Assessing Sustainability of the Continuous Improvement Through the Identification of Enabling and Inhibiting Factors

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ABSTRACT

This research presents results of innovation management practices and sustainability of continuous improvement. Innovation is recognized as a growth tool for economies in general however not all economy sectors have innovation as a strategy. This research served as a case study to analyze how innovation is managed within innovative firms to help less innovative sectors, such as the wood products industry, to become profitable. Among the observed innovation management practices, this study was able to identify the use of continuous improvement to support incremental innovation. Although, continuous improvement is well known and accepted, there are still challenges to reach a sustainable state of continuous improvement. This research also addresses the difficulty in sustaining continuous improvement through a longitudinal case study.

A literature review was conducted to identify factors influencing the sustainability of the continuous improvement. These factors were gathered within a research framework which functioned as the main source to establish the questionnaire used as the research tool. Utilizing this tool, the study evaluated the hypotheses relating to the effects of time, location and company type on the behavior of the enabling and inhibiting factors, and the relationships among them. Results demonstrated that time has no effect on factors affecting the sustainability of the continuous improvement, although changes affect how the factors are perceived as success factors in sustaining continuous improvement. The study also concluded that type of company and location impact how the inhibiting and enabling factors are perceived as supporters of the sustainability of the continuous improvement. Finally, the study revealed that these factors are correlated among them, thus sustainability is the result of a dynamic multifactor process rather that an unique factor.

In addition to this new framework, the study also developed a self-assessment tool to be used for continuous improvement practitioners. With this tool, the new developed framework can be continuously monitored and proper and informed action can be taken by managers to address any observed gap in sustaining continuous improvement. Finally, the study also brings an example of interdisciplinary research which gathers quantitative methods from the statistics field, and qualitative methods from the business and social science fields.

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1. Introduction

1.1. Research Motivation

As companies move toward the future, they face new challenges and difficulties to remain sustainable. Moreover, globalization has raised customer awareness of new tendencies in the market resulting in higher expectations of products and services to fulfill their needs. Increasingly, firms are searching for novel ways to satisfy new expectations while continuing to profit. Since there is no magic formula for success, firms are constantly undergoing a trial-and-error loop in search of excellence.

Although there is no single direction that leads to success, networking structures among industries have proven an accurate tool for identifying management methodologies for achieving performance. Some examples include Ford Motor Company's moving assembly line in early 1900s, statistical quality control introduced by Western Electric in mid 1920s, the continuous improvement methodology shared by Toyota Motor in the mid 1940s and the Six Sigma methodology introduced by Motorola in late 1980s [1].

Today's practitioners suggest that, in a highly competitive world, firms should focus on retaining current customers by adding value to what is offered, and gaining new customers by innovating the market [2]. This is extremely challenging since it requires organizations to be able to predict what is needed and, at the same time, be able to discover future opportunities.

Because innovation breaks all the traditional management structure inside companies, this research sought to understand how to support innovation as a road to growth. Madrigal & Quesada [3] performed preliminary research to identify what best practices are frequently employed at innovative industries. Findings allowed the researchers to recognize the use of continuous improvement (CI) methodology to support incremental innovation. The apparent potential for CI to support innovation, specifically incremental innovation, is impressive. It appears that CI-oriented organizations have defined a training structure that allows dissemination of knowledge across all levels of the organization; workers are more creative , more tolerant of failure, and more willing to take risks to develop solutions to current needs [4-6]. However, despite the popularity of CI and the recognized benefits, the CI methodology has proven to be difficult to sustain [7-9].

The current body of knowledge regarding CI is focused on aspects of implementation, demonstrates various potential management models, and identifies areas where management dimensions are lacking or are costly to apply in real settings. [10, 11]. Although, current models and guidelines are very useful for practitioners of CI, a widely accepted methodology for the implementation of CI has yet to be identified. Therefore, there is a strong need for additional research on how to support CI to achieve its full potential to support incremental innovation inside firms.

1.2. Research Questions

The prevailing research question for this study is: *What are factors that affect the sustainability of the continuous improvement process?*. Within this overall research question, the following sub-questions arise:

- *What is the effect of time on the sustainability of CI?*
- *What is the effect of the geographic location of firms on the sustainability of CI?*
- *What is the relationship between the identified factors?*
- *What are the steps recommended for practitioners when implementing CI to ensure sustainability?*

To answer these questions this study aims to conduct a longitudinal multi-site field study for an in-depth analysis of the CI process and examine the effects of identified variables which refine and sustain the implementation of the CI process.

To answer these questions this study aims to conduct a longitudinal multi-site field study, to deeply analyze the CI process and to test the effect of the variables to refine the implementation and sustain the CI orientation.

1.3. Research Purpose and Objectives

The primary goal of this study was to expand the body of knowledge regarding CI within firms - that is, to increase our understanding of what factors affect the sustainability of CI, the perception of how these factors are contributing to CI inside firms, and what steps companies should follow to achieve this sustainability. This research will fulfill these needs by increasing the current knowledge on CI and proposing a set of recommendations for practitioners to sustain CI. The proposed study identified the following specific objectives:

- To identify the factors needed to sustain CI.
- To construct and validate a measurement tool to evaluate perceptions of workers regarding how these factors contribute to CI sustainability.
- To evaluate the effect of time, region and type of industry on the factors affecting CI sustainability.
- To test the relationship among the identified factors.
- To develop a set of guidelines and recommendations for organizations and researchers to sustain the CI process.

1.4. Problem Statement

As observed in the preliminary work conduced, the ability to innovate is extremely important to supporting economic growth. Also, innovation is related to different practices where CI philosophy is a recognized supporter of incremental innovation by unleashing creativity and inventiveness. Thus, CI as a philosophy still faces many challenges, and one of them is to remain sustainable. Therefore, this research used a multiple case study approach to empirically test the preliminary hypothesis of factors affecting CI sustainability. This was achieved by identifying factors from the literature, testing the effect of time and region on these factors, recognizing the existing relationship among the factors, and drawing conclusions through causal relationship analysis. While CI is a very popular method used to achieve better performance, there is still a lack of evidence suggesting how industries can sustain CI. Furthermore, current CI management models lack longitudinal analysis, and are mainly focused in one region, limiting the ability to compare CI management practices on a global scale.

To fully address the identified gap of knowledge, this study will deconstruct the main problem using the following objectives:

- *Objective 1.To identify the factors needed to sustain CI*. This sub-problem was addressed by conducting an extensive literature review. This resulted in a set of seven initial key factors identified by academia and industry practitioners. These factors were submitted to list of experts on the subject for validation.
- *Objective 2.To construct and validate a measurement tool to evaluate perceptions of workers regarding how these factors contribute to CI sustainability.* The research tool was influenced by the literature review conducted. Items to evaluate each factor were also supported by the Malcolm Baldrige Award framework. The instrument developed was submitted to experts on the topics for feedback. Also Cronbach's α was used to test the internal validity of items within the questionnaire. Confirmatory and exploratory factor analysis were conducted to confirm the structure of the constructs.
- *Objective 3. To evaluate the effect of time, region and type of industry on the factors affecting CI sustainability.* This study tested a set of hypotheses to identify significant differences among employees’ perceptions of these factors based on the proposed variables. This analysis was conducted using Analysis of Variance (ANOVA) in the statistical software SAS.
- *Objective 4. To characterize the relationship among the identified factors*. The relationships among the factors were identified and characterized using a correlation analysis. The testing was performed with the statistical software SAS.
- *Objective 5.To develop a set of guidelines and recommendations for organizations and researchers to sustain the CI process.* This sub-problem involved the statistical analysis previously performed, as well the interpretation of results using the observations collected through interviews and site visits.

The outcomes for the objectives are:

- *Objective 1. Identify the factors needed to sustain CI*. A list of factors affecting the sustainability of CI. Chapter 4 describes the literature review conducted and the identified factors.
- *Objective 2.Construct a measurement tool to evaluate perceptions of workers on how these factors contribute to sustain CI.* The research tool developed consisted of a questionnaire with 60 items. The validation of the tool is described in Chapter 5 and the tool can be found in Appendix A.
- *Objective 3. Evaluate the effect of time, region and type of industry on the factors affecting the sustainability of CI.* A set of hypotheses were developed. ANOVA analysis provided results suggesting how the time, region and type of industry influences the constructs.
- *Objective 4. Test the relationship among the identified factors*. The results of the correlation analysis enabled the study to construct a model displaying the existing relationships among the constructs.
- *Objective 5. Develop a set of guidelines and recommendations for organizations and researchers to sustain the CI process.* The guidelines include recommendations about which constructs affect CI sustainability. Also, the guidelines provide a set of concrete actions that companies can take to address each factor observed at the participating industries.

1.5. Proposed Research Framework and Definitions

In order to conduct the study, a preliminary research framework of the factors affecting CI sustainability was proposed (Figure 1). The preliminary research framework depicts the hypothesized relationship between the evaluated items (represented as V_n) and their corresponding constructs. This initially proposed framework was refined as validation of constructs was performed.

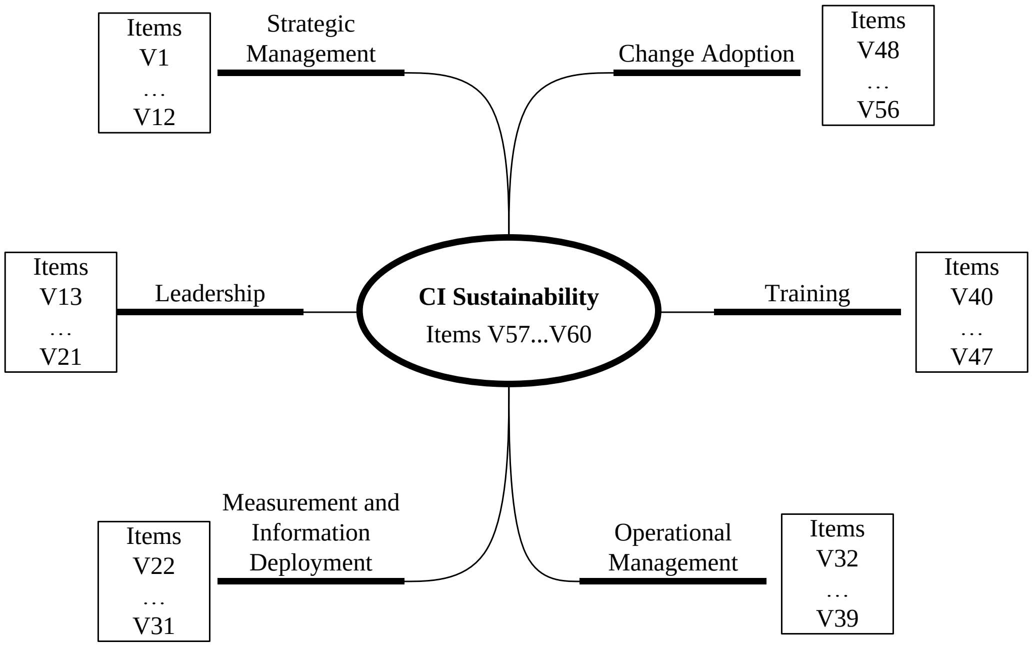

Figure 1. Proposed Research Framework

According to the literature, sustainability is affected by six main factors, which can be evaluated through a set of items. The main factors being evaluated for this proposed model are:

- *Strategic management.* Describes how the management level integrates a plan to accomplish CI as an explicit objective, as well as how this strategic plan is deployed and perceived by associates at all levels.
- *Leadership.* Refers to how formal and informal guidance is exercised across the organization, including the mechanisms developed for decision making, two-way communication, feedback, and development of leaders. Also, it evaluates how values and directions are reinforced.
- *Measurement and Information Deployment.* Determines to what extent information related to improvement and performance dimensions of outcomes is clear and accessible to every associate, how systematic the information deployment is as part of daily work procedures, and how employees are awarded for contributions.

- *Operational management.* Evaluates the CI management process at the operational level, including how associates are actively involved in identifying needs, solutions, and actions required to solve problems.
- *Training.* Determines to what extent training has become a formal process inside the organization, and to what extent it has been applied to functional areas.
- *Change Adoption.* Examines how the need for change, as improvement, is understood, and the effort of the organization to adopt new ways to work.

1.6. Research Hypothesis

To carry out the research objectives, the following hypotheses were investigated. The hypotheses were developed based on the proposed research framework and the effect of region, time and type of industry variables.

H_1. Type of industry has no effect on the perception of constructs affecting the sustainability of CI.

H_2. Region has no effect on the perception of constructs affecting the sustainability of CI.

H_3. Time has no effect on the perception of constructs affecting the sustainability of CI.

1.7. Overview of Research Methodology and Limitations

The research design involves multiple case studies. Case studies were selected from the medical devices, chemical, wood products and health care industries. Case studies also were located in two different countries (US and Costa Rica) since the author was interested in evaluating the effect of this variable on the sustainability of CI. The main research instrument consisted of a questionnaire constructed after a thorough literature review to evaluate potential factors affecting CI sustainability. This tool was used to collect data over the period of one year to evaluate the effect of time on CI sustainability, and was supported by interviews with managers, CI coordinators and staff personnel at the participating firms as well site visits as suggested by Yin [12] and Miles & Huberman[13].

Cronbach's α was used to test the internal validity of the research tool,. Confirmatory and exploratory factor analysis were performed to determine the structure of the constructs, and a correlation analysis was used to establish any existing relationships among the factors [14-18]. To evaluate the effect of time, region, and type of industry, ANOVA tests were conducted [16] using the software SAS.

Finally, to draw conclusion and recommendations, a causal relationship analysis was performed to further enhance the results from ANOVA testing. Future directions for further research were developed based on the limitations of the study and the observed research opportunities.

The following premises and limitations are part of the study:

- Although case study methodology is a qualitative research method, it allows the in-depth study of contemporary events [12]. Findings from this research are not applicable to all industries; however, findings may serve as a valuable reference for practitioners and academics aiming to reach CI sustainability.
- This study did not attempt to include industries from all regions. While cultural and environmental conditions may influence factors such as leadership styles and payment schemes [19], it was of the interest of the author to identify American industries located in at least two different countries.
- This research did not attempt to study external factors that could affect the sustainability of the CI process. Instead, identified factors correspond to internal elements which can be control and modified by leaders and managers of the organization. However, this could be an opportunity for future research, where external factors such as regulations, the existence of worker unions, and the cultural values of a region can be evaluated as influential variables of CI sustainability.
- This research contains a relatively small sample of participating firms. This is mainly due to the unwillingness of some companies to participate in a longitudinal study, and also by limiting the study to only a few companies we

could conduct a more in-depth analysis including site visits and face-to-face interviews.

- The study mainly focused on manufacturing industries since manufacturing plays a central role in the US economy. However, this study did include a service provider industry as well. Future research should perform similar analyses with a larger sample of manufacturing and non-manufacturing industries.

1.8. Contributions of the Research

This research contributes to the current body of knowledge regarding the continuous improvement process and its sustainability, to organizational practice and the wood product business management. The contribution to the current body of knowledge of the continuous improvement sustainability is made by empirically identifying the constructs comprising the continuous improvement process, and by testing how these constructs are influenced by time, company's location and type of industry sector. While many other continuous improvement frameworks, and constructs of its sustainability have been cited by practitioners in the literature, there has been no empirical testing to verify the construct validity and internal reliability of the proposed models. In particular, leadership has been identified as a key element within the strategic management construct. Additionally, although several frameworks to sustain continuous improvement have been developed, these frameworks do not bring a self assessment tool to be used by practitioners looking for lower cost management models. Finally, no explicit correlation have been made between constructs by empirically testing the frameworks. This study contributes an empirically tested framework for sustaining the continuous improvement process in the wood products industry, describing constructs, event and measures. The results of the study will be used to create qualitative guidelines for managing the continuous improvement process. Finally, the data collection tool and the methods provide instruments to organizations and researchers to measure the framework's performance in real settings.

This research contributes to organizational practices by increasing understanding of continuous improvement sustainability. The study will help organizations to develop and implement more sustainable continuous improvement processes. In addition, the framework help the organization to focus on a limited but essential factors, maximizing resources and better allocating efforts. The main observed practices will be classified and summarized by each construct.

This study clearly contributes to the wood products industry. Literature cited emphasizes the reluctance of practitioners form the wood products industry to adopt new business methodologies. This reluctance is caused by various factors such as high implementation costs, the need of specialized resources and the investment required in technology. Thus, by identifying continuous improvement as a working methodology with benefits, and by developing a framework with specific actions, the research will enable the application of continuous improvement is a more feasible way in the wood products industry.

Furthermore, framework developed in this study, collaborates by bringing a measurement tool designed for practitioners to evaluate the effectiveness of each construct comprising the sustainability of the continuous.

Regarding to the methodology, the study employs the Confirmatory Factor Analysis (CFA) and the Exploratory Factor Analysis (EFA) to test validity of an initial 7 constructs framework to finally develop a 5 constructs framework. The use of this technique enable practitioners with a reliable framework fitted to real data.

The document is organized as follows: Chapter 2 provides a review on CI and Innovation, and the existing relationship among them. Chapter 3 provides the preliminary work that is was conducted in preparation for this study. Chapter 4 provides the literature review to identify the theoretical framework of the factors affecting the CI sustainability. Chapter 5 describes the methodology used to conduct the study and the research tool validation. Chapter 6 depicts the hypothesis testing done to address the study objectives. Chapter 7 provides the reader with conclusions, limitations, and suggested directions of future research.

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2. Literature Review

Innovation is widely accepted as a driver for success [1]. As globalization intensifies and customers set higher standards, innovation appears as a tool to meet these expectations. Also, organizations are realizing that innovation is a complex tool; therefore, creating an supportive environment to foster innovation is crucial. In previous research, Madrigal & Quesada [2] identified that innovative companies support innovation through the application of continuous improvement (CI). Understanding how innovation and CI are related is a prerequisite to staying in the competitive race and profiting. This section provides the literature review on CI and innovation, and how these two tools interconnect with each other to help companies improve their performance.

2.1. Definition and Evolution of Continuous Improvement

Continuous improvement is philosophy characterized by many authors. For example, Collins [3] and Wilkinson *et al*. [4] describe it as an approach to quality assurance that involves creating a culture concerned with quality as an integral part of the product/service delivery. Bessant *et al.* [5] also describes CI as "*a company-wide process of focused and continuous incremental innovation,"* where small changes with high frequency result in a cumulative positive impact on performance. Deming [6], who is recognized as a pioneer in this field, defines it as " consistent improvements that increase success and reduce failures". However, for this study and based on the company-wide approach, the definition of CI given by Bhuiyan & Baghel [7] is used for reference. The authors define CI as a culture of sustained improvement which continuously focuses on eliminating waste in all the processes of the organization. This continuous effort involves everyone across the organization making improvements and searching for problem root causes, sources of variation and waste, and finding ways to minimize, and ultimately, eliminate them.

Historically, the root of the continuous improvement can be traced back to the 1800s. At this time, organizations started believing in inducing the workers to be part of process improvement by devising new and better methods to manufacture. This is recognized as the beginning of the continuous improvement process [8]. One of the earliest documented examples of the application of CI started at a Scottish shipbuilding company, which established a reward system for employees based on the improvement or introduction of new methods, machine, or hand tools in the process. This system also awarded improvements or inventions with respect to carrying methods, prevention of accidents, ways to avoid material waste, render superior quality or improve economical performance [9].

Another influential character in the early stages of the continuous improvement is John H. Patterson, who ran the National Cashier Register Company (NCR) [10]. Patterson, who was previously involved in sales, got himself involved in the root cause analysis of a large shipment return made to NCR in 1894 from England. He found that the poor environmental conditions of the factory had influenced the workers to intentionally pour acid in the cash register. After this finding, Patterson improved the working conditions, including subsidized meals which decreased the rate of absenteeism at the factory. These improvements also included a written suggestions program where employees were able to submit ideas to solve problems. This program included prizes for selected ideas which sometimes resolved situations before managers were aware of them.

The next step in the continuous process evolution is marked not only for award programs, but also for equality between employees and managers [11]. The communication required to sustain a continuous improvement philosophy was supported by open door policies, and employee advisory boards meetings with top management. This strong encouragement to communicate helped employees understand that productivity did not mean termination but rather better job opportunities. Companies such as Lincoln Electric Company put together a training program where employees were able to attend classes at night for a low fee. With this continuing education, employees were more likely to obtain better positions in the company. Also, companies understood the benefits of sharing profits; therefore, profit sharing plans were developed to reward workers based on their contributions to improvements [12].

The following stage in the evolution of the continuous improvement is marked by the cooperation established between the US and Japanese manufacturing industries after the

World War II [12]. During World War II, the Training Within the Industry Service (TWI) was established to increase production output. The TWI consisted of modules called "J" programs which targeted a major impact on manufacturing through training in job instructions, job methods and job relations [13]. This training program had been successful at supporting the industrial effort in the US for the war. After Japan was defeated, the US focused on rebuilding the Japanese manufacturing industry, and the TWI program was used with Japanese managers to reach this goal [14]. A group of former TWI trainers were invited to Japan to start the process. Several Japanese industries, including Toshiba in 1946, Matsushita Electric in 1950, and Toyota in 1950, attended the training sessions and promoted them nationally. This massive training effort created what is now known as the Japanese Management, where Kaizen is the most recognized method [14].

In the 1960s , the quality circles started what is known as the zero defects program, where employees are committed to produce with no defects. The Japanese industry Matsushita Electric became the first Japanese company to successfully implement the zero defects program and achieved a seven-month period with no quality defects in 1977 [12]. In the 1980s, there was a direct Japanese investment in US companies which led to a reintroduction of continuous improvement programs. The most recognized cooperation was led by Toyota and General Motors who created the New United Manufacturing Motor , Inc. (NUMMI) to produce the Chevy Nova and the Toyota Corolla. This endeavor resulted in a mix of Japanese efficiency and powerful US union which raised the percentage of employee participation from 26% (1,716 suggestions) in 1986 to 70.8% (10,671 suggestions) in 1988 [15].

Nowadays, continuous improvement is not as much related to work improvement as in the early stages. Today, the focus of continuous improvement is typically linked to organized and comprehensive methods that allow all levels of the organization to take part in the initiatives in a sustained way [7]. This new focus is the result of the need to improve in a larger scale, reducing waste, reducing complexity in products and process production, and improving quality level. The lean manufacturing, Six Sigma, and lean

Six Sigma are among the most utilized methodologies in the continuous improvement process.

2.2. Continuous Improvement Methodologies

As mentioned before, the different methodologies used in the CI process are developed to engage a larger population of participants company-wide. This section provides an explanation of the most recognized methodologies, as well the tools used to support them.

2.2.1. Lean Manufacturing

Lean manufacturing can be traced to Henry Ford's concept of mass production. By standardizing his production, Ford created the concept of flow, which later was improved by the Japanese [7, 16]. AfterWorld War II, Taiichi Ohno, who was the vice president of Toyota was requested to lead the improvement of the Japanese auto motor company. Ohno developed what is today known as the Toyota Production System (TPS) or lean manufacturing [17]. The lean manufacturing methodology focuses on banishing all waste to create a wealthy organization, and is endless in nature. Customers do not want to pay for activities at the manufacturer or seller that do not add value to the good or service [18]. The waste targeted by lean is classified in nine types: (1) idle time, (2) transportation, (3) overproduction, (4) unnecessary motion, (5) defects, errors or mistakes, (6) excess of inventory, (7) excess of processing and packaging, (8) inappropriate design, and (9) excess of labor [19].

Lean manufacturing is based on five main principles. The first principle states that value is defined from the customer's perspective; only the customer can define what value is based on his own requirements of the service or good. The second principle refers to identifying the value stream using a tool known as value stream mapping. This procedure allows one to identify all the steps that occur when producing a good or a service. The third principle requires a continuous flow of material and information across the business units. The fourth principle focuses on a pull system by the customer. The fifth principle requires the commitment of all the organization to the continuous improvement [7, 16, 17].

To successfully apply lean manufacturing, it is necessary to understand the customer requirements; only then can a company develop the value stream map and identify those non-value added activities that are increasing the cost of producing the good or service based on the customer's perspective [16]. Also, it is of high importance for companies to understand that lean manufacturing happens in a set of interrelated dimensions, where concepts and initiatives support each other to continuously identify and reduce waste [20]. This multidimensional effort can be seen in companies which apply several techniques and tools. These techniques can include value stream mapping and work standardization to reduce waste in labor use [20]. Another tool is the 5 S's to reduce costs, increase quality, and improve safety by sorting useable elements from non useable ones, simplifying work stations, sweep tidiness of the area ensuring an accurate performance of equipment, standardize work procedure, and sustain the housekeeping activities to continuously reach efficiency[16]. Another tool to reduce idle time is total productive maintenance (TPM) to improve machine availability and a better utilization of maintenance and production resources [21]. Despite the tools and techniques used to implement lean manufacturing, firms must consider a holistic approach.

To ensure successful implementation, firms need to develop metrics. There are a set of commonly used metrics applicable to lean manufacturing. Table 1 shows a selection of these set of metrics and their scope.

Table 1. Selected lean manufacturing metrics (Adapted from Kocakülah, Austill &Schenk [16])

Metric	Scope
Inventory turnover	How many times a company's inventory is sold and replaced over a period
Manufacturing cycle efficiency (MCE)	The total value add time in the overall manufacturing time
First time yield (FTY)	The yield that results from the first time through the process prior to any rework
Cycle time (CT)	The length of time from when materials enter a production facility until the final product exists
Takt time	The pace of production required to match the customer demand
Customer reject rate	Measures the number of complete units rejected by external customers (expressed in parts per million)
Lead time	The total time a customer must wait between placing an order and receive the product

2.2.2. Six Sigma

Six Sigma was developed in the 1980s by the efforts of Bill Smith, an engineer at Motorola Inc., who started using it as a tool for statistical process control to reduce variation in the manufacturing environment[22]; however, Six Sigma gained popularity through Jack Welch, and its application in General Electric [23].

This term refers to a measure of defects rate within a system, and uses the Greek letter sigma which indicates the standard deviation. Within Six Sigma, the focus is to produce no more than 3.4 defects for every million of produced units [24]. Table 2 shows the defects per million based on the sigma level.

Table 2. Defects per million at different sigma levels (adapted from Drake, Sutterfield &Ngassam [22])

Sigma (σ) Level	Percentage yield	Defects per Million
1 σ	31%	690,000
2 σ	69%	308,000
3 σ	93.3%	66,800
4 σ	99.38%	6,210
5 σ	99.977%	230
6 σ	99.99966%	3,4

Pande, Neuman and Cavanagh [25] illustrate the difference between 99% quality against Six Sigma quality. The authors stated that a television station operating at 99% will be off the air during 1.68 hours, while operating at Six Sigma level this time will reduced to 1.8 seconds.

As a methodology, Six Sigma is very structured, and uses quantitative data for decision making and defects reduction. In this methodology, training is critical since the scientific approach needs to be widely understood and fully accepted. [26]

The main methodology used by Six Sigma is the DMAIC methodology[22]. This methodology is divided in five phases, and each phase has a corresponding set of tools to conduct the corresponding analysis. Table 3 shows each phase and selected tools.

Table 3. DMAIC methodology and selected tools (adapted from Drake, Sutterfield &Ngassam [22])

Phase	Goal	Tools
Define	Define the process or product to improve, the team to work on the project, the customers and their needs	High-level process map (SIPOC) Process flowcharts Customer surveys, interviews
Measure	Identify the most influential factors and define how to measure them	Pareto charts Statistical methods and sampling Value stream mapping Capability analysis Total lead time analysis
Analyze	Analyze the selected factors	Statistical analysis Cause-Effect diagrams Pareto charts Simulation models Root-cause analysis Failure Mode Effect Analysis (FMEA)
Improve	Design solutions. implement the most effective	Brainstorm solutions Simulation models The 5S method Error proofing Failure Mode Effect Analysis (FMEA)
Control	Use metrics to verify the performance of the selected solution over time	Control charts Training requirements Documented new processes Return on investment (ROI)

When the improvement is related to a product or a process which does not meet the customer requirements, the methodology employed is known as DMADV and follows five phases as well. These phases are: (1) define, (2) measure, (3) analyze, (4) design and (5) verify, and share many of the tools used by DMAIC methodology.

2.2.3. Lean Six Sigma

According to Sheridan [27], the term lean Six Sigma is used to reference a combination of both approaches. Lean focuses on eliminating noise and defining standards, while Six Sigma brings the know-how to solve and eliminate specific problems identified in the value stream. Previously, authors such as Pepper & Spedding [26] and Arnheiter & Maleyeff [28] identified how lean and Six Sigma work together at every step of application. According to these authors, lean firms should take advantage of statistical analysis and quantitative data for decision making. In lean environments, quality control uses the zero quality defect (ZQD) approach which focuses in finding defects before finishing the product rather than identify variation sources, which can be identified using Six Sigma methodology. Six Sigma has been utilized as a cost reduction technique by improving quality; however, it can gain value by embedding the customer perspective of value add activities. Table 4 shows a summary of the steps used in a lean manufacturing environment and how they can be improved by applying Six Sigma methodology.

Table 4. List of cooperation between integration steps of Lean and Six Sigma tools (adapted from Pyzdek [29])

Lean Step	Six Sigma Tool
Establish methodology for improvement	Policy deployment methodology
Focus on customer value stream	Customer requirements measurement
Understand current conditions	Knowledge discovery
Collect product and process data	Data collection and analysis tools
Document layout and process	Data collection tools, SPC
Create standard work combination sheets	Process control planning
Evaluate options	FMEA, cause and effect
Reduce waste	Seven management tools, seven quality control tools, design of experiments

There are some challenges to face when constructing a lean Six Sigma environment. First, there is a need for the implementation to be defined as a strategy and focus on process. Second, there has to be a balance among both methodologies to obtain the largest amount of benefits from both lean and Six Sigma. Third, a balance must exist between complexity and sustainability, since some problems are unique and will require the application of different tools [26].

Organizations looking into this methodology also must be aware that current status does not include a comprehensive framework that shows the implementation road for lean six sigma [30]. Available literature comprises case studies where benefits of implementing lean Six Sigma can be reviewed. These benefits include an increase in productivity and customer satisfaction, and a decrease in operational costs. Other benefits include global optimization instead of focal optimization, decision making will be data-driven producing scientific results, and implementation will help to develop a company culture highly focused on education and training [26, 28, 30].

