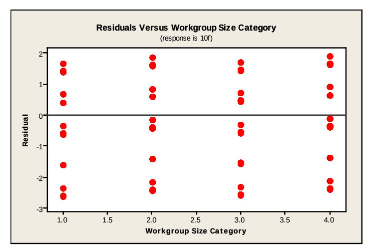
Analysis of Variance for 10f, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	17.243	15.754	5.251	3.63	0.013
Workgroup Size Category	3	10.305	10.305	3.435	2.38	0.069
Error	1150	1662.898	1662.898	1.446		
Total	1156	1690.446				

S = 1.20250   R-Sq = 1.63%   R-Sq(adj) = 1.12%







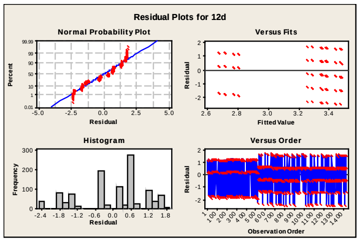
General Linear Model: 12d versus Survey, Workgroup Size Category

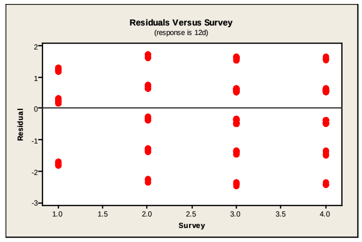
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

Analysis of Variance for 12d, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	108.169	105.386	35.129	29.04	0.000
Workgroup Size Category	3	2.164	2.164	0.721	0.60	0.617
Error	1096	1325.618	1325.618	1.210		
Total	1102	1435.951				

S = 1.09978   R-Sq = 7.68%   R-Sq(adj) = 7.18%





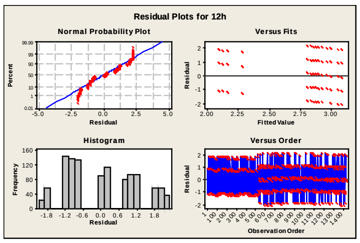
General Linear Model: 12h versus Survey, Workgroup Size Category

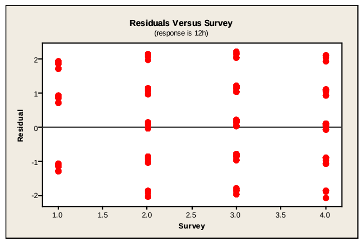
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

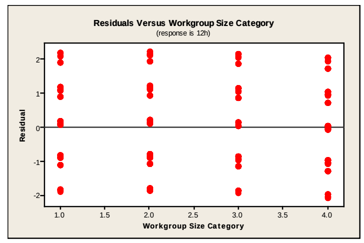
Analysis of Variance for 12h, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	131.194	133.884	44.628	31.58	0.000
Workgroup Size Category	3	6.757	6.757	2.252	1.59	0.189
Error	1100	1554.657	1554.657	1.413		
Total	1106	1692.609				

S = 1.18883   R-Sq = 8.15%   R-Sq(adj) = 7.65%







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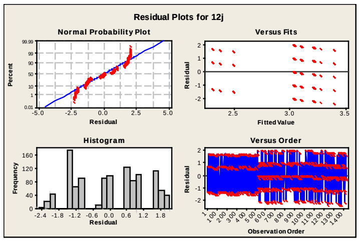
General Linear Model: 12j versus Survey, Workgroup Size Category

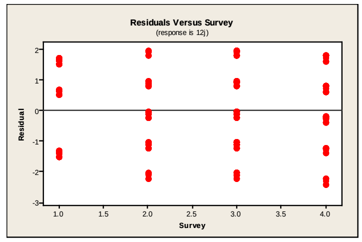
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

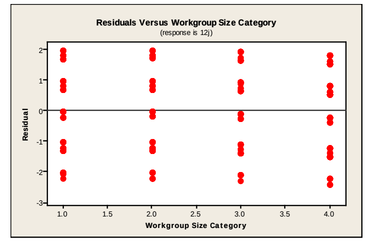
Analysis of Variance for 12j, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	146.024	149.511	49.837	32.97	0.000
Workgroup Size Category	3	7.041	7.041	2.347	1.55	0.199
Error	1096	1656.661	1656.661	1.512		
Total	1102	1809.726				

S = 1.22945   R-Sq = 8.46%   R-Sq(adj) = 7.96%







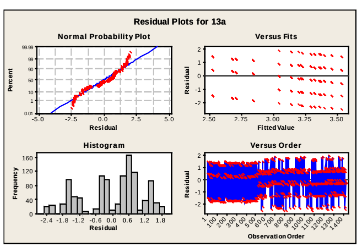
General Linear Model: 13a versus Survey, Workgroup Size Category

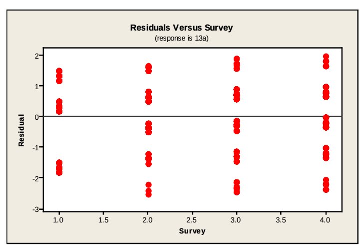
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

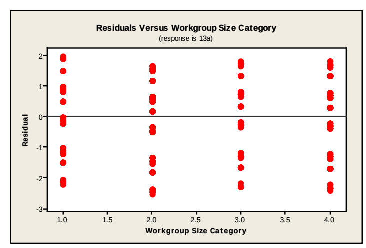
Analysis of Variance for 13a, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	91.304	93.347	31.116	26.15	0.000
Workgroup Size Category	3	11.332	11.332	3.777	3.17	0.023
Error	1094	1301.561	1301.561	1.190		
Total	1100	1404.196				

S = 1.09075   R-Sq = 7.31%   R-Sq(adj) = 6.80%







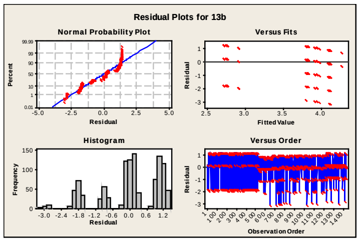
General Linear Model: 13b versus Survey, Workgroup Size Category

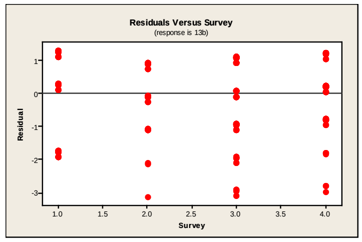
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

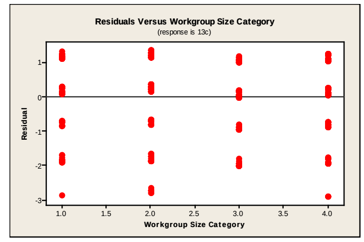
Analysis of Variance for 13b, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Survey	3	350.363	350.730	116.910	101.27	0.000
Workgroup Size Category	3	5.277	5.277	1.759	1.52	0.207
Error	1094	1262.966	1262.966	1.154		
Total	1100	1618.607				

S = 1.07445   R-Sq = 21.97%   R-Sq(adj) = 21.54%







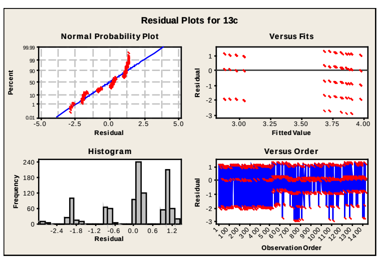
General Linear Model: 13c versus Survey, Workgroup Size Category

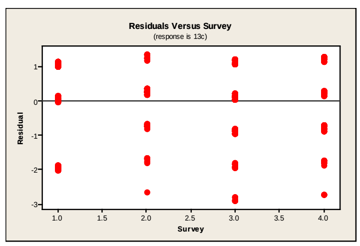
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

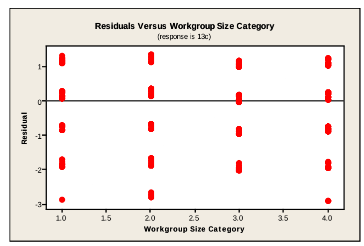
Analysis of Variance for 13c, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	193.713	193.915	64.638	59.29	0.000
Workgroup Size Category	3	3.222	3.222	1.074	0.99	0.399
Error	1094	1192.674	1192.674	1.090		
Total	1100	1389.609				

S = 1.04412   R-Sq = 14.17%   R-Sq(adj) = 13.70%







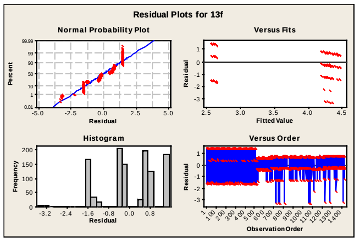
General Linear Model: 13f versus Survey, Workgroup Size Category

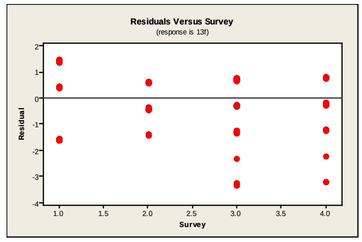
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

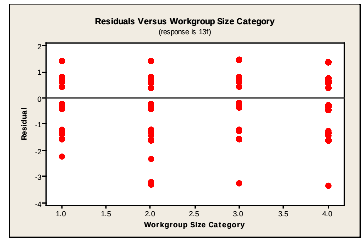
Analysis of Variance for 13f, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	719.93	716.57	238.86	222.03	0.000
Workgroup Size Category	3	0.70	0.70	0.23	0.22	0.884
Error	1099	1182.28	1182.28	1.08		
Total	1105	1902.91				

S = 1.03720   R-Sq = 37.87%   R-Sq(adj) = 37.53%







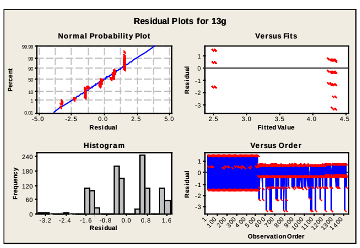
General Linear Model: 13g versus Survey, Workgroup Size Category

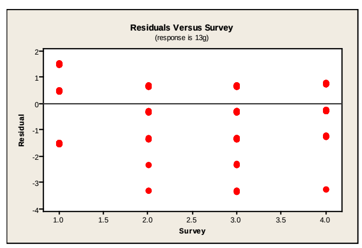
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

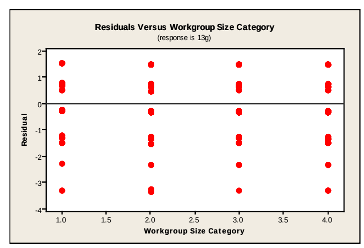
Analysis of Variance for 13g, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	815.33	811.80	270.60	246.42	0.000
Workgroup Size Category	3	0.26	0.26	0.09	0.08	0.971
Error	1124	1234.31	1234.31	1.10		
Total	1130	2049.89				

S = 1.04792   R-Sq = 39.79%   R-Sq(adj) = 39.47%







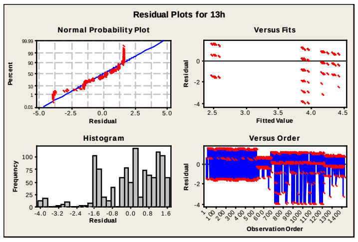
General Linear Model: 13h versus Survey, Workgroup Size Category

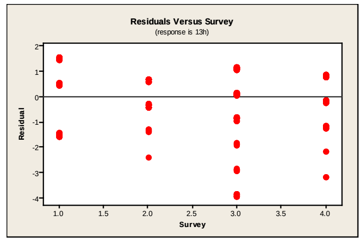
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

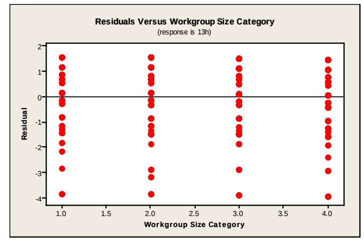
Analysis of Variance for 13h, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Survey	3	589.814	589.108	196.369	124.23	0.000
Workgroup Size Category	3	1.769	1.769	0.590	0.37	0.772
Error	1086	1716.640	1716.640	1.581		
Total	1092	2308.223				

S = 1.25726   R-Sq = 25.63%   R-Sq(adj) = 25.22%







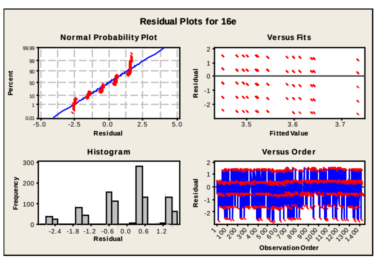
General Linear Model: 16e versus Survey, Workgroup Size Category

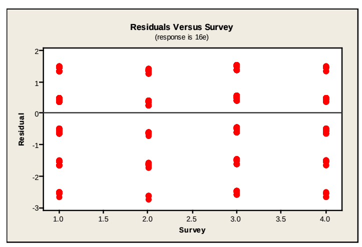
Factor	Type	Levels	Values
Survey	fixed	4	1, 2, 3, 4
Workgroup Size Category	fixed	4	1, 2, 3, 4

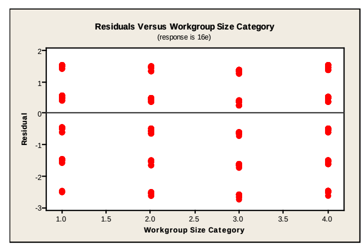
Analysis of Variance for 16e, using Adjusted SS for Tests

Source	DF	Seq SS	AdjSS	Adj MS	F	P
Survey	3	1.452	1.771	0.590	0.50	0.685
Workgroup Size Category	3	2.942	2.942	0.981	0.82	0.480
Error	1068	1270.430	1270.430	1.190		
Total	1074	1274.824				

S = 1.09066   R-Sq = 0.34%   R-Sq(adj) = 0.00%







APPENDIX C: ANOVA Results (Leadership Hypothesis)

Spring 2011

Two-Sample T-Test and CI: 6a, Involved

```
Two-sample T for 6a
Involved    N  Mean  StDev  SE Mean
0           6  2.17   1.83     0.75
1         119  1.61   1.17     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.562
95% CI for difference:  (-0.433,
1.556)
T-Test of difference = 0 (vs not
=): T-Value = 1.12  P-Value = 0.266
DF = 123
Both use Pooled StDev = 1.2005
```

Two-Sample T-Test and CI: 6b, Involved

```
Two-sample T for 6b
Involved    N  Mean  StDev  SE Mean
0           6  2.00   1.55     0.63
1         114  1.54   1.13     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.456
95% CI for difference:  (-0.498,
1.411)
T-Test of difference = 0 (vs not
=): T-Value = 0.95  P-Value = 0.346
DF = 118
Both use Pooled StDev = 1.1508
```

Two-Sample T-Test and CI: 6c, Involved

```
Two-sample T for 6c
Involved    N  Mean  StDev  SE Mean
0           6  2.67   1.86     0.76
1         118  2.51   1.49     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  0.158
95% CI for difference:  (-1.094,
1.411)
T-Test of difference = 0 (vs not
=): T-Value = 0.25  P-Value = 0.803
DF = 122
Both use Pooled StDev = 1.5118
```

Two-Sample T-Test and CI: 6d, Involved

```
Two-sample T for 6d
Involved    N  Mean  StDev  SE Mean
0           6  2.83   1.72     0.70
1         116  3.02   1.49     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.184
95% CI for difference:  (-1.425,
1.057)
T-Test of difference = 0 (vs not
=): T-Value = -0.29  P-Value =
0.770  DF = 120
Both use Pooled StDev = 1.4967
```

Two-Sample T-Test and CI: 7, Involved

```
Two-sample T for 7
Involved    N  Mean  StDev  SE Mean
0           5  2.60   2.19     0.98
1         116  2.72   1.63     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  -0.124
95% CI for difference:  (-1.617,
1.369)
T-Test of difference = 0 (vs not
=): T-Value = -0.16  P-Value =
0.870  DF = 119
Both use Pooled StDev = 1.6510
```

Two-Sample T-Test and CI: 8a, Involved

```
Two-sample T for 8a
Involved    N  Mean  StDev  SE Mean
0           6  3.00   1.79     0.73
1         110  3.18   1.07     0.10
Difference = mu (0) - mu (1)
Estimate for difference:  -0.182
95% CI for difference:  (-2.077,
1.714)
T-Test of difference = 0 (vs not
=): T-Value = -0.25  P-Value =
0.815  DF = 5
```

Two-Sample T-Test and CI: 8b, Involved

```
Two-sample T for 8b
Involved    N  Mean  StDev  SE Mean
0           6  3.00   1.79     0.73
1         109  3.10   1.10     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  -0.101
95% CI for difference:  (-1.045,
0.843)
T-Test of difference = 0 (vs not
=): T-Value = -0.21  P-Value =
0.833  DF = 113
Both use Pooled StDev = 1.1362
```

Two-Sample T-Test and CI: 8c, Involved

```
Two-sample T for 8c
Involved    N  Mean  StDev  SE Mean
0           6  3.00   1.79     0.73
1         108  2.87   1.11     0.11
```

```
Difference = mu (0) - mu (1)
Estimate for difference:  0.130
95% CI for difference:  (-0.826,
1.086)
T-Test of difference = 0 (vs not
=): T-Value = 0.27  P-Value = 0.789
DF = 112
Both use Pooled StDev = 1.1503
```

Two-Sample T-Test and CI: 8d, Involved

```
Two-sample T for 8d
Involved     N  Mean  StDev  SE Mean
0            6  3.33   1.51     0.61
1          106  2.98   1.13     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.352
95% CI for difference:  (-0.604,
1.308)
T-Test of difference = 0 (vs not
=): T-Value = 0.73  P-Value = 0.467
DF = 110
Both use Pooled StDev = 1.1493
```

Two-Sample T-Test and CI: 8e, Involved

```
Two-sample T for 8e
Involved     N  Mean  StDev  SE Mean
0            6  3.33   1.51     0.61
1          107  3.21   1.09     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.128
95% CI for difference:  (-0.795,
1.051)
T-Test of difference = 0 (vs not
=): T-Value = 0.27  P-Value = 0.784
DF = 111
Both use Pooled StDev = 1.1102
```

Two-Sample T-Test and CI: 8f, Involved

```
Two-sample T for 8f
Involved     N  Mean  StDev  SE Mean
0            6  3.67   1.63     0.67
1          108  2.94   1.15     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.722
95% CI for difference:  (-0.255,
1.700)
T-Test of difference = 0 (vs not
=): T-Value = 1.46  P-Value = 0.146
DF = 112
Both use Pooled StDev = 1.1764
```

Two-Sample T-Test and CI: 8g, Involved

```
Two-sample T for 8g
Involved     N  Mean  StDev  SE Mean
0            6  3.67   1.63     0.67
1          108  2.91   1.03    0.099
```

```
Difference = mu (0) - mu (1)
Estimate for difference:  0.759
95% CI for difference:  (-0.124,
1.642)
T-Test of difference = 0 (vs not
=): T-Value = 1.70  P-Value = 0.091
DF = 112
Both use Pooled StDev = 1.0624
```

Two-Sample T-Test and CI: 9a, Involved

```
Two-sample T for 9a
Involved    N  Mean  StDev  SE Mean
0           5  3.00   1.58     0.71
1          99  2.33   1.16     0.12
Difference = mu (0) - mu (1)
Estimate for difference:  0.667
95% CI for difference:  (-0.406,
1.739)
T-Test of difference = 0 (vs not
=): T-Value = 1.23  P-Value = 0.221
DF = 102
Both use Pooled StDev = 1.1799
```

Two-Sample T-Test and CI: 9b, Involved

```
Two-sample T for 9b
Involved    N  Mean  StDev  SE Mean
0           5  2.60   1.52     0.68
1          97  1.89   1.06     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.713
95% CI for difference:  (-0.271,
1.697)
T-Test of difference = 0 (vs not
=): T-Value = 1.44  P-Value = 0.153
DF = 100
Both use Pooled StDev = 1.0814
```

Two-Sample T-Test and CI: 9c, Involved

```
Two-sample T for 9c
Involved    N  Mean  StDev  SE Mean
0           5  2.60   1.52     0.68
1          97  2.00   1.11     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.600
95% CI for difference:  (-0.426,
1.626)
T-Test of difference = 0 (vs not
=): T-Value = 1.16  P-Value = 0.249
DF = 100
Both use Pooled StDev = 1.1278
```

Two-Sample T-Test and CI: 9d, Involved

```
Two-sample T for 9d
Involved    N   Mean  StDev  SE Mean
0           5   4.00   1.41     0.63
1          96  3.719  0.981     0.10
```

```
Difference = mu (0) - mu (1)
Estimate for difference:  0.281
95% CI for difference:  (-0.631,
1.193)
T-Test of difference = 0 (vs not
=): T-Value = 0.61  P-Value = 0.542
DF = 99
Both use Pooled StDev = 1.0020
```

Two-Sample T-Test and CI: 9e, Involved

```
Two-sample T for 9e
Involved   N   Mean  StDev  SE Mean
0          5  2.600  0.548     0.24
1         98   3.55   1.09     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  -0.951
95% CI for difference:  (-1.923,
0.021)
T-Test of difference = 0 (vs not
=): T-Value = -1.94  P-Value =
0.055  DF = 101
Both use Pooled StDev = 1.0691
```

Two-Sample T-Test and CI: 9f, Involved

```
Two-sample T for 9f
Involved   N  Mean  StDev  SE Mean
0          5  3.00   1.00     0.45
1         97  3.40   1.10     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  -0.402
95% CI for difference:  (-1.396,
0.592)
T-Test of difference = 0 (vs not
=): T-Value = -0.80  P-Value =
0.424  DF = 100
Both use Pooled StDev = 1.0923
```

Two-Sample T-Test and CI: 9g, Involved

```
Two-sample T for 9g
Involved   N  Mean  StDev  SE Mean
0          5  3.80   1.30     0.58
1         98  4.17   1.10     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  -0.373
95% CI for difference:  (-1.385,
0.638)
T-Test of difference = 0 (vs not
=): T-Value = -0.73  P-Value =
0.465  DF = 101
Both use Pooled StDev = 1.1118
```

Two-Sample T-Test and CI: 9h, Involved

```
Two-sample T for 9h
Involved   N   Mean  StDev  SE Mean
0          5  3.000  0.707     0.32
1         95   3.52   1.08     0.11
```

```
Difference = mu (0) - mu (1)
Estimate for difference:  -0.516
95% CI for difference:  (-1.488,
0.456)
T-Test of difference = 0 (vs not
=): T-Value = -1.05  P-Value =
0.295  DF = 98
Both use Pooled StDev = 1.0677
```

Two-Sample T-Test and CI: 9i, Involved

```
Two-sample T for 9i
Involved   N  Mean  StDev  SE Mean
0          5  3.00   1.22     0.55
1         96  2.38   1.12     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.625
95% CI for difference:  (-0.396,
1.646)
T-Test of difference = 0 (vs not
=): T-Value = 1.21  P-Value = 0.227
DF = 99
Both use Pooled StDev = 1.1214
```