Current studies also identified limitations in implementing lean Six Sigma methodology. One limitation is the balance required between statistical tools and creative solutions since both methodologies used structured tools. Finding this balance is necessary to perform at the desired scientific level along with the right team leadership, idea generation, and mentoring [31]. A second limitation of implementing the lean Six Sigma is the large set of tools available, which sometimes results in difficulty for a professional when choosing the correct tool for application in the business environment [30]. A third difficulty is the uneven level of mathematical and statistical knowledge, which make the lean Six Sigma tools more challenging for some employees [32].

2.2.4. Total Quality Management

The total quality management (TQM) philosophy finds its root in the work performed by Juran, Deming and Ishikawa [33]. TQM as a concept also is defined mostly as a management philosophy that supports reduction of costs by creating high quality products and services fulfilling customer requirements [34, 35].

Initially, quality management used to focus on inspection dealing with sorting of acceptable and non-acceptable products. Later, quality management included to concept of quality control (QC), which emphasizes in process control with tools like control charts and sampling to monitor the process. Quality assurance (QA) became the next step in quality management and focused in meeting customers' requirements by improving process control. Finally, the concept of total quality management emerged to integrate all the internal players in the production of services and goods to meet external requirements [36].

In the 1980's Deming introduced the term Total Quality Management. Basically TQM focuses in three main principles: (1) focus on customer satisfaction, (2) achieve continuous and sustainable improvement in processes and outputs, and (3) ensure full commitment of employees to improve quality [37].

TQM operates through the application of techniques and procedures used to reduce or eliminate variation in the production processes of goods and services, improving efficiency, reliability and quality [38]. According to Cua, McKone & Schroeder [39] these techniques and procedures can be applied across nine dimensions: process management, supplier quality management, customer involvement, information and feedback, committed leadership, strategic planning, cross-functional training, and employee involvement.

2.2.5. Kaizen

Kaizen is the Japanese word for improvement, and it is used to describe a focused and structured improvement project targeting a specific goal, in a specific area, in a short period of time [40].

According to Kosandal & Farris [41], kaizen event can bring substantial technical improvement such as inventory reduction and improved performance. Drickhamer [42] also discusses that kaizen event contribute to social improvement by developing knowledge and skills in workers.

Usually, when implementing a kaizen event team use tools such as process flow analysis, histograms, cause-effect diagrams, set up reduction procedures, takt-time analysis and 5-

S programs identify the root cause of a problem, define the course of action, and measure the performance of the implemented solutions [43]. Imai [44] offers a list of five principles to follow to implement successful kaizen events. These principles are: (1) focus on processes and results, (2) put quality first, (3) gather hard data, (4) customer as main target, and (5) use visual management.

Kaizen events, as any other improvement initiative also face challenges. According to Jorgensen, Boer & Gertsen [45] companies must be aware and willing to embrace kaizen events to improve performance, otherwise the organizational culture will fail at adopting kaizen events. A second obstacle to overcome, is the lack of participation in setting the target, which is directly related to the level of empowerment required to implement kaizen events [46]. Finally, the largest difficulty in implementing kaizen is breaking old habits, which means that organizations must ensure a culture of change that enable creativity to do new things [47]

2.3. Benefits of Implementing Continuous Improvement

The implementation of CI is a highly dynamic and complex process that bring several benefits to firms [48]. These benefits occur in a multidimensional environment and may improve all aspects of the organization.

The reinforcement of organizational learning is the first large benefit observed when implementing CI. According to Stuckman and Yammarino [49], continuous improvement encourages the organization to undergo a learning process to develop and select optimal solutions to problems. LeBrasseur, Whissell & Ojha [50] recognize how continuous improvement forces the organization to revise its assumptions and values, enabling the creation of new problem solving approaches. In terms of work force learning, continuous improvement also supports the development of an integrated training and educational program. This program aims to provide skills in areas such as statistical control process (SPC), problem solving, team building, and leadership. This education is crucial, since its goal is to provide a more fundamental understanding of the elements necessary for continuous improvement to occur in the organization instead of merely creating awareness of CI [51].

Other benefits obtained by implementing continuous improvement are observed in process and consequently in financial performance. Several studies have shown how performance metrics such as cycle time, labor usage and quality exhibit a positive trend when implementing CI. For example, Pirraglia, Saloni & Vand Dyk [52] suggest that CI can cause companies to reduce inventory waste by 80%, decrease manufacturing cycle times and labor by 50%, and increase quality and product quality in facilities by 50%, positively impacting profits, system flexibility, cash flow, and delivery accuracy. Cheng & Shih [53] also reduced costs associated with poor quality, which was the main cause of service failure in sports centers. Kumar & Sosnoski [54] implemented CI tools to improve production quality and subsequently reduce cost on the shop floor. They were able to implement a process improvement that represented $10,000 of saving per year (2% of the company's annual revenue). Large companies such as General Electric reported a market capitalization that increased from $12 billion in 1960 to $500 billion in 2000 as a result of CI activities targeting cost reduction and higher efficiency [55]. Another important metric which improves over time when implementing CI is customer satisfaction. Swinehart &Smith [56] recognized that customer service surveys generally provide positive feedback on levels of quality, efficiency and effectiveness in those organizations oriented to the CI philosophy.

Implementing CI also benefits organizational culture and employee satisfaction. Literature indicates that CI promotes a culture where workers are willing to learn and teach, reinforcing team building concepts. Also, leaders in CI-focused firms manage by facts and lead by example which creates a trustworthy work environment[57].

Buch & Tolentino[58] and Schön, Bergquist & Klefsjö [59] were able to identify positive influences of CI on job satisfaction. Their work supported the positive influence of CI on workers, including greater recognition from management, a higher sense of responsibility and desire to develop new skills, and new areas of responsibility. Their findings also suggested that workers had a much clearer view of results and enjoyed their work duties more as a result of CI. At the company performance level, this positive environment reduced the turnover and absenteeism rates, resulting in higher productivity and quality [57]. Finally, Salis &Hingley [60] and Hill & Wilkinson [61] characterized CI firms as organizations oriented to meet internal and external customer quality requirements continuously. This effort is made using teamwork and guided by a long-term commitment from management to continuously reach excellence in performance.

2.4. Limitations in Implementing Continuous Improvement

In spite of the simplicity of the definition and the benefits of CI (including the support given to incremental innovation), the implementation of CI is not always a successful process and has been particularly difficult to sustain in the long term. For example, Laraia, Moody and Hall [62] indicated that most firms will face difficulties maintaining half of the outcomes from continuous improvement applications. Other studies that evaluated the success of continuous improvement tools (e.g., Kaizen events closely related to lean manufacturing philosophy) show evidence of a weak learning culture, which may lead to struggles during organizational change resulting from CI implementation [40, 63, 64].

As mentioned by Bessant *et al.* [5], CI is an adequate instrument to unleash creativity and create an inventive outlook, which results in incremental innovation within organizations. However, the success of CI depends upon a supportive organizational environment, which relies on developing CI inside a learning organization. This organization must be willing to go through experimentation, risk taking, and change adoption, relying on the leadership of managers, supervisors and owners of the CI [65, 66].

Jaikumar [67] and Walton [68] performed studies of change adoption across several countries. They concluded that organic structures (i.e., those organizations willing to take risks and undergo a learning process) focus on providing skills and knowledge to their associates, and prove more successful in adopting and implementing change. In these organizations, members are conscious of generating, retaining, and leveraging learning toward improving performance. Members also use tools to monitor and ensure long-term sustainability of learning. Developing learning programs with focus on a central goal, commitment to supporting continuous learning at operational and management levels to develop strategic thinking, and a culture with an organizational climate which tolerates failure associated with learning and experimentation are required for change adoption [69].Table 5 displays a summary of factors identified as inhibitors of CI sustainability based on the current literature.

Table 5. A review of inhibitors for CI sustainability

Factor (inhibitor)	Author
Process issues Lack of structure to stop backsliding No formal problem-solving process Unsuccessful implementation of changes suggested Failure to complete projects	Bessant *et al*.[5] ; Dale *et al.[70]*; Kaye & Anderson [71]; Upton [72]; Jorgansen, Boer & Gertsen [45]; Bateman [73];
Strategy and objectives Absence of target and common understanding of direction Lack of deployment plan Lack of CI strategy No long term objectives linked to CI No measurable objectives related to CI	Bessant *et al*.[5] ; Kaye & Anderson [71]; Upton [72]; Dabhilkar & Bengtsson [74]; Kerrin [75]; Escrig-Tena [76]
Leadership and motivation Lack of clear motivation as to why improvement is important Inadequate leadership (e.g., no experience, no charismatic leaders) Absence of top management support	Bessant *et al*.[5] ; Dale *et al*.[70]; Kaye & Anderson [71]; Upton [72]; Cherian [77]; Choudrie[78]; Irani *et al.* [79]
Cultural issues Resistance to change Lack of awareness of CI by employees and managers	Bessant *et al*.[5] ; Dale *et al*.[70]; Kaye & Anderson [71]; Marksberry *et al*.[80]; Van Aken [63]
Measurement and information Lack of measurement Inadequate information and analysis No feedback systems	Bessant *et al*. [5]; Dale *et al*.[70]; Kaye & Anderson [71]; Bond [81];
Training learning and skills Lack of learning as a value in the organization Lack of training Lack of problem solving skills	Bessant *et al*.[5] ; Dale *et al*.[70]; Kaye & Anderson [71]; Upton [72]; Buckler [82]; Oliver [83]
Others Emphasis in disruptive innovation undertaken incremental innovation Break of CI teams Short resources assigned to CI Gap in involving employees at every level	Bessant *et al*.[5] ; Dale *et al*.[70]; Kaye & Anderson [71]; Upton [72]

2.5. Current Research on Continuous Improvement

According to Buckler [82],a firm must be capable of improving and innovating at the same time to be successful in today's business environment. Kim & Mauborgne [84] clearly suggest that firms should focus on gaining new customers through innovation, and sustaining existing customers by improving current services and goods. In order to support this management approach and remain competitive, researchers have focused on describing management models to sustain CI and bring value to current customers [85, 86]. Other researchers such as Harrington [87] and Terziovski [88], have focused their research on understanding the link between CI and innovation, arguing that an innovative culture detached from CI is not sustainable.

Based on the findings of challenges to implementing CI, and the link between CI and innovation, the following sections provide an overview of ongoing efforts to sustain CI, as well an overview of the current status of innovation research and relationships with CI.

2.5.1. Management Models for Continuous Improvement Implementation

Bessant & Caffyn [85] developed an index to measure CI maturity; this index is based on the CMMI model where firms are classified into 5 levels based on the effectiveness of the improvement program. However, this tool does not evaluate the amount and nature of the training, the effectiveness of communication systems, or the extent of formal commitment from senior management [85]. Table 6 shows a description of the maturity levels proposed by the CI maturity index model.

Table 6. CI maturity index [85]

Level	Description	Characteristics
1	Native CI	CI practices take place in response to the beliefs of individuals or in response to special problems. The use of CI stops once the problem is solved.
2	Structured CI	An individual introduces some of the techniques or vehicles of CI but has not integrated it with the strategic process of the company.
3	Goal-oriented CI	Top-down structures start to link aspects of the CI process to the strategic processes of the business. Some feedback loops using measures of performance and formal deployment of strategic goals are incorporated into the CI process.
4	Empowered CI	The top-down focus is now extended to permit emergent strategic aspects, or “bottom-up” actions to create part of the strategy.
5	Systemic CI	CI is seen as part of “how we do business around here” in all aspects of the business.

A second methodology to measure the sustainability of the CI process was developed by the Industry Forum and the Lean Enterprise Research Center. In this model, five levels based on the performance in four phases of the CI implementation process are used to classify companies. This method only includes the analysis of KAIZEN events and does not analyze other type of CI initiatives. Table 7 shows the summary of classes of improvement for each level [89].

Table 7. Summary of classes based on improvement [89]

Class	A	B	C	D	E
Improvement during workshop. Initial knowledge	Yes	Yes	Yes	Yes	Yes
Maintain new methods of working. Standardize improvements.	Yes	Yes	Yes	No	No
Close out actions. Deepen knowledge	Yes	Yes	No	Yes	No
Application of tools to new problems in the cell. Deepen and broaden knowledge	Yes	No	No	No	No

A third approach to measure the maturity level of processes inside organizations is known as Capability Maturity Model Integration (CMMI). CMMI framework involves a collection of models with the best practices designed to help organizations improve their processes [90]. Simon, Schoeman & Sohal [91] state that CMMI seeks to operationalize key factors that are identified for successful business and aims to facilitate the integration of functions by setting process improvement objectives. CMMI, as a framework, brings quality guidance for processes and provides a reference to analyze and evaluate the current process [91].

According to this approach, a high mature process is significantly improved using those best practices from the industry sector. In this model, five levels are used to classify industries according to the maturity of the processes in the organization; these levels are shown in Table 8.

Table 8. CMMI maturity levels [90]

Level	Description
1. Initial	Organizations are characterized by a tendency to over commit, quit their processes, and be unable to repeat success achieved.
2. Managed	Work status is visible to managers; commitments are developed between the firm and the stakeholders and reviewed as required; work products are according to procedures and specifications.
3. Defined	Processes are well understood and clearly explained in standards, procedures, and tools. At this level, the organization looks to improve level 2 processes to achieve level 3 as well.
4. Quantitatively Managed	The firm and projects use the established quantitative objectives for quality and process performance to manage projects. These objectives are based on needs of the customer, end users, organization, and process implementer. The performance of projects and selected sub-processes is controlled using statistical and other quantitative techniques.
5.Optimizing	The organization continually improves its processes based on a quantitative understanding of its business objectives and performance needs; also, the organization focuses on continually improving process performance through incremental and innovative process and technological improvements.

Even though CMMI is a widely accepted tool, its implementation has some disadvantages for small- and medium-sized enterprises. The tool is complex; currently only 41 countries worldwide have reported using CMMI (75% of those countries have reported less than 10 appraisals), leaving regions such as Central America with no participating industries [92].

As Staples *et al.* [93] and Brodman & Johnson [94] explained, a low rate of industries actually implement performance assessment tools such as CMMI, especially in small and medium manufacturing enterprises because of the high cost of performing the assessment. This is caused by the specialized overhead required, and the long periods needed to do this assessment, which is especially difficult when no resources have been allocated for this task. Other models, such as ISAT [86] focuses on identifying success factors for Kaizen events rather than including all the dimensions of a management model.

2.6. Evolution and Definition of Innovation

Innovation has been related to terms such as radical, incremental, really new, architectural, modular, innovativeness and many more business, marketing and technology concepts [95]. Zahra & Covin [96] refer to innovation as the life blood of a firm's survival and growth. Bessant *et al.*[97] argue that innovation is the core of any organization's survival. Without innovation, firms limit opportunities for the creation and delivery of new value to the market.

Innovation as a driver is complex. It is coupled to different elements such as change, economic growth, and welfare, and can be defined across several disciplines, such as business and management [98], economics [99] and marketing [1] among others . Each of these disciplines brings a definition of innovation which aligns with their field of study.

Baregheg, Rowley & Sambrook [100] identified at least 60 definitions of innovation across seven different disciplines from 1934 to 2008. The authors found that 70% of the definitions referred to innovation as a something new versus 32% that used the term improved, superior or changed. The study shows that 55% of the innovation definitions include product innovation, while 35% of them included service or process innovation; however, researchers found that defining innovation as a process and not merely as a discrete event is widely accepted.

From a chronological perspective, innovation has evolved over time. Various authors, such as Cooper [101], Rothwell [102] and Niosi [103], have researched this phenomena and were able to identify different “ages” in the evolution of innovation. As the authors indicate, the social and organizational context is critical to understanding how to approach innovation since the market mainly drives what is defined as innovative. It was Schumpeter, who through his works, first put innovation as the core of industrial evolution in the mid 1930's in his book *The Theory of Economic Development* [99]. Schumpeter's approach to was to analyze innovation as either a creative destruction (decline of industries) or creative accumulation emergence and growth of industries). Schumpeter's work goes to the late 1950's when the focus of study changes from the dynamic of industries, to the analysis of the relationship between innovation and firms size, and innovation and the market structure [104]. Table 9 shows a summary of the evolution of innovation after Schumpeter's work.

Table 9. Evolution of innovation (Adapted from Liyanage, Greenfield & Don [105] and Miller [106])

Age	Approach to innovation	Socio-organizational context of innovation
Mid 1930's to late 1950's	The approach is towards industry dynamics.	*Innovation is seen as creator or destructor of industries. *Innovation is not yet still linked to market structure nor firms size
Post war to mid 1960s	The approach is towards technology. Innovation came directly from the scientific labs into the market place.	*Innovation is well seen. R&D is standardized by government in universities. *Organizations are mostly technology and process oriented.
Mid 1960s to late 1970s	The market defined innovation. Needs are over scientific and technological innovation. Divisions funded R&D projects.	*Prosper period, markets became more competitive. *Organizations focused on growth and target economy of scale and needs of customers.
Late 1970s to early 1990s	Innovation is a hybrid of customer requirements and technological discoveries. Innovation projects are developed by internal and external partners, and become part of an innovation portfolio.	*This period is characterized by oil crisis and economy become less stable. *Companies control and reduce costs and become more flexible.
Early 1990s to mid 2000s	Innovation is focused on alliances. The objective is to bring new value to the market, but also develop new business. Highly collaborative relationships among partners, and communication and information are key to develop innovation.	*Globalization rules economies and competition increases. Information is key to make decisions. *Organizations focus on shortening time-to-market and strategies are aligned with core competences.

As observed, innovation is dynamic and complex. A single definition of innovation does not exist. Authors have suggested approaches within different dimensions. For example, Robbins [107] argues that innovation is the application of new ideas to develop or modify a product, a process, or a service; meanwhile Thompson [108] and Zaltman, Duncan & Holbek [109] define innovation as the realization of a new method, product, or service including the generation of a concept, its evaluation, and implementation. For the purpose of this study, and based on the multidimensional approach which also accounts for the nature of the innovation (novelty or improvement), the definition referenced is given by the Organization for Economic Co-Operation and Development (OECD) in the Oslo Manual. According to the Oslo Manual, innovation occurs in 4 dimensions: (1) product innovation, (2) process innovation, (3) marketing innovation, and (4) organizational innovation [110]. These four dimensions are characterized in Table 10 shown below.

Table 10. Categories of innovation based on OECD definition [110]

Innovation Category	Definition
Product Innovation	A good or service that is new or has been significantly improved. Significant improvements include technical specifications, components and materials, software, user friendliness, or other functional characteristics.
Process Innovation	A new or significantly improved production or delivery method including relevant changes in techniques, equipment, and/or software.
Marketing Innovation	New marketing methods involving significant changes in product design or packaging, product placement, promotion or pricing.
Organizational Innovation	The introduction of a new organizational method in the business practices of the firm, workplace organization, or external relations.

2.7. Current Status of Innovation

It is generally accepted that innovation, despite its category, has an impact on economy of nations and organizations alike [111]. It has been estimated that in the 1950s, 80% of the US economy consisted of manufacturing such as processed food, materials, and derivates of minerals, and the remaining 20% in intellectual capital; however, by 1995, this ratio changed to 70% manufacturing and 30% intellectual capital [112]. This continuous change represents the importance of innovation in knowledge-based economies where innovating results in lasting advantages, contributing to greater competitiveness and value creation [113].

Several authors have analyzed the impact of innovation in economic activities. Some described innovation as directly relating to the creation of new markets, since it brings value with new working methods, new products, and materials [99]. Porter and Stern

[114] stated that innovation is the defining challenge for global competitiveness. The same authors explained that continued operational improvements is a given, and production using standard methods will not support competitive advantage. Therefore, advanced nations must develop a stream of new products and processes to continuously change the technology.

2.7.1. Global Status of Innovation

Innovation is critical to economic growth and to the creation of new and better jobs [99]. Thus, investment of time, effort, and human and financial resources is fundamentally important to sustaining innovation. Institutions have attempted to measure the factors that impact the development and support of innovation. The organization for Economic Cooperation and Development (OECD) has established the guidelines for collecting and interpreting the data on innovation since 1992 [110]. Among the most recognized and globally accepted index is The Boston Consulting Group/National Association of Manufacturers Index (BCG/NAM), constructed in 2009 to define a ranking among the US states and other countries. This index only includes the manufacturing sector and has been published once in 2009 [115]. Another recognized index is The European Innovation Scoreboard/Innovation Union Scoreboard which focuses on enablers of innovation (i.e., human resources, research systems, and finance support), firm activities (i.e., firm investments, linkages/entrepreneurship and intellectual assets), and outputs (i.e., innovators and economic effects) for countries within the European Union [116]. A third model is developed by the World Economic Forum and is known as the Global Competitiveness Index (GCI), which measures competitiveness using twelve pillars that overlap with innovation [117]. This research uses the Global Innovation Index (GII) as a reference of worldwide innovation. This report is developed and supported by entities such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), National Science Foundation (NSF), European Organization for Nuclear research (CERN), among others [118]. The GII index measures institutions, human capital and research, infrastructure, market sophistication and business sophistication as input pillars. The index describes the enabling environment for innovation, scientific outputs, and creative outputs as pillar outputs describe actual achievement in innovation [119]. The

GII corresponding to the year 2011 includes 125 countries, which accounts for 93.2% of the world's population and 98% of the world's GPI.

According to previous research, countries ranking among the most innovative economies have common practices such as an increasing R&D expenditure, a strong knowledge-based work force, and a high rate of firms involved in innovative activities[120]. A list of the top-ranked global economies based on their innovation index is shown in Table 11, followed by a summary of the actions taken for the first five countries.

Table 11. Top 10 innovative countries based on GII [121]

Rank	Country
1	Switzerland
2	Sweden
3	Singapore
4	Hong Kong
5	Finland
6	Denmark
7	United States
8	Canada
9	Netherlands
10	United Kingdom

As observed in Table 11, Switzerland's economy has the largest innovation index. This country is reknown for creating intellectual knowledge, and ranks first as the patents creator, especially in agriculture, building materials, clothes, construction, and electronic/instrument/medical technology [122]. Also, Switzerland is the first producer of scientific and technical journal articles [121].   Switzerland's economy is also known for having a large research and development (R&D) ratio intensity, investing almost 3% of its GDP in R&D activities. This ratio is above the OECD country average ratio which is nearly 2.25% [123]. Another driver of Swiss innovation is the large percentage of R&D staff. According to the Swiss American Chamber [122], 15% of company employees have a job in R&D.

Sweden is ranked as the second most innovative country. This country is recognized by the large amount of scientific and technical journal articles (3rd place in the world), and for its high computer software spending [122]. The high innovation activity is also a driver for the Swedish economy, where the 5.5% of public research is funded by private business and 49% of Swedish companies also report innovation activities such as R&D [124].

Singapore ranks in the third place according to the GII index. This country is known for its high standards in education, which result in a large cluster of knowledge-based companies, such as the medical/pharmaceutical sector [125]. Also, the government has set specific policies to foster the bio-medical sciences, training doctors and post-graduates to become clinicians. The training program reached 100 participants in 2007, and aims to reach 1,000 by 2015 [126]. Another key driver of innovation in Singapore is the increasing R&D expenditures; less than 1% of the GDP was attributed to R&D in 1996, whereas expenditures increased to 2.35% ($5.6 billion) in early 2010 [127].

Hong Kong is considered the fourth most innovative country in the GII. Hong Kong has shown an increment of nearly a 4% increase in total R&D expenditures from 2009 to 2010, reaching a total of $1.7 billion. Another key factor in the success of Hong Kong innovation is the amount of business with technological activities; 4% of all companies located in Hong Kong conducted business in this area in 2010 [128]. A crucial indicator for this country's success is the infrastructure, which according to the GII, is second in the world, offering an attractive environment for investors [115].

Finland ranks fifth according to the GII. As a country, Finland offers a stable political environment and press freedom [115]. According to the country's statistics, 43% of Finnish enterprises incorporate innovative activities and employ nearly 75% of Finnish workers [129]. Of all products entering the market in Finland, 15% are new or significantly improved, making Finland one of the countries with the highest proportion of innovations introduced. Finally, similarly to the previous four countries, Finland is characterized by a highly educated work force, especially in the areas of science and engineering, and maintains a constant portion of the R&D expenditure [130].

2.7.2. Innovation Status in the US

There is an increasing demand for information on innovation and its related activities, basically because innovation is a main driver of productivity, helping to achieve social and other national goals [131].

The process of collecting and measuring innovation is a extremely progressive procedure, requiring the continuous identification of new inputs and outputs of innovation [132]. Indicators of innovation can be roughly typed into four main groups according to scope of their measures over time. Table 12 shows a summary of this classification and metric examples for a better understanding of the evolution of innovation measurement.

Table 12. Overview of innovation metrics evolution (Adapted from Milbergs & Vonortas [133])

Generation	Scope	Examples
1st generation 1950s-1960s	A linear concept mainly focused on inputs of innovation.	R&D Investment Education Expenditure Technology intensity University graduates
2nd generation 1970s-1980s	Covers inputs and introduces intermediate inputs of science and technology activities.	Number of Patents Number of technical and scientific publications Counts of new products and processes
3rd generation 1990s	Marked by a richer set of innovation indexes. The objective is to benchmark and rank nation's capacity for innovation.	Innovation surveys Global Index
4th generation 2000+emerging focus	Highly complex and focuses on measuring knowledge indicators, innovation networking, and conditions for innovation. Many of these indexes are still in the development phase.	Innovation development and diffusion Cooperative research Characteristics of environment (i.e. structure, political climate)

In the US, this need for innovation information has been addressed over the years. Several national data collection efforts have been developed, including national surveys on R&D statistics, science and engineering indicators and US innovative activity with economic data, as well several technical reports on innovation policies and business statistics [134]. These efforts are mainly based on internationally accepted methodologies defined in Frascati Manual [135] , the OSLO Manual [110] , and some others related guides for technology and globalization measurement. The current stakeholders in the design, collection and dissemination of innovation in the US are divided in six main groups shown in table 13.

Table 13. Stakeholders in the design, collection and dissemination of innovation (Adapted from Milbergs & Vonortas [133])

Stakeholder	**Scope**
US government statistical agencies	Includes institutions like the US Census Bureau, Bureau of Economic Analysis, the National Science Foundation, Bureau of Labor Statistics and Department of Energy. These entities are responsible for indicators such as R&D national surveys, counts of labor, graduates in science and engineering indexes, among others.
Financial standards and reporting entities	The main roles are performed by Securities and Exchange Commission (SEC). SEC provides accounting information on intangibles, innovation and risk. The Financial Accounting Standard Board (FASB) which is focused in standardized the information given by users and auditors on financial matters.
Trade and professional associations	Includes bodies such as Industrial Research Institute, Semiconductor Industry Association, the National Association of Manufacturers who provide information on their associates' indicators.
State and local agencies	These entities provide and disseminate information of local and regional performance of the innovation infrastructure and economy.
Universities, private research centers and consultants	Focused on surveys and integrate technology into the market. Usually industry or regionally focused.
International organizations	Major roles played by the OECD, the European Commission, UN agencies, the World Bank, and the World Economic Forum, with large efforts in standardizing metrics and measurement methods. Countries, especially those which are member of the OECD, use systems to measure innovation and to develop innovation policies.

In regards to centralizing the innovation process at the government level, Benjamin & Rai [136] argue that the US lacks a single expert entity that oversees innovation; however, several individual efforts are made by single entities. This has caused an excessive workload at institutions where activities are part of the design, collection, and measurement of innovation [137].

An example of this excessive workload caused by discrepancies among institution policies takes place in the US Patent and Trademark Office (USPTO). Here, the applications for new patents rose from 175,000 in 1990 to 380,000 in 2005, with a projected 8% rate of increase annually. This increase caused USPTO workers to review 25% more patents and is mainly driven by the expansion of patents required for goods and services in the business, methods, software, and biotechnology areas according to decision made by the United States Court of Appeals for the Federal Circuit [138].

In a national effort to develop a policy on innovation, the National Economic Council released the Strategy for American Innovation policy in 2009, and an updated version in 2011 [139]. This policy focused on three main aspects: (1) investing in the building blocks of American innovation, (2) promoting competitive markets that spur productive entrepreneurships, and (3) catalyzing breakthroughs to meet national priorities and foster innovation for the next decade. Table 14 shows a summary of each aspect of the American innovation policy and a selection of the actions proposed.

Table 14. A summary of the main aspects of the American innovation policy [139]

Aspect	Scope	Example of Actions Proposed
Invest in the building blocks of American innovation	Ensuring access to all tools necessary for successful innovation (i.e., human, physical and technological capital).	Reinforce the research with the largest R&D investment ($18.3 billion), elevate the percentage of GDP invested in R&D to 3%, and to fully cover the research and experimentation tax with the government budget ($75 billion).
Promote competitive markets that spur productive entrepreneurships	Ensuring access to innovation diffusion and global exchange of ideas.	Promote American exports, support the opening of capital markets, encourage the growth of innovation based companies, and support innovation at the community level.
Catalyze breakthrough for national priorities	Targets markets of national priority which have not delivered the desired outputs.	Funds the production of clean energy, development of biofuels, improvement of health care quality, and reduction of health care costs

As recognized by authors, current efforts to develop national policies are widely accepted; however, US still has many actions to take to accomplish the proposed agenda toward innovation [134, 136].

In parallel to the government and policy makers, the main institutions leading the national efforts to measure innovation have issued several reports on the status of innovation. For example, results from the Business Research Development and Innovation Survey conducted by NSF [118] indicated that during the period 2006-08, close to 22% of the manufacturing companies surveyed introduced product innovations and 22% introduced process innovations. In contrast, non-manufacturing firms reported a lower occurrence of product (good/services) and process innovation, which was close to 8% for both types of innovations [118].

The same report indicates that 9% of 1.5 million firms surveyed were active innovators (n= 135,000 firms). However, as the data are analyzed further, one can observe which sectors and type of firms tend to present more innovations.

In the manufacturing sector, the Navigation/measuring/electromedical/control instruments business (NAICS 3345) reported that 47% of their surveyed firms had a new or significantly improved goods or services among their innovations. The Computers/peripheral equipment industry (NAIC 3341) reported the highest rate of any new or improved processes (46% of the firms) [118].