Two-Sample T-Test and CI: 9j, Involved

```
Two-sample T for 9j
Involved   N   Mean  StDev  SE Mean
0          5  3.800  0.837     0.37
1         96   3.66   1.12     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.144
95% CI for difference:  (-0.869,
1.156)
T-Test of difference = 0 (vs not
=): T-Value = 0.28  P-Value = 0.779
DF = 99
Both use Pooled StDev = 1.1122
```

Two-Sample T-Test and CI: 9k, Involved

```
Two-sample T for 9k
Involved   N   Mean  StDev  SE Mean
0          5   3.00   2.00     0.89
1         96  2.625  0.976     0.10
Difference = mu (0) - mu (1)
Estimate for difference:  0.375
95% CI for difference:  (-2.124,
2.874)
T-Test of difference = 0 (vs not
=): T-Value = 0.42  P-Value = 0.698
DF = 4
```

Two-Sample T-Test and CI: 9l, Involved

```
Two-sample T for 9l
Involved   N   Mean  StDev  SE Mean
0          5  2.800  0.447     0.20
1         94   3.09   1.23     0.13
Difference = mu (0) - mu (1)
```

Estimate for difference: -0.285
95% CI for difference: (-1.388, 0.817)
T-Test of difference = 0 (vs not =): T-Value = -0.51 P-Value = 0.609 DF = 97
Both use Pooled StDev = 1.2104

Two-Sample T-Test and CI: 9m, Involved

Two-sample T for 9m

Involved	N	Mean	StDev	SE Mean
0	3	2.333	0.577	0.33
1	94	2.68	1.11	0.11

Difference = mu (0) - mu (1)
Estimate for difference: -0.348
95% CI for difference: (-1.629, 0.934)
T-Test of difference = 0 (vs not =): T-Value = -0.54 P-Value = 0.592 DF = 95
Both use Pooled StDev = 1.1007

Two-Sample T-Test and CI: 9n, Involved

Two-sample T for 9n

Involved	N	Mean	StDev	SE Mean
0	5	2.200	0.837	0.37
1	95	2.47	1.22	0.13

Difference = mu (0) - mu (1)
Estimate for difference: -0.274
95% CI for difference: (-1.372, 0.824)
T-Test of difference = 0 (vs not =): T-Value = -0.49 P-Value = 0.622 DF = 98
Both use Pooled StDev = 1.2058

Two-Sample T-Test and CI: 9o, Involved

Two-sample T for 9o

Involved	N	Mean	StDev	SE Mean
0	5	3.20	1.30	0.58
1	97	3.64	1.06	0.11

Difference = mu (0) - mu (1)
Estimate for difference: -0.439
95% CI for difference: (-1.416, 0.537)
T-Test of difference = 0 (vs not =): T-Value = -0.89 P-Value = 0.374 DF = 100
Both use Pooled StDev = 1.0732

Two-Sample T-Test and CI: 9p, Involved

Two-sample T for 9p

Involved	N	Mean	StDev	SE Mean
0	5	3.80	1.30	0.58
1	93	3.66	1.15	0.12

Difference = mu (0) - mu (1)
Estimate for difference: 0.144
95% CI for difference: (-0.907, 1.195)
T-Test of difference = 0 (vs not =): T-Value = 0.27 P-Value = 0.786 DF = 96
Both use Pooled StDev = 1.1537

Two-Sample T-Test and CI: 10a, Involved

Two-sample T for 10a

Involved	N	Mean	StDev	SE Mean
0	6	4.000	0.894	0.37
1	98	3.33	1.26	0.13

Difference = mu (0) - mu (1)
Estimate for difference: 0.673
95% CI for difference: (-0.363, 1.710)
T-Test of difference = 0 (vs not =): T-Value = 1.29 P-Value = 0.200 DF = 102
Both use Pooled StDev = 1.2428

Two-Sample T-Test and CI: 10c, Involved

Two-sample T for 10c

Involved	N	Mean	StDev	SE Mean
0	6	3.67	1.51	0.61
1	97	2.88	1.25	0.13

Difference = mu (0) - mu (1)
Estimate for difference: 0.790
95% CI for difference: (-0.266, 1.847)
T-Test of difference = 0 (vs not =): T-Value = 1.48 P-Value = 0.141 DF = 101
Both use Pooled StDev = 1.2659

Two-Sample T-Test and CI: 10d, Involved

Two-sample T for 10d

Involved	N	Mean	StDev	SE Mean
0	6	3.17	1.72	0.70
1	97	3.22	1.17	0.12

Difference = mu (0) - mu (1)
Estimate for difference: -0.050
95% CI for difference: (-1.058, 0.958)
T-Test of difference = 0 (vs not =): T-Value = -0.10 P-Value = 0.922 DF = 101
Both use Pooled StDev = 1.2076

Two-Sample T-Test and CI: 10f, Involved

Two-sample T for 10f

Involved	N	Mean	StDev	SE Mean
0	6	4.33	1.03	0.42
1	97	3.40	1.38	0.14

Difference = mu (0) - mu (1)
Estimate for difference: 0.931
95% CI for difference: (-0.209, 2.072)
T-Test of difference = 0 (vs not =): T-Value = 1.62 P-Value = 0.108 DF = 101
Both use Pooled StDev = 1.3667

Two-Sample T-Test and CI: 12d, Involved

Two-sample T for 12d

Involved	N	Mean	StDev	SE Mean
0	6	2.833	0.983	0.40
1	92	2.90	1.19	0.12

Difference = mu (0) - mu (1)
Estimate for difference: -0.069
95% CI for difference: (-1.053, 0.915)
T-Test of difference = 0 (vs not =): T-Value = -0.14 P-Value = 0.890 DF = 96
Both use Pooled StDev = 1.1768

Two-Sample T-Test and CI: 12h, Involved

Two-sample T for 12h

Involved	N	Mean	StDev	SE Mean
0	6	2.50	1.22	0.50
1	93	2.06	1.25	0.13

Difference = mu (0) - mu (1)
Estimate for difference: 0.435
95% CI for difference: (-0.608, 1.479)
T-Test of difference = 0 (vs not =): T-Value = 0.83 P-Value = 0.410 DF = 97
Both use Pooled StDev = 1.2481

Two-Sample T-Test and CI: 12j, Involved

Two-sample T for 12j

Involved	N	Mean	StDev	SE Mean
0	6	2.67	1.37	0.56
1	92	2.38	1.30	0.14

Difference = mu (0) - mu (1)
Estimate for difference: 0.286
95% CI for difference: (-0.804, 1.376)
T-Test of difference = 0 (vs not =): T-Value = 0.52 P-Value = 0.603 DF = 96
Both use Pooled StDev = 1.3031

Two-Sample T-Test and CI: 13a, Involved

Two-sample T for 13a

Involved	N	Mean	StDev	SE Mean
0	6	2.17	1.33	0.54
1	92	2.65	1.23	0.13

Difference = mu (0) - mu (1)
Estimate for difference: -0.486
95% CI for difference: (-1.516, 0.545)
T-Test of difference = 0 (vs not =): T-Value = -0.94 P-Value = 0.352 DF = 96
Both use Pooled StDev = 1.2320

Two-Sample T-Test and CI: 13b, Involved

Two-sample T for 13b

Involved	N	Mean	StDev	SE Mean
0	6	2.17	1.33	0.54
1	92	2.97	1.27	0.13

Difference = mu (0) - mu (1)
Estimate for difference: -0.801
95% CI for difference: (-1.866, 0.265)
T-Test of difference = 0 (vs not =): T-Value = -1.49 P-Value = 0.139 DF = 96
Both use Pooled StDev = 1.2737

Two-Sample T-Test and CI: 13c, Involved

Two-sample T for 13c

Involved	N	Mean	StDev	SE Mean
0	6	3.17	1.17	0.48
1	92	2.87	1.40	0.15

Difference = mu (0) - mu (1)
Estimate for difference: 0.297
95% CI for difference: (-0.865, 1.459)
T-Test of difference = 0 (vs not =): T-Value = 0.51 P-Value = 0.613 DF = 96
Both use Pooled StDev = 1.3892

Two-Sample T-Test and CI: 13f, Involved

Two-sample T for 13f

Involved	N	Mean	StDev	SE Mean
0	6	1.333	0.816	0.33
1	92	2.68	1.44	0.15

Difference = mu (0) - mu (1)
Estimate for difference: -1.351
95% CI for difference: (-2.538, -0.165)
T-Test of difference = 0 (vs not =): T-Value = -2.26 P-Value = 0.026 DF = 96
Both use Pooled StDev = 1.4186

Two-Sample T-Test and CI: 13g, Involved

Two-sample T for 13g

Involved	N	Mean	StDev	SE Mean
0	6	2.00	1.55	0.63
1	92	2.39	1.43	0.15

Difference = mu (0) - mu (1)
Estimate for difference: -0.391

95% CI for difference: (-1.592, 0.810)
T-Test of difference = 0 (vs not =): T-Value = -0.65 P-Value = 0.519 DF = 96
Both use Pooled StDev = 1.4358

Two-Sample T-Test and CI: 13h, Involved

Two-sample T for 13h

Involved	N	Mean	StDev	SE Mean
0	6	1.67	1.03	0.42
1	89	2.53	1.45	0.15

Difference = mu (0) - mu (1)
Estimate for difference: -0.861
95% CI for difference: (-2.057, 0.334)
T-Test of difference = 0 (vs not =): T-Value = -1.43 P-Value = 0.156 DF = 93
Both use Pooled StDev = 1.4275.

Two-Sample T-Test and CI: 16e, Involved

Two-sample T for 16e

Involved	N	Mean	StDev	SE Mean
0	6	4.000	0.632	0.26
1	90	3.63	1.16	0.12

Difference = mu (0) - mu (1)
Estimate for difference: 0.367
95% CI for difference: (-0.583, 1.316)
T-Test of difference = 0 (vs not =): T-Value = 0.77 P-Value = 0.445 DF = 94
Both use Pooled StDev = 1.1341

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Two-Sample T-Test and CI: 6a, Involved

All values in column are identical.

Two-Sample T-Test and CI: 6b, Involved

All values in column are identical.