Among the firms from the non-manufacturing sector, the software publishers (NAICS 5112) reported the largest proportions of innovations in goods and services with rates of 58% and 56% of the firms surveyed. Software publishers also accounted for the largest proportion of process innovation among the non-manufacturing sector, where 53% of the surveyed firms reported new or significantly improved production methods [118].

The amount of information available on innovation indices is large. In addition to the Business Research Development and Innovation Survey, NSF also releases the Science and Engineering Indicators. This set of indicators contains information related to elemenatry and secondary education, and higher education in science and engineering, science and engineering labor, and business and academic R&D, among others [140].

According to the Science and Engineering Indicators in 2012, the US ranks sixth in engineering graduates (4% of the 2.0 million graduates), following China with 34% of graduates, European Union (EU) with 17%, Asia with 17%, Russia with 5% and Japan accounting for 4% of the total graduates in engineering worldwide[127]. The US and EU have been dominating the world in scientific and technical publications; however, the proportion of articles published worldwide has decreased steadly from 69% in the mid 1990s to 58% of the published articles in 2009 [127].

Innovation is also tightly linked to the creation of knowledge- and technology-intensive (KTI) jobs, which are recognized generally as well-paid jobs. According to the Science and Engineering Indicators [127], the US generated the largest porportion of KTI firms, accounting for $3.1 trillion in 2010.

Another important metric used to evaluate innovation in the US is the number of companies with research and development (R&D) activities. NSF indicates that R&D expenditure is a very convenient index, since it allows comparison of how much economic activity is dedicated to innovation. This index also allows comparison of different economies in a standardized unit [127]. According to the data collected in the Business Innovation Survey, only 3% of the surveyed firms (47,000 out of 1.5 million) performed any R&D activity. However, some indication suggests that those firms with investments below $50 million in R&D are also the firms with the highest rates of product and process innovations [141].

Based on the R&D expenditures in the US, the largest business sector investing in innovation is the semiconductor/other electronics with 15% of their sales produced by their R&D expenditures. The wood products industry is ranked at the bottom; only 1% of their sales are produced by R&D expenditures. Figure 2 shows the rank for these industries.

Figure 2. R&D expenditures as a ratio to company sales for different business sectors [142]

2.7.3. Continuous Improvement and Innovation

Continuous improvement (CI) has been one of the largest advances in business management. As Dean & Bowen [143] suggest, there are few businesses, especially in the manufacturing sector, that could ignore CI as a working philosophy. Innovation is also receiving attention as a tool for sustainable growth and competitive advantage [144]. However, based on the different nature of these two approaches, there are authors who have challenged whether both approaches can occur successfully in the same organization. For example, Maguire & Hagen [145] argue that CI is not compatible with innovation, since CI is developed for managing quality while innovation is required to break all the standards that come when adopting something new. As Prajogo & Sohal [146] state, organizations are concerned about choosing between quality and innovation if success in both areas is not attainable. Concerns are clear and understandable, therefore various author have made efforts to clarify the similarities and differences between both concepts.

Lefler [147] states that improvement is not innovation. This author states that today these two terms are used almost as synonymous, creating a trend of innovators entrepreneurs and consultants. His work focuses in identify some differences between innovation and improvement. First, he indicates that continuous improvement as philosophy aims to meet customers' needs by fulfilling market standards and react to novelty in the market, while innovation is about to bring something completely new to the market (radical innovation) or make a large contribution to improve an existing process or product not necessarily associated to meet a requirement or standard. Second, the author mentions that innovation is a strategy to differentiate from the competitors while continuous improvement helps companies to achieve lower costs and high quality but not necessarily differentiation. Lastly, Lefler indicates that innovation is clearly driven by creativity and innovativeness, therefore making a change or an improvement that can be easily copy by the competitors is not innovation. Schenk [148], also agrees with differentiating innovation from continuous improvement. According to this author, continuous improvement embraces the current state of process and aim reach a better performance while innovation brings a challenge to the current state. She also discusses that unlike continuous improvement, innovation is looking for ways to differentiate a firms from its competitors.

The Food and Drug Administration (FDA), also has emphasizes in the need of continuous improvement and innovation, clearly identifying differences among both approaches [149]. According to the FDA, the term continuous improvement is essentially a modern quality management that aims to improve efficiency by optimizing processes through elimination of waste. Unlike, innovation is not part of a production routine, and requires large investments in resources, resulting sometime in completely new production design and operations. Table 15 shows a summary of the main differences between innovation and continuous improvement.

Table 15. Main differences among innovation and continuous improvement [150]

Dimension	Innovation	Continuous Improvement
Timeframe	Continuous and incremental	Intermittent and non-incremental
Change	Abrupt and volatile	Slow and gradual
Scope of the effort	Technological breakthroughs, new inventions, new theories	Conventional know-how
Advantage	Works well in fast-growth economies	Works well in slow-growth economies
Requirements	Large investments	Low investments
Modality of work	Scrap, rebuild or replace	Maintenance and improve

Several other authors agree in both innovation and continuous improvement being different in nature, however there is a general agreement in the existing link between both approaches. The literature includes several studies showing the positive link between CI and innovation. McAdam, Armstrong and Kelly [151] researched fifteen organizations to evaluate the existing relationship between CI and innovation. They concluded that the relationship between CI and innovation is a causal relationship, where incremental innovation is the result of the introduction of continuous improvement. Additionally, this study showed that firms with high scores in innovation tended to build an innovative culture based on establishing a continuous improvement program. Comparatively, the firms that had a low score in innovation also lacked an existing CI program.

Flynn [152] conducted a study with 712 respondents from 42 manufacturing firms to analyze the relationship between quality management practices and incremental innovation. The author concluded that a culture based on a strong notion of quality and continuous improvement develops the organizational support required to employ incremental innovation in products and processes.

Prajogo & Sohal [146] also researched the relationship between CI and incremental innovation and concluded that both approaches are focused on meeting customer needs. CI encourages small, but constant, changes in current products, processes, and working methods; therefore, CI can lead firms to become innovative by taking these small changes as an approach to innovation, or more specifically, incremental innovation.

Other studies have suggested that a relationship exists between CI and innovation, and that CI continues to foster a culture that develops innovation. Several authors' findings have supported the positive relationship between CI and innovation. For example, Monden [153], Terziovski [88], and Womack, Jones & Roos [17] determined that innovation and CI are approaches searching to resolve customer needs. These authors also suggest that CI fosters an organizational culture which embraces change and risk taking, and supports associates' contributions to solving current needs. This type of culture is required to foster innovation within firms.

Other authors such as Flyn [152] and Baldwin & Johnson [154] identified a positive performance in innovation indicators within organizations oriented to CI. Table 16 shows a summary of the literature review conducted on the relationship between innovation and CI. This summary contains the main findings and the corresponding authors.

Table 16. Relationship between CI and Innovation

Relationship CI-Innovation	Author
Both approaches search to solve customer needs CI improvement can lead to incremental innovation Organizational culture oriented to CI contains vital elements to developing an innovative firm.	Monden [153]; Terziovski [88]; Womack, Jones & Roos [17]
The use of problem-solving tools in CI helps to foster creativity and invention, which are elements that develop innovation.	Prajogo & Sohal [146]; Tomas [155]
Firms that perform tasks under CI initiatives also have shown positive performance in innovation.	Flyn [152]; Gustafson & Hundt [156]; Baldwin & Johnson [154]; Yamin *et al.*[157]; Whestpal, Gulati & Shortell [158]; McAdam *et al.*[151]; Prajogo & Sohal [146]
A culture of CI within a company acts as a solid foundation on which an innovative culture and organization can be built. Also, training associated with CI resulted in increased employee knowledge of customers, competition, and markets which, in turn, lead to employee-generated innovative product-related ideas.	McAdam *et al*. [151]; McAdam, Stevenson & Armstrong [159]; Hoerl & Gardner [160]

O'Sullivan & Dooley [161] also argues about the existing relationship between innovation and continuous improvement. The authors discuss that although companies make headlines with radical innovations, this also includes a high risk that not every firm is willing to take. Thus, companies look into incremental innovations which have less potential for financial returns but also have less operating risks. To support this incremental innovation, the authors identify the use of continuous improvement approaches such as lean manufacturing, Six-Sigma and TQM . This is also supported by preliminary work performed by Madrigal & Quesada [2], who conducted research with firms from innovative and non-innovative sectors to identify the best practices in the innovation management process. The authors identified the use of CI to support incremental innovation as one of the best practices for innovative management. CI promotes a training structure based on problem solving tools that reaches every level of the organization. This creates opportunities for finding new ideas recognized as incremental innovations. Using CI helps the organizations adopt change and take risks by evaluating and implementing solutions to address current needs.

2.8. Findings, Research Question and Objectives

Generally, literature review suggests businesses compete in an environment characterized by globalization. Companies are not only focused on meeting the customers' requirements, but also on being profitable at the same time. To help in this endeavor, various tools have been developed and introduced in the industry. However, as companies implement those tools, they also discover challenges in implementation and sustainability.

One of the methodologies developed to help firms gain competitive advantage is continuous improvement. In the journey of implementing CI, firms can obtain benefits in economic performance, such as reduced costs as a result of improved quality and process efficiency [52, 58, 59]. Benefits also accrue for the organizational culture, which evolves to embrace change and take risks to resolve current needs. The workforce in CI-oriented firms also benefits from implementation. Workers continuously undergo training programs which improve their skills, and help them strive for better job positions in the organization [54, 55].

The benefits of implementing CI are not limited to these dimensions; practitioners from industry and academia have recognized the value of CI to foster incremental innovation [88, 146, 154]. Innovation is greatly recognized as a tool to achieve better productivity and economic growth. In a highly competitive world, innovation is mandatory for firms to survive. CI fosters a supportive environment to embed innovation into the organizational culture [162].

CI is often portrayed as a successful tool to positively impact performance; however, it also is subject to challenges. Practitioners have suggested that CI is hard to sustain, causing half of the companies pursuing CI to suspend efforts after the second year of implementation [62].

Currently, various CI management models have been developed to help firms sustain CI. However, these available models have some gaps that need to be addressed like (1) models are sometimes expensive to apply [90, 93] ,(2) data from all the functional departments across the organization are unavailable [85, 163], or (3) the models are focused on specific CI activities rather than on the CI process as a whole [86]. Thus, according to the literature review conducted, questions still remain to fully understand constraints to CI sustainability.

To help in addressing these gaps, this study focused on conduct a longitudinal analysis of the CI process within various industries over time to observe how changes in the environment affect CI sustainability. Finally, the study was conducted in two different geographic regions to determine the influence of region on the sustainability of CI. With this research, the author aimed to solve the following question:

What are factors that affect the sustainability of the continuous improvement process?

The defined objectives to answer this research question were:

1.Conduct a case study to determine the contribution of CI towards innovation through the analysis of innovation management practices.

2. Identify the factors needed to sustain CI.

3. Construct and validate a measurement tool to evaluate perceptions of workers regarding how these factors contribute to CI sustainability

4. Evaluate the effect of time, region and type of industry on the factors affecting CI sustainability

5. Characterize the relationship among the identified factors.

6. Develop a set of guidelines and recommendations for organizations and researchers to sustain the CI process.

2.9. Development of Hypothesis

Justification for hypothesis testing is given throughout the literature. As previously described in the findings there is a need for more research to reach CI sustainability, therefore this study will empirically test the effect of three variables and their effect on CI sustainability. The following objectives (1) conduct a case study to determine the contribution of CI towards innovation through the analysis of innovation management practices, (2) conduct an extensive literature review to identify what factors are constraining or fostering the sustainability of CI (3) develop a tool to evaluate perceptions of how these factors contribute to CI sustainability among industries are considered the tools to construct and test hypothesis, therefore these objectives are not linked to any hypothesis. The objective (5) Characterize the relationship among the identified factors and (6) determine a set of recommended steps for companies to implement CI in a sustainable manner, are not related to any hypothesis since they will be built upon results of hypothesis testing for objective (4). For objective (4) the supporting literature is given in the sections 2.91 through 2.9.3 of this chapter.

2.9.1. Analysis of the Effect of Type of Industry on CI Sustainability

Studying the continuous improvement process and how its managed and sustained across industries is not a new practice. Authors such as Elmuti & Kathawala [164], Dattakumar & Jagadeesh [165] and Rogowski[166] state that comparison of continuous improvement across industries to determine how CI is managed and sustained helps to provide information for the performance of firms in general.

The American Society for Quality, also argues that analyzing the CI process across several industries enable firms to determine more effective and efficient management practices to address CI [167]. Companies such as Dell, Xerox, and General Electric have conducted previous analysis of their management processes, comparing and sharing discussions about best practices and problem-solving strategies to sustain CI [168, 169].

For this specific research, the study of CI across manufacturing and healthcare business is of high relevance. According to the literature, manufacturing and healthcare are main drivers in the economy of the US (refer to Chapter 5 for an extensive description of these two business sectors), and both faces challenges in achieving sustainable growth [143, 170]. Specific industry business like the manufacturing of medical devices offers an interesting field to study how CI is applied and sustained in highly regulated environments, where the use of methodologies such as TQM is a low a 30% compared to other manufacturing firms [171]. The chemical manufacturing industry, represents a successful industry when implementing CI, since nearly 90% of CI oriented firms in this sector have reported benefits such as inventory and lead time reduction [172]. The wood products, is also an example of a manufacturing sector that has shown a declined market share in the past years [173]. The wood products industry requires the adoption of process management philosophies that result in profitable growth, however the adoption of CI is still slow in the sector, specially now when the industry is characterized for a larger number of small and medium enterprises, which are more reluctant to adopt new management practices [174].

Finally, the last sector of interest is the healthcare. According to regulatory bodies for this industry, this sector incurs in mistakes that cost nearly $29 billion to companies and users of the service, this is also even more dangerous when considering that patients lives might be at risk because of these errors [175].

Based on the deep understanding and valuable experiences resulting from comparing the CI process across sectors to enhance its performance, and as established in the research objective (4) determine if time, industry type, or region impact CI sustainability, this study will focus in comprehending how different business sector might influence the performance of the constructs that affect the sustainability of the CI. To address this research objective, the following hypothesis will be empirically tested:

H_0: Type of industry has no effect on the constructs comprising CI sustainability

2.9.2. Analysis of the Effect of Region on CI sustainability

A commonly asked question in the management field is if companies should adapt their practices to fit in a specific culture. Choi & Liker [176] clearly argues that Japanese success in implementing CI is far away from US success. The authors mention that CI in the US often results in disconnected improvements, that lack continuity and end up being relegated to another proven methodology rather than a sustainable business practice. Lakhe & Mohanty [177] also discuss that work culture has an impact on how CI is managed. The authors indicate that US has not a quality oriented culture, thus this has an impact of how workers and companies understand quality as a core concept. They also argue that developing nations have a poor concept of quality due to lack of education, lack of political will and commitments. Brannen [178] also supports these findings by reinforcing that a work culture is also dependable of the external culture of the region where the firm is located.

Robert et al. [179] also performed a study to understand the effect of the region where firms operate. The authors conducted a study in American, Mexican, Polish and Indian firms to compare empowerment and CI as management practices. Findings from the study reflect that empowerment and CI, are both, affected by culture. Thus, they also indicate that CI is less sensitive to the culture than empowerment, and highly recommended to consider the local regional culture when deciding to manage employees.

Doeringer, Evans-Klock & Terkla [180], also performed a study among Japanese and American industries to determine management best practices. Findings of the study indicated that regions can be lead management practices in different type of business, which is the case of the Japanese management in the automotive industry, and the American management in the electronics manufacturing. According to the authors the key patterns to lead a type of business from a managerial perspective is understanding the role of work force and labor market institutions on each country. This understanding refers to compensation practices, recruitment and selection processes, employment security, and the concept of quality, which based on the results are influenced by political, financial, educational and other cultural aspects.

This previous discussion derivates in a need to better understand how CI processes are managed within firms located in different regions of the world. According to various authors previously mentioned, CI is affected by regional factors, however a deeper analysis is required to observe and describe specific actions taken to succeed at sustaining CI. This analysis, also is required to describe how these differences affect specific enablers of the CI rather than a categorical classification of differences observed. To address this concern in identifying concrete actions toward specific constructs, this study will empirically test the effect of the region on the constructs that support the CI sustainability, as specified in objective (4) determine if time, industry type, or region impact CI sustainability. For conducting this testing, the following research hypothesis was developed:

H_0: Region has no effect on the perception of constructs comprising CI sustainability.

2.9.3. Analysis of the Effect of Time on CI Sustainability

CI is a complex and dynamic process [48]. Aiming to help firms in achieving sustainability of CI various authors, such as Van Aken [63], Bessant & Caffyn [85] and Cocca & Alberti [163], have developed management frameworks with methodologies and recommendations for practitioners. Thus, this important effort made by researcher in the field of CI, current research frameworks are lacking of the longitudinal dimension as indicated by Grütter, Field & Faull [181] and Marin-García, Pardo del Val & Bonavía Martín [182]. de Waal & Frijns also indicate [183] that most of the longitudinal studies in the literature focus on the analysis of financial performance rather than in the analysis of factors that might be contributing to the performance of the firms.

According to the literature review conducted, current studies are mainly focused in single case analysis such as Marin-García & Poveda [184], Lise Busk, Gertsen & Jorgensen [185], and Mitki, Shani & Meiri [186]. Longitudinal studies focusing on multiple cases analysis seem to be more limited than single case analysis. The literature review conducted was able to identify few examples. Among them, Suárez-Barrasa, Ramis-Pujol & Tort-Martorell Llabrés [187] and Augsdorfer & Harding [188] observed differences over time among CI management practices in various firms. Still, some of the available studies such as Mitleton-Kelly [189]focus in a single factor. For this study, sustainability is analyzed only the leadership dimension. Alvarez, Pilbeam & Wilding also [190] recently conducted a study on sustainability of CI but their work focuses only in the supply chain field.

If the longitudinal analysis cases are narrowed by regional contexts, the available sample of studies is even smaller. For example, de Waal [191] performed a literature review of 290 papers published from 1966 to 2007 looking for studies conducted in Asia, and only six of them correspond to Asian companies. This current literature was able to identify three studies performed in Spanish [182, 184, 187] companies and none in Latin America in the past five years.

Thus, as indicated by Manzoni [192], Morton [193] and de Waal & Frijns[183] unfortunately only few studies identifying success factors for high performance in organizations over time are available, and more research is required. The importance of conducting longitudinal research, is also highlighted by Yin [194] and Reinig, Horowitz & Whittenburg [195], who indicated that this type of study is an opportunity to observe how the variables of study behaves over time. Within a CI implementation process, where numerous factors can hinder successful performance, a longitudinal analysis enable researchers with observations of events and their effects in real time [185]. This same highlighted importance is driving the interested of this study.

Based on current CI sustainability frameworks available and the limited previous longitudinal research conducted, this work aims to contribute to the body of knowledge to sustain CI by assessing over time the constructs that enable CI sustainability as indicated in research objective (4) determine if time, industry type, or region impact CI sustainability.. To test the effect of time on these constructs, this study will conduct testing to the following research hypothesis:

H_0: Time has no effect on the perception of constructs comprising CI sustainability.

2.10. Summary of the Methodology

This section aims to provide the general methodology implemented, while specific methodology is properly detailed in each chapter. Figure 3 depicts a diagram of the used methodology, and a brief explanation is given below.

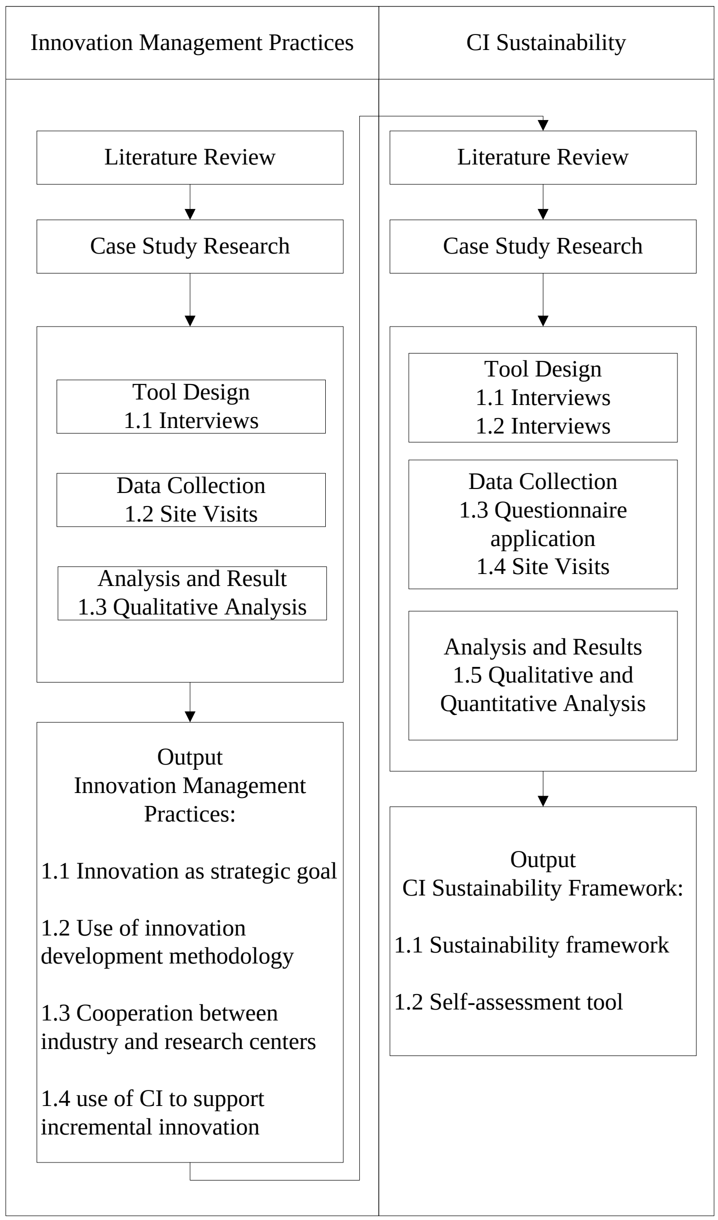

Figure 3. Diagram of research methodology

Preliminary research in the form of a case study was conducted to prepare for the current research. This initial work was performed to understand how innovative firms manage the process of innovation. Case study firms were selected from the energy generation, wood products, and medical devices manufacturing sectors. The research tool consisted of interviews with managers responsible for the innovation process held at the participating companies. After data collection, a single case and a cross-case analysis was performed to determine common practices in innovation management. The results of this previous study showed that participating firms indicated four common practices for pursuing innovation: (1) set innovation as a strategic goal to ensure resources across the organization, (2) establish cooperation between the industry and research centers, such as university. This cooperation enables industry to have access to the latest knowledge, decrease research costs, and support the education of students. (3) Define a methodology to implement innovation projects, and (4) use CI to unleashing creativity and innovativeness and support incremental innovation. The detail description of this research can be found in Chapter 3 of this document.

This phase of the study described here is built upon the use of CI to support innovation identified in previous conducted work (refer to Chapter 3 of this document). After literature review, CI appeared to drive innovation; however, CI faces challenges to remain sustainable. With this new finding, this research focused on helping CI practitioners reach sustainability. The case study methodology was selected based on the ability to analyze a contemporary event (CI process) in a real environment [194]. Case studies were selected from the medical devices, chemical, wood products and health care industries. Case studies also were located in two different regions (US and Costa Rica) since it was of interest to the author to evaluate regional effects on the CI sustainability. The main research instrument consisted of a questionnaire constructed with influence from literature review evaluating the factors affecting CI sustainability. This tool was used to collect data over one year to evaluate the effect of time on CI sustainability, and was supplemented by interviews to managers, CI coordinators, and staff personnel at the participating firms, as well site visits as suggested by Yin [194] and Miles & Huberman [196].

Cronbach's α analysis was used for further testing of the internal validity of the research tool.. Also, confirmatory and exploratory factor analyses were performed to determine the structure of the constructs, and a correlation analysis was run to identify the existing relationships among the factors [197-201]. A set of ANOVA tests were used to test regional and time effects on the factors and observe difference among industries [199]. This statistical analysis were conducted using the software SAS.

Finally, to draw conclusions and recommendations, a causal relationship analysis was performed to supplement the ANOVA test results. Direction for further research was developed based on the limitations of the study and the observed research opportunities. Chapter 5 and Chapter 6 contain the expanded methodology used to conduct the research.

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3. Innovation: Case Study Among Wood, Energy, Medical Firms

According to several authors in the wood products industry, this business sector is experiencing the consequences of the economic crisis. Since 2007 economic growth slowed and reversed to become a market crisis [1]. In 2008, the national GDP stagnated around 0% growth decreasing almost 2.6% in 2009 [2]. This situation was mainly caused by a slowdown in manufacturing, retail trade, finance, and insurance [3].

The wood products industry (NAICS 321 and NAICS 337) was hardly affected by the decreasing activity in new residential construction; the softwood lumber sawmilling (NAICS 32111) slowdown from sales of 28.6 billion BF in 2005 to 6.9 billion BF in 2009 [4]. Kitchen cabinets manufacturing decreased from $20.8 billion in 2006 to $15.0 billion in 2009 [5]. In addition to these industries, the office furniture industry (NAICS 33721) also experienced a drop in sales from $30.2 billion in 2006 to $20.6 billion in 2009 [5].

Some authors have claimed, that the ongoing globalization trades has also affected the industry, causing bankruptcies, closure of operations, or relocation to other countries starting prior to the financial crisis [6-9]. Decline in employment from 1999 to 2004 ranged between 8.9% to 35.2%, and the job cuts reached their highest peak in 2001 with 18,000 jobs lost. This situation also included a decline of shipments in the wood products industry, which as indicated before dropped 24.65% from 2008 to 2009 [9, 10].

Closing of plants also reflects the crisis in the wood products industry (NAICS 321), according to Quesada & Gazo [9] 142 manufacturing sites closed. In the case of the furniture manufacturing sector (NAICS 337) 168 sites closed from 1999 to 2004. In both cases, North Carolina experienced the greatest losses.

To support the wood products industry, this study originally focused in understanding how innovation, as a growth tool, can bring new opportunities to reinforce manufacturing sites within the industry. It is of the interested of the study to understand what is being done in firms from innovative sectors to adopt innovation management practices to reach profitable growth in the wood products industry.

3.1. Introduction

It is commonly accepted that American society perceives wood as a high value among the raw materials used for manufacturing products [11]. The annual total consumption of roundwood to be used as raw material for the wood products industry in the United States of America has increased constantly from 12 billion cubic foot by 1965 to approximately 17.2 billion cubic foot by 2005 [12], representing a per capita usage of 255 board feet and also 1.75% of the GDP of the country. Yet still the wood products industry is a large business in the American economy. It is also a business sector which has been facing many challenges to maintain itself as a profitable sector [13-18]. This situation has opened up an opportunity to research for proposals aiming to help this industry to achieve sustainable growth. Innovation seems to be the right path especially for the wood products industry since, according to US economy indicators, this sector shows one of the less innovative performances based on the Research and Development expenditure compared to the company sales. Figure 4 shows a comparative chart for R/D expenditures as a ratio to company sales for different business sectors.

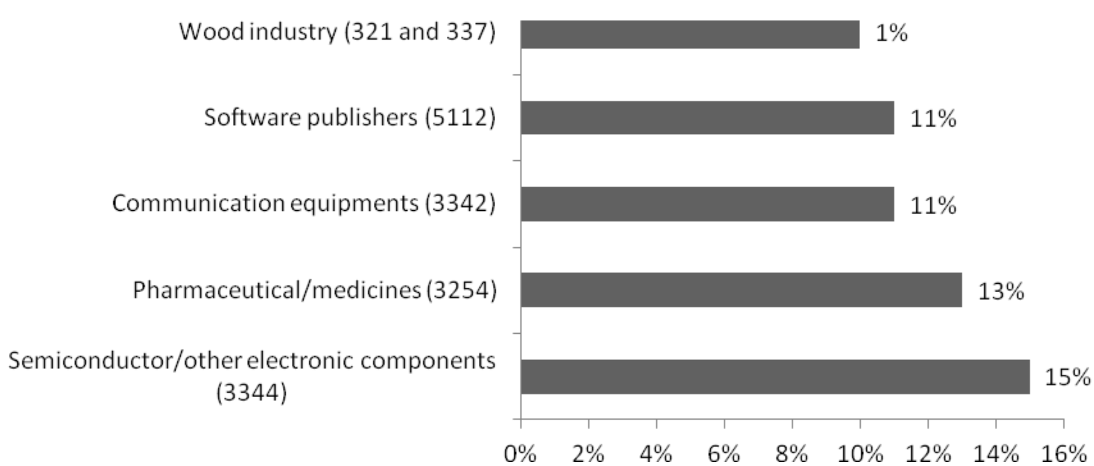

Figure 4. R&D expenditures as a ratio to company sales for different business sectors (Wolfe [19])

These proposals also have led researchers to a better understanding of the innovation process among industries in general since a better understanding of innovation is a crucial activity to develop sustainable growth and welfare in the [20, 21].

This research about the innovation process inside the wood products industry can be divided in three large sections according to Hansen *et al*. [22]: (1) organizational innovativeness, which concerns factors that influence innovativeness and the effect on financial performance; (2) innovation systems, which focuses on studying the relationship between companies and regulations and policies in the innovation field; and (3) new product development which researches about product development and all the involved stages.

Findings from literature shows some studies that were developed based on the previously discussed categorization, such as Crespel and Hansen [15] who researched about work climate and its relationship with innovativeness inside wood industry firms. However to the knowledge of the authors, no investigation inside successful innovative firms and a later comparison to wood industry firms has been previously developed, therefore the authors identified the need of a comparative study among the wood products industries and other industries aiming to answer the following research need:

What common innovation practices can be identified in innovative industries such as energy and medical devices firms compared to wood products firms?

3.2. Literature Review

3.2.1. Innovation as a Driver for Success

Innovation as an economic activity has been widely studied by several authors; Schumpeter [23] analyzed the impact of innovation and how innovation brings value to the market since it creates working methods, products and material sources. Porter [24] defined that innovation driven phase in a nation’s economy as the last step to achieve a wealth driven phase in a nation´s economy. Most recently, literature shows how innovation is well accepted as a tool for competitiveness, where companies are engaged in a continuous process of innovation to enhance more competitive environments for firms in all sectors [25, 26].