Two-Sample T-Test and CI: 6c, Involved

Two-sample T for 6c

Involved	N	Mean	StDev	SE Mean
0	15	2.60	1.64	0.42
1	75	2.52	1.43	0.16

Difference = mu (0) - mu (1)
Estimate for difference: 0.080
95% CI for difference: (-0.742, 0.902)
T-Test of difference = 0 (vs not =):
T-Value = 0.19 P-Value = 0.847 DF = 88
Both use Pooled StDev = 1.4629

Two-Sample T-Test and CI: 6d, Involved

Two-sample T for 6d

Involved	N	Mean	StDev	SE Mean
0	15	2.80	1.66	0.43
1	76	2.92	1.56	0.18

Difference = mu (0) - mu (1)
Estimate for difference: -0.121
95% CI for difference: (-1.004, 0.761)
T-Test of difference = 0 (vs not =):
T-Value = -0.27 P-Value = 0.786 DF = 89
Both use Pooled StDev = 1.5720

Two-Sample T-Test and CI: 7, Involved

Two-sample T for 7

Involved	N	Mean	StDev	SE Mean
0	14	3.43	1.91	0.51
1	76	3.14	1.76	0.20

Difference = mu (0) - mu (1)
Estimate for difference: 0.284
95% CI for difference: (-0.749, 1.316)
T-Test of difference = 0 (vs not =):
T-Value = 0.55 P-Value = 0.586 DF = 88
Both use Pooled StDev = 1.7864

Two-Sample T-Test and CI: 8a, Involved

Two-sample T for 8a

Involved	N	Mean	StDev	SE Mean
0	15	3.47	1.25	0.32
1	71	3.13	1.08	0.13

Difference = mu (0) - mu (1)
Estimate for difference: 0.340
95% CI for difference: (-0.288, 0.967)
T-Test of difference = 0 (vs not =):
T-Value = 1.08 P-Value = 0.285 DF = 84
Both use Pooled StDev = 1.1105

Two-Sample T-Test and CI: 8b, Involved

Two-sample T for 8b

Involved	N	Mean	StDev	SE Mean

```
0          15  3.40   1.12     0.29
1          71  3.07   1.18     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  0.330
95% CI for difference:  (-0.329,
0.989)
T-Test of difference = 0 (vs not
=): T-Value = 0.99  P-Value = 0.323
DF = 84
Both use Pooled StDev = 1.1662
```

Two-Sample T-Test and CI: 8c, Involved

```
Two-sample T for 8c
Involved   N  Mean  StDev  SE Mean
0          13  2.77   1.30     0.36
1          70  3.00   1.08     0.13
Difference = mu (0) - mu (1)
Estimate for difference:  -0.231
95% CI for difference:  (-0.899,
0.438)
T-Test of difference = 0 (vs not
=): T-Value = -0.69  P-Value =
0.494  DF = 81
Both use Pooled StDev = 1.1128
```

Two-Sample T-Test and CI: 8d, Involved

```
Two-sample T for 8d
Involved   N  Mean  StDev  SE Mean
0          15  3.40   1.24     0.32
1          71  3.10   1.14     0.13
Difference = mu (0) - mu (1)
Estimate for difference:  0.301
95% CI for difference:  (-0.351,
0.954)
T-Test of difference = 0 (vs not
=): T-Value = 0.92  P-Value = 0.361
DF = 84
Both use Pooled StDev = 1.1542
```

Two-Sample T-Test and CI: 8e, Involved

```
Two-sample T for 8e
Involved   N   Mean  StDev  SE Mean
0          15  3.467  0.990     0.26
1          71   3.24   1.10     0.13
Difference = mu (0) - mu (1)
Estimate for difference:  0.227
95% CI for difference:  (-0.385,
0.840)
T-Test of difference = 0 (vs not
=): T-Value = 0.74  P-Value = 0.463
DF = 84
Both use Pooled StDev = 1.0838
```

Two-Sample T-Test and CI: 8f, Involved

```
Two-sample T for 8f
Involved   N  Mean  StDev  SE Mean
0          15  3.27   1.28     0.33
1          70  2.96   1.20     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  0.310
95% CI for difference:  (-0.376,
0.995)
T-Test of difference = 0 (vs not
=): T-Value = 0.90  P-Value = 0.372
DF = 83
Both use Pooled StDev = 1.2114
```

Two-Sample T-Test and CI: 8g, Involved

```
Two-sample T for 8g
Involved   N  Mean  StDev  SE Mean
0          15  3.07   1.10     0.28
1          71  3.06   1.13     0.13
Difference = mu (0) - mu (1)
Estimate for difference:  0.010
95% CI for difference:  (-0.627,
0.647)
T-Test of difference = 0 (vs not
=): T-Value = 0.03  P-Value = 0.974
DF = 84
Both use Pooled StDev = 1.1271
```

Two-Sample T-Test and CI: 9a, Involved

```
Two-sample T for 9a
Involved   N  Mean  StDev  SE Mean
0          14  2.79   1.37     0.37
1          67  2.36   1.21     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  0.428
95% CI for difference:  (-0.299,
1.154)
T-Test of difference = 0 (vs not
=): T-Value = 1.17  P-Value = 0.245
DF = 79
Both use Pooled StDev = 1.2415
```

Two-Sample T-Test and CI: 9b, Involved

```
Two-sample T for 9b
Involved   N  Mean  StDev  SE Mean
0          14  2.36   1.50     0.40
1          67  1.79   1.14     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  0.566
95% CI for difference:  (-0.137,
1.270)
T-Test of difference = 0 (vs not
=): T-Value = 1.60  P-Value = 0.113
DF = 79
Both use Pooled StDev = 1.2028
```

Two-Sample T-Test and CI: 9c, Involved

```
Two-sample T for 9c
Involved   N  Mean  StDev  SE Mean
0          14  1.79   1.19     0.32
```

```
1          67  2.09   1.20     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  -0.304
95% CI for difference:  (-1.006,
0.398)
T-Test of difference = 0 (vs not
=): T-Value = -0.86  P-Value =
0.392  DF = 79
Both use Pooled StDev = 1.2003
```

Two-Sample T-Test and CI: 9d, Involved

```
Two-sample T for 9d
Involved   N  Mean  StDev  SE Mean
0         14  3.29   1.27     0.34
1         68  3.60   1.17     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.317
95% CI for difference:  (-1.012,
0.377)
T-Test of difference = 0 (vs not
=): T-Value = -0.91  P-Value =
0.366  DF = 80
Both use Pooled StDev = 1.1892
```

Two-Sample T-Test and CI: 9e, Involved

```
Two-sample T for 9e
Involved   N  Mean  StDev  SE Mean
0         14  3.57   1.22     0.33
1         66  3.56   1.25     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  0.011
95% CI for difference:  (-0.721,
0.743)
T-Test of difference = 0 (vs not
=): T-Value = 0.03  P-Value = 0.977
DF = 78
Both use Pooled StDev = 1.2490
```

Two-Sample T-Test and CI: 9f, Involved

```
Two-sample T for 9f
Involved   N  Mean  StDev  SE Mean
0         14  3.36   1.08     0.29
1         67  3.09   1.26     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  0.268
95% CI for difference:  (-0.455,
0.991)
T-Test of difference = 0 (vs not
=): T-Value = 0.74  P-Value = 0.463
DF = 79
Both use Pooled StDev = 1.2359
```

Two-Sample T-Test and CI: 9g, Involved

```
Two-sample T for 9g
Involved   N  Mean  StDev  SE Mean
0         14  4.50   1.09     0.29
1         68  4.13   1.17     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  0.368
95% CI for difference:  (-0.309,
1.044)
T-Test of difference = 0 (vs not
=): T-Value = 1.08  P-Value = 0.283
DF = 80
Both use Pooled StDev = 1.1582
```

Two-Sample T-Test and CI: 9h, Involved

```
Two-sample T for 9h
Involved   N  Mean  StDev  SE Mean
0         14  4.21   1.12     0.30
1         68  3.31   1.34     0.16
Difference = mu (0) - mu (1)
Estimate for difference:  0.905
95% CI for difference:  (0.142,
1.669)
T-Test of difference = 0 (vs not
=): T-Value = 2.36  P-Value = 0.021
DF = 80
Both use Pooled StDev = 1.3080
```

Two-Sample T-Test and CI: 9i, Involved

```
Two-sample T for 9i
Involved   N  Mean  StDev  SE Mean
0         14  2.50   1.16     0.31
1         64  2.25   1.15     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  0.250
95% CI for difference:  (-0.429,
0.929)
T-Test of difference = 0 (vs not
=): T-Value = 0.73  P-Value = 0.466
DF = 76
Both use Pooled StDev = 1.1556
```

Two-Sample T-Test and CI: 9j, Involved

```
Two-sample T for 9j
Involved   N  Mean  StDev  SE Mean
0         14  4.14   1.03     0.27
1         68  3.62   1.20     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  0.525
95% CI for difference:  (-0.159,
1.209)
T-Test of difference = 0 (vs not
=): T-Value = 1.53  P-Value = 0.131
DF = 80
Both use Pooled StDev = 1.1714
```

Two-Sample T-Test and CI: 9k, Involved

```
Two-sample T for 9k
Involved   N  Mean  StDev  SE Mean
0         14  2.86   1.10     0.29
1         65  2.71   1.13     0.14
Difference = mu (0) - mu (1)
```

Estimate for difference: 0.149
95% CI for difference: (-0.510, 0.809)
T-Test of difference = 0 (vs not =): T-Value = 0.45 P-Value = 0.653 DF = 77
Both use Pooled StDev = 1.1233

Two-Sample T-Test and CI: 9l, Involved

Two-sample T for 9l

Involved	N	Mean	StDev	SE Mean
0	14	3.86	1.23	0.33
1	66	3.12	1.20	0.15

Difference = mu (0) - mu (1)
Estimate for difference: 0.736
95% CI for difference: (0.032, 1.440)
T-Test of difference = 0 (vs not =): T-Value = 2.08 P-Value = 0.041 DF = 78
Both use Pooled StDev = 1.2023

Two-Sample T-Test and CI: 9m, Involved

Two-sample T for 9m

Involved	N	Mean	StDev	SE Mean
0	14	3.50	1.34	0.36
1	64	2.70	1.20	0.15

Difference = mu (0) - mu (1)
Estimate for difference: 0.797
95% CI for difference: (0.074, 1.519)
T-Test of difference = 0 (vs not =): T-Value = 2.20 P-Value = 0.031 DF = 76
Both use Pooled StDev = 1.2294

Two-Sample T-Test and CI: 9n, Involved

Two-sample T for 9n

Involved	N	Mean	StDev	SE Mean
0	14	2.79	1.12	0.30
1	67	2.33	1.30	0.16

Difference = mu (0) - mu (1)
Estimate for difference: 0.457
95% CI for difference: (-0.285, 1.199)
T-Test of difference = 0 (vs not =): T-Value = 1.23 P-Value = 0.224 DF = 79
Both use Pooled StDev = 1.2686

Two-Sample T-Test and CI: 9o, Involved

Two-sample T for 9o

Involved	N	Mean	StDev	SE Mean
0	14	3.71	1.27	0.34
1	65	3.46	1.15	0.14

Difference = mu (0) - mu (1)
Estimate for difference: 0.253
95% CI for difference: (-0.432, 0.938)
T-Test of difference = 0 (vs not =): T-Value = 0.73 P-Value = 0.465 DF = 77
Both use Pooled StDev = 1.1678

Two-Sample T-Test and CI: 9p, Involved

Two-sample T for 9p

Involved	N	Mean	StDev	SE Mean
0	14	3.36	1.22	0.32
1	66	3.62	1.12	0.14

Difference = mu (0) - mu (1)
Estimate for difference: -0.264
95% CI for difference: (-0.930, 0.402)
T-Test of difference = 0 (vs not =): T-Value = -0.79 P-Value = 0.432 DF = 78
Both use Pooled StDev = 1.1365

Two-Sample T-Test and CI: 10a, Involved

Two-sample T for 10a

Involved	N	Mean	StDev	SE Mean
0	14	3.36	1.22	0.32
1	63	3.49	1.31	0.16

Difference = mu (0) - mu (1)
Estimate for difference: -0.135
95% CI for difference: (-0.895, 0.625)
T-Test of difference = 0 (vs not =): T-Value = -0.35 P-Value = 0.725 DF = 75
Both use Pooled StDev = 1.2908

Two-Sample T-Test and CI: 10b, Involved

Two-sample T for 10b

Involved	N	Mean	StDev	SE Mean
0	14	2.64	1.08	0.29
1	64	2.94	1.21	0.15

Difference = mu (0) - mu (1)
Estimate for difference: -0.295
95% CI for difference: (-0.992, 0.403)
T-Test of difference = 0 (vs not =): T-Value = -0.84 P-Value = 0.403 DF = 76
Both use Pooled StDev = 1.1863

Two-Sample T-Test and CI: 10c, Involved

Two-sample T for 10c

Involved	N	Mean	StDev	SE Mean
0	14	3.29	1.27	0.34
1	64	3.38	1.05	0.13

Difference = mu (0) - mu (1)
Estimate for difference: -0.089

```
95% CI for difference:  (-0.728,
0.550)
T-Test of difference = 0 (vs not
=): T-Value = -0.28  P-Value =
0.782  DF = 76
Both use Pooled StDev = 1.0874
```

Two-Sample T-Test and CI: 10d, Involved

```
Two-sample T for 10d
Involved   N  Mean  StDev  SE Mean
0         14  3.57   1.40     0.37
1         64  3.41   1.23     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  0.165
95% CI for difference:  (-0.576,
0.906)
T-Test of difference = 0 (vs not
=): T-Value = 0.44  P-Value = 0.658
DF = 76
Both use Pooled StDev = 1.2611
```

Two-Sample T-Test and CI: 12b, Involved

```
Two-sample T for 12b
Involved   N  Mean  StDev  SE Mean
0         13  3.00   1.15     0.32
1         64  3.22   1.15     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.219
95% CI for difference:  (-0.915,
0.477)
T-Test of difference = 0 (vs not
=): T-Value = -0.63  P-Value =
0.533  DF = 75
Both use Pooled StDev = 1.1485
```

Two-Sample T-Test and CI: 12e, Involved

```
Two-sample T for 12e
Involved   N  Mean  StDev  SE Mean
0         13  3.23   1.01     0.28
1         63  2.87   1.20     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  0.358
95% CI for difference:  (-0.352,
1.068)
T-Test of difference = 0 (vs not
=): T-Value = 1.00  P-Value = 0.319
DF = 74
Both use Pooled StDev = 1.1700
```

Two-Sample T-Test and CI: 12f, Involved

```
Two-sample T for 12f
Involved   N  Mean  StDev  SE Mean
0         13  3.54   1.05     0.29
1         64  3.11   1.24     0.15
Difference = mu (0) - mu (1)
Estimate for difference:  0.429
```

```
95% CI for difference:  (-0.303,
1.161)
T-Test of difference = 0 (vs not
=): T-Value = 1.17  P-Value = 0.247
DF = 75
Both use Pooled StDev = 1.2081
```

Two-Sample T-Test and CI: 13a, Involved

```
Two-sample T for 13a
Involved   N  Mean  StDev  SE Mean
0         13  2.92   1.38     0.38
1         63  3.03   1.12     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.109
95% CI for difference:  (-0.817,
0.600)
T-Test of difference = 0 (vs not
=): T-Value = -0.31  P-Value =
0.761  DF = 74
Both use Pooled StDev = 1.1675
```

Two-Sample T-Test and CI: 13b, Involved

```
Two-sample T for 13b
Involved   N  Mean  StDev  SE Mean
0         13  3.85   1.21     0.34
1         64  3.66   1.10     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  0.190
95% CI for difference:  (-0.489,
0.869)
T-Test of difference = 0 (vs not
=): T-Value = 0.56  P-Value = 0.579
DF = 75
Both use Pooled StDev = 1.1203
```

Two-Sample T-Test and CI: 13c, Involved

```
Two-sample T for 13c
Involved   N   Mean  StDev  SE Mean
0         13  4.154  0.899     0.25
1         64   3.81   1.02     0.13
Difference = mu (0) - mu (1)
Estimate for difference:  0.341
95% CI for difference:  (-0.266,
0.949)
T-Test of difference = 0 (vs not
=): T-Value = 1.12  P-Value = 0.267
DF = 75
Both use Pooled StDev = 1.0029
```

Two-Sample T-Test and CI: 13e, Involved

```
Two-sample T for 13e
Involved   N   Mean  StDev  SE Mean
0         13  4.231  0.927     0.26
1         63  4.222  0.906     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.009
```

```
95% CI for difference:  (-0.543,
0.561)
T-Test of difference = 0 (vs not
=): T-Value = 0.03  P-Value = 0.975
DF = 74
Both use Pooled StDev = 0.9094
```

Two-Sample T-Test and CI: 10e, Involved

```
Two-sample T for 10e
Involved   N  Mean  StDev  SE Mean
0         14  4.21   1.05     0.28
1         64  4.05   1.05     0.13
Difference = mu (0) - mu (1)
Estimate for difference:  0.167
95% CI for difference:  (-0.447,
0.782)
T-Test of difference = 0 (vs not
=): T-Value = 0.54  P-Value = 0.589
DF = 76
Both use Pooled StDev = 1.0464
```

Two-Sample T-Test and CI: 13f, Involved

```
Two-sample T for 13f
Involved   N   Mean  StDev  SE Mean
0         13  4.077  0.954     0.26
1         62  4.129  0.914     0.12
Difference = mu (0) - mu (1)
Estimate for difference:  -0.052
95% CI for difference:  (-0.612,
0.508)
T-Test of difference = 0 (vs not
=): T-Value = -0.19  P-Value =
0.853  DF = 73
Both use Pooled StDev = 0.9208
```

Two-Sample T-Test and CI: 11c, Involved

```
Two-sample T for 11c
Involved   N  Mean  StDev  SE Mean
0         14  3.21   1.19     0.32
1         64  3.41   1.29     0.16


Difference = mu (0) - mu (1)
Estimate for difference:  -0.192
95% CI for difference:  (-0.942,
0.558)
T-Test of difference = 0 (vs not
=): T-Value = -0.51  P-Value =
0.612  DF = 76
Both use Pooled StDev = 1.2763
```

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Two-Sample T-Test and CI: 6a, Involved

```
Two-sample T for 6a
Involved    N  Mean  StDev  SE Mean
0          26  1.96   1.40     0.27
1         112  2.30   1.47     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.342
95% CI for difference:  (-0.969,
0.285)
T-Test of difference = 0 (vs not
=): T-Value = -1.08  P-Value =
0.283  DF = 136
Both use Pooled StDev = 1.4568
```

Two-Sample T-Test and CI: 6b, Involved

```
Two-sample T for 6b
Involved    N  Mean  StDev  SE Mean
0          25  1.68   1.28     0.26
1         108  2.11   1.42     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.431
95% CI for difference:  (-1.045,
0.183)
T-Test of difference = 0 (vs not
=): T-Value = -1.39  P-Value =
0.167  DF = 131
Both use Pooled StDev = 1.3982
```

Two-Sample T-Test and CI: 6c, Involved

```
Two-sample T for 6c
Involved    N  Mean  StDev  SE Mean
0          26  2.38   1.39     0.27
1         111  2.91   1.52     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.525
95% CI for difference:  (-1.171,
0.121)
T-Test of difference = 0 (vs not
=): T-Value = -1.61  P-Value =
0.110  DF = 135
Both use Pooled StDev = 1.4988
```

Two-Sample T-Test and CI: 6d, Involved

```
Two-sample T for 6d
Involved    N  Mean  StDev  SE Mean
0          27  3.22   1.42     0.27
1         109  3.23   1.46     0.14
Difference = mu (0) - mu (1)
Estimate for difference:  -0.007
95% CI for difference:  (-0.626,
0.612)
T-Test of difference = 0 (vs not
=): T-Value = -0.02  P-Value =
0.982  DF = 134
Both use Pooled StDev = 1.4556
```

Two-Sample T-Test and CI: 7, Involved

```
Two-sample T for 7
Involved    N  Mean  StDev  SE Mean
0          26  2.54   1.65     0.32
1         109  3.33   1.75     0.17
Difference = mu (0) - mu (1)
Estimate for difference:  -0.792
95% CI for difference:  (-1.539, -
0.044)
T-Test of difference = 0 (vs not
=): T-Value = -2.10  P-Value =
0.038  DF = 133
Both use Pooled StDev = 1.7311
```

Two-Sample T-Test and CI: 8a, Involved

```
Two-sample T for 8a
Involved   N   Mean  StDev  SE Mean
0         22  3.364  0.848     0.18
1        107   3.36   1.01    0.098
Difference = mu (0) - mu (1)
Estimate for difference:  -0.001
95% CI for difference:  (-0.458,
0.457)
T-Test of difference = 0 (vs not
=): T-Value = -0.00  P-Value =
0.997  DF = 127
Both use Pooled StDev = 0.9876
```

Two-Sample T-Test and CI: 8b, Involved

```
Two-sample T for 8b
Involved   N   Mean  StDev  SE Mean
0         22  3.364  0.790     0.17
1        107  3.252  0.991    0.096
Difference = mu (0) - mu (1)
Estimate for difference:  0.111
95% CI for difference:  (-0.334,
0.556)
T-Test of difference = 0 (vs not
=): T-Value = 0.49  P-Value = 0.622
DF = 127
Both use Pooled StDev = 0.9610
```

Two-Sample T-Test and CI: 8c, Involved

```
Two-sample T for 8c
Involved   N   Mean  StDev  SE Mean
0         20  2.900  0.788     0.18
1        104   2.99   1.17     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  -0.090
95% CI for difference:  (-0.631,
0.451)
T-Test of difference = 0 (vs not
=): T-Value = -0.33  P-Value =
0.741  DF = 122
Both use Pooled StDev = 1.1191
```

Two-Sample T-Test and CI: 8d, Involved

```
Two-sample T for 8d
Involved   N   Mean  StDev  SE Mean
0         22  3.273  0.883     0.19
1        107   3.26   1.01    0.098
Difference = mu (0) - mu (1)
Estimate for difference:  0.011
95% CI for difference:  (-0.449,
0.471)
T-Test of difference = 0 (vs not
=): T-Value = 0.05  P-Value = 0.962
DF = 127
Both use Pooled StDev = 0.9922
```

Two-Sample T-Test and CI: 8e, Involved

```
Two-sample T for 8e
Involved   N   Mean  StDev  SE Mean
0         21  3.286  0.644     0.14
1        106  3.434  0.995    0.097
Difference = mu (0) - mu (1)
Estimate for difference:  -0.148
95% CI for difference:  (-0.493,
0.196)
T-Test of difference = 0 (vs not
=): T-Value = -0.87  P-Value =
0.390  DF = 41
```

Two-Sample T-Test and CI: 8f, Involved

```
Two-sample T for 8f
Involved   N   Mean  StDev  SE Mean
0         22  3.182  0.958     0.20
1        107   3.12   1.01    0.097
Difference = mu (0) - mu (1)
Estimate for difference:  0.060
95% CI for difference:  (-0.402,
0.523)
T-Test of difference = 0 (vs not
=): T-Value = 0.26  P-Value = 0.797
DF = 127
Both use Pooled StDev = 0.9988
```

Two-Sample T-Test and CI: 8g, Involved

```
Two-sample T for 8g
Involved   N   Mean  StDev  SE Mean
0         22  3.091  0.868     0.19
1        106   2.96   1.04     0.10
Difference = mu (0) - mu (1)
Estimate for difference:  0.129
95% CI for difference:  (-0.342,
0.599)
T-Test of difference = 0 (vs not
=): T-Value = 0.54  P-Value = 0.589
DF = 126
Both use Pooled StDev = 1.0144
```