In past or present, there is always recognition of innovation; its contribution is clearly pointed out as a key element to help organizations capitalizing on knowledge and creating market opportunities by taking ideas into practice [20]. At the strategic level, Cooper and Edget [27] emphasized the importance of innovation goals inside business objectives. This approach directs businesses to ask themselves how innovation fits into the overall business plan and how innovation will contribute to the firm's growth.

3.2.2. The Concept of Innovation.

Innovation has historically evolved and still today, innovation appears under several definitions which are more narrowly defined allowing a concept with more common elements between single statements.

Zaltman *et al.* [28] defined innovation as any idea, practice or material perceived as new by the consumer, meanwhile, West and Farr [29] have defined innovation as the introduction and application of any idea, process, product or procedure, relevant enough with an observable benefit to the individual, organization or society.

The Oslo Manual, defines innovation as *"the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations"* [30].

According to Schramm [31], innovation is defined as *"the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers in a way that improves the financial return for the firm."*

Despite the fact that there are several stated definitions for innovation in the literature, it is observed that they share common elements; essentially they recognize innovation as bringing new value to the consumer resulting from new or large changes in current product, process, business methods or marketing practices closely tied to an intrinsic benefit obtained from the innovation.

3.2.3. Innovation Measurement.

By measuring innovation, policy makers and business man are able to understand the hidden and exposed drivers that will help fostering a sustainable competitiveness in economies around the world [32].

Despite the well known complexity of measuring innovation performance, efforts have been made and an innovation index has been developed by tracking innovative capacity of seventeen Organization for Economic Co-operation and Development (OECD) economies since 1973, and eight emerging economies since 1990, where results show four main factors directly related to innovation performance, (1) the amount of investment directed to Research and Development (R&D), (2) the size of the labor force dedicated to R&D, (3) the resources given to higher education, and (4) the effort made in encouraging investment and commercialization by creating national policies [32].

These drivers are also impacted by the behavior of single firms and groups of similar firms, called clusters, and therefore public and private investments have to be analyzed as well to determine the conditions innovative capacity is facing. The sub indicators around public and private investments affecting the factors related to innovation index are (1) investment in basic research, (2) R&D spending, (3) supply of risk capital, (4) aggregate level of education in the population, (5) protection of intellectual property, (6) openness to trade and investment, and (7) changes in market demands [33].

3.2.4. Research and Development.

Also known as R&D, Research and Development is "*an activity involving significant transfers of resources among units, organizations and sectors and especially between government and other performers*" [34]. This innovation performance driver has been considered uncertain and sometimes unpredictable due to the complexity of its elements [35], however it is recognized by the contribution brought to companies in terms of competitive advantage [36].

R&D is commonly divided in three categories depending on the type of research and results obtained, (1) Basic research covers all the experimental and theoretical work developing knowledge for the foundation of a topic but with no defined application or use; (2) Applied research is knowledge developed through original investigation aiming an objective; and (3) Experimental development is created under a systematic work, developing knowledge or using existing knowledge, targeting improvement of current material, products, process and services or the development of new materials, products, processes and services [34].

In terms of economy for firms, R&D represents not only activities but expenditures that comprise 5.8% of annual firm expenditures and it is responsible for nearly 7% of the GDP of the US economy [37]; this impact in economy has given R&D a role as an innovation measure that has been accepted among industry and government, helping firms to accomplish strategic positioning inside business sectors [38].

As specified by Chiesa et al. [39] measuring R&D is the result of a mix of several complex and dynamic contributors, including firm's R&D strategy, R&D entities, the type of R&D performed, and the resources involved, and this indicator is only a single component of the multi-dimensional measuring performance system for innovation.

1.5 Best Practices Benchmarking. Best practices are guidelines on how to perform an activity in a way that has successful results for other organizations. As Pertuzé et al. [40] pointed out best practices are those activities that help organizations to ultimately reach their goals in the best known way.

Holloway et al., [41] define best practice benchmarking as a technique through which firms are under a continuous review process of their outputs, and looking to identify ways to make changes to improve those results. Also in the literature is recognized four types of benchmarking, internal, competitive, functional, and generic benchmarking [41-45], for this study the functional benchmarking, was applied to the innovation development and management process in the same function (manufacturing) but outside the industry as suggested by [46] in order to understand the innovation development and management process, and also to identify those guidelines that will be useful to develop a framework for the wood industry in order to set innovation as a tool for sustainable growth.

3.3. Methodology

Selecting the appropriate research methodology is, according to Yin [47], based on three main conditions (1) the form of the research question, (2) required control over the behavioral events, and (3) how focused the study is on contemporary events. In this research, authors analyzed the methodology for the innovation process inside three different companies from three different industry sectors; this analysis aims to identify which current practices lead to successful implementation of innovation inside the firm to ultimately develop a best innovation practice summary applicable to the wood industry firms.

For this particular research, questions were written as explanatory questions (how and why) in order to understand the current practices (contemporary event) related to innovation management in the selected firms. These innovation practices are also known as the events and are not under the control of the researchers, leaving a scenario where multiple case studies are an accurate research methodology according to several authors [47-49].

3.3.1. Best Practices in Innovation Development Process.

In order to collect relevant data about best practices in the Innovation Development Process, the researchers reviewed existing literature about the topic to understand the innovation phenomenon inside selected organizations. From this literature review it was understood the concept of innovation, the methods that different companies use to implement and measure innovation, and how organizations see innovation as a part of its core strategy. Figure 5 shows the methodology used in this research.

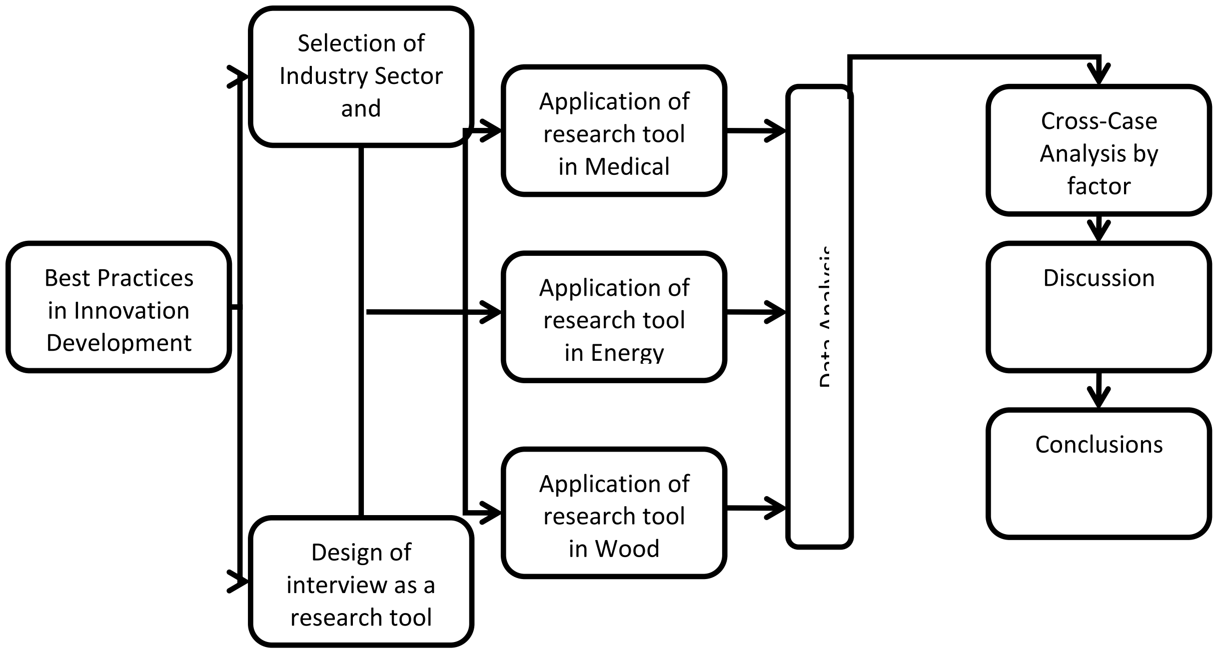

Figure 5. Multiple Case Study Methodology (Adapted from Yin [47])

3.3.2. Industry Selection

The Research and Development (R&D) process brings together all activities that involve transferring of resources among organizations, government and industries, to develop knowledge and/or uses for this knowledge [34]. The R&D activity is a worldwide practice, and therefore, several efforts have been done in order to measure it and its impact as an economy driver. These measuring efforts became standard metrics, where R&D expenditure as a ratio of sales is worldwide accepted [34] and has been selected as the metric to define whether a company has a successful performance in innovation process or not.

For this case study, the innovation process was analyzed in selected companies within/and similar to Semiconductor/Other electronic (NAICS 3344) and Pharmaceutical/Medicines (NAICS 3254) because they have the largest R&D expenditure to company sales ratio, showing how innovation, measured as R&D expenditure, is a contributor to company performance [50-52] and wood products industry (NAICS 321 and 337) which shows the lowest R&D expenditure to company sales ratio. These ratios are shown in Table 17.

Table 17. R&D expenses to company sales ratio [19]

Industry (NAICS code)	Sales worldwide ($ million)	R&D expenditure ($ million)	R&D as a share of sales
Manufacturing industries, including (3344)	192,258	28,812	15%
Pharmaceutical/medicines (3254)	529,601	69,516	13%
Wood Industry (321 and 337)	83,471	806	1%

The first sector, medical devices industry is considered as a part of the US healthcare system and also is considered an industry with high manufacturing costs associated which also increase in a very fast rate; sales worldwide for this industry reach over $100 billion ($43 billion only in US) and the sales rate increases at proximately 9% annually [52-54]. US healthcare expenditure, according to the US Department of Health and Human Services [55], was 16% of the GDP ($2.3 trillion) in 2007 and the annual growth rate from 2007 to 2014 is expected to be 6.7%.

As a manufacturing industry, medical devices face a development cycle that takes between 18 and 24 months, and also they face regulations from FDA (Federal Drug Administration), which sets and controls the requirements for development, validation, manufacturing, and promotions of products. This highly regulated environment represents a risk management challenge for this industry which is not part of other manufacturing environments [56].

Despite the major challenges this industry faces DeFoggi and Buck [54] pointed out that innovation is required to stay competitive and according to Wolfe [19] the R&D expenditure of this sector was $69.5 billion dollar in 2008 which makes this industry the second largest in R&D expenditure and the largest contributor for research and development in the Chemical business sector (NAICS 325).

This leadership held by this business sector has also been analyzed to understand the innovation process and several conclusions have risen from these studies. For example, Ackerly et al. [57] concluded that innovation inside the medical sector has been supported using venture capital practices which allow companies to get the needed capital to develop the ideas, especially in early stages of the innovation management process where medical devices firms have to face the high costs associated to FDA's development requirements.

Russel and Tippet [58] performed a study were they identified the critical success factors (CSF's) that influence the most the selection on innovation projects in the medical devices industry. With this approach practitioners in this field are having a better understanding of front end CFS's developing also better criteria to select the most accurate project mix and achieving a higher consistency in meeting objectives.

DeFoggi and Buck [54] constructed a framework that allows medical devices companies to identify unmet need of customers, in this way firms are able to foster innovation by applying a proactive marketing approach.

Worldwide there is an important effort made in the innovation field by the medical sector. This effort is the creation of the Medical Future Award which allows clinicians and academics to present the innovative ideas to a panel of experts who coach and mentor the development and validation process [59].

As is understood from the literature, the innovation process inside medical field is spread to several processes including product development, marketing strategies, financial support and more lately fostering forums for innovation where business people from the sector also can learn how to protect their ideas, write business plans or obtain funding for their ideas.

Based on the R&D expenditure to company sales ratio, the second sector is semiconductor/other electronic components (NAICS 3344); for this study the researchers were not able to obtain data from a company in this business subsector, therefore applying the same selection criteria described in the industry selection section of this study, a company from the electrical equipment manufacturing business subsector (NAICS 3353) was selected. This company belongs to energy generation industry, and as the semiconductor/other electronics components are located in the under manufacturing sector (NAICS 33) which comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products.

According to researchers in the field by 2020 the electricity consumption will raised 75% compared to 2000. This large increment also raises concerns related to the impact of green houses gases produced by power plants, the imminent death of the actual transmission and distribution infrastructure and the variability of fuel prices which are used to generate electricity [60].

These mentioned conditions leave the energy generation industry in a large urgency to develop new ways to produce electricity and also new ways to improve the current available resources ensuring also a sustainable development and growth.

To solve these needs, the US government has spent since 1978 a total of $75 billion, of which $30 billion is for nuclear energy generation, $20 billion to coal, $13 billion for renewable energy and $4 billion to other fossil sources [61]. This expenditure is allowing the industry to develop several capabilities by 2015 where the focus has been raising efficiency in coal (up to 60%) and natural gas (up to 75%) as electricity sources; a second focus is DOE Advance Turbine System which aims to raise steam turbine efficiency to 60%. As a third target, the oil and gas extraction technologies has been speed up in order to look for domestic production, and finally, the expenditure is also supporting research to find ways to reduce transportation costs transportation for coal and natural gas fuels [62].

As future innovation trends in the business sector Garrity [60] points out that energy generation industry will be focusing in elevate efficiency of high voltage energy distribution, also expanding the renewable energy generation and consumption, also industry has to start looking into distribution automation to improve distribution systems in general; clean and lower emission sources will continue as the backbone of any new innovation in the energy sourcing and finally nuclear energy will grow despite the challenges in the industrialized countries.

The third sector selected is the wood products industry; this industry has faced challenges in order to remain as a profitable sector [13-16]. This desired condition for the business performance can be achieved through innovation activity, which has been recognized as vital among the industry [11, 20, 21]. However, it is also well known that for this particular industry, there is a modest amount of analysis about innovation, which also has been increasing in recent years [11, 63]. This gap in studies related to innovation inside the wood products industry results in a major research opportunity to contribute to a better understanding of this event inside this sector in order to come with outputs that help industry to obtain a sustainable and profitable growth.

3.3.3. Company Selection

The methodology selected for this study allows analyzing every industry as an individual object of study, to understand a real-life phenomenon in depth and how it behaves under that specific environment [47]. This type of analysis is fundamental to obtain data for a later contrast between what literature suggests about innovation under certain conditions defined for industry selection, and also, is fundamental to compare the innovation development process through a cross analysis within the 3 chosen firms.

Among the selected industry sectors, the researchers chose the participating companies, based on the following factors: (1) companies with a strong quality oriented culture that pursues incremental improvements in existing systems [20], for this specific case study the selected companies apply 6 Sigma and Quality Control Techniques as part of their continuous improvement process, (2) company size. For this research, large companies were selected since it implies also, a larger effort to develop and sustain an innovation culture among the company. Literature suggests that large firms are more productive and have a more aggressive approach to innovation since there is a larger amount of support activities between R&D and other functional departments, such as manufacturing and marketing. In addition to this it is also suggested that larger firms tend to obtain higher profitability since innovation costs are widely spread [64-66]. In the medical device sector, the selected company has over 40,000 employees worldwide, the energy generation company has more than 400,000 employees worldwide and the selected company in the wood products sector has 56,000 employees worldwide, (3) their innovation process is performed under a systematic environment allowing also continuous innovation portfolio health which can allow strong results based on the fact that the scenario containing innovations with the higher returns is more clear [67], and (4) company willingness to be part of the study, sharing information useful to accomplish the objectives.

2.4 Design and application of interview as a research tool. Using the definition of innovation given in the Oslo Manual [30], the researchers structured a survey; divided in four different parts as follows. This research tool was applied at the firm site in order to also perform direct observation of the innovation development activities that firms were able to share. The interviews were answered by personnel with the highest rank in the New Technology, New Product and Processes and Quality Departments

1. Demographic and general information: company name/location, employee job title, industry activity, number of employees. This first part of the interview is designed to collect information about the firm for a better understanding of the environment and conditions where the activities take place.
2. Innovation from a management perspective: definition of innovation based on the firm understanding, definition of innovation as part of the strategic objectives. Also firms were asked for the number of product, process, marketing and organizational innovation activities done in the past 5 years and a description of the innovation development process and R&D expenditure as a financial indicator was emphasized based on literature findings that suggest a relationship between effective R&D expenditure and growth [27, 67].
3. Innovation activities: this third question analyzes the application of innovation as a standardized practice inside the firm process.
4. Factors affecting innovation: determine internal and external conditions affecting innovation through SWOT analysis, where every firm was asked about at least two items in each category. This section of importance relies on the fact that researchers wanted to better understand factors that could be possibly affecting the innovation development process.

3.3.4. Data Analysis.

For studies where there is an evident need of a better understanding on how and why innovation takes place inside the firms, Yin [47] suggests the use of Exploratory Multiple Case Study, which according to literature produces a more robust study [49, 68] and increasing the robustness of the theory being tested [69].

The data was analyzed using data displays in order to capture the findings separately and then through the use of tables to establish patterns among the 3 selected firms [47, 70].

3.4. Results

This section aims to present the inputs collected through the application of the interviews, and site visits as well as the analysis of those inputs. Information is presented based on the scheme developed for the interview as it was applied. The findings are compared to previous research and theory in the literature in order to contrast or compare with previous results.

3.4.1. Demographic and Management Perspective on Innovation Inside the Firms.

Table 18 shows a summary of the information collected from the participating firms. In this section researchers had the opportunity to apply the research tools in firms inside and outside the USA. This last factor is important since it allowed comparing literature against both, national and international sites.

Table 18. Demographics and general information summary

Company Business	Main Activity	Location	Number employees	Employee interviewed	Definition of innovation
Energy generation	Research and Development	North America	1000	Engineering Director Technology Development Manager Senior Technology Development Engineer	New products or changes to improve them either make them cheaper or to last longer).
Medical devices	Manufacturing	Central America	1100	New Products and Processes Manager	New or improved product or processes that solves current or future needs
Cabinet manufacturer	Manufacturing	North America	300	Senior Continuous Improvement Coordinator	New or improved products to offer to our clients or new or improved processes to be more profitable.

Firms were asked to briefly describe what innovation means for them. The three firms defined innovation in terms of new or improved product or process, and none of them referred to marketing or organizational innovation as part of the definition of innovation. In addition, firms were also asked about innovation examples. Each firm was only able to identify innovation examples in the category of product and processes, where the energy generation firm pointed out three innovative products and three innovative processes, similar to the medical devices firm where the interviewed manager was able to identify 15 product innovations and around 30 process innovations in the past five years. And finally the cabinet manufacturer was able to identify 10 product innovation and more than 40 process innovations in the past 5 years.

These definitions and examples are consistent with definitions given by several authors who usually do not consider marketing or organizational innovations among definitions of innovation found in the literature. For example, Schumpeter [23] considers innovation as any major change in product, process or thinking. O´Sullivan and Dooley [71] define innovation as something new that brings value to markets. Zaltman *et al*. [28] state that innovation is any idea, practice or material perceived as new by the consumer, and West and Farr [29] mention innovation as the introduction and application of any idea, process, product or procedure, relevant enough with an observable benefit to the individual, organization or society.

Firms were also asked about their perspective about innovation and how this perception is linked to their strategic goals. The energy generation firm indicated that innovation is a key factor for a sustainable profitable growth**.** As part of the strategic plan for a profitable growth, the firm set a Return on Investment (ROI) rate between 10% and 15% for every innovation project in order to sustain a constant growth.

In the case of the medical devices company, a similar answer was found. In this case, innovation is considered also a fundamental driver for the company's growth. This firm requires a higher ROI for innovation projects in order to accomplish incremental revenue of 10%.

These findings are similar to previous research, where several authors have indicated that organizations use their strategic goals and objectives to prioritize their improvement activities such as innovation ([20, 38, 67, 72, 73]

In contrast with the findings in the energy generation and medical devices firms, the cabinet manufacturer firm presents a different situation. This firm recognizes the importance of being sustainable and profitable to stay competitive but innovation projects are not used as a growth strategy for the company. This firm requires a variable growth, which changes upon the yearly company budget and therefore there is no standard ROI for projects or a similar defined company growth goal.

3.4.2. Innovation Activities (Describing the Innovation Development Process).

Nieto and Santamaría [74] and Conforto and Capaldo [75] suggest that innovation can be developed using different methodologies despite company size or other characteristics. These methodologies according to Corso and Pavesi [72] are usually systematic approaches developed inside firms and also are the result of alliances with external sources such as universities and research centers.

In this study it was observed that energy generation firms and medical devices firms are consistent with the approach suggested before. These two firms have defined innovation as a growth strategy and use structured methodologies for tracking innovation performance. These methodologies are described below.

Energy generation firm develops innovation projects using three main sources: (1) customer feedback, which can be obtained directly from the customer or through the monitoring services installed products in customer facilities; (2) employee's creativity which reinforces idea generation. This source follows a defined methodology that takes every idea, to the next management level to be approved and entered into an Innovation Portfolio. This portfolio contains all those ideas that have large potential to become an innovative product or innovative process; and (3) cooperation between the firm and research centers such as universities, where basic research is developed and becomes useful for the new technology development process. This cooperation among the firm and third parties is included in the company budget and it reaches a third of the total New Technology Development yearly budget.

The energy generation firm also shows a very clear methodology to follow up on portfolio health known as Technology Readiness Levels (TRL). TRL is a systematic metric-measurement system, adopted from NASA, which supports assessment of a particular technology. A general model includes 5 large steps subdivided in 9 different levels. These 5 steps are: (1) basic research in new technologies without a specific goal, (2) focused technology development for a specific goal, (3) technology development and demonstration for each specific application before the full development of the application, (4) system development and (5) system launch and operations.

The Medical Devices firm also obtains part of its innovation opportunities from feedback from customers. This feedback is handled by the Customer Service Department, who receives the information and generates the feedback to the corresponding area. A second innovation source, is an internal program developed as part of the continuous improvement culture, where employees bring innovative ideas that are analyzed by the next management level and based on its feasibility and innovation potential are taken into an innovation portfolio. For this firm there is also a clear methodology to develop innovation at the product and process level. This company uses a systemic methodology known as 7 M's which consists of 7 steps where every innovation project has to go through in order to maintain its feasibility and achieve goals.

M0 phase includes the idea generation. M1 and M2 are activities aiming to fulfill any required regulation. M3, M4 and M5 cover the different stages of production, starting with the production launch, followed by production based in forecast and finally production based on demand. M6 and M7 are steps where deployment occurs since there is a new innovation available to substitute current technology. This methodology allows the firm to move forward on every innovation under a systematic approach, which also, makes innovation visible at every step and feasible to be controlled, improved or discarded if it is found that feasibility is not as required by the firm.

The wood products industry also uses feedback from customers to look at innovation opportunities. This information is collected through Customer Service and is directed to the Marketing Department, who joins efforts with the Design Department to develop answers to customers' needs. Employees have also an active role in the feedback process by providing innovative ideas; however there is no systemic approach for communicating innovation opportunities. The wood products industry deals with innovation in a very different way since this firm does not have a systematic methodology to generate ideas and or develop these ideas. Innovation for this industry arises from employees and customer feedback, but there are no standardized steps to follow up and start the innovation development process. In this case, innovation seems to be more the result of a random situation instead of being the result of a planned strategy embedded in the business strategic growth.

3.5. Discussion

3.5.1. Strengths, Weaknesses, Opportunities and Treats (SWOT)

Table 19 shows the results of the SWOT analysis performed in the case study firms with the goal to understand what internal and external factors might be affecting the innovation process.

Table 19. SWOT analysis results

Industry	Energy Generation	Medical Devices	Wood Products
Strengths	Highly skilled personnel	Strong improvement culture based on Lean Manufacturing techniques	Strong improvement culture based on Lean Manufacturing techniques
	Research partnership with universities and governmental research centers	High motivation of employees towards Innovation development	Resources availability that could be allocated towards innovation development
Weaknesses	Communication gap among other divisions about Innovation developments that could be useful for this firm	Existing gap among innovation performance and innovation measurement	Lack of formal innovation development methodology
	Innovation development time up to 10 years	Not all functional areas are aligned with innovation development as a growth strategy	Innovation is not promoted as everyone's job
Opportunities	Partnership with universities and research centers contributes to research cost reduction	Develop metrics based on data available to measure innovation performance	Lean Manufacturing offers a strong training system useful towards innovation training
	Access to high skilled personnel inside and outside the firm	Lean Manufacturing offers a strong training system useful towards innovation training	Large mix of organizational cultures coming from different sites that allows sharing a wider scope of knowledge

Treats	High competence among the business sector which make innovation hard to develop	High regulated environment creates a negative perception about change	The product is a commodity product therefore economic conditions have a direct impact on availability of resources
	Innovation is mainly developed as top secret therefore cannot be publicly announced	High technology requirements could make creativity to be seen as unnecessary	Set innovation as a corporate growth strategy to align all site and assure resources

In the energy generation firm SWOT analysis pointed to highly skilled personnel as a valuable strength, where graduate students and professionals with doctoral degrees are in charge of R&D activities and highly involved in the steps to develop innovation. Interviewed managers also stated that collaboration with external organizations such as research centers and universities allows them to have access to the latest knowledge and high level scientists. As one of the weaknesses, this firm mentioned that communication among other divisions is not constant and structured, therefore; innovation activities that take place in different divisions are not shared resulting in an extra effort in knowledge or practices that are already tested and approved inside the firms other divisions. This firm also mentioned that because it takes up to 10 years to develop some products, the product development cost is extremely high, therefore the use of a methodology to track the development process is crucial to control the execution of selected projects and reduce waste of resources. As part of the opportunities, this firm mentioned that having high skilled employees would be critical to sustaining highly competitive work. Cooperation with universities and research centers would let them decrease the cost of innovation projects because research expenses are shared through this collaboration. The firm also identified that its sector is highly competitive and it makes innovation a difficult target to achieve because new technologies are developed also by major competitors at the same speed they develop their own causing every innovation project to be treated as top secret to avoid new technologies being shared before its implementation.

The medical devices firm pointed out as strength the firm’s strong process improvement system, which leads employees to identify improvement opportunities. This system is also reinforced by the high motivation level that employees have towards this improvement culture setting an open mind environment for innovation inside the firm.

This firm mentioned that using the continuous improvement methodology allows to capture data that could be used for measuring innovation; however it is pointed out as a first weakness that innovation measurement is not performed at every department. A second weakness is the different levels of involvement where not every department perceives innovation as part of their daily routine. As opportunities the manager mentioned that even though innovation measuring was not clearly performed, the firm has a good improvement opportunity because data is available and metrics can be developed as required. Also, it was mentioned that a strong training system through Lean Manufacturing methodology is in place and can be used as the platform to train individuals inside the organization towards innovation making innovation a vital part of the firm culture. This strategy has been mentioned by Hoerl and Gardner [76]. Two threats were identified inside this firm: (1) Low openness for process and product changes since the firm belongs to a highly regulated sector which requires strict validation processes for changes in current products or processes; and (2) also the perception about the high technology requirement. Employees from areas different than engineering might perceive that innovation is only for scientific job positions that are able to develop large improvements or changes based on their technical skills.

The wood products firm mentioned that Lean Manufacturing methodology has helped to develop an improvement culture, where employees see opportunities to improve as part of their job. This situation which is similar to the one found in medical devices, helps the firm to involve employees in the innovation process by taking advantage of the training system and the open mind culture towards improvement that is already in place. This firm also recognized that inside the organization there are resources and a training structure that can be used to promote innovation inside the firm. As weaknesses, the firm mentioned that there is no formal innovation process where employees can transmit their ideas, which is observed in the other two firms where formal processes are established for creativity and idea generation. This situation is also related to a second weakness which was identified by the manager interviewed as a weak perception of innovation as part of everyone’s job.

Two opportunities in the wood products firm were identified: the use of the current training system to develop innovation training, and being part of a large corporation with extensive knowledge in different disciplines that can be used for creativity and idea generation. As threats, the firm recognized that they manufactured a commodity product therefore; this organization is more sensitive to market fluctuations than other types of industries such as energy generation and medical devices, this condition has a direct impact on the budget available to develop innovation projects. A second threat is related to organizational management since the firm has not defined innovation as a growth strategy and therefore is not perceived as a company goal and consequently; is not developed at every level of the organization and resources are not accordingly assigned.

3.5.2. Best Innovation Practices from Energy Generation, Medical Devices Industries

Based on the previous discussion, authors observed that energy generation, medical devices and wood products firms share critical activities such as liaisons, resources availability, strong continuous improvement culture, using Lean Manufacturing techniques, which help to build the basics for developing the innovation process as a company strategy.

Researchers were also able to identify, through weaknesses and threats, that energy generation and medical devices firms have a different scenario from the one observed in the wood industry firm. In the first two firms, the weaknesses and threats are strongly related to factors affecting the current innovation development process such as communication gaps, the impact of high competence among industry and the presence of high regulated environments which according to firms' representatives could have a negative impact on innovativeness since these conditions might lead employees to discouragement towards innovation initiatives. However, in the wood products firm the scenario shows very different elements. This firm's representative clearly recognized as a first element that innovation has not been set as strategy for sustainable growth at the top management. As a second element, the firm also recognized that innovation is not promoted as everyone's job and is not developed through a formal methodology, even though the firm recognized that they possess a strong continuous improvement system useful to support and stimulate the innovation process. As a third element, the company pointed out the fact that the wood products are commodity products, highly dependable on the market's conditions and therefore the economy has a high impact on monetary resources. According to the representative, low cost strategies are developed using continuous improvement and are set as company goals. However, there is no budget assigned for innovation activities, which is consequently because of the fact that innovation is not a strategy used as part of the strategic planning, and therefore resources assignments are not discussed for this topic.

This previous analysis had strongly demonstrated a lack in the innovation process development inside the participating wood industry firm compared to the innovation process development held in the participating energy generation and medical devices firms. Based on this finding and fulfilling the objective of this research, authors have also identified four major guidelines known as best innovation practices. These best practices were identified using tools previously explained in the methodology section, which also is supported by similar methods used by studies found in the literature such as Walter [77], who identified best practices in ergonomics for construction businesses through survey of several contractors among the US, and Pertuzé *et al*. [40] who identified best practices for collaboration among universities and industries using interviews (surveys) with managers from aerospace, information technology, materials, consumer electronics, automotive, biomedical, mining, paper and petrochemical industries.

The best innovation practices were identified as remarkable since they help both, medical devices and energy generation firms, to develop and implement the innovation process and therefore, authors agree that they will also help in the successful implementation and development of the innovation process among the wood products industry. Table 20 shows a summary of the best innovation practices identified and the positive impact observed inside the organizations.