Two-Sample T-Test and CI: 10a, Involved

Two-sample T for 10a

Involved	N	Mean	StDev	SE Mean
0	19	2.58	1.02	0.23
1	106	2.42	1.19	0.12

Difference = mu (0) - mu (1)
Estimate for difference: 0.164
95% CI for difference: (-0.413, 0.741)
T-Test of difference = 0 (vs not =): T-Value = 0.56 P-Value = 0.575 DF = 123
Both use Pooled StDev = 1.1700

Two-Sample T-Test and CI: 10b, Involved

Two-sample T for 10b

Involved	N	Mean	StDev	SE Mean
0	19	1.79	1.08	0.25
1	105	1.80	1.10	0.11

Difference = mu (0) - mu (1)
Estimate for difference: -0.011
95% CI for difference: (-0.550, 0.529)
T-Test of difference = 0 (vs not =): T-Value = -0.04 P-Value = 0.969 DF = 122
Both use Pooled StDev = 1.0938

Two-Sample T-Test and CI: 10c, Involved

Two-sample T for 10c

Involved	N	Mean	StDev	SE Mean
0	19	1.79	1.23	0.28
1	102	1.98	1.14	0.11

Difference = mu (0) - mu (1)
Estimate for difference: -0.191
95% CI for difference: (-0.763, 0.381)
T-Test of difference = 0 (vs not =): T-Value = -0.66 P-Value = 0.510 DF = 119
Both use Pooled StDev = 1.1563

Two-Sample T-Test and CI: 10d, Involved

Two-sample T for 10d

Involved	N	Mean	StDev	SE Mean
0	18	3.89	1.13	0.27
1	104	3.750	0.963	0.094

Difference = mu (0) - mu (1)
Estimate for difference: 0.139
95% CI for difference: (-0.361, 0.639)
T-Test of difference = 0 (vs not =): T-Value = 0.55 P-Value = 0.583 DF = 120
Both use Pooled StDev = 0.9886

Two-Sample T-Test and CI: 10e, Involved

Two-sample T for 10e

Involved	N	Mean	StDev	SE Mean
0	18	3.44	1.38	0.33
1	104	3.769	0.997	0.098

Difference = mu (0) - mu (1)
Estimate for difference: -0.325
95% CI for difference: (-1.034, 0.384)
T-Test of difference = 0 (vs not =): T-Value = -0.96 P-Value = 0.351 DF = 20

Two-Sample T-Test and CI: 10f, Involved

Two-sample T for 10f

Involved	N	Mean	StDev	SE Mean
0	19	3.53	1.22	0.28
1	104	3.38	1.06	0.10

Difference = mu (0) - mu (1)
Estimate for difference: 0.151
95% CI for difference: (-0.386, 0.688)
T-Test of difference = 0 (vs not =): T-Value = 0.56 P-Value = 0.578 DF = 121
Both use Pooled StDev = 1.0875

Two-Sample T-Test and CI: 10g, Involved

Two-sample T for 10g

Involved	N	Mean	StDev	SE Mean
0	19	4.21	1.18	0.27
1	104	4.413	0.663	0.065

Difference = mu (0) - mu (1)
Estimate for difference: -0.203
95% CI for difference: (-0.785, 0.379)
T-Test of difference = 0 (vs not =): T-Value = -0.73 P-Value = 0.475 DF = 20

Two-Sample T-Test and CI: 10h, Involved

Two-sample T for 10h

Involved	N	Mean	StDev	SE Mean
0	19	3.74	1.33	0.30
1	102	3.57	1.12	0.11

Difference = mu (0) - mu (1)
Estimate for difference: 0.168
95% CI for difference: (-0.403, 0.740)
T-Test of difference = 0 (vs not =): T-Value = 0.58 P-Value = 0.561 DF = 119
Both use Pooled StDev = 1.1548

Two-Sample T-Test and CI: 10i, Involved

Two-sample T for 10i

Involved	N	Mean	StDev	SE Mean
0	18	2.33	1.08	0.26
1	103	2.39	1.16	0.11

Difference = mu (0) - mu (1)
Estimate for difference: -0.055
95% CI for difference: (-0.635, 0.525)
T-Test of difference = 0 (vs not =): T-Value = -0.19 P-Value = 0.851 DF = 119
Both use Pooled StDev = 1.1467

Two-Sample T-Test and CI: 10j, Involved

Two-sample T for 10j

Involved	N	Mean	StDev	SE Mean
0	18	3.44	1.29	0.30
1	104	3.942	0.923	0.090

Difference = mu (0) - mu (1)
Estimate for difference: -0.498
95% CI for difference: (-1.161, 0.166)
T-Test of difference = 0 (vs not =): T-Value = -1.57 P-Value = 0.133 DF = 20

Two-Sample T-Test and CI: 10k, Involved

Two-sample T for 10k

Involved	N	Mean	StDev	SE Mean
0	18	2.61	1.04	0.24
1	103	2.63	1.08	0.11

Difference = mu (0) - mu (1)
Estimate for difference: -0.020
95% CI for difference: (-0.565, 0.525)
T-Test of difference = 0 (vs not =): T-Value = -0.07 P-Value = 0.942 DF = 119
Both use Pooled StDev = 1.0779

Two-Sample T-Test and CI: 10l, Involved

Two-sample T for 10l

Involved	N	Mean	StDev	SE Mean
0	19	2.89	1.24	0.29
1	103	3.35	1.17	0.12

Difference = mu (0) - mu (1)
Estimate for difference: -0.455
95% CI for difference: (-1.038, 0.129)
T-Test of difference = 0 (vs not =): T-Value = -1.54 P-Value = 0.125 DF = 120
Both use Pooled StDev = 1.1804

Two-Sample T-Test and CI: 10m, Involved

Two-sample T for 10m

Involved	N	Mean	StDev	SE Mean
0	18	2.44	1.20	0.28
1	104	3.02	1.26	0.12

Difference = mu (0) - mu (1)
Estimate for difference: -0.575
95% CI for difference: (-1.208, 0.059)
T-Test of difference = 0 (vs not =): T-Value = -1.80 P-Value = 0.075 DF = 120
Both use Pooled StDev = 1.2530

Two-Sample T-Test and CI: 10n, Involved

Two-sample T for 10n

Involved	N	Mean	StDev	SE Mean
0	19	2.05	1.13	0.26
1	104	2.45	1.30	0.13

Difference = mu (0) - mu (1)
Estimate for difference: -0.399
95% CI for difference: (-1.029, 0.230)
T-Test of difference = 0 (vs not =): T-Value = -1.26 P-Value = 0.212 DF = 121
Both use Pooled StDev = 1.2750

Two-Sample T-Test and CI: 10o, Involved

Two-sample T for 10o

Involved	N	Mean	StDev	SE Mean
0	19	3.47	1.26	0.29
1	104	3.750	0.963	0.094

Difference = mu (0) - mu (1)
Estimate for difference: -0.276
95% CI for difference: (-0.777, 0.224)
T-Test of difference = 0 (vs not =): T-Value = -1.09 P-Value = 0.277 DF = 121
Both use Pooled StDev = 1.0133

Two-Sample T-Test and CI: 10p, Involved

Two-sample T for 10p

Involved	N	Mean	StDev	SE Mean
0	19	3.58	1.22	0.28
1	104	3.942	0.868	0.085

Difference = mu (0) - mu (1)
Estimate for difference: -0.363
95% CI for difference: (-0.970, 0.243)
T-Test of difference = 0 (vs not =): T-Value = -1.25 P-Value = 0.227 DF = 21

Two-Sample T-Test and CI: 9a, Involved

```
Two-sample T for 9a
Involved    N  Mean  StDev  SE Mean
0          22  3.50   1.10     0.23
1         108  3.47   1.08     0.10
Difference = mu (0) - mu (1)
Estimate for difference:  0.028
95% CI for difference:  (-0.474,
0.530)
T-Test of difference = 0 (vs not
=): T-Value = 0.11  P-Value = 0.913
DF = 128
Both use Pooled StDev = 1.0840
```

Two-Sample T-Test and CI: 9b, Involved

```
Two-sample T for 9b
Involved   N   Mean  StDev  SE Mean
0         22   3.41   1.10     0.23
1        107  3.178  0.979    0.095
Difference = mu (0) - mu (1)
Estimate for difference:  0.232
95% CI for difference:  (-0.232,
0.695)
T-Test of difference = 0 (vs not
=): T-Value = 0.99  P-Value = 0.324
DF = 127
Both use Pooled StDev = 0.9998
```

Two-Sample T-Test and CI: 9c, Involved

```
Two-sample T for 9c
Involved   N   Mean  StDev  SE Mean
0         22  3.545  0.963     0.21
1        108  3.556  0.921    0.089
Difference = mu (0) - mu (1)
Estimate for difference:  -0.010
95% CI for difference:  (-0.439,
0.419)
T-Test of difference = 0 (vs not
=): T-Value = -0.05  P-Value =
0.963  DF = 128
Both use Pooled StDev = 0.9275
```

Two-Sample T-Test and CI: 9d, Involved

```
Two-sample T for 9d
Involved    N  Mean  StDev  SE Mean
0          22  3.50   1.10     0.23
1         108  3.45   1.15     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  0.046
95% CI for difference:  (-0.481,
0.574)
T-Test of difference = 0 (vs not
=): T-Value = 0.17  P-Value = 0.862
DF = 128
Both use Pooled StDev = 1.1397
```

Two-Sample T-Test and CI: 11b, Involved

```
Two-sample T for 11b
Involved   N   Mean  StDev  SE Mean
0         17   3.35   1.27     0.31
1        104  3.317  0.927    0.091
Difference = mu (0) - mu (1)
Estimate for difference:  0.036
95% CI for difference:  (-0.472,
0.544)
T-Test of difference = 0 (vs not
=): T-Value = 0.14  P-Value = 0.890
DF = 119
Both use Pooled StDev = 0.9805
```

Two-Sample T-Test and CI: 11d, Involved

```
Two-sample T for 11d
Involved   N   Mean  StDev  SE Mean
0         17  2.588  0.870     0.21
1        104   2.86   1.15     0.11
Difference = mu (0) - mu (1)
Estimate for difference:  -0.268
95% CI for difference:  (-0.847,
0.312)
T-Test of difference = 0 (vs not
=): T-Value = -0.91  P-Value =
0.363  DF = 119
Both use Pooled StDev = 1.1188
```

Two-Sample T-Test and CI: 11e, Involved

```
Two-sample T for 11e
Involved    N  Mean  StDev  SE Mean
0          17  2.94   1.30     0.31
1         104  3.16   1.19     0.12
Difference = mu (0) - mu (1)
Estimate for difference:  -0.222
95% CI for difference:  (-0.847,
0.403)
T-Test of difference = 0 (vs not
=): T-Value = -0.70  P-Value =
0.483  DF = 119
Both use Pooled StDev = 1.2063
```

Two-Sample T-Test and CI: 12a, Involved

```
Two-sample T for 12a
Involved   N   Mean  StDev  SE Mean
0         18  3.500  0.985     0.23
1        104  3.317  0.948    0.093
Difference = mu (0) - mu (1)
Estimate for difference:  0.183
95% CI for difference:  (-0.299,
0.664)
T-Test of difference = 0 (vs not
=): T-Value = 0.75  P-Value = 0.454
DF = 120
Both use Pooled StDev = 0.9532
```