Table 20. Best Innovation Practices

Best Innovation Practice (BIP's)	Positive Impact
1. Define innovation as a strategic goal for sustainable and profitable growth.	This BIP will allow the company to understand and use innovation as a tool through all the organization, making resources available and measuring its impact on the firm's objectives.
2. Cooperation among firm, customer and research centers.	It was observed that obtaining feedback from customers becomes a very ideal generation source where needs are evaluated and solved, also cooperation with research partners allows the firm access to the latest knowledge and cost sharing decreasing the research expenditure.
3. Use of structured methodology to develop innovation project.	This practice aims to project feasibility evaluation and further performance tracking to ensure a healthy innovation portfolio.
4. Use of improvement process methodologies.	The use of these methodologies allows companies to reach personnel through previously developed structures making it easier for the firm to spread innovation as part of everyone's job since elements such as training systems and feedback processes can be used towards innovation development.

3.6. Conclusions and Future Research.

This multiple case study was designed to understand current practices related to the innovation development process in three industries from different sectors and develop a best innovation practices framework useful for the wood products industry. This framework is shown in Figure 6.

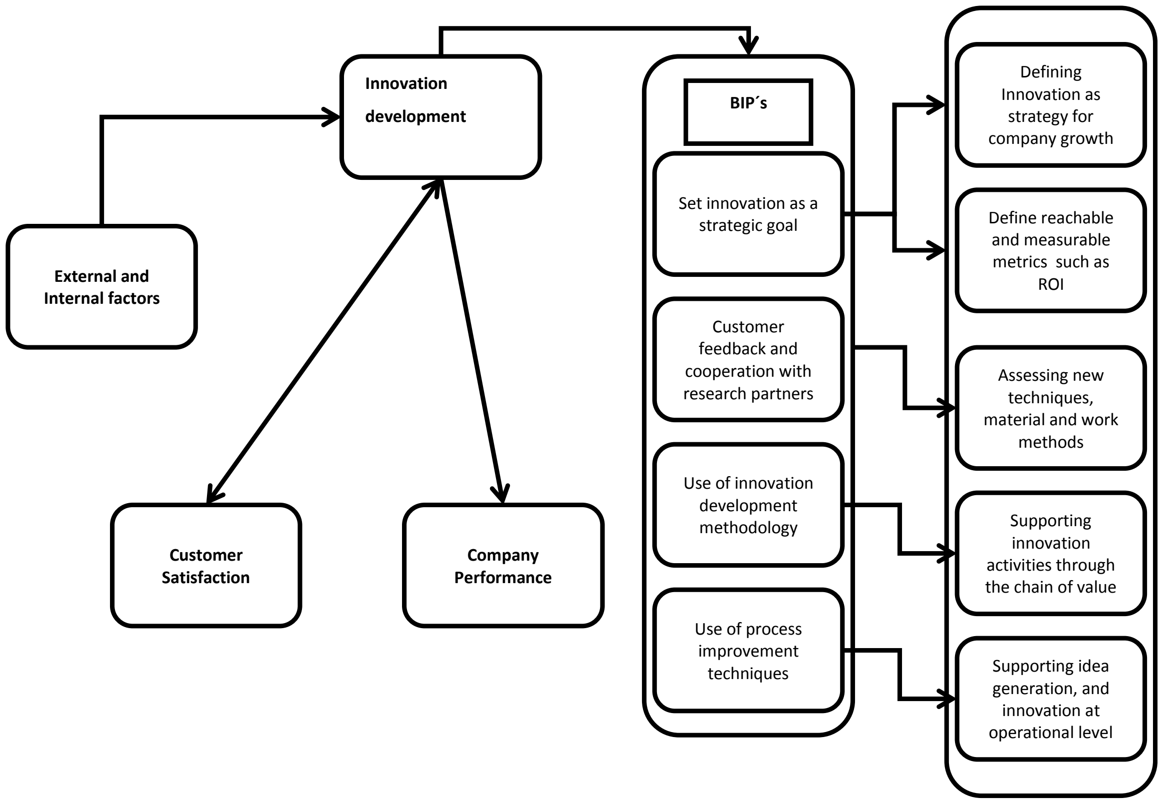

Figure 6. Best Innovation Practices

In this research it was found that innovation development as a process is affected by internal and external factors. Also, it was identified that customer satisfaction is a very reliable source to generate ideas that could eventually become innovations among the firms. Innovation development is also recognized among two out of the three firms as a process with a direct impact on company performance. Therefore, in energy generation and medical devices firms innovation development is used as a profitable growth strategy.

These best practices identified in the previous section of this research will contribute to industry and education institutions to adopt a general understanding that leads to the use of innovation as a company growth strategy based on successful results in both, energy generation and medical devices. Also, these findings aim to contribute remarking the importance of feedback from the customer and the cooperation among industry-research centers. Since this will fulfill the innovation development pipeline with several ideas to innovate, they also aim to contribute by setting the path for future research about further understanding how innovation could become part of a learning process for individuals inside universities, developing the necessary set of skills for future professionals to become more innovative in daily tasks, contributing also to achieve the firm's growth through the innovation process. For this future research, the authors identify that obtaining data relevant to innovation learning and innovation teaching using tools as laboratories and surveys to evaluate these topics among industry will bring valuable information to support the innovation development process inside the industry and cooperation among research centers.

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4. Development of the Theoretical Framework and Hypothesized Constructs

Initial work developed in Chapter 3 contributes to the body of knowledge on how to use innovation as a growth strategy for industries. The results of this initial work indicate that innovative industries employ four main practices: (1) set innovation as a strategic goal rather than a random activity, (2) use a defined methodology to develop innovation, (3) establish cooperation with research center, and (4) use continuous improvement to support incremental innovation.

As indicated in previous work found in Chapter 3, innovation is a required growth tool to remain profitable, and there are several practices companies can take to achieve innovation. Specifically, the wood products industry is requiring, not only innovation but also more business process management to achieve profitability and growth. According to Chandler & McEvoy [1] and Reid & Harris [2] the survival rate in SME's, like a vast majority of wood products industries, is enhanced when continuous learning is part of the organization, and the most successful SMEs provide more employee training time tha average to acquire new skills and strengths. Also, previous studies such as Hansen & Smith [3], Michael & Leschinsky [4], Thomas, Hansen & Brackley [5] and Vlosky & Chance[6] provide evidence suggesting that CI will bring business management knowledge, reasoning/ problem-solving skills and quality control skills to the wood products industry. In spite of CI contribution to enhancing performance and to supporting incremental, still this methodology faces challenges to become sustainable. Thus, the researcher was interested in analyzing deeper the existing relationship between CI and innovation, to further support CI sustainability, and ultimately enable incremental innovation.

Constructing a theoretical framework is helpful to better understand the CI process and how it can become sustainable. Theoretical frameworks are used to depict components' (constructs') attributes, and the existing relationships among the components of the system [7]. For this study, the construction of the theoretical framework aims to identify, according to the available literature, the factors that influence CI sustainability.

The rationale supporting this framework is drawn clearly from the literature. The difficulty of CI practitioners comes not in the definition, but in its implementation and sustainability [8]. Previous empirical research in the CI field has identified a set of factors that foster CI sustainability. According to the literature review these factors are: (1) the strategic management of the CI process, (2) the leadership, (3) the change adoption, (4) the training, (5) the operational management, and (6) the measurement and information deployment.

The theoretical framework developed has also identified the characteristics of these factors. These characteristics are the foundational theory to characterizing each construct, and to developing the evaluating items in the research tool (see Appendix A).

The characterization of relationships among these factors was also enabled by the construction of the framework. According to available literature, the factors are interrelated and have a direct impact on CI sustainability, meaning that higher performance within individual factors will result in a stronger CI sustainability.

This current chapter describes the theory behind the construction of the proposed research framework. Furthermore, an extensive description of each hypothesized construct is given below followed by the identification of operationalized measures for each construct, as well the corresponding supporting literature. Finally, the chapter describes the procedure employed in developing the questionnaire, based on the described constructs and operationalized measures.

4.1. Constructs of the Continuous Improvement Sustainability Framework

For a better understanding of overcoming the challenges facing by CI sustainability and ultimately supporting innovation, revising the listed constructs according to the available literature is vital. The construction of a framework is important so the researcher can clearly indentify proposed constructs from the literature and use the framework as a reference for further analysis. Table 21 shows a summary of an extensive literature review to identify these constructs followed by an explanation of each construct and the corresponding hypothesis.

Table 21. Constructs of the proposed research framework

Factor	Description	Selection of cited literature
Strategic Management (SM)	Describes how the management level integrates a plan to accomplish CI as an objective, as well as how this strategic plan is deployed and perceived by associates at all levels.	Bessant *et al.* [9], Kaye & Anderson [10] and Upton [11]
Leadership (LE)	Refers to how formal and informal guidance is exercised across the organization, including the mechanisms developed for decision making, two-way communication, feedback, and development of leaders. Also, evaluates how values and directions are reinforced.	Bessant *et al.* [9] , Kaye & Anderson [10], Upton [11] and Dale *et al.*[12]
Measurement and Information Deployment (MID)	Determines to what extent information related to improvement and performance dimensions of outcomes is simple and available to every associate and how systematic the information deployment is.	Bessant *et al*. [9], Kaye & Anderson [10], Dale *et al*. [12]
Operational Management (OM)	Evaluates the CI management process at the operational level, including active involvement of associates in identifying needs, solutions, and actions required to solve problems. Also examines the extent to which CI is incorporated into work methods, and how employees are being awarded for contributions.	Bessant *et al*.[9] , Kaye & Anderson [10], Dale *et al*. [12]
Training (TR)	Determines to what extent training has become a formal process inside the organization, and to what extent it has been applied to functional areas.	Bessant *et al*. [9], Kaye & Anderson [10], Dale *et al*. [12]
Change Adoption (CA)	Examines how the need for change, as improvement, is understood, and the effort the organization is making to adopt new ways to work .	Bessant *et al*. [9] Kaye & Anderson [10], Dale *et al*. [12], Marksberry *et al*. [13]

4.1.1. Strategic Management

The literature available in strategic management is vast. However authors have reached a consensus in defining strategic management as the ability of the general managers, on behalf of the stakeholders, to develop initiatives and courses of action, involving the utilization of the resources to enhance the internal and external performance of the company [14-17].

In the field of CI, Linberg & Berger [18] argue that strategic management can follow a diverse number of paths for designing, organizing and managing the CI process. Bessant, Caffyn & Gallagher [19] and Jorgensen, Boer & Gertsen [20]also argue that even though strategies to achieve CI can vary among firms, characterizing elements applicable to the strategies defined do exist. When defining CI strategies and measurable goals, it is fundamental that individual and group objectives align to ensure achievement of the desired goals.

Kaye &Anderson [10] advocate for aligning of CI goals with the requirements set by the stakeholders; they consider this the overall goal of a CI oriented firm. Moreover, the researchers' findings show that communication is a key element of CI strategic management. They state that successful organizations must share the vision and mission toward CI with their employees, and the quality policy should include a commitment with CI as a strong component.

Chapman & Hyland [21] draw attention to the importance of top management's role in sustaining CI. The findings from these authors' research carried out identified that initiatives have to be accepted across all levels of the organization; an effective way to promote the acceptance and practice of CI is following up with performance metrics from top to bottom.

Another important element in the CI strategic management is the ability to recognize shortcomings. Ncube & Wasburn [22] mentions that a continuous revision of the CI strategy enables the organization to anticipate and prepare for a coordinated response when the proposed CI goals are not met.

The literature review above highlights the need for incorporating CI into the organization through strategic management and is the source characterizing the strategic management construct as a success factor of CI sustainability.

In order to measure and evaluate the strategic management construct, the study proposes a set of items (referenced with the letter V) ranging from item 1 through 12 in the research tool. Table 22 shows the list of the items and the corresponding description.

Table 22. Evaluating items of strategic management construct

Item	Description	Source
V1	CI strategic plan	Wilshaw & Dale [23]; Carpinetti, Gerolamo & Dorta [24]
V2	Alignment of CI and departmental goals	Kaye & Anderson [10]; Bernett & Nentl [25]
V3	Use of historic data to develop CI goals	Mehra [26]
V4	Systematic follow up of CI goals	Pinheiro da Lima, Gouvea da Costa & Angelis [27]
V5	CI as strategic plan to meet customers' needs	Wilshaw & Dale [23]; Kaye & Anderson [10]
V6	Communication of CI goals	Bessant *et al*. [9]
V7	CI goals adjustment based on follow up	Pinheiro da Lima, Gouvea da Costa & Angelis [27]
V8	Available resources across the firm to support CI	Bessant *et al*. [9]
V9	Effective communication of reached goals	Bernett & Nentl [25]
V10	Frequent monitoring of CI goals progress	Ncube & Wasburn [22]
V11	CI goals drive the day to day work	Pinheiro da Lima, Gouvea da Costa & Angelis [27]
V12	CI goals are understood at every level of the organization	Kaye & Anderson [10]

This operationalization of the strategic management construct is tested using the following hypothesis:

H_1. Items V1 through V12 are valid operationalized measures describing the strategic management construct.

4.1.2. Leadership

Leadership is a very broad concept originated in the political arena in the 19th century [28]. Today, leadership is commonly defined in the business environment as the ability of an individual to motivate others to contribute toward the effectiveness of the organization with which they are associated [29].

In the field of CI, leadership is also linked to actions and values. Jabnoun [30] discusses that values are required for the success of CI. Other authors suggest that humbleness, openness, respect for people, responsibility and integrity, empathy, trust and cooperation are basic components to enhancing CI [31-33]. Schein [34] argues that leadership is fundamental to not only activating the required initiatives to accomplish goals, but also to infuse strong values to motivate individuals toward a goal.

Perles [35] discusses that failure of a CI program might be caused by a lack of understanding regarding the leadership competences required. Authors such as Guillén & González [36] and Goetsch & Davis [37] pointed out that CI requires that leaders are able to influence and encourage the creativity of employees, develop and integrate teams to reach goals, create and communicate the vision of the CI, and generate compromise by exemplifying continuous improvement through their actions.

The important role of leadership in CI is also recognized by well known quality entities such as the Deming Prize and the Malcolm Baldrige Award. These awards indicate that only a management team characterized by active leadership is able to effectively define goals, hold strong values, and, therefore maintain the elements to implement and sustain CI [38] .

It is not surprising that even the most elegant and well-structured plan will be unsuccessful if the creators do not exemplify the standards they set; therefore, in terms of leadership, managers and supervisors must learn that leadership in the CI environment means doing what is expected on a daily basis [20, 39].

To further evaluate the leadership construct, a list of items was developed corresponding to item 13 through 21 in the research tool. Table 23 shows the operationalized measures for the leadership construct.

Table 23. Evaluating items of leadership construct

Item	Description	Source
V13	Perception of CI as a company value	LeBrasseur, Whissell & Ojha [40] ; Jabnoun [30]
V14	Improvement as core element for company's permanence	Shareef [41]
V15	Role modeling of CI initiatives by managers	Carman [42]
V16	CI as an element of the vision and mission	Brown *et al*. [43]
V17	Accurate organizational structure to support CI	Samson & Terziovski [44]
V18	Resources allocation for invention and creativity	Augsdorfer & Harding [45]; Jabnour [30]
V19	Recognition of innovation and creativity	Augsdorfer & Harding [45]; Jabnour [30]
V20	Accessibility to CI leader	Roberts [46]; Jabnoun [30]
V21	CI leader is clearly recognized	Henderson & Evans [47]; Brown *et al*. [43]

This operationalization of the leadership construct is tested with the following hypothesis:

H_2. Items V13 through V21 are valid operationalized measures describing the leadership construct.

4.1.3. Measurement Information and Deployment

CI is about improving to meet internal and external customer requirements [10]. Hyland *et al.* [48] argues that, to achieve these requirements the CI process should be goal oriented. The authors also state that a well structured CI program incorporates systemic deployment of the CI goals and their performance.

According to Chang & Chow [49] measuring and deploying the information on goals performance raises awareness for workers from four perspectives: (1) customer perspective-- allowing individuals to understand how the customer sees them and how they are performing to meet customers' expectations. (2) Internal business perspective-- enabling members of the organization to visualize the internal processes performance according to the customers' needs. (3) Innovation and learning perspective-- allows workers to evaluate if they can continue improving and creating value for the customers. (4) Financial perspective-- shows the workers how they are translating the efforts and resources of CI into financial well-being.

Involving workers in the CI process by communicating changes and performance evaluations, as well as lessons learned is imperative for the success of CI [50, 51]. Therefore, when establishing a measurement information and deployment system, practitioners must ensure that data collected is used by improvement teams to take actions as suggested by Burns [52].

Involving workers in the CI process is also supported by Choi & Liker [53] who analyzed how communication influences CI effectiveness across organizations. Their results demonstrate that CI oriented firms value systematic progress and frequently measure progress against stated goals. This systemic process allows enterprises to evaluate effectiveness of their processes and to effectively manage the firm by setting new courses of action or sharing proven successful solutions.

The previous discussion on the literature about measurement information and deployment leads to the definition of the set of operationalized measures for the construct. This set of operationalized measures is represented by items V22 through V31 of the questionnaire. Table 24 shows the list of operationalized measures for the measurement information and deployment construct.

Table 24. Evaluating items of measurement information and deployment construct

Item	Description	Source
V22	Display of CI metrics	Dabhilkar & Bengtsson [54]
V23	Consistent overall and departmental CI goals	Dabhilkar & Bengtsson [54]
V24	Longitudinal collection of CI metrics data	Mehra [26]
V25	CI metrics at the operational level	Kaye & Anderson [10]
V26	Use of lessons learned to support performance	Jacobsen [55]; Savolainen & Haikonen [56]
V27	CI goals reflect customers' requirements	Wilshaw & Dale [23]; Jacobsen [55]
V28	IT supports CI measurement and deployment	Mereau & Labbe [57]
V29	Timely CI reporting	Bond [58]
V30	Existing database of lessons learned	Oliver [59]
V31	Electronic management of CI data	Mereau & Labbe [57]; Barber, Munive-Hernandez & Keane [60]

This operationalization of the measurement information and deployment construct is tested with the following hypothesis:

H_3. Items V22 through V31 are valid operationalized measures describing the measurement information and deployment construct.

4.1.4. Operational Management

The operational management construct describes the mechanisms employed to identify the key supporting process in the implementation of CI. According to Upton [11], a support process does not transform material; however this process is important and required to ensure that the remaining processes across the organization occur at the right place and at the right time.

Dale *et al*. [12] indicates that misalignment commonly exists between departmental and overall CI goals and may lead to barriers preventing cooperation of functional areas. When this occurs sustaining the CI process becomes difficult.

Kaye and Anderson [10] and Dyason and Kaye [61] state the importance of focusing on the non manufacturing related process depends on the perspective of the customers. The authors suggest that a CI oriented firm recognizes the value in meeting external customer requirements in the form of goods and services, but also recognizes the value of meeting internal customers requirements by delivering the resources required to perform.

Eight items (V32 thought V39 in the questionnaire) were developed to measure the operational management construct. Table 25 shows the list of the operationalized measures for this construct.

Table 25. Evaluating items of operational management construct

Item	Description	Source
V32	CI increases job flexibility	Dale *et al*. [12]
V33	Openness to suggestion of ideas	Jabnoun [30]
V34	Employees contribution to meet customers' needs	Jacobsen [55]
V35	CI empowers employees	Kaye & Anderson [10]; Ford & Fottler [62]
V36	CI goals toward supporting functional areas	Wilshaw & Dale [23]; Davenport [63]
V37	Multidisciplinary CI teams	Sutton [64]; Ahmed, Loh & Zairi [65]
V38	CI as preventive rather than reactive methodology	Fryer, Jiju & Douglas [66]
V39	CI brings new technology to improve products and processes	Upton [11]

This operationalization of the operational management construct is tested with the following hypothesis:

H_4. Items V32 through V39 are valid operationalized measures describing the operational management construct.

4.1.5. Training

Activities happening within organizations create knowledge according to Upton [11]. The author also mentions that organizations require development of systematic methodologies to capture the knowledge and to diffuse that knowledge across all levels the firm. In the area of CI improvement, various authors recognized that training is vital to acquiring external knowledge, and also to share best practices and lessons learned [10].

Oliver [59], Terziovski & Sohal [67] and Kaye & Anderson [10] indicate that the success of CI depends on the ability of the firm to learn and apply concepts throughout the organization.

Goff, Sheckley & Hastings [68] suggest that the fast-changing world requires organizations to continuously learn. Liedtka & Rosenblum [69] argue that continuous learning is the source for firms' advancement; therefore training plays a vital role in adopting new methodologies. DiBella, Nevis & Gould [61] also recognize the value of learning from experiences. The authors suggest learning from experience is characteristic of an organization capable of observing, describing and analyzing the internal events.

Findings from previous research carried out by Terziovski *et al.*[70] show that the success of CI initiatives is correlated positively with commitments to learn in the organizations. This learning commitment allows the organization to recognize the value of transforming knowledge into an asset; that later is distributed as lessons learned to particular units or throughout the organization through operating procedures, meetings, or training sessions [59].

According to Bessant & Francis [71] training can be seen as the foundation for CI programs since it provides the capabilities and skills to take the necessary actions. Also, training assists the organization by highlighting successful paths and diffusing lessons learned to reduce failure in the future. The above findings and arguments lead to the construction of the following the operationalized measures represented by items V40 through V 47 on the questionnaires. Table 26 shows the list of the operationalized measures related to training.

Table 26. Evaluating items of training construct

Item	Description	Source
V40	CI is a component of the induction phase for workers	Bessant & Francis [71]; Ahmed, Loh & Zairi [65]
V41	Existence of a continuous training plan for CI	Goff, Sheckley & Hastings [68]
V42	CI goals are set at the individual level	London & Smither [72]
V43	CI training is part of workers' development plans	Dale *et al*. [12]; London & Smither [72]
V44	Active role of manager in the CI process	Carman [42]
V45	Failure as a learning opportunity	Ahmed, Loh & Zairi [65]
V46	Risk taking to promote innovation and creativity	Ahmed, Loh & Zairi [65]
V47	Learning organization from CI experiences	Savolainen & Haikonen [56]; Jacobsen [55]; Oliver [59]

The operationalization of the training construct is tested with the following hypothesis:

H_5. Items V40 through V47 are valid operationalized measures describing the training construct.

4.1.6. Change Adoption

According to the literature, change is inherent in any CI process, because CI itself requires people working in the organizations to newly perceive opinions, ideas, values, rules, behavioral patterns and norms [73].

Galpin [74] listed nine components that are crucial when implementing change in the organization. (1) the creation of rules and policies that reinforce desired ways of operating; (2) the creation of goals specific to operations with results that depend on measurements of how the employees conduct the process; (3) customs and norms to reinforce new working ways; (4) training that includes real time and active participation for a better understanding and adoption of new working methods; (5) recognition for employees who successfully implement and achieve their goals; (6) management behavior publicly recognizing and awarding those who adopt the desired behavior; (7) communication of changes before, during, and after the implementation, as well the use of two-way communication to obtain feedback about the implemented change from managers and employees; (8) physical environment used to support change, such that managers and change leaders should be close to employees in order to work together to make successful changes, and (9) organizational structure that reinforce the operational changes.

Upton [11] recognizes that the CI process brings change, along with some chaos that comes with any of these changes. Dale *et al.*[12] also indicates that any change required by CI process implementation is wide and complex, and requires the development of an environment where employees feel the motivation to continuously improve. If the senior leadership and managers fail to create this environment, then the systems, tools and techniques employed to sustain CI process will be ineffective.

Moreover, Kaye and Anderson [10] found that at least 63% of the participants anticipated resistance to changes required for successful CI implementation. To reduce resistance organizations create systems to retain current knowledge, and shape current managers' roles by offering higher training and technical support skills [11].

Finally, as suggested by Bessant *et al*. [9] and Rampersad [73], the success of change management lies in five main points that senior leadership should consider while requesting change across the organization: (1) explain the need for the change; (2) raise awareness of the need for improvement through change; (3) show the opportunities available from improvement; (4) communicate in both directions to obtain feedback on the change and the results, and (5) show involvement and commitment with the proposed change and the activities required for change to happen. The previous arguments led to the construction of the operationalized measures for the change adoption construct. These operationalized measures were listed as item V48 through item V56 in the questionnaire. Table 27 also shows a summary of the operationalized measures for the change adoption construct.

Table 27. Evaluating items of change adoption construct

Item	Description	Source
V48	Evolving working environment	Upton [11]
V49	Mindful responses rather than inefficient solutions	Savolainen & Haikonen [56]
V50	Objective selection of solutions	Savolainen & Haikonen [56]
V51	Dynamic portfolio of lessons learned	Jacobsen [55]; Oliver [59]; Savolainen & Haikonen [56]
V52	Leaders model CI by embracing change	Savolainen [75]
V53	Feedback system to avoid backsliding	Oliver [59]; London & Smither [72]
V54	Change adoption is supported by success stories	Savolainen [75]
V55	Clear vision of why change is required	Payyazhi & Hussain [76]; Marín-García, Pardo del Val & Bonavía Martin [77]
V56	Overall support of the organization to adopt change	McAdam *et al.*[78]

The operationalization of the change adoption construct is tested with the following hypothesis:

H_6. Items V48 through V56 are valid operationalized measures describing the change adoption construct.

4.1.7. Sustainability of the Continuous Improvement

A set of defined standards to indicate if the CI process is sustainable does not exist. Shingo [79] and Schonberger [80] argue that CI sustainability should be measured using waste indicators. These authors developed a list of seven waste sources that should be set as metrics to evaluate if the CI programs are successful and sustainable over time. These seven waste sources are: (1) overproduction, (2) transportation, (3) process waste, (4) operator movement, (5) inventory, (6) idle time, and (7) bad quality.

Bateman and David [81] also stated that indicators of the sustainability of the CI process should not only include financial metrics related to cost reduction based on reducing waste, but also the number of initiatives such as Kaizen events, training programs on CI techniques, and the application of new and improved working methods.

A list of four operationalized measures was developed to describe CI sustainability. These operationalized measures are listed as items V57 through V60 in the questionnaire. Table 28 shows the summary of the items.

Table 28. Evaluating items of sustainability of CI construct

Item	Description	Source
V57	CI initiatives are defined as metrics	Dabhilkar & Bengtsson [54]
V58	Defined metrics for waste reduction in the long term	Shingo [79]; Schonberger [80]
V59	Defined metric for ongoing CI training in the long term	Goff, Sheckley & Hastings [68]
V60	Vision of CI as a stable management philosophy	Brown *et al*. [43]

The operationalization of the sustainability construct is tested with the following hypothesis:

H_7. Items V57 through V60 are valid operationalized measures describing the sustainability construct.

Summarizing, the current proposed research framework consists of seven constructs, evaluated through 60 operationalized measures. Figure 7 depicts the proposed research framework graphically, and the corresponding items for each construct. A brief description of each summary is also provided and the test results for the structure of the constructs is presented in Chapter 5.

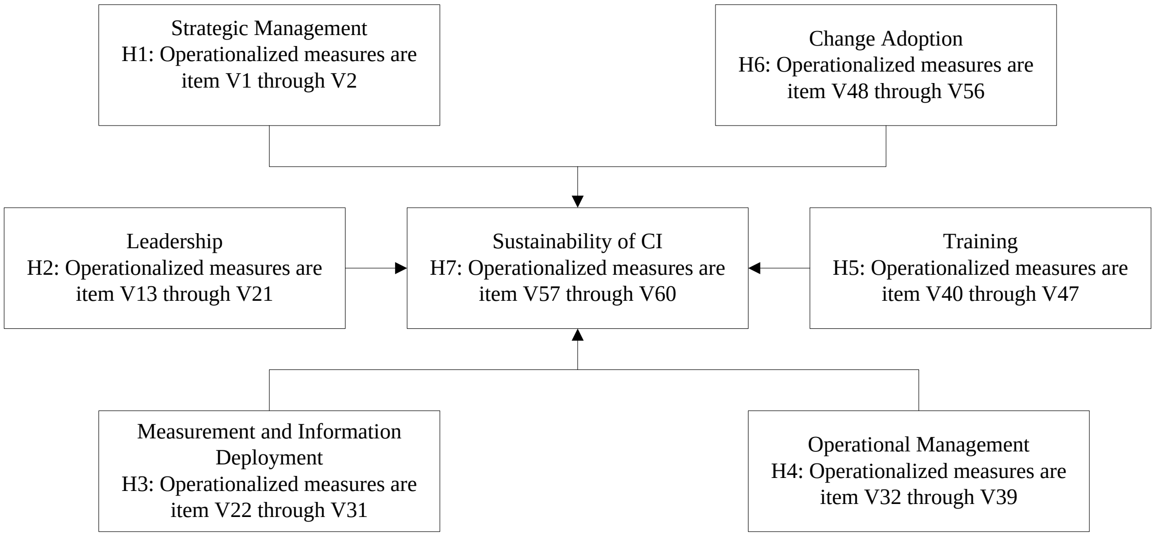

Figure 7. Proposed research framework

4.2. Development of the Research Tool

The questionnaire was built considering factors and related items identified in the literature review which, along with experts' opinions, have demonstrated an impact on the sustainability of the CI process. The selected factors to be examined through the application of the questionnaire are: (1) strategic management, (2) leadership, (3) measurement and information deployment, (4) operational management, (5) training, (6) change adoption and (7) sustainability of the CI process. A summary of the steps followed to construct the questionnaire is shown in Figure 8 followed by a detailed explanation of each phase.

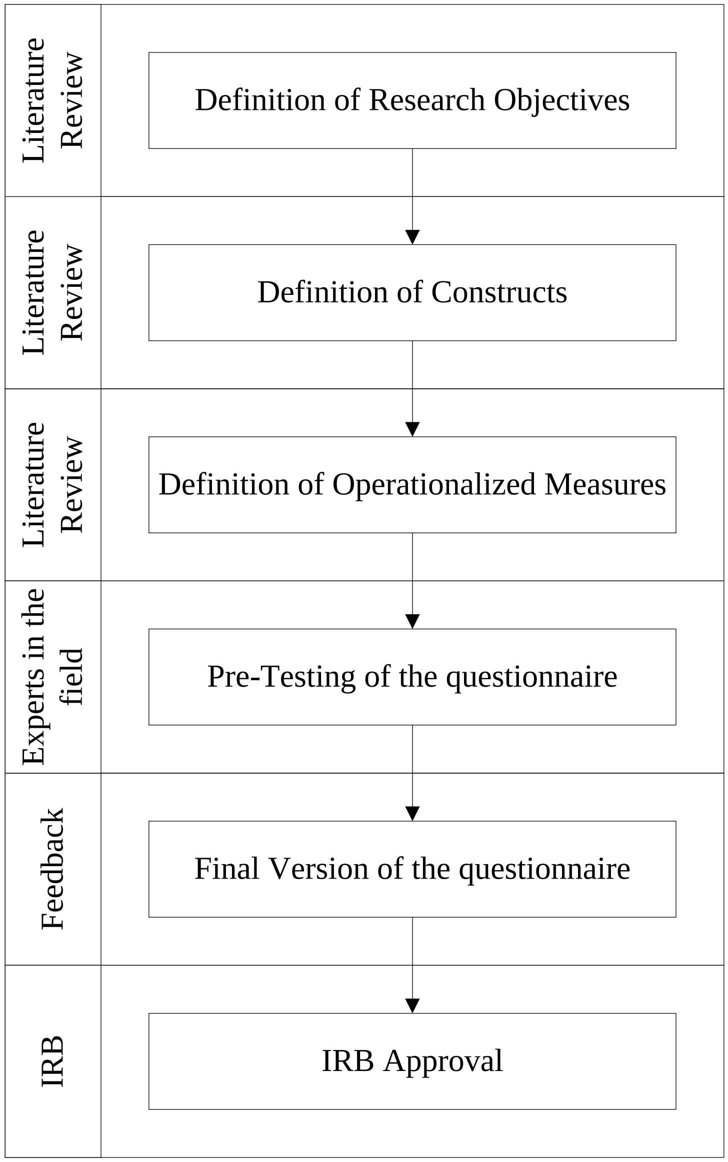

Figure 8. Methodology for questionnaire design

Structurally, the questionnaire was designed with two main parts. The first part of the design aims to collect demographic information of the respondents. Demographic information was important for this study and results are included as frequencies and percentages. The use of this type of information enables the researcher to describe the frequency of scores for each variable by summarizing the data set [82]. Trochim [83] also indicated that descriptive statistics are commonly used to detail the main characteristics of the data. The author remarks that descriptive statistics give simple summaries that, used together with graphic analysis, are the foundation for the quantitative analysis of data. Finally, Mann [84] suggests that descriptive statistics present an extensive story and are useful in characterizing the main features of the collected data for research reporting. The questions analyzed with descriptive statistics target information including the length of employment at the company, the functional area where they work, and the job level.

The second part of the questionnaire aimed to collect the perceptions of employees regarding the role constructs play in sustaining the CI process. According to the literature, a perception is how a respondent evaluates an item based on the available categories of the selected measuring scale [85]. For each construct, a list of items (operationalized measures) was developed based on the current literature, and the research asked respondents to report their perceptions of how each item is related to CI sustainability in form of a ranking scale.

The practice of measuring perceptions on questionnaires using scales is quite common in the business field, as indicated by Bartikowski, Kamei & Chandon [85]. There are various scale types from which researchers can choose. Some of the most well-known include Stapel scale, which is used to measure consumers' attitudes and was developed by Jan Stapel. This scale allows respondents to rate using ten possible response categories, from +5 (very accurate) to -5 (very inaccurate) without showing the written description of each possible rating [86]. A second measuring scale is known as Thurston scale. This type of scale measures the attitudes or perceptions towards a concept or construct by evaluating a large number of items related to that concept or construct. These items can be evaluated in 11 different categories where each category expresses a different level of favorableness. Thurston scale is also known for being time consuming and labor intensive [87]. A third scale is the Guttman scale named after Louis Guttman. This scale was developed in an discrete order so that a respondent who agrees with a particular statement also agrees with lower-rank statements [88]. The use of Guttman scale is observed mainly when the researchers aim to use a short questionnaire with an adequate level of discriminating ability. Guttman scale use is also recommended when constructs are clearly hierarchical and structured. Finally, a fourth well known scale is Likert scale. This type of scale is commonly used in research that involves questionnaires, allowing researchers to properly distinguish patterns in the analysis of items [89] and provides a consistent former for further statistical analysis [90] . Lee & Soutar [91] argue that there are various ways to gather quantitative data, but undoubtedly rating scales remain the most popular method. Likert-type scales are built upon the work of Rensis Likert, who set up a list of options for respondents reactions ranging from "strongly agree" to strongly disagree", which is the most common format, above a 7-point scale, suggested by Dawes [92]. Usually, Likert-type scale consist of a declarative sentence and a range of response options, which are linear and have equal intervals between them according to DeVellis [93]. This set of sentences is also written in a close-ended question format and presented with the scoring metric, which limits the respondents to selecting only one option.

For this study, and based on its simplicity and level of acceptance compared to other measuring scales, operationalized items were evaluated using a Likert scale. Although, Likert-scale type are frequently used, there is still much discussion on the optimal number of responses. For this study in particular, the 5-point Likert scale was chosen over the 7-point Likert scale to reduce the respondent burden, and also because evidence suggest having a 7-point scale over a 5-point scale does not increase reliability [94].

The pre-test of the questionnaire is important when carrying out research to identify question variation, meaning, task difficulty, and respondents interest and attention [95]. Pre-testing of the questionnaire should occur before the field tests, with a small and targeted sample, and in a controlled environment. The benefits of pretesting are: (1) reduction of survey development time, (2) reduction of survey costs, and (3) improved quality of collected data, among others [96]. There is no single technique available for pretesting, and various authors describe different techniques to be used for pretesting. These techniques are described below.

Expert Review [97, 98]. This method consists of an individually-based review by specialists in the field, who are able to identify potential difficulties that cannot be identified in pretest with respondents. When employing this method, the questionnaire review form has a check box to mark if a problem has been encountered in the specific items. Another option is to collect the comments and notes referencing a specific difficulty identified.

Forms Appraisal [98]. This technique allows the researcher to identify any potential flaws for each question by completing previously designed questionnaire appraisal forms. These appraisal forms usually evaluate eight dimensions: (1) reading, (2) instructions, (3) clarity, (4) assumptions, (5) knowledge/memory, (6) sensitivity/bias, (7) response categories, and (8) others. Each dimension has several sub-dimensions to evaluate; when identifying a difficulty for an item. Explanation is also provided in the form.

Cognitive Interviews [96, 97]. This method uses a cognitive interview applied to a small sample of respondents to identify problems in question comprehension, memory recall, selecting responses, interpretation of reference periods, and reactions to sensitive questions. The method can be applied by the researchers, by experts in cognitive psychology, or by a combination of experts and non-experts, usually in an audio recorded environment. Some of the cognitive interviews can use "think aloud" methods (i.e. tell me what you think?), probing questions, and card sorting tasks.

Focus Groups [99]. This technique consists of grouping a sample of similar respondents, who under the guidance of a moderator, focus on responding the questionnaire items. Through this exercise, participants are able to identify and evaluate difficulties in answering the questionnaire items. Also, participants can make recommendations for the addition of new items to increase data quality.

Observational interviewers [96]. In this method, a trained interviewer observes the survey process to identify where respondents seem to have trouble, problems in wording, question order, presentation or layout. This method is usually used in self administered questionnaires, such as the Census.

Behavior coding [96]. This technique focuses on evaluating the respondent and interviewer's behavior during the interview. By employing a third-party evaluator who records observations using a behavior coding sheet to find problems in question wording or understanding.

A selection of attributes of pre-testing techniques is summarized in Table 29.

Table 29. Selected attributes for pre-testing questionnaire techniques [96].

Method	Resources	Time to obtain results	Time for method application
Expert Review	Low	Fast	Early
Forms Appraisal	Medium	Fast	Early
Cognitive Interviews	High	Fast	Middle
Focus Groups	Medium	Fast	Early
Observational Interviewers	High	Moderate	Middle
Behavior Coding	High	Slow	Later

Furthermore, to determine the right pretesting techniques, the researcher should consider the combination of methods and factors such as cost, skilled resources, timeliness of results, and the stage of development of the questionnaire [96]. For this specific study, the pre-testing technique selected was the experts review. This selection was based on restricting factors such as time and skill resources, and also it was based on previous studies conducted such as Li [100] and Sanchez [101].

The recommendations/suggestions of the expert reviewers were limited but of high importance. First, the reviewers recommended designing the questions so respondents felt their answers were confidential. To address this recommendation, no personal information was requested at any point of the questionnaire. The second observation was to limit the quantity of open-ended questions since they could be addressed though the interview sessions. A third suggestion was to provide a clear introduction to the questionnaire; therefore an introductory page summarizing the scope and objectives of the study was provided with every questionnaire administered. Finally, a fourth suggestion was to develop all items with positive language so that ratings were meaningful in the same way for all items. After the pre-test of the questionnaire, the document was submitted to the Institutional Review Board for Research Involving Human Subjects (IRB) to ensure a proper and ethical guidance in the study (IRB#11-530). This approval was extended in May 2012 until the conclusion of the study.

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5. Application and Validation of the Framework Tool

Engaging in activities to enhance performance is a requirement in the high-speed changing world [1-3]. Continuous improvement (CI) offers many advantages for firms to achieve performance excellence and ensure continuous delivery of positive results [1, 4]. Specifically, CI bring benefits such as organizational learning, strong company culture and better financial performance, however, firms still struggle to sustain CI [5].

Aiming to help industries sustain CI, various authors have conducted research to identify success factors that lead to sustainability. Efforts include implementation frameworks such as CMMI [6], ISAT [7], and the Maturity Index model [8]; however, some of these frameworks are expensive to adopt, lack management dimensions such as strategic planning, or only focus on specific tools rather than the whole process of CI [5, 9, 10].

It seems that more research has been conducted in order to help practitioners and academics understand what factors have critical roles in sustaining CI. Hence, the objective of Chapter 5 is to determine if the success factors that sustain CI cited in the literature are a valid framework for industry and academy reference. Only by designing a valid framework will firms be able to embrace the process toward CI sustainability, and consequently improve performance and ensure growth.

5.1. Summary of the Theoretical Research Framework

For a better understanding of the factors influencing CI sustainability, a conceptual research model was created based on similar research [11-13]. A summary drawn from work performed in Chapter 4 describes the suite of factors affecting the CI and is provided below

Strategic Management (SM). How the management level integrates a plan to accomplish CI as an objective, as well as how this strategic plan is deployed and perceived by associates at all levels [11, 14, 15].

Leadership (LE). How formal and informal guidance is exercised across the organization, including the mechanisms developed for decision making, two-way communication, feedback, and development of leaders. Also, leadership evaluates how values and directions are reinforced [11, 14-16].

Measurement and Information Deployment (MID). Determines to what extent information related to improvement and performance dimensions of outcomes is simple and available to every associate and, the extent to which information deployment is systematic [11, 14, 16].

Operational Management (OM). Evaluates the CI management process at the operational level, including associates' level of active involvement in identifying needs, solutions, and actions required to solve problems. Also, this factor will examine to what extent CI is part of daily work methods, and how employees are being rewarded for contributions [11, 14-16].

Training (TR). Determines to what extent training has become a formal process inside the organization, and to what extent it has been applied functionally [11, 14, 16].

Change Adoption (CA). Examines how the need for change, as improvement, is understood, and the effort the organization is making to adopt new methods to avoid backsliding to previous practices [11, 14, 16, 17].

CI Sustainability (CIS). The sustainability and performance of the CI [18]. Figure 8 depicts the proposed theoretical framework and the corresponding constructs and operationalized measures.

5.2. Research Methodology

Yin [19] states that selecting the appropriate methodology for research depends on three main factors: (1) the way the research question is formulated, (2) the level of control exercised by the research on the event to be analyzed, and (3) the contemporary nature of the event. For this specific research, the analysis focused on the continuous improvement process within two manufacturing firms located in the US and one Costa Rica, as well one healthcare firm located in the US. The research aims to evaluate factors identified in the literature as current inhibitors of CI sustainability, and secondly to identify other possible factors having the same effect on CI sustainability.

The research question used in this project is an exploratory question (i.e.what) in order to understand the current factors influencing the CI (current event) sustainability. The CI process also represents an event which is not under the control of the researcher. Based on the above characteristics of the research, the case study methodology is convenient [19-21].

5.3. Selection of the Business Sectors

To select the cases in the current study an analysis of the manufacturing and healthcare contribution to the economy was conducted. Once it was determined that both business sectors are of vital importance to the economy's growth, firms from both sectors were selected. For this study, the business sectors selected were the manufacturing industry due to the large contribution to US and Costa Rican economies, and the health care, sector which has contributed in the creation of nearly 40% of the new jobs in the past 4 years in the US [22]. The following section details the contributions to the both countries' economies.

5.3.1. Manufacturing and Healthcare Sectors

The continuous improvement process brings together all those activities carried out in an organization to systematically improve the way they operate [23]. In general, CI is widely practiced and accepted in the business sector. Based on CI acceptance and its common use as a performance improvement tool in the manufacturing and healthcare industries [24, 25], these two sectors have been selected as the sources for data collection. Also, companies from the business sectors selected are located in the US (2 companies) and Costa Rica (2 companies) due to the importance of manufacturing and healthcare to the economy of both countries, and to address a gap in information related to the CI measurement systems in diverse regions [26].

a. Manufacturing Sector in Costa Rica

Costa Rica is geographically located in Central America, and has access to the Caribbean Sea and Pacific Ocean. This location grants a preferential access platform to 2.4 billion people (35% of the population of the world) responsible for nearly 65% of the GDP worldwide [27].

The gross domestic product (GDP) of the country has shown a growing rate in recent years. In 2008 it grew 8.8%. In 2009, due to the economic crisis, it declined by 1.3%, but in 2010, a full recovery began, and according to the International Monetary Fund, the GDP rose 4.3% and 4.4% in 2011 [27, 28]. Figure 9 shows the GDP growth for Costa Rica over the past 12 years (2012 is expected).

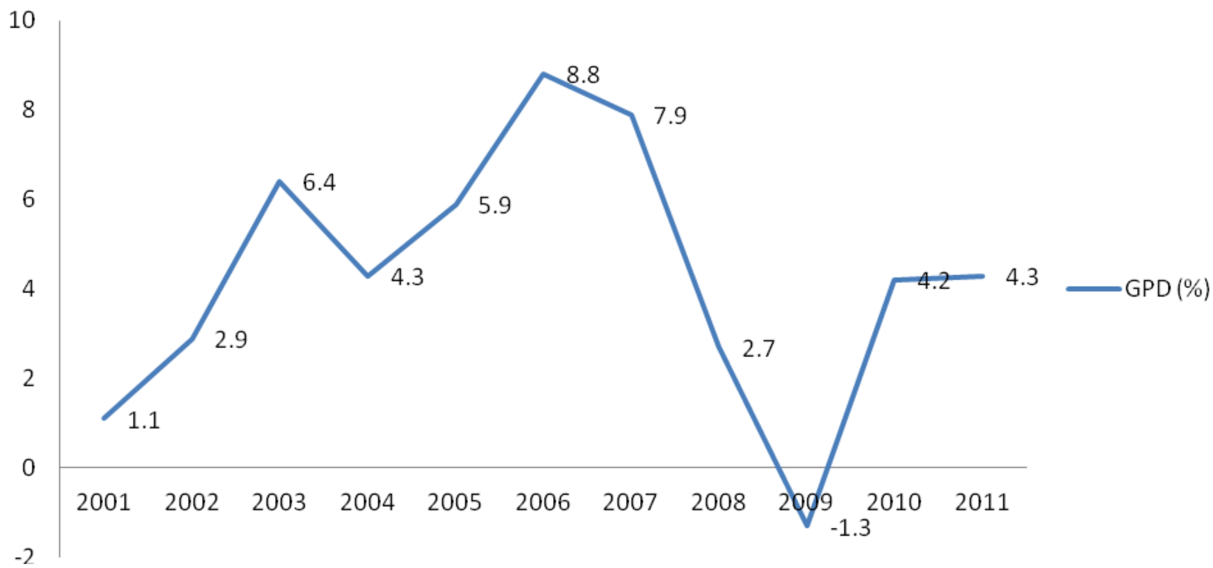

Figure 9. Real Gross Domestic Product Growth Rate 2001-2012 [29]

The gross domestic product per capita was $7,843 billion in 2010, and has been increasing since 2001. However, the GDP decreased from $6,582 billion in 2008 to $6,488 billion in 2009. Foreign direct investment (FDI) reached $2.8 billion in 2010, and the target for the period 2010-2014 is $9 billion, which represents an increase of 32.5% from the 2006-2009 period [27]. According to the Costa Rica Central Bank [30], almost

55% of the FDI received in 2010 came from US. Figure 10 shows the distribution of FDI per region of origin.

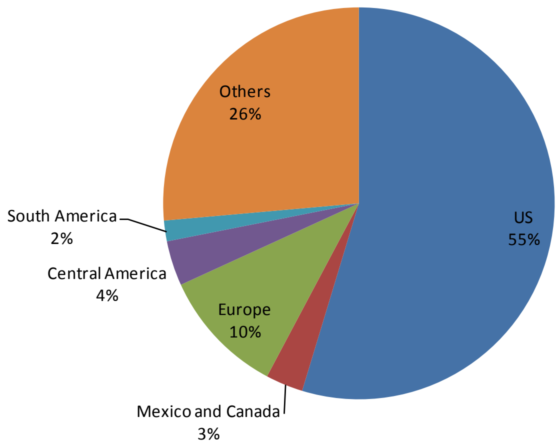

Figure 10. Foreign Direct Investment distribution by region of origin in 2010 [27, 30]

According to the Costa Rican Investment Promotion Agency, Costa Rica is one of the countries in Latin America with the largest FDI in the manufacturing sector. During 2010, 70% of the FDI was directly invested in the manufacturing industry, followed by real estate with 10.5%. Figure 11 shows the distribution of the FDI by the destination sector in 2010 [27].

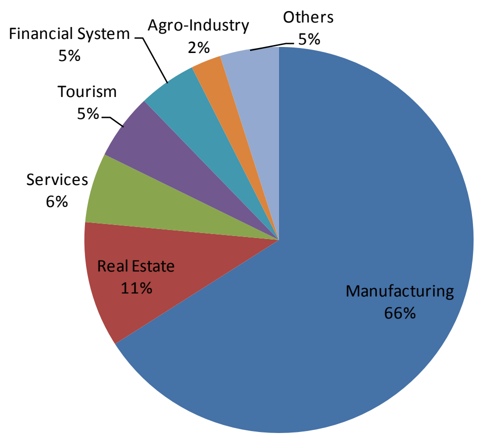

Figure 11. Foreign Direct Investment distribution by destination in 2010 [27]

Regarding the Costa Rican market for exports, the most important is the US (including Puerto Rico), which accounts for a total of $3.8 billion (37.1% of the exports of the country), followed by The Netherlands with $737.7 million (7.1%) and Hong Kong with $572.6 million (5.5%). Table 30 shows a distribution of exports for the top ten countries of destination in 2011 [31].

Table 30. Costa Rica's largest foreign trade partners [31]

Rank	Country	Value of trade ($ millions)	%
1	United States	3,848.7	37.1
2	The Netherlands	737.7	7.1
3	Panama	572.6	5.5
4	Hong Kong	510.2	4.9
5	Nicaragua	463.4	4.5
6	Guatemala	413.8	4.0
7	Honduras	340.4	3.3
8	Mexico	318.6	3.1
9	Belgium	288.9	2.8
10	El Salvador	288.5	2.8

The Costa Rican Investment Promotion Agency (CINDE) and the Ministry of Foreign Trade set an export goal of $17 billion for 2014 ($12 billion of goods and $5 billion for services) [27].

Based on exporting sectors during 2010, integrated circuits & electronic microstructures, computer parts, agriculture products and medical devices were the most important products exported. Table 31 shows a summary of the top seven exported goods [27].

Table 31. Highest value good exports per product category for Costa Rica [27]

Rank	Product	Value of trade ($ millions)	%
1	Integrated Circuits & Electronic Microstructures	948.2	10.1
2	Computer Parts	876.7	9.4
3	Banana	738.9	7.9
4	Pineapple	665.9	7.1
5	Intravenous Sets	457.5	4.9
6	Medical Prosthesis	315.7	3.4
7	Pharmaceuticals	285.8	3.0

b. Manufacturing Sector in US

The Unites States of America (US) is considered the largest economy in the world with a per capita GDP of $48,100 billion [28]. US GDP increased from 2001 to 2004, but declined from 2005 to 2009. During 2010, the economy recovered. However, in 2011, the GDP rate declined again compared to the previous year. Figure 12 shows the GDP rate for the US from 2001 to 2011.

Figure 12. Real Gross Domestic Product Growth Rate 2001-2012 [29, 32].

According to the US Department of Commerce [33], the FDI in the US support approximately six million jobs in the last ten years (2000-2010), with two million jobs associated with the manufacturing sector. Manufacturing workers in companies supported with foreign investment are paid 30% more than domestic manufacturing jobs, on average [33]. FDI accounted for $194 billion in 2010 and more than $1.7 trillion over the last decade. The manufacturing sector accounted for 41% of the total FDI in the country in 2010 (nearly $78 billion) averaging a 39% of the total FDI in the last 14 years [34]. This sector also represented 12.80% of the GDP in 2010.

FDI is derived mainly from a small set of countries knows as the “top 8 foreign investors” including Switzerland, United Kingdom, Japan, France, Germany, Luxembourg, the Netherlands and Canada, accounting for 84% of the total FDI. Contributing countries include Caribbean nations, Brazil, and Australia representing 10% of the total FDI. Other European countries account for the remaining 6% of the total FDI [33]. Figure 13 shows the ranking of the top 14 countries with the highest direct investment in the US in 2010 based on historical data.

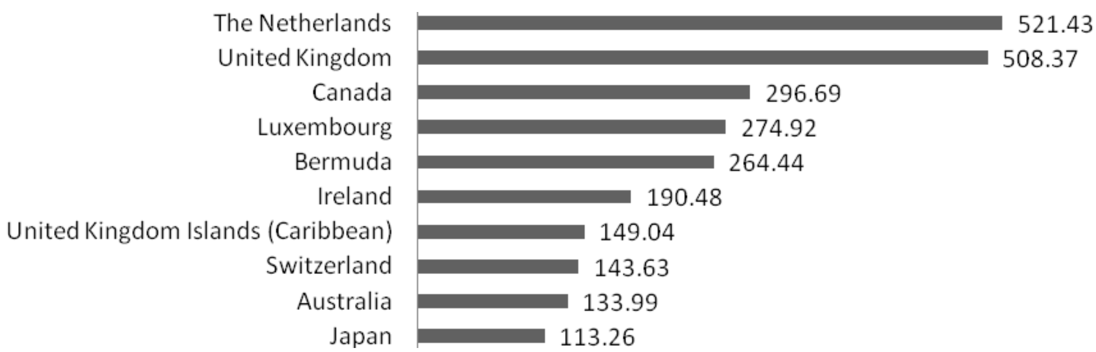

Figure 13. Foreign Direct Investment ($ US billion) in the US by country in 2010 [35]

The US exported a total of $1,122.416 billion in export goods in 2010. This amount is largely a result of four main categories of domestic products, one of which (i.e. manufacturing) accounted for 85% of the total exports [34]. Table 32 shows the distribution of export goods by sector in 2010.

Table 32. US largest export of goods per sector in 2010 [34]

Rank	Product	Value of trade ($ millions)	%
1	Manufacturing	952,409	84.9
2	Special classification provisions	77,186	6.9
3	Agricultural, forestry, and fishery products	65,737	5.9
4	Mining	26,234	2.3

c. Healthcare Sector in US

The health care sector in the US is divided into eleven main categories, with hospital care representing 36% of the total health care expenditure in 2009 [36]. The total expenditure in the healthcare sector in 2009 was near $2 billion [37].

Compared to other countries, the US has the largest health care expenditure per capita, which also shows the largest increasing trend worldwide. For example, in 2000, the average per capita expenditure was close to $2,557 in developed countries; however, the US showed an average of $4,703 per capita. In 2008, the global average increased to $3,944, while the US average reached $7,538 per capita [38]; this increase maintained the US average expenditure on health care approximately twice the expenditure of other advanced industrialized nations. Figure 14 shows the total health expenditures per capita in selected countries from 1970 to 2008.

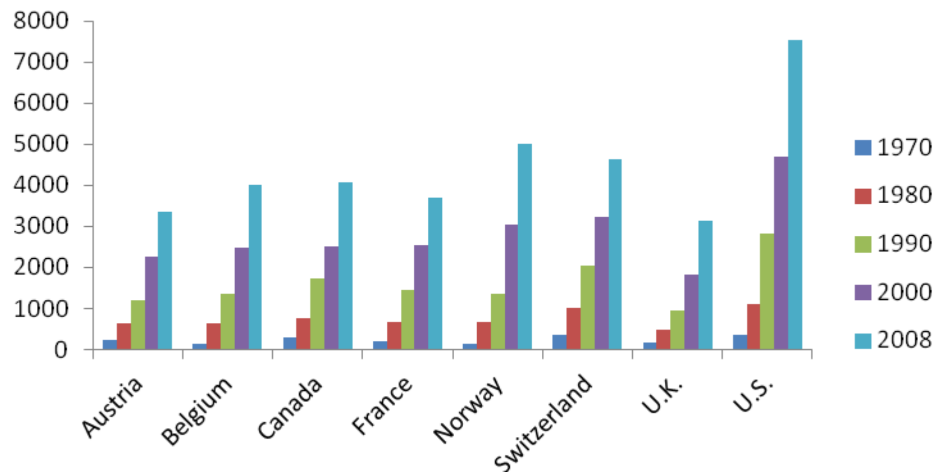

Figure 14. Total health care expenditure per capita in selected countries, 1970-2008 [38]

In terms of GDP, the health care expenditure is as high as 16% of the GDP representing a growing cost [25]. This has led to an increasing population of uninsured and underinsured health care users [39], and has accumulated pressure on the health care organizations to reduce costs and develop an affordable quality service [40].

5.3.2. Continuous Process Improvement in Manufacturing and Healthcare Sectors

As suggested by Dean & Bowen [24], few businesses, especially in the manufacturing sector, can afford not to implement continuous improvement as a tool to achieve productivity goals. Actually, it is estimated that manufacturers in the US invest more than $250 billion per year toward achieving better performance and many of the expenditures are related to CI methodologies [41]. For example, Grütter, Field & Faull [42] analyzed the manufacturing environment, where they observed improved productivity, quality, and time of manufacture resulting from CI implementation. Also, Bond [43] and Modarress, Ansari & Lockwood [44] found cost reduction to be a benefit from using CI.

In manufacturing sectors, such as the medical devices industry, the influence of regulatory and procurement environments created by the Food and Drug Administration (FDA) in the US, and the Medical Device Directive (MDD) in Europe have built a very strong quality culture. This culture facilitates greater empowerment and knowledge distribution [45]. Continuous improvement has increased the effectiveness of processes such as research, product development, clinical assessment and marketing [46]. Despite the benefits that CI brings to performance, there is an evident challenge in firms: the changes that occur as a result of CI initiatives face difficulties meeting regulatory compliance and challenges associated with making changes to products or process once they are validated and approved, especially in smaller and newer companies [46, 47]. These difficulties are also reflected in the lower use of methodologies such as Total Quality Management (30.4%) in medical devices firms as compared to other industries like automotive, where use of TQM is 54%, and information industries where use is 71.5% [46, 48]. Figure 15 shows several methodologies within the CI framework commonly used in the medical devices manufacturing industry.

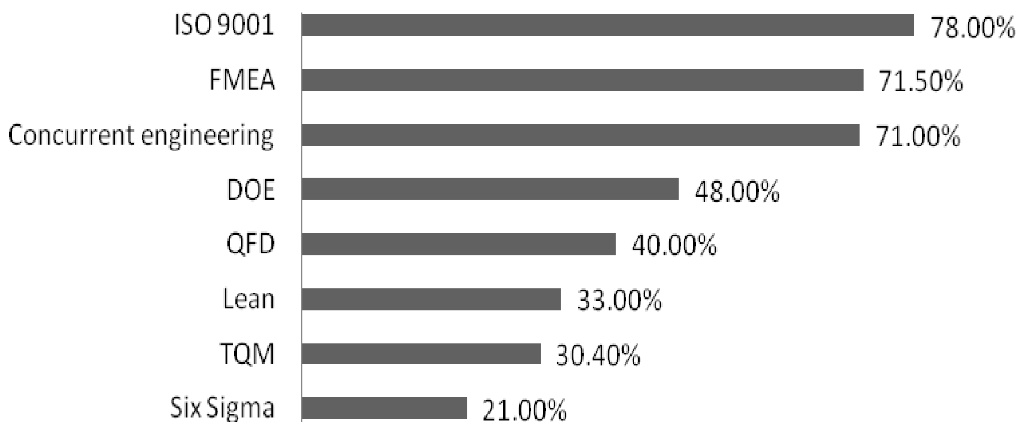

Figure 15. Commonly used CI methodologies in the medical devices industry (adapted from Brown *et al.*[46])

The chemical manufacturing sector is different than medical device manufacturing. This sector is characterized by extensive capital and inflexible process, with high volume and types of finished products leaving room for improvement of processes [49]. According to White [50], 90.3% of chemical manufacturers employing CI have reported a net overall benefit from its use. Successful cases include companies such as 3M coating operations, which reported 50% inventory reduction and 90% lead time reduction; BASF, which reported 30% inventory investment reduction and on-time delivery increases to 97%; and Dupont, which reported a working capital reduction of $2 million [51].

While medical devices and chemical industries are open to adopt CI, the wood products industry is a notable exception [52]. According to Quesada & Gazo [53], the wood products industry is losing market share, specially reflected in the furniture manufacturing. Also, Wisdom [54] indicates that the wood products industry should adopt cost reduction, product innovation, flexibility and quality improvement to become competitive. According to Milauskas [55], at least ten thousand jobs have been lost in this sector in the last ten years.