Two-Sample T-Test and CI: 12b, Involved

Two-sample T for 12b

Involved	N	Mean	StDev	SE Mean
0	18	3.83	1.10	0.26
1	104	3.923	0.900	0.088

Difference = mu (0) - mu (1)
Estimate for difference: -0.090
95% CI for difference: (-0.560, 0.381)
T-Test of difference = 0 (vs not =): T-Value = -0.38 P-Value = 0.706 DF = 120
Both use Pooled StDev = 0.9304

Two-Sample T-Test and CI: 12c, Involved

Two-sample T for 12c

Involved	N	Mean	StDev	SE Mean
0	18	3.67	1.03	0.24
1	103	3.874	0.750	0.074

Difference = mu (0) - mu (1)
Estimate for difference: -0.207
95% CI for difference: (-0.610, 0.195)
T-Test of difference = 0 (vs not =): T-Value = -1.02 P-Value = 0.310 DF = 119
Both use Pooled StDev = 0.7958

Two-Sample T-Test and CI: 12e, Involved

Two-sample T for 12e

Involved	N	Mean	StDev	SE Mean
0	18	4.17	1.25	0.29
1	103	4.350	0.637	0.063

Difference = mu (0) - mu (1)
Estimate for difference: -0.183
95% CI for difference: (-0.815, 0.449)
T-Test of difference = 0 (vs not =): T-Value = -0.61 P-Value = 0.551 DF = 18

Two-Sample T-Test and CI: 9e, Involved

Two-sample T for 9e

Involved	N	Mean	StDev	SE Mean
0	22	3.91	1.11	0.24
1	108	4.343	0.751	0.072

Difference = mu (0) - mu (1)
Estimate for difference: -0.434
95% CI for difference: (-0.943, 0.076)
T-Test of difference = 0 (vs not =): T-Value = -1.75 P-Value = 0.092 DF = 25

Two-Sample T-Test and CI: 13c, Involved

Two-sample T for 13c

Involved	N	Mean	StDev	SE Mean
0	18	3.39	1.79	0.42
1	102	4.01	1.24	0.12

Difference = mu (0) - mu (1)
Estimate for difference: -0.621
95% CI for difference: (-1.539, 0.297)
T-Test of difference = 0 (vs not =): T-Value = -1.42 P-Value = 0.173 DF = 19

Two-Sample T-Test and CI: 14a, Involved

Two-sample T for 14a

Involved	N	Mean	StDev	SE Mean
0	18	3.33	1.28	0.30
1	97	3.443	0.957	0.097

Difference = mu (0) - mu (1)
Estimate for difference: -0.110
95% CI for difference: (-0.625, 0.405)
T-Test of difference = 0 (vs not =): T-Value = -0.42 P-Value = 0.673 DF = 113
Both use Pooled StDev = 1.0129

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Two-Sample T-Test and CI: 6a, Involved

```
Two-sample T for 6a
Involved   N   Mean  StDev  SE Mean
0         12  1.167  0.389     0.11
1         34   2.03   1.45     0.25
Difference = mu (0) - mu (1)
Estimate for difference:  -0.863
95% CI for difference:  (-1.412, -
0.313)
T-Test of difference = 0 (vs not
=): T-Value = -3.17  P-Value =
0.003  DF = 42
```

Two-Sample T-Test and CI: 6b, Involved

```
Two-sample T for 6b
Involved   N   Mean  StDev  SE Mean
0         12  1.083  0.289    0.083
1         35   1.83   1.22     0.21
Difference = mu (0) - mu (1)
Estimate for difference:  -0.745
95% CI for difference:  (-1.195, -
0.295)
T-Test of difference = 0 (vs not
=): T-Value = -3.34  P-Value =
0.002  DF = 42
```

Two-Sample T-Test and CI: 6c, Involved

```
Two-sample T for 6c
Involved   N  Mean  StDev  SE Mean
0         12  1.75   1.06     0.30
1         35  3.06   1.47     0.25
Difference = mu (0) - mu (1)
Estimate for difference:  -1.307
95% CI for difference:  (-2.239, -
0.375)
T-Test of difference = 0 (vs not
=): T-Value = -2.82  P-Value =
0.007  DF = 45
Both use Pooled StDev = 1.3835
```

Two-Sample T-Test and CI: 6d, Involved

```
Two-sample T for 6d
Involved   N  Mean  StDev  SE Mean
0         12  2.75   1.48     0.43
1         34  3.29   1.49     0.26
Difference = mu (0) - mu (1)
Estimate for difference:  -0.544
95% CI for difference:  (-1.550,
0.462)
T-Test of difference = 0 (vs not
=): T-Value = -1.09  P-Value =
0.282  DF = 44
Both use Pooled StDev = 1.4871
```

Two-Sample T-Test and CI: 7, Involved

```
Two-sample T for 7
Involved   N  Mean  StDev  SE Mean
0         12  2.75   1.71     0.49
1         35  3.34   1.76     0.30
Difference = mu (0) - mu (1)
Estimate for difference:  -0.593
95% CI for difference:  (-1.773,
0.588)
T-Test of difference = 0 (vs not
=): T-Value = -1.01  P-Value =
0.317  DF = 45
Both use Pooled StDev = 1.7521
```

Two-Sample T-Test and CI: 8a, Involved

```
Two-sample T for 8a
Involved   N   Mean  StDev  SE Mean
0          8  3.000  0.535     0.19
1         33   3.39   1.03     0.18
Difference = mu (0) - mu (1)
Estimate for difference:  -0.394
95% CI for difference:  (-1.158,
0.371)
T-Test of difference = 0 (vs not
=): T-Value = -1.04  P-Value =
0.304  DF = 39
Both use Pooled StDev = 0.9592
```

Two-Sample T-Test and CI: 8b, Involved

```
Two-sample T for 8b
Involved   N   Mean  StDev  SE Mean
0          8  3.375  0.518     0.18
1         33   3.27   1.01     0.18
Difference = mu (0) - mu (1)
Estimate for difference:  0.102
95% CI for difference:  (-0.647,
0.851)
T-Test of difference = 0 (vs not
=): T-Value = 0.28  P-Value = 0.784
DF = 39
Both use Pooled StDev = 0.9395
```

Two-Sample T-Test and CI: 8c, Involved

```
Two-sample T for 8c
Involved   N   Mean  StDev  SE Mean
0          7  2.857  0.900     0.34
1         33   3.03   1.33     0.23
Difference = mu (0) - mu (1)
Estimate for difference:  -0.173
95% CI for difference:  (-1.248,
0.901)
T-Test of difference = 0 (vs not
=): T-Value = -0.33  P-Value =
0.746  DF = 38
```

Both use Pooled StDev = 1.2755

Two-Sample T-Test and CI: 8d, Involved

Two-sample T for 8d

Involved	N	Mean	StDev	SE Mean
0	7	3.571	0.787	0.30
1	33	3.30	1.02	0.18

Difference = mu (0) - mu (1)
Estimate for difference: 0.268
95% CI for difference: (-0.559, 1.096)
T-Test of difference = 0 (vs not =): T-Value = 0.66 P-Value = 0.515 DF = 38
Both use Pooled StDev = 0.9825

Two-Sample T-Test and CI: 8e, Involved

Two-sample T for 8e

Involved	N	Mean	StDev	SE Mean
0	8	3.125	0.641	0.23
1	32	3.47	1.08	0.19

Difference = mu (0) - mu (1)
Estimate for difference: -0.344
95% CI for difference: (-1.153, 0.465)
T-Test of difference = 0 (vs not =): T-Value = -0.86 P-Value = 0.395 DF = 38
Both use Pooled StDev = 1.0110

Two-Sample T-Test and CI: 8f, Involved

Two-sample T for 8f

Involved	N	Mean	StDev	SE Mean
0	8	2.750	0.707	0.25
1	33	3.30	1.13	0.20

Difference = mu (0) - mu (1)
Estimate for difference: -0.553
95% CI for difference: (-1.404, 0.298)
T-Test of difference = 0 (vs not =): T-Value = -1.31 P-Value = 0.196 DF = 39
Both use Pooled StDev = 1.0678

Two-Sample T-Test and CI: 8g, Involved

Two-sample T for 8g

Involved	N	Mean	StDev	SE Mean
0	8	2.63	1.06	0.37
1	33	3.15	1.09	0.19

Difference = mu (0) - mu (1)
Estimate for difference: -0.527
95% CI for difference: (-1.393, 0.340)
T-Test of difference = 0 (vs not =): T-Value = -1.23 P-Value = 0.227 DF = 39
Both use Pooled StDev = 1.0874

Two-Sample T-Test and CI: 10a, Involved

Two-sample T for 10a

Involved	N	Mean	StDev	SE Mean
0	8	1.625	0.744	0.26
1	31	2.19	1.19	0.21

Difference = mu (0) - mu (1)
Estimate for difference: -0.569
95% CI for difference: (-1.471, 0.334)
T-Test of difference = 0 (vs not =): T-Value = -1.28 P-Value = 0.210 DF = 37
Both use Pooled StDev = 1.1236

Two-Sample T-Test and CI: 10b, Involved

Two-sample T for 10b

Involved	N	Mean	StDev	SE Mean
0	8	1.250	0.707	0.25
1	31	1.581	0.923	0.17

Difference = mu (0) - mu (1)
Estimate for difference: -0.331
95% CI for difference: (-1.043, 0.381)
T-Test of difference = 0 (vs not =): T-Value = -0.94 P-Value = 0.353 DF = 37
Both use Pooled StDev = 0.8861
'

Two-Sample T-Test and CI: 10c, Involved

Two-sample T for 10c

Involved	N	Mean	StDev	SE Mean
0	8	1.500	0.535	0.19
1	31	1.84	1.16	0.21

Difference = mu (0) - mu (1)
Estimate for difference: -0.339
95% CI for difference: (-0.917, 0.240)
T-Test of difference = 0 (vs not =): T-Value = -1.21 P-Value = 0.239 DF = 25

Two-Sample T-Test and CI: 10d, Involved

Two-sample T for 10d

Involved	N	Mean	StDev	SE Mean
0	8	4.125	0.641	0.23
1	31	3.61	1.02	0.18

Difference = mu (0) - mu (1)
Estimate for difference: 0.512
95% CI for difference: (-0.261, 1.285)
T-Test of difference = 0 (vs not =): T-Value = 1.34 P-Value = 0.188 DF = 37
Both use Pooled StDev = 0.9618

Two-Sample T-Test and CI: 10e, Involved

```
Two-sample T for 10e
Involved    N   Mean  StDev  SE Mean
0           8  4.250  0.707     0.25
1          31  3.839  0.969     0.17
Difference = mu (0) - mu (1)
Estimate for difference:  0.411
95% CI for difference:  (-0.332,
1.155)
T-Test of difference = 0 (vs not
=): T-Value = 1.12  P-Value = 0.270
DF = 37
Both use Pooled StDev = 0.9255
```

Two-Sample T-Test and CI: 10f, Involved

```
Two-sample T for 10f
Involved    N   Mean  StDev  SE Mean
0           8  3.625  0.744     0.26
1          31   3.48   1.26     0.23
Difference = mu (0) - mu (1)
Estimate for difference:  0.141
95% CI for difference:  (-0.808,
1.090)
T-Test of difference = 0 (vs not
=): T-Value = 0.30  P-Value = 0.765
DF = 37
Both use Pooled StDev = 1.1811
```

Two-Sample T-Test and CI: 10g, Involved

```
Two-sample T for 10g
Involved    N   Mean  StDev  SE Mean
0           8  4.375  0.744     0.26
1          31   4.19   1.11     0.20
Difference = mu (0) - mu (1)
Estimate for difference:  0.181
95% CI for difference:  (-0.661,
1.024)
T-Test of difference = 0 (vs not
=): T-Value = 0.44  P-Value = 0.665
DF = 37
Both use Pooled StDev = 1.0490
```