The efforts made to sustain business by implementing CI in the wood products industry have been covered in various publications; however, this research is mostly related to large organizations due to the decline of small business and the reluctance of smaller companies to train and adopt manufacturing improvement programs [56]. Recently, authors such as Espinoza, Bond & Kline [57] and Fricke [58], have conducted research on how CI contributes to supply change management and highlight the need for CI training in the industry; however, research opportunity still exists to understand how CI is being implemented in the wood products industry.

Another important sector in the American economy which urgently recognizes the need for improving efficiency by integrating process improvement into its culture is the healthcare business, which accounted for 7.5% of the GDP in the early 1970s and increased to 16% by 2005 [25]. According to the Institute of Medicine [59], the healthcare system experiences errors that, along with risking human lives, result in an estimated cost of $29 billion per year, overshadowing the quality agenda. In addition to the poor performance cost, it is also estimated that for each dollar spent on healthcare, approximately 75% is spent on the non-patient related activities such as communicating, scheduling, coordinating, and supervising [40]. This low performance scenario indicates that the healthcare system has a waste of resources between 30% and 40% [60].

Various authors have identified the main challenges facing this industry regarding the implementation of CI initiatives. Among these challenges, authors cite the internal dissatisfaction with other departments' performance, the existing gap between the vision of the CI and the leadership roles, and the resistance to change which, have negative impacts on long-term focus and CI adoption [25].

5.3.3. Selection of Participating Companies

The participating firms were selected based on the following requirements: (1) companies must be involved in a CI program in the selected facility for at least one year prior the star of the study. The intent of this criterion is to minimize the effect of the organizational learning curve and allow the research to take place in an organization with a fairly mature knowledge of CI initiatives [61]. (2) Participating firms belong to different regional contexts; therefore, organizations were selected by location to ensure US and non-US based firms representation. By introducing regional context into this study, the author was able to determine regional influences on workers' perceptions of the constructs supporting CI sustainability [62]. (3) Participating firms must manufacture products of some kind, not merely provide service or knowledge. This criterion ensures that firms have similarities in focus, processes, and performance metrics. (4) The organization must have CI initiatives programmed during the period of observation to ensure the analysis of ongoing CI efforts, and reduce the variability caused by the absence of CI initiatives. (5) Finally, the selection of participating firms relied on the willingness of the company to participate in the study, share information, and accommodate interviews and site visits in their schedule. A description of the participating firms is given below.

Company A belongs to the manufacturing sector. This industry is a subsidiary of an American corporation located in California. The corporation's portfolio includes pharmaceutical, biologics, medical devices and over-the-counter consumer products. Worldwide Company A is recognized for high investment in R&D and manufacturing improvement. Globally, the company employs nearly 100,000 workers and has sites in over 100 countries. The participating site is dedicated to the manufacturing of medical devices and is located in Costa Rica. Here, the company employees over 300 workers with a projection to grow by 500 additional workers in the next five years. Currently the company has been developing a CI program at the selected site for the past two years. The company structure includes a CI leader who works directly with the Manufacturing Director, and both are responsible for the implementation of CI under the guidance and support of the management team.

Company B belongs to the manufacturing sector. This industry is also part of an American corporation located in Minnesota. The company's portfolio offers industrial adhesive, sealant, paints and other related materials. The overall corporation employs nearly 3,500 workers. The participating site is located in Costa Rica where the company employs nearly 300 workers. This site is mainly focused on the manufacturing of adhesive for commercial and non-commercial use and paints. The selected site has been enrolled in the CI process for more than eight years. Right now, the CI program includes a leader for each functional department and a group of engineers who work with the Financial Director to oversee the CI program.

Company C is part of an American corporation. The corporation employs near 56,000 workers worldwide and their product portfolio includes kitchen and bathroom faucets and cabinetry lines. The participating firm is located in Virginia and employs nearly 380 workers. The main products are kitchen cabinets. The company has been involved in CI programs for over fifteen years and has been awarded with the Shingo Prize for their lean manufacturing processes.

Company D is part of an American network of non-profit healthcare providers located in western Michigan. As healthcare providers, the company has been recognized among the top ten best children's hospitals. The company employs nearly 10,000 workers and the participating site employees nearly 400 of them. The current participating site includes a hospital and the functional departments such as Finance, Facilities, and Human Resources. The CI programs at this site started nearly 24 months ago.

5.4. Management of the Research Tool

As suggested by Yin [19] and Koulikoff-Souviron & Harrison [63], as part of the application of case study methodology, the data collection process should consider multiple data collection tools to increase validity. For this research, the data collection tools included a questionnaire, interviews and data gathering through site visits. The following sections provide a description of the administration and validation of the questionnaire, and the procedures for interviews and site visits.

5.4.1. Procedure for Questionnaire Implementation

One important factor in an empirical study is the quality of the respondents. When administering a questionnaire, several methodologies can be employed. First, the literature recognizes differences between electronic and non-electronic questionnaire data collection techniques based on the advances associated with incorporating technology into research [64]. Bowling [65] also suggests that differences between questionnaire administration methods are related the mode, particularly between self-administered questionnaire or an interview (face to face or by telephone). This author suggests that a personal, face-to-face interview might produce less burden effect on the respondents than telephone interviews. Table 33 shows a summary of the different methods available for questionnaire administration.

Table 33. Questionnaire administration techniques [65]

Method	Mode
Verbal-interviews, face to face using the traditional paper and pencil (PAPI) questionnaire	Non-electronic
Verbal-interviews, face to face using computer assisted personal interviewing methods via personal computer (PC) or lap top PC questionnaire programs (CAPI)	Electronic
Verbal- interviews, by telephone, using paper questionnaire	Non-electronic
Verbal- interviews, by telephone, using computer assisted questionnaire (CATI)	Electronic
Self-administered using PAPI methods by post, or handing paper questionnaires to respondents in person, asking them to answer and return to the researcher	Non-electronic
Computer-assisted self-administered interview methods (CASI) by automated electronic methods including audio and computer-assisted	Electronic
Self-administration via interactive voice response methods with automated computer-assisted telephone programs (ACASI).	Electronic

Regarding the quality of data collected, Tourangeau, Rips & Rasisnki [66] mention that the questionnaire us well-designed when tested questions likely mean the same thing to all respondents; if not potential error can be introduced by the setting for the data collection. The author argues that bias can result from interviews and self-administered methods, or even from multiple interviewers administrating the questionnaire. Yet, there is no agreement on bias resulting from the questionnaire administration method, researchers such as, Fowler, Gallagher & Nederend [67], Durant & Carey [68] and Cam, Akman & Cicekci [69] performed studies to compare self-administered questionnaire and interview methods and found no significant differences among results obtained. This is also congruous with a study performed by Williams *et al.* [70] who reported no effect of mode of administration on responses obtained from a HIV risk behavior study. Based on the previous discussion about no significant difference between a self-administered questionnaire and a face to face interview, and taking into account the limited resources such as time and money, the researcher selected the self-administered using PAPI method for data collection.

The respondents were employed at the company. Human Resources (HR) manager or the CI coordinator randomly selected the respondents across all the organizations since the employee list is considered confidential. The randomized respondent selection criteria was used to ensure fairly generalizable results from the population under study as recommended by Trochim [71]. The questionnaire collected data from employees about their perceptions about the previously defined items corresponding to the factors affecting the sustainability of the CI process. A random and anonymous sample of 50 associates in each participating company was selected at each time the questionnaire was administered.

The questionnaire was administered quarterly (intervals of three months) on each site based on the suggestion made by Yin [19], who indicates that making repeated observations when using case studies is considered an analytic approach useful to highlight change. The questionnaires were designed to be self-administered. Thus, 50 questionnaires were handed out to the randomly selected respondents (i.e., one questionnaire per respondent). After this, respondents were given a week to return the questionnaires to their direct supervisor who sent them back to the HR manager or the CI coordinator. Those respondents who did not return the questionnaires within the first week were verbally reminded after two and three weeks. Questionnaire collection was considered closed four weeks after their distribution. A total of 67 were collected in company A, 63 questionnaires in company B, 153 in company C and 69 in company D at the end of the fourth questionnaire application.

In addition to data collection regarding the factors affecting the CI sustainability , the researcher collected the following demographic information, such as level of the job position, current functional area of the participant, and time working with the company. The questionnaire was developed to function as a stand-alone document to avoid data collection errors and to facilitate the collection of data which occurs in the absence of the researcher.

To support the qualitative analysis of repeated observations, the researcher performed site visits to gather information through observation and semi-structured interviews as an effort to more broadly understand the factors and how they impact the sustainability of CI. Methods used were similar to those suggested by Mansourian & Madden [72] when analyzing perceptions. Finally, completed semi-structured interviews and questionnaires were filed in a cabinet in the researcher's office; all electronic data was stored on a personal PC and backed up on an external data storage unit to ensure data safety.

Also, since this study involves human subjects, Virginia Tech IRB approval was required and processed under IRB-11-530 Research Protocol. Participation in the study was completely voluntary, and no compensation was given, although participating firms will have access to final results of the study. Confidentiality of participating firms and individuals resulted in no more than minimal risk resulting from this study.

5.4.2. Procedure for Questionnaire Validation

The validation of the questionnaire aims to ensure validity of the constructs of the research tool. Kumar [73] indicates that the validity of the constructs is the degree to which inferences made upon the operationalized measures are legitimate. Trochim [74] also argues that construct validity determines if the operationalized items are really measuring the construct desired, mainly so drawn arguments and conclusions are valid.

As suggested by Stone [75] items within the questionnaire should come from previous studies to ensure validity. Thus, when items were developed by the author based on the literature review, the researcher must conduct validation analysis to ensure internal reliability and construct validity [76].

For this study, questionnaires were handed out to respondents directly by HR manager or CI leader. Also, prior to the start of the research, approval from the management team was obtained. This strong support was observed in the manual revision, done to after questionnaires were returned. During this manual revision no missing information was detected for descriptive statistics section or items.

5.4.2.1. Test of Internal Reliability

To perform testing of the internal reliability of the items, the researcher selected Cronbach's alpha coefficient (Cronbach's α). Sijtsma [77] indicates that Cronbach's alpha coefficient is probably the most reported method used to test internal reliability. Previous studies such as Krishnaveni & Raja [78], Roszkowski, Delaney & Cordell [79] and Akkonyunlu & Yilmaz-Soylu [80], among others, used the Cronbach's alpha coefficient to measure the internal consistency of the items.

Cronbach's α is defined as :

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2}\right)$$

where K is the number of items, σ_X^2 is the variance of the observed total scores, and $\sigma_{Y_i}^2$ is the variance for the component *i* for the current sample of respondents [81]. This calculation shows the correlation of items within the scale.

Ranges of α can vary from 0 to 1 (negative values are considered unacceptable internal consistency), since alpha is a ratio of two dispersion measures with higher values of α most desirable. George & Mallery [82] and Gliem & Gliem [83] suggest that acceptable values for α are equal or greater than 0.7. Once the internal consistency of the items is tested, the next step is to test the validity of the constructs.

5.4.2.2. Test of Constructs Validity

When a study includes a set of hypotheses intended to measure a common domain, it is necessary to test the validity of these hypotheses. This testing analyzes the covariance of a set of variables to provide an explanation for the existing relationships through a smaller set of constructs, while accounting for approximately the same amount of information [84]. According to Hurley *et al.* [85], the strongest method used to conduct this testing is known as Factor Analysis, which can be applied in the form of confirmatory or exploratory factor analysis. Previous studies such as Gerlich, Drumheller & Sollosy [86], Mcollum, Kajs, & Minter [87] and Isaac, Chandrasekharan & Anantharaman [88], among others, used the CFA to test the validity of constructs in diverse fields such as marketing, education and quality management. Figure 16 shows the required steps to perform a CFA analysis followed by a detailed explanation of each step. For this study, the research framework was initially tested using confirmatory factor analysis (CFA), since the study begins with hypotheses previously constructed from literature review [89].

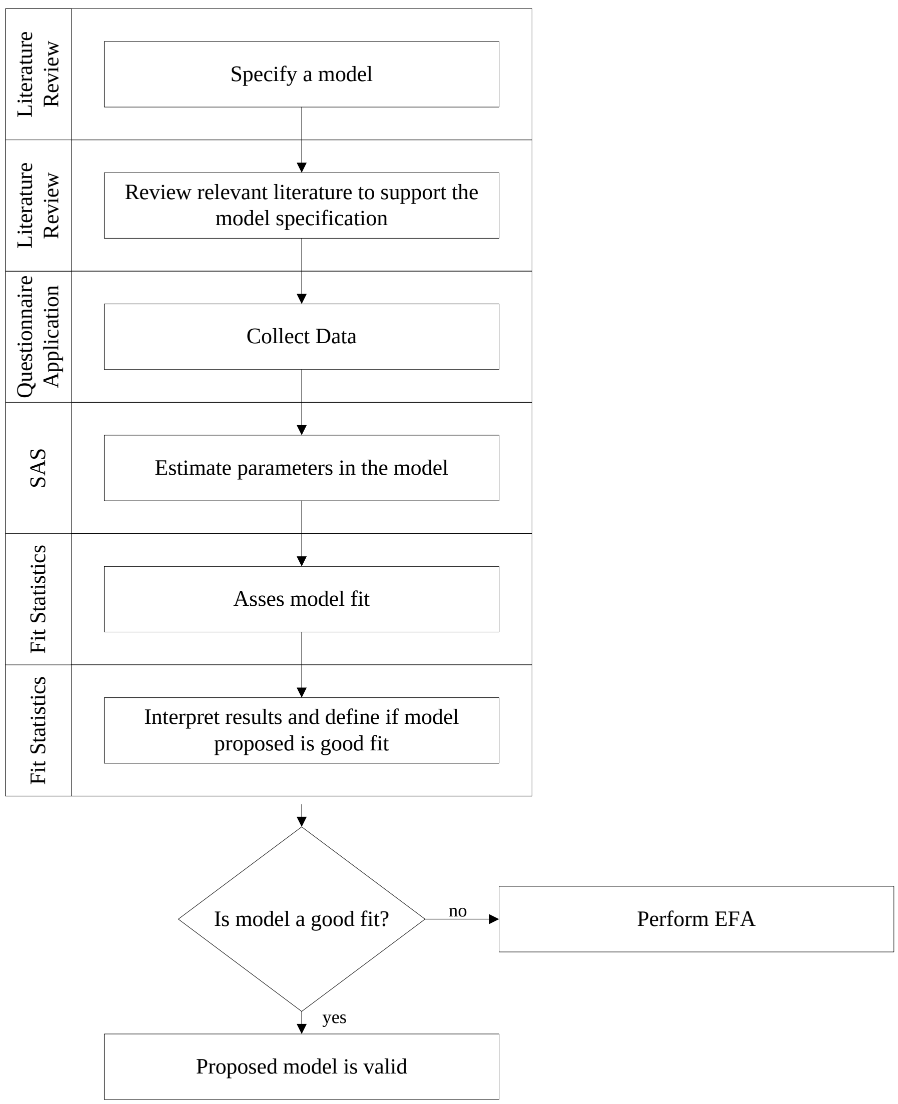

Figure 16. Methodology to conduct a confirmatory factor analysis [85]

When conducting a CFA, the theoretical model is used for estimating the population covariance matrix which is compared with the observed covariance matrix. The smaller the difference between covariance matrices, the better the fit the hypothesized model [90]. In interpreting the data, the use of fit statistics is relevant; fit statistics tell how well the proposed model fit the data. The most common used fit statistics are the Chi Square, the Bentler Comparative Fit Index (CFI), and the Goodness-of-fit Index (GFI) [89].

If the theoretical model does not show enough evidence of being statistically significant, then a reconstruction of the model should occur. Byrne [91] advised that if this is the case, then the research has moved from a confirmatory to an exploratory study. Figure 18 depicts the steps to conduct a CFA.

Exploratory factor analysis [92] seeks to undercover the underlying structure of a set of variables. The researcher has no certainty of which indicator (item) is associated with which construct. The EFA also looks to account for as much variance as possible from the set of variables under study [93]. As part of the EFA procedure, several goodness of fit indexes are estimated, commonly using the maximum likelihood method.

When factors are analyzed using the goodness of fit indexes, the next step is to select the appropriate number of factors. There are a number of methods for selecting the quantity of factors for the new model; however, the most commonly used methods are the scree plot which is a visual method that examines the graph to determine where the Eigenvalues (which represent how much of the variance is accounted for by a factor) drop substantially; the Kaiser criterion determines how many factors should be include using a cut off of Eigenvalues greater than or equal to 1; and Root Square Error of Approximation (RMSEA) which estimates the discrepancy between the model and the data. An acceptable value for the RMSEA is less than 0.08 [94].

The last step in the EFA is to perform the factor rotation. The most commonly used technique in social sciences is the orthogonal rotation. Once the orthogonal rotation is conducted, the factor loadings are obtained. The factor loadings indicate the strength and direction of the item in measuring a given factor. A commonly accepted cut off value for the factor load is greater or equal than 0.5 [94]. Previous use of EFA technique is documented by authors such as Sun, Zhao & Xu Ya [95] and Moran, Palmer & Borstorff [96] who were able to determine success factors in the creation of organizational culture. Figure 17 depicts the required steps in conducting an exploratory factor analysis.

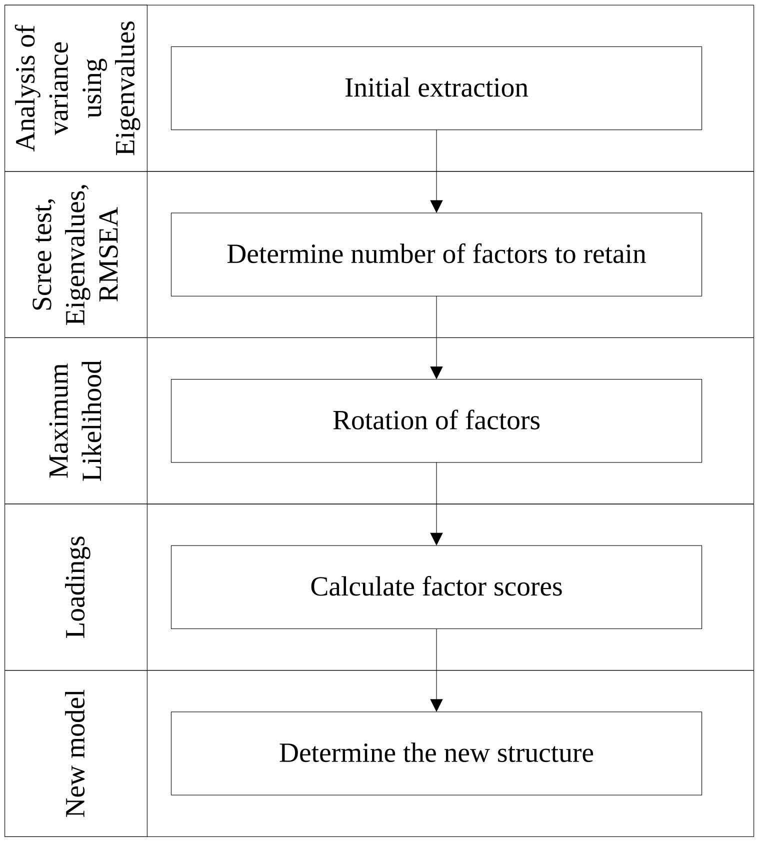

Figure 17. Methodology to conduct a confirmatory factor analysis

5.5. Results for Internal Reliability and Construct Validity Testing

A total of 352 questionnaires were collected over the period of study. For observation 1, the researcher collected 132 questionnaires, 98 questionnaires were collected at observation 2, 53 questionnaires collected during observation 3, and 65 questionnaires during observation 4. This represents a response rate of 44.00% out of the 800 questionnaires distributed for the study. Once the questionnaires were collected, the rating of perceptions for the items was compiled for statistical analysis.

After the manual revision for data integrity of the collected questionnaires, the first step in data analysis was to determine the internal reliability of the items in the questionnaire (i.e., the level of interrelatedness of a set of items measuring the same underlying characteristic) [97, 98]. Table 34 shows the Cronbach's alpha result for the internal reliability of the items of the constructs.

Table 34. Results of Cronbach's α testing for individual constructs

Proposed Factor	Item	Cronbach's α
Strategic Management (F1)	V1 to V12	0.95
Leadership (F2)	V13 to v21	0.95
Measurement and Information Deployment (F3)	V22 to V31	0.95
Operational Management (F4)	V32 to V39	0.95
Training (F5)	V40 to V47	0.95
Change Adoption (F6)	V48 to V56	0.95
Continuous Improvement Sustainability (F7)	V57 to V60	0.96

According to Bland & Altman [99], Cronbach's α should be above 0.7 to represent a satisfactory internal validity. In this initial analysis, Cronbach's α results show values ranking from 0.95 to 0.96 which demonstrated a satisfactory internal reliability for each construct.

Following the calculation of Cronbach's alpha, the data set was reduced by single data summation in preparation for confirmatory factor analysis (CFA). The CFA was run using the CALIS procedure in the statistical software SAS (refer to Appendix C all statistical procedures). This procedure test construct validity [94]. In this research, the CFA results showed that the relationship among the measuring items does not support the current structure. Values of the CFA test for each construct are shown in Table 35.

Table 35. Results of CFA on individual constructs

Proposed Construct	Variable	CFA Fit Statistics		
		P-value	RMSEA	CFI
Strategic Management (F1)	V1 to V12	<0.0001	0.10	0.91
Leadership (F2)	V13 to V21	<0.0001	0.07	0.95
Measurement and information deployment (F3)	V22 to V31	<0.0001	0.17	0.84
Operational Management (F4)	V32 to V39	<0.0001	0.10	0.95
Training (F5)	V40 to V47	<0.0001	0.18	0.85
Change Adoption (F6)	V48 to V56	<0.0001	0.12	0.94
Continuous improvement sustainability (F7)	V57 to V60	<0.0001	0.22	0.95

Acceptable p-values using Chi-square test should be equal to or greater than 0.05; acceptable values for the comparative fit index (CFI) should range from 0.9 to 1.0; and acceptable values for the root mean square of approximation [100] should be less than 0.08. Since most of the consistency indicators were not met, an exploratory factor analysis [92] was run to determine the structure of the constructs as suggested by Byrne [91] when proposed research models do not provide a good fit for the data set.

The EFA analysis was run using the FACTOR procedure in the statistical software SAS. The communality estimates used the method of squared multiplied correlations, and items were retained using a cut off value of 1 based on the Kaiser criterion for the Eigenvalues. The maximum likelihood was used as the extraction method followed with a varimax rotation. This analysis resulted in five factors that can be retained by the Kaiser criterion. In addition to this criterion, the scree plot test [101] was used to confirm the number of factors. By using this rule, the researcher observed that the curve based on Eigenvalues formed an elbow indicating five factors. Given this, five constructs were retained. These five constructs account for 86% of the total variance. For each construct, all items with a load equal to or greater than 0.50 were assigned to the corresponding construct. Using 0.50 as the cut off value, ten items were removed. After the new distribution of items based on the load cut off value of 0.5, factors were renamed to accurately reflect the new items included as previously done by Zakuan *et al.* [102] while analyzing TQM practice in the automotive industry.

The first construct was renamed Change Management. To build this construct, all items with loading values higher than 0.5 for F1 were grouped. Items selected are related to Change Adoption, Training, and Operations Management according to previous research performed by Bessant *et al.* [14], Kaye and Anderson [11] and Marksberry et al. [17]. Items with loadings lower than 0.50 or heavy loads in multiple constructs were eliminated. After the assignment of the items to construct 1, a Cronbach's α analysis was performed and an acceptable value of 0.96 was obtained. The new structure for construct 1 is shown in Table 36.

Table 36. Structure of change management after EFA and Cronbach's α analysis

Item	Description	F1	F2	F3	F4	F5	Factor	α value
V47	Learning organization from CI experiences	0.73	0.26	0.29	0.09	0.22	Change Management	0.96
V44	Active role of manager in the CI process	0.69	0.25	0.12	0.15	0.21		
V52	Leaders role model CI by embracing change	0.67	0.37	0.21	0.24	0.13		
V20	Accessibility to CI leader	0.66	0.34	0.15	0.22	-0.18		
V51	Dynamic portfolio of lessons learned	0.65	0.20	0.35	0.18	0.25		
V49	Mindful responses rather than inefficient solutions	0.64	0.28	0.26	0.19	0.23		
V46	Risk taking to promote innovation and creativity	0.61	0.27	0.33	0.08	0.11		
V56	Overall support of the organization to adopt change	0.60	0.33	0.28	0.10	0.42		
V45	Failure as a learning opportunity	0.59	9.22	0.33	0.14	0.13		
V54	Change adoption is supported by success stories	0.59	0.20	0.37	0/07	0.30		
V35	CI empowers employees	0.60	0.33	0.42	0.18	0.05		
V19	Recognition of innovation and creativity	0.54	0.40	0.30	0.06	0.00		
V34	Employees contribution to meet customers' needs	0.54	0.37	0.33	0.25	0.14		
V33	Openness to suggestion of ideas	0.54	0.37	0.19	0.23	0.00		
V48	Evolving working environment	0.51	0.16	0.31	0.30	0.30		

The second construct was called strategic planning [103]. The items with factor loads above or equal to 0.5 were classified as strategic planning items. These items are mainly related to strategic management and leadership corresponding to previous work done by Bessant et al. [14], Upton et al. [15] and Kaye and Anderson [11]. Items with loadings lower than 0.50 or heavy loads in multiple constructs were eliminated. After the assignment of the items to strategic planning, a Cronbach's α analysis was performed and an acceptable value of 0.95 was obtained. The new structure for this construct is shown in Table 37.

Table 37. Structure of strategic planning construct after EFA and Cronbach's α analysis

Item	Description	F1	F2	F3	F4	F5	Factor	α value
V16	CI as an element of the vision and mission	0.35	0.62	0.22	0.22	0.06	Strategic Planning	0.95
V12	CI goals are understood at every level of the organization	0.25	0.60	0.36	0.22	0.11		
V9	Effective communication of reached goals	0.23	0.60	0.18	0.23	0.15		
V2	Alignment of CI and departmental goals	0.19	0.59	0.19	0.33	0.12		
V7	CI goals adjustments based on follow up	0.25	0.58	0.39	0.13	0.11		
V10	Frequent monitoring of CI goals	0.11	0.57	0.29	0.26	0.26		
V13	Perception of CI as a working value	0.29	0.57	0.18	0.24	0.17		
V15	Role model of CI initiatives by managers	0.39	0.56	0.09	0.25	0.22		
V5	CI as strategic plan to meet customer's needs	0.37	0.56	0.02	0.16	0.21		
V11	CI goals drive day to day work	0.28	0.55	0.32	0.17	0.16		
V4	Systematic follow up of CI goals	0.25	0.55	0.25	0.21	0.24		
V14	Improvement as core element for company's permanence	0.42	0.54	0.08	0.22	0.04		
V1	CI strategic plan	0.22	0.54	0.20	0.41	0.09		
V17	Accurate organizational structure to support CI	0.33	0.52	0.43	0.22	0.08		
V8	Available resources across the firm to support CI	0.41	0.52	0.30	0.09	0.14		
V6	Communication of CI goals	0.24	0.52	0.31	0.23	0.02		
V3	Use of historic data to develop CI goals	0.15	0.50	0.31	0.13	0.12		

The third construct is named Knowledge Management (KM). Items assigned to this construct show a factor load above 0.5. These items were identified as part of the Measurement and Information Deployment and Training according to Bessant et al., 1994; Dale et al., 1997; Kaye & Anderson, 1999. After assigning the corresponding items, a Cronbach's α analysis was performed resulting in a value of 0.91. Table 38 shows the structure for knowledge management.

Table 38. Structure of knowledge management after EFA and Cronbach's α analysis

Item	Description	F1	F2	F3	F4	F5	Factor	α value
V30	Existing database of lessons learned	0.22	0.19	0.74	0.19	0.15	Knowledge Management	0.91
V31	Electronic management of CI data	0.24	0.30	0.67	0.28	0.07		
V29	Timely CI reporting	0.18	0.28	0.63	0.30	0.04		
V28	IT supports CI measurement and deployment	0.23	0.26	0.62	0.16	0.06		
V39	CI brings new technologies to improve process and products	0.39	0.14	0.57	0.10	0.11		
V18	Resources allocation for invention and creativity	0.33	0.37	0.52	0.05	0.07		
V41	Existence of a continuous training plan for CI	0.42	0.15	0.51	0.26	0.16		
V43	CI training is part of workers development plan	0.39	0.16	0.51	0.36	0.10		
V38	CI as preventive rather than corrective methodology	0.41	0.29	0.50	0.17	0.22		

The fourth construct is called performance measurement (PM), and items belonging to this construct have a factor load higher than 0.5. Items assigned to performance measurement are related to Measurement and Information Deployment Strategic according to Bessant et al., 1994; Dale et al., 1997; Kaye & Anderson, 1999. A Cronbach's α analysis was performed to ensure internal reliability, obtaining a value of 0.90. Table 39 shows the new structure for construct.

Table 39. Structure of performance measurement after EFA and Cronbach's α analysis

Item	Description	F1	F2	F3	F4	F5	Factor	α value
V23	Consistent overall and departmental goals	0.16	0.35	0.27	0.65	0.11	Performance Measurement	0.90
V22	Display of CI metrics	0.12	0.32	0.19	0.64	0.19		
V25	CI metrics at operational level	0.15	0.33	0.27	0.59	0.26		
V27	CI goals reflect customers requirements	0.28	0.32	0.32	0.58	0.15		
V24	Longitudinal collection of CI metrics	0.24	0.33	0.36	0.55	0.12		

The last construct is named CI Sustainability (CIS). To assign the corresponding items, a cut off higher than or equal to 0.50 was used. Items with lower loads or heavy loads in more than one construct were eliminated. The identified items are related to the performance and sustainability of the CI process as indicated by Carleton [18]. A Cronbach's α analysis was performed obtaining an acceptable value of 0.84. Table 40 shows the structure for the fifth construct.

Table 40. Structure of CI sustainability after EFA and Cronbach's α analysis

Item	Description	F1	F2	F3	F4	F5	Factor	α value
V59	Defined metric for ongoing CI training in the long term	0.33	0.26	0.36	0.31	0.56	CI Sustainability	
V58	Defined metrics for waste reduction in the long term	0.19	0.28	0.33	0.36	0.55		
V57	CI initiatives are defined metrics	0.29	0.23	0.07	0.38	0.54		

Based on the previous analysis conducted, a new structure for the constructs of the CI sustainability was found and it is discussed in the following section of this chapter.

5.6. Discussion and Conclusions

Existing literature illustrates how confirmatory and exploratory factor analyses contribute to the development of new construct structure to assess different topics. For example, Rock [104] was able to determine a new structure of constructs to assess psychological mindfulness. In his study, the author tested a theoretical model using CFA, but when the result did not show the theoretical model to be a good fit for the data, an EFA was conducted. After running the EFA, the study was able determine a new structure for the constructs which were also renamed to reflect the items loaded. Mansourian *et al*. [72] and Yurchisin [105] were also able to perform studies to determine TQM practices in the automotive industry, and to characterize the relationship among salesperson appearance, employee-organization identification, job involvement and job performance correspondingly. In these studies, researchers conducted CFA and EFA to find a model with good fit for the data. In both cases authors rearranged items among constructs based on their factor loading cut off value and renamed these new factor to reflect the new structure. Based on these studies found in the literature and the results obtained from the CFA and EFA analysis, the study is able to determine a new structure for the constructs in the research model. This new structure consisted of five constructs: (1) change management, (2) strategic planning, (3) knowledge management, (4) performance measurement and (5) CI sustainability, and includes 50 out of the 60 initially proposed items. A comparison between current findings and previous work in the literature is summarized below and the graphical representation for this new constructs model is shown in Figure 18.

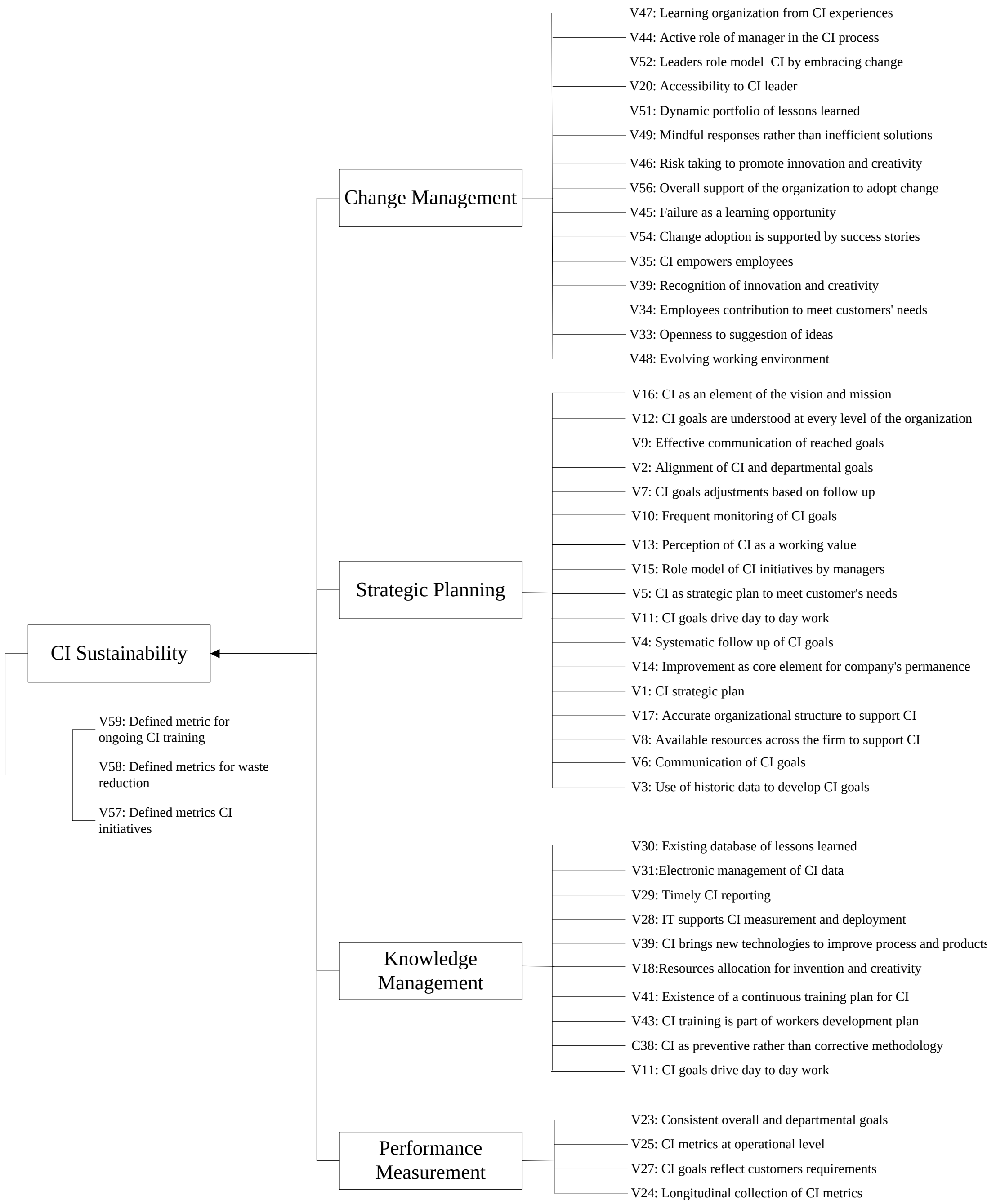

Figure 18. New structure for constructs of CI sustainability

Change Management (CM). Within the CI literature, change management is cited as critical. Initially , the study considered a construct called change adoption which cover various operationalized measures for CM, however after the validation, CM grouped items previously identified as training and operational management measures.

Comparing with various authors in the field, the results for this construct are consistent. For example, Fryer, Jiju & Douglas [106] argue that changes related to CI are more successful when introduced by workers. From this study, this characteristic is also included in items V33, V34, V35 among others. These items focus on the importance of employee-driven change by contributing ideas and solutions to meet customers' needs. Perry [107] also supports the current findings for CM as a construct. His work reveals that change is embraced once workers visualize the need for and benefits of change. The author suggests the use of CI leaders and the implementation of success stories as instruments to help workers recognize these needs and benefits. Similar findings were identified through this study, specifically items V47, V52, V54 and V45 which evaluate this construct by analyzing the existence of CI leaders and the use of past experiences to support the required change.

Strategic Planning (SP). SP is broadly found as a success factor when implementing and sustaining CI. Formerly, strategic management and leadership were considered separate constructs; however, findings from this work revealed that both are merged in a unique construct. This is congruous with findings in the literature. Authors such as Anderson, Rungtusanatham & Schroeder [108] concluded that leadership and strategic planning are positively associated since managers are required to develop a clear path to achieve CI and are also called to manage by example. In the new structure proposed for SP, this is observed in items like V13, V15, V14 and V1, which explicitly evaluate the connection between the CI strategic plan and the role modeling of managers. This finding is also supported by Flynn, Roger & Sadao [109]. These authors' research indicates that those in leadership roles, such as managers, must initiate communication of CI, and help workers embrace improvement as a core value of the organization, which is detailed in items V14, V6, V9 and V13.

Knowledge Management (KM). KM as a construct is the result of merging items previously associated with measurement and information deployment and training. This constructs seeks to evaluate how the information resulting from CI is reported and capitalized as knowledge. Demerest [110] suggests knowledge management seeks to capture, use and transfer knowledge to improve efficiency and competitive advantage. Moffet, McAdam & Parkinson[111] strongly argue that managers should look for ways to integrate information technologies and knowledge management. This finding is clearly identified by items V28, V30 and V31 which evaluate how CI data and knowledge are electronically managed. Furthermore, Bessant & Francis [112] agree that a successful CI-oriented firm is willing to allocate resources for invention and creativity, and well establish a training plan to continuously educate on CI. These findings are also consistent with items V39. V18 and V41 of the KM construct.

Performance Measurement (PM). PM integrates the measurement system put in place to sustain CI. Maskell [113] criticizes using profit metrics as the only way to measure performance because they only help to achieve short term goals; thus, CI should include other types of metrics to support sustainability. Nanni, Dixon & Vollman [114] indicate that performance metrics must be congruent with goals. This is also indicated by items V23 and V27 in the PM construct. Bond [115] also suggests that metrics need to be designed for the operational level since workers can take responsibility for delivering what customers require. This finding is also reflected in V24 and V25 of this construct. Finally, as an overall finding, Bond clearly defines the urgency of a performance measurement system to provide a mechanism that enables senior management to follow up on how policies and strategies are cascading to the product and processes levels.

Sustainability of CI (CIS). The findings for this study indicate that defining few key indicators over the long term help practitioners understand how CI performs over time. Escrig-Tena [116] suggests that only with key performance indicators and collection of relevant data, firms will be able to support CI in the long run. As indicated by Terziovski & Samson [117] key performance indicators of CI sustainability are related to waste reduction, continuous learning in the organization and the several activities conducted over time to ensure different approaches to improve performance. The results of the study align with these findings, since items V57, V58 and V59 of this construct measure sustainability through the metrics toward waste reduction, CI initiatives and CI training in the long term.

The previous discussion leads the researcher to conclude that CI sustainability can be studied through the analysis of five factors rather than the seven originally proposed. These five factors were defined after grouping and renaming the resulting constructs based on the EFA test. This reduction of dimensions seeks to find more concise ways for practitioners to analyze their CI management systems. Finally, the use of rigorous methods such as confirmatory factor analysis and exploratory factor analysis, as well congruency with previous research ensure future users the validity of the new defined framework to sustain continuous improvement. This proposed framework is depicted in Figure 19.

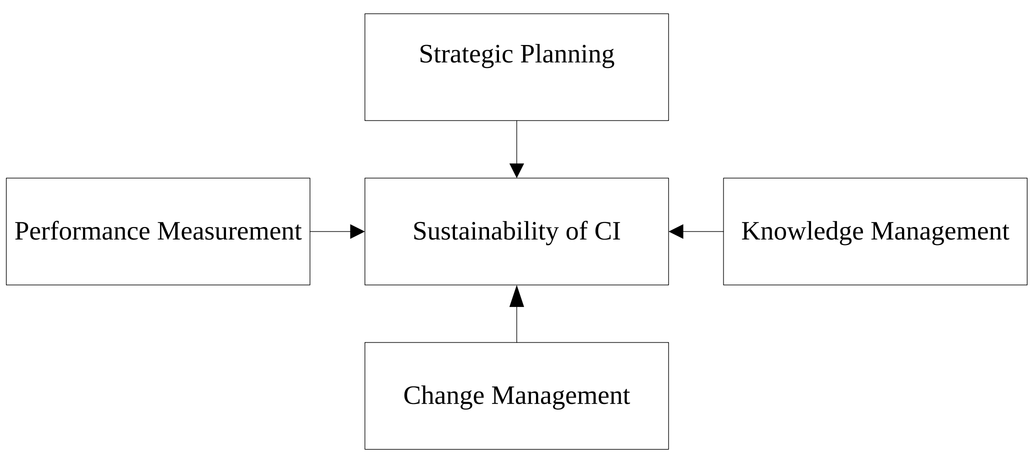

Figure 19. CI Sustainability Framework

5.7. References

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6. Analysis of the Effect of Time, Regional Context and Type of Industry on CI Sustainability: Hypothesis Testing

While companies agree that implementing CI helps them to remain sustainable by improving processes and reducing operating costs, there is still a broad field of knowledge to explore to lead CI sustainability [1]. Even though, previous research has helped in clarifying successful constructs to sustain CI, authors such as Staples *et al.*[2] and Cocca & Alberti [3] recognize the need for deeper understanding of these success constructs.

This section provides the analysis of the constructs identified in the research framework in Chapter 4. This analysis is conducted in three dimensions: (1) longitudinal dimension, (2) regional context, and (3) industry context, aiming to understand how these constructs behave according to each perspective

Various authors, such as Savolainen [1] and Marin-Garcia, Pardo del Val & Bonavía-Martin [4] have formerly conducted longitudinal analysis in the context of CI implementation. Even though these studies bring considerable insights into CI implementation, a need still exists to incorporate quantitative and qualitative data analysis and increase validity as suggested by Patton [5] and Fielding & Fielding In the regional context, there is little evidence of regional context effects in the sustainability of the CI process. Rather, studies such Svensson & Klefsjo [6] and Marin-Garcia & Poveda [7] deliver results primarily related to industries located in a single region.

The last dimension of this analysis allows the comparison of the validated constructs in various types of industries. This cross-case analysis allows understanding of how different firms define and allocate their resources to sustain CI as recommended by Mather [8]. It is within the author’s interests to integrate these dimensions using qualitative and quantitative data analysis to provide practitioners and academics with rigorous scientific knowledge to support CI.

6.1. Methodology

This sections aims to provide the theoretical foundations to develop the descriptive and the statistical analysis of the collected data. As suggested by Patton [5], using qualitative and quantitative data analysis enhances the validity of the data, and allows the researcher to develop more rigorous conclusions [9].

6.1.1. Data Reduction

Prior to the analysis of Likert items, the study used CFA and an EFA to find the best fit structure for the data collected. Once the structure was defined, constructs were reduced from seven to five, items were allocated to the constructs using a cut off value of 0.5, and constructs were renamed to reflect all elements. A reliability (internal consistency) test using Cronbach's α analysis was run to ensure that items within the new structure are intercorrelated (i.e., measure the same construct). The results of these tests are shown in detailed in Chapter 5 of this document.

With a new valid structure, the Likert items are analyzed using scales (scores) as suggested by Zhu & Kim [10]. For this research, responses per item were collected and averaged to obtain a single score per construct. This method is found in previous studies such as Glick et al. [11] and Glick & Fiske [12] who performed parametric analysis on construct' scores computed by calculating the mean of individual responses. This methodology is also supported by Norman [13] and de Winter & Dodou [14] who concluded that use of parametric analysis methods leads to rigorous and repeatable results and conclusions.

This procedure suggested by Darrington [15] and Johnson [16] consists of calculating the mean (commonly called average) of responses corresponding to each item within a construct. The mathematical description is given by:

$$\bar{Y} = \frac{\sum_1^n X_i}{n * i}$$

where $\bar{Y}$ is the average response per construct, n is the number of responses, and X_i is the response per item for that specific construct.

6.1.2. Longitudinal Study

Longitudinal study is a term that refers to research methods aimed toward identifying changes in the observed variables over time [17]. The benefits of employing this type of research include: (1) the recording of incident events, which allows the researcher to identify correlations between the response observed and the event occurring at the time of the data collection; (2) measurement of individual changes in the outcome, since observations are made at the individual unit level; and (3) the opportunity to analyze development in a real setting [18]. This research methodology, as any other, has disadvantages as well. Some of the most cited are (1) the participant follow-up, which may introduce bias due to drop-out of respondents, and (2) the large cost of applying longitudinal analysis in large populations [19].

Longitudinal research is widely applied in social research. Authors such as McAdam et al. [20] used this method to evaluate the implementation of innovation management in manufacturing in small and medium enterprises. Also, this technique is used for medical studies, where medical conditions are analyzed over time and changes on patients are recorded. Specifically, in the social sciences, Yin [21] describes how repeated observations over time can be embedded in a case study. This mix of research methods allows the researchers to understand behavioral phenomena that can be identified only after several periods of observation.

There are various statistical techniques for longitudinal data analysis. When data corresponds to a sequence of set points which are typically measured at successive time snapshots spaced at uniform time intervals, also known as time series, the most commonly used method is the regression analysis as suggested by Bloomfield [22]. In analyzing repeated measures, like this study, the most commonly used statistical approach is the analysis of variance (ANOVA) [23]. With this method, the researcher is able to determine if observed change in measures over time is statistically significant. It is also important to note that ANOVA requires no missing data across time to reduce the error. A third technique is known as mixed-effect regression model. This method is similar to ANOVA, however it is less sensitive to missing data [24]. A fourth technique is to plot of data points. This technique is usually combined with statistical analysis and allows the study to identify seasonal behavior and change pattern associated with collected data.

6.1.3. Analysis of Variance

Analysis of variance (ANOVA) is a group of statistical models used to test significance among means of several groups based on the variance observed in the set of data [25]. For this research, the ANOVA models used for further hypothesis testing were the fixed-effect model and contrast-effect model. The fixed-effect model relates to an experiment with fixed effect types, and the contrast-effect model is a model that enables a linear combination of two or more construct averages. The contrast-effect model is commonly used to compare fixed and mixed effects, and to determine differences among scores after a period of time (i.e. the difference between two grade scores at the beginning and the end of a semester) [26].

6.1.4. Correlation Analysis

Correlation analysis is a statistical method useful for describing the linear association of variables. There are different types of analyses that can be used. For the purpose of this research, the multiple linear regression is considered.

Multiple linear regression estimates the regression coefficients in a multiple regression model. The general model for a multiple linear regression is given by:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik} + \varepsilon_i \qquad i = 1,2,\ldots..n$$

where n is the number of variables, k the number of observations and β represents the regression coefficients.

6.2. Descriptive Statistics Analysis

Once the validation of the questionnaire and the research model was completed, descriptive statistics were used. According to Krathwol [27] descriptive statistics characterize a different aspect of a set of data. For this specific work, the descriptive statistics enable the study describe the respondents based on their type of job, level of employment within a company, and the time working for each participating company.

In total, the researcher collected 352 questionnaires. During Observation 1, 132 questionnaires were collected out of the 200 questionnaires distributed, which equals a response rate of 66.00%. For Observation 2, a total of 98 questionnaires were collected, producing a response rate of 49.00%. Observation 3 showed a response rate of 26.50%, representing a sample of 53 questionnaires collected. Finally, for Observation 4, the response rate was 32.50% with a total of 65 questionnaires collected. Figure 20 shows the distribution of questionnaires collected per company over time.

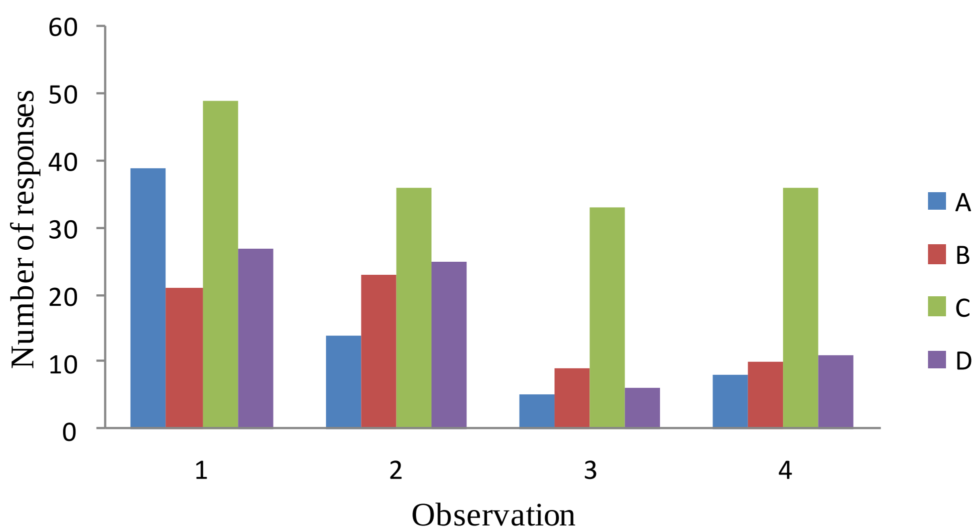

Figure 20. Distribution of questionnaires collected per company and observation

6.2.1. Descriptive Statistics of the Respondents

The respondents were characterized using three categories. The first category wass related to the level of their job position. Job positions were classified as a director, manager, supervisor, staff or operational level. According to the results obtained, 32.39% of the respondents worked at an operational level, 31.43% worked as staff employees, 17.43% had a supervisory role, 11.43% performed as a manager, 6.29% refereed their current job position level as "other," and 1.14% were directors at the time of answering the questionnaire.

Regarding the functional area where respondents were working at the time they answered the questionnaire, 42.29% of respondents were employed in a role related to manufacturing/production. The second most common functional area was customer service including 18.57% of the respondents, and other (including quality control) with 15.14% of the respondents. Figure 21 shows the distribution of responses (as a percentage) per functional area.

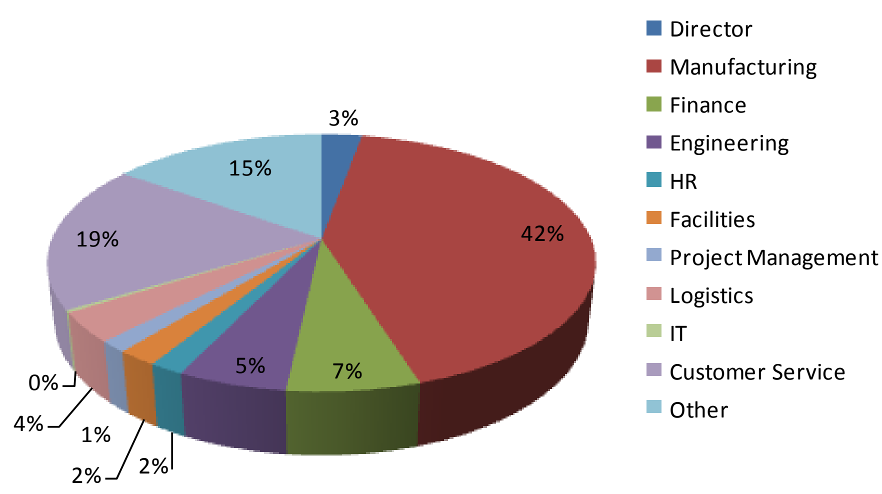

Figure 21. Percentage of responses per functional area

Related to number of years at the organization, 62.86% of the respondents indicated that they have been part of the organization for five or more years. Twenty seven point one four percent indicated that they had been working for the company for more than a year but less than five years, and 8.57% of respondents had been working for less than one year.

6.3. Hypothesis Testing

This section describes the findings of hypothesis testing related to accomplishing the objectives of this study. The results of the statistical analysis, using a value of α=0.05, are grouped and discussed below.

6.3.1. Analysis of the Effect of Type of Industry on the Constructs

To analyze how region impacts the constructs of CI sustainability the following research hypothesis was proposed:

H_0: Type of industry has no effect on the constructs comprising CI sustainability

This is also represented by:

$$H_0 : F_A = F_B = F_C = F_D = 0$$

$$H_1 : F_A \neq F_B \neq F_C \neq F_D \neq 0;$$

where F represents the construct and A,B,C and D represent the participating company.

a. Change Management

The results obtained from this testing showed that company had a significant effect on the on the perceptions of respondents of Change Management as a construct affecting CI sustainability. According to the results, the average response for this construct is not significantly different between Companies A and D, and between Companies B and C. The findings also indicate that the average response between Companies A and D is significantly different from Companies B and C. Table 41 shows the results for this test.

Table 41. ANOVA test results for CM construct means within companies

Ho	P-value	Result
H_o: $CM_A = CM_B$	0.0012	Reject H_0
H_o: $CM_A = CM_C$	<0.0001	Reject H_0
H_o: $CM_A = CM_D$	0.5152	Accept H_0
H_o: $CM_B = CM_C$	0.4232	Accept H_0
H_o: $CM_B = CM_D$	0.0060	Reject H_0
H_o: $CM_C = CM_D$	<0.0001	Reject H_0

b. Strategic Planning

According to the analysis conducted, the researcher observed that respondents had different perceptions about strategic planning [28] as a construct affecting CI sustainability. Results showed that perceptions of how SP affects the CI at Company A is significantly different from the remaining companies; also, Companies C and D are significantly different between them. Companies B and C, and Companies B and D seem to have no significant difference. The results for this test are shown in Table 42.

Table 42. ANOVA test results for SP construct means within companies

Ho	P-value	Result
H_o: $SP_A = SP_B$	0.0002	Reject H_0
H_o: $SP_A = SP_C$	<0.0001	Reject H_0
H_o: $SP_A = SP_D$	0.0047	Reject H_0
H_o: $SP_B = SP_C$	0.6226	Accept H_0
H_o: $SP_B = SP_D$	0.6679	Accept H_0
H_o: $SP_C = SP_D$	0.0244	Reject H_0

Company A (medical devices manufacturing) was ranked as the top of the four companies while Company C (wood product industry) was ranked at the bottom regarding to perceptions of how SP contributes to sustain CI. Based on the information collected through interviews, this difference might be caused by the intensity of informational meetings about CI initiatives held, which occurred on a daily basis for Company A (at the start of each production shift) and quarterly for Company C. Also, a worker from Company C expressed that information deployment from top management does not occur on a frequent basis.

Finally, another important event that might affect why A is significantly different from the other is related to the management group. Managers at Company A have been in the company for nearly two years, and the main focus of the management group is to restructure the company with new goals and targets; therefore, getting involved with all employees and letting them know the new directions are a priority among the group.

c. Knowledge Management

The results from the analysis conducted on the perceptions of the KM construct as a contributor toward CI sustainability are shown in Table 43. These results indicate that perceptions at Company C are significantly different from Company A and Company D, but there is no significant difference between Company C and Company B. Companies A, B and D showed no significant difference among their perceptions ok KM contributes to sustain CI.

Table 43. ANOVA test results for KM construct within companies

Ho	P-value	Result
H_o: $KM_A = KM_B$	0.2173	Accept H_0
H_o: $KM_A = KM_C$	0.0078	Reject H_0
H_o: $KM_A = KM_D$	0.7840	Accept H_0
H_o: $KM_B = KM_C$	0.7566	Accept H_0
H_o: $KM_B = KM_D$	0.5701	Accept H_0
H_o: $KM_C = KM_D$	0.0188	Reject H_0

In the overall ranking, Company A is placed at the top unlike Company C, which is ranked at the bottom. Using the information collected through the questionnaires and the interviews, this situation might be caused by the absence of information surrounding the implementation of the plant-wide measurement system. The managers decided to cancel initiatives and activities related to CI projects and this impacted associates. One of the associate respondents noted, *"They don't tell us much about what happens here,"* which can be interpreted as a lack of information regarding main changes in the CI program.

d. Performance Measurement

According to the ANOVA conducted, perceptions from respondents at Company A were identified as significantly different from the perceptions of respondents from Companies B, C and D. These results are shown in Table 44.

Table 44. ANOVA test results for PM construct within companies

Ho	P-value	Result
H_o: $PM_A = PM_B$	0.0090	Reject H_0
H_o: $PM_A = PM_C$	0.0015	Reject H_0
H_o: $PM_A = PM_D$	0.0010	Reject H_0
H_o: $PM_B = PM_C$	0.9991	Accept H_0
H_o: $PM_B = PM_D$	0.8854	Accept H_0
H_o: $PM_C = PM_D$	0.7365	Accept H_0

Results from descriptive statistics also show that respondents from Company A agree (mean response 4.05) that PM as a construct affects the sustainability of CI, while respondents from Companies B, C and D neither agree nor disagree (mean response 3.58, 3.60, and 3.48, correspondingly).

e. Sustainability Indicators

The results from the ANOVA analysis showed that the average response from Company A is significantly different from those responses obtained in Companies B, C and D. These results are shown in Table 45.

Table 45. ANOVA test results for PM construct within companies

Ho	P-value	Result
H_o: $SI_A = SI_B$	0.0009	Reject H_0
H_o: $SI_A = SI_C$	<0.0001	Reject H_0
H_o: $SI_A = SI_D$	<0.0001	Reject H_0
H_o: $SI_B = SI_C$	0.9123	Accept H_0
H_o: $SI_B = SI_D$	0.2490	Accept H_0
H_o: $SI_C = SI_D$	0.3448	Accept H_0

According to the descriptive statistics, respondents from Company A agreed that initiatives, such as Kaizen events and a long-term, defined goals moving toward waste reduction, are likely to sustain the CI process. Respondents from Companies B, C and D neither agreed nor disagreed with these statements and how they will support CI.

6.4. Analysis of Constructs Per Region

This section describes how the mean response for each construct were similar based on the region where participating companies were located. Region 1 refers to companies located outside the US and Region 2 refers to companies located in the US. The research hypothesis developed for this testing is:

H_0: Region has no effect on the perception of constructs comprising CI sustainability.

This hypothesis is also represented by the following expressions:

$$H_0: F_1 = F_2 = 0$$

$$H_1: F_1 \neq F_2 \neq 0;$$

where F represents the construct in Region 1 or Region 2.

The results of the hypothesis testing for the regional context are shown in Table 46.

Table 46. Results of hypothesis testing for regional context

Ho	P-value	Result
H_o: $CM_1 = CM_2$	0.9580	Accept H_0
H_o: $SP_1 = SP_2$	0.0131	Reject H_0
H_o: $KM_1 = KM_2$	0.2841	Accept H_0
H_o: $PM_1 = PM_2$	0.0207	Reject H_0
H_o: $S_1 = S_2$	<0.0001	Reject H_0

As observed in the results, the constructs strategic planning, performance measurement and sustainability show significant differences among responses based on the region where companies are located. Figure 22 shows the values corresponding to each construct based on the regional context of respondents. The figure shows how Region 1 has a higher perception of all constructs and their contribution to sustain CI. However, according to the results from the hypothesis testing, this difference is statistically significant for SP, PM, and S constructs.

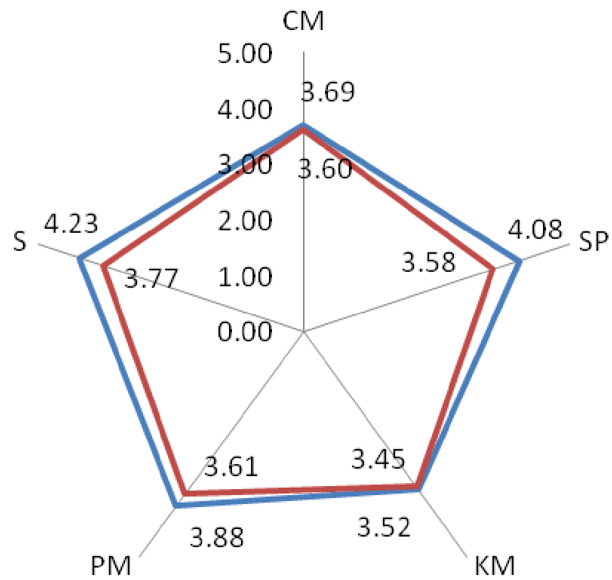

Figure 22. Construct average response rate per region

6.4.1. Longitudinal Analysis of Constructs

To determine if time had an effect on the identified construct, the following research hypothesis was developed:

H_0: Time has no effect on the perception of constructs