Two-Sample T-Test and CI: 10h, Involved

```
Two-sample T for 10h
Involved    N   Mean  StDev  SE Mean
0           8  3.875  0.991     0.35
1          31   3.74   1.06     0.19
Difference = mu (0) - mu (1)
Estimate for difference:  0.133
95% CI for difference:  (-0.711,
0.977)
T-Test of difference = 0 (vs not
=): T-Value = 0.32  P-Value = 0.751
DF = 37
Both use Pooled StDev = 1.0502
```

Two-Sample T-Test and CI: 10i, Involved

```
Two-sample T for 10i
Involved    N   Mean  StDev  SE Mean
0           8   2.38   1.51     0.53
1          31  2.323  0.979     0.18
Difference = mu (0) - mu (1)
Estimate for difference:  0.052
95% CI for difference:  (-0.830,
0.935)
T-Test of difference = 0 (vs not
=): T-Value = 0.12  P-Value = 0.905
DF = 37
Both use Pooled StDev = 1.0985
```

Two-Sample T-Test and CI: 10j, Involved

```
Two-sample T for 10j
Involved    N  Mean  StDev  SE Mean
0           8  4.00   1.41     0.50
1          31  3.71   1.16     0.21
Difference = mu (0) - mu (1)
Estimate for difference:  0.290
95% CI for difference:  (-0.684,
1.264)
T-Test of difference = 0 (vs not
=): T-Value = 0.60  P-Value = 0.550
DF = 37
Both use Pooled StDev = 1.2124
```

Two-Sample T-Test and CI: 10k, Involved

```
Two-sample T for 10k
Involved    N   Mean  StDev  SE Mean
0           8  2.250  0.707     0.25
1          31   2.71   1.10     0.20
Difference = mu (0) - mu (1)
Estimate for difference:  -0.460
95% CI for difference:  (-1.294,
0.375)
T-Test of difference = 0 (vs not
=): T-Value = -1.12  P-Value =
0.271  DF = 37
Both use Pooled StDev = 1.0383
```

Two-Sample T-Test and CI: 10l, Involved

```
Two-sample T for 10l
Involved    N  Mean  StDev  SE Mean
0           8  2.75   1.58     0.56
1          30  3.17   1.15     0.21
Difference = mu (0) - mu (1)
Estimate for difference:  -0.417
95% CI for difference:  (-1.420,
0.587)
T-Test of difference = 0 (vs not
=): T-Value = -0.84  P-Value =
0.405  DF = 36
Both use Pooled StDev = 1.2435
```

Two-Sample T-Test and CI: 10m, Involved

```
Two-sample T for 10m
Involved   N  Mean  StDev  SE Mean
0          8  2.13   1.13     0.40
1         31  2.58   1.20     0.22
Difference = mu (0) - mu (1)
Estimate for difference:  -0.456
95% CI for difference:  (-1.412,
0.501)
T-Test of difference = 0 (vs not
=): T-Value = -0.97  P-Value =
0.341  DF = 37
Both use Pooled StDev = 1.1903
```

Two-Sample T-Test and CI: 10n, Involved

```
Two-sample T for 10n
Involved   N  Mean  StDev  SE Mean
0          8  2.25   1.28     0.45
1         31  2.10   1.19     0.21
Difference = mu (0) - mu (1)
Estimate for difference:  0.153
95% CI for difference:  (-0.819,
1.126)
T-Test of difference = 0 (vs not
=): T-Value = 0.32  P-Value = 0.751
DF = 37
Both use Pooled StDev = 1.2104
```

Two-Sample T-Test and CI: 10o, Involved

```
Two-sample T for 10o
Involved   N  Mean  StDev  SE Mean
0          8  3.38   1.30     0.46
1         31  3.68   1.11     0.20
Difference = mu (0) - mu (1)
Estimate for difference:  -0.302
95% CI for difference:  (-1.224,
0.619)
T-Test of difference = 0 (vs not
=): T-Value = -0.67  P-Value =
0.510  DF = 37
Both use Pooled StDev = 1.1467
```

Two-Sample T-Test and CI: 10p, Involved

```
Two-sample T for 10p
Involved   N   Mean  StDev  SE Mean
0          8  4.125  0.991     0.35
1         31   3.61   1.05     0.19
Difference = mu (0) - mu (1)
Estimate for difference:  0.512
95% CI for difference:  (-0.326,
1.350)
T-Test of difference = 0 (vs not
=): T-Value = 1.24  P-Value = 0.223
DF = 37
Both use Pooled StDev = 1.0427
```

Two-Sample T-Test and CI: 9a, Involved

```
Two-sample T for 9a
Involved   N  Mean  StDev  SE Mean
0          8  3.50   1.07     0.38
1         33  3.27   1.10     0.19
Difference = mu (0) - mu (1)
Estimate for difference:  0.227
95% CI for difference:  (-0.644,
1.098)
T-Test of difference = 0 (vs not
=): T-Value = 0.53  P-Value = 0.601
DF = 39
Both use Pooled StDev = 1.0925
```

Two-Sample T-Test and CI: 11i, Involved

```
Two-sample T for 11i
Involved   N   Mean  StDev  SE Mean
0          8  2.875  0.641     0.23
1         30   3.20   1.27     0.23
Difference = mu (0) - mu (1)
Estimate for difference:  -0.325
95% CI for difference:  (-1.273,
0.623)
T-Test of difference = 0 (vs not
=): T-Value = -0.70  P-Value =
0.491  DF = 36
Both use Pooled StDev = 1.1747
```

Two-Sample T-Test and CI: 9c, Involved

```
Two-sample T for 9c
Involved   N  Mean  StDev  SE Mean
0          8  3.25   1.04     0.37
1         33  3.48   1.06     0.19
Difference = mu (0) - mu (1)
Estimate for difference:  -0.235
95% CI for difference:  (-1.079,
0.609)
T-Test of difference = 0 (vs not
=): T-Value = -0.56  P-Value =
0.577  DF = 39
Both use Pooled StDev = 1.0591
```

Two-Sample T-Test and CI: 9d, Involved

```
Two-sample T for 9d
Involved   N  Mean  StDev  SE Mean
0          8  3.50   1.07     0.38
1         32  3.38   1.36     0.24
Difference = mu (0) - mu (1)
Estimate for difference:  0.125
95% CI for difference:  (-0.926,
1.176)
T-Test of difference = 0 (vs not
=): T-Value = 0.24  P-Value = 0.811
DF = 38
Both use Pooled StDev = 1.3129
```

Two-Sample T-Test and CI: 11c, Involved

Two-sample T for 11c

Involved	N	Mean	StDev	SE Mean
0	8	3.00	1.07	0.38
1	30	3.37	1.25	0.23

Difference = mu (0) - mu (1)
Estimate for difference: -0.367
95% CI for difference: (-1.346, 0.612)
T-Test of difference = 0 (vs not =): T-Value = -0.76 P-Value = 0.452 DF = 36
Both use Pooled StDev = 1.2130

Two-Sample T-Test and CI: 11f, Involved

Two-sample T for 11f

Involved	N	Mean	StDev	SE Mean
0	8	3.250	0.886	0.31
1	30	2.87	1.25	0.23

Difference = mu (0) - mu (1)
Estimate for difference: 0.383
95% CI for difference: (-0.577, 1.344)
T-Test of difference = 0 (vs not =): T-Value = 0.81 P-Value = 0.423 DF = 36
Both use Pooled StDev = 1.1898

Two-Sample T-Test and CI: 11h, Involved

Two-sample T for 11h

Involved	N	Mean	StDev	SE Mean
0	8	3.750	0.886	0.31
1	30	3.17	1.44	0.26

Difference = mu (0) - mu (1)
Estimate for difference: 0.583
95% CI for difference: (-0.507, 1.673)
T-Test of difference = 0 (vs not =): T-Value = 1.09 P-Value = 0.285 DF = 36
Both use Pooled StDev = 1.3506

Two-Sample T-Test and CI: 12a, Involved

Two-sample T for 12a

Involved	N	Mean	StDev	SE Mean
0	8	2.875	0.991	0.35
1	30	3.10	1.09	0.20

Difference = mu (0) - mu (1)
Estimate for difference: -0.225
95% CI for difference: (-1.092, 0.642)
T-Test of difference = 0 (vs not =): T-Value = -0.53 P-Value = 0.602 DF = 36
Both use Pooled StDev = 1.0746

Two-Sample T-Test and CI: 12b, Involved

Two-sample T for 12b

Involved	N	Mean	StDev	SE Mean
0	8	3.750	0.707	0.25
1	30	3.67	1.03	0.19

Difference = mu (0) - mu (1)
Estimate for difference: 0.083
95% CI for difference: (-0.703, 0.870)
T-Test of difference = 0 (vs not =): T-Value = 0.21 P-Value = 0.831 DF = 36
Both use Pooled StDev = 0.9742

Two-Sample T-Test and CI: 12c, Involved

Two-sample T for 12c

Involved	N	Mean	StDev	SE Mean
0	8	3.750	0.886	0.31
1	30	3.63	1.16	0.21

Difference = mu (0) - mu (1)
Estimate for difference: 0.117
95% CI for difference: (-0.780, 1.014)
T-Test of difference = 0 (vs not =): T-Value = 0.26 P-Value = 0.793 DF = 36
Both use Pooled StDev = 1.1114

Two-Sample T-Test and CI: 12e, Involved

Two-sample T for 12e

Involved	N	Mean	StDev	SE Mean
0	8	3.875	0.641	0.23
1	30	4.07	1.01	0.19

Difference = mu (0) - mu (1)
Estimate for difference: -0.192
95% CI for difference: (-0.961, 0.578)
T-Test of difference = 0 (vs not =): T-Value = -0.51 P-Value = 0.617 DF = 36
Both use Pooled StDev = 0.9537

Two-Sample T-Test and CI: 12f, Involved

Two-sample T for 12f

Involved	N	Mean	StDev	SE Mean
0	8	4.250	0.886	0.31
1	30	4.267	0.868	0.16

Difference = mu (0) - mu (1)
Estimate for difference: -0.017
95% CI for difference: (-0.720, 0.687)
T-Test of difference = 0 (vs not =): T-Value = -0.05 P-Value = 0.962 DF = 36
Both use Pooled StDev = 0.8719

Two-Sample T-Test and CI: 12g, Involved

```
Two-sample T for 12g
Involved   N   Mean  StDev  SE Mean
0          8  4.000  0.926     0.33
1         30  4.167  0.874     0.16
Difference = mu (0) - mu (1)
Estimate for difference:  -0.167
95% CI for difference:  (-0.880,
0.547)
T-Test of difference = 0 (vs not
=): T-Value = -0.47  P-Value =
0.639  DF = 36
Both use Pooled StDev = 0.8845
```

Two-Sample T-Test and CI: 14d, Involved

```
Two-sample T for 14d
Involved   N  Mean  StDev  SE Mean
0          8  2.88   1.36     0.48
1         29  3.59   1.24     0.23
Difference = mu (0) - mu (1)
Estimate for difference:  -0.711
95% CI for difference:  (-1.736,
0.313)
T-Test of difference = 0 (vs not
=): T-Value = -1.41  P-Value =
0.168  DF = 35
Both use Pooled StDev = 1.2639
```

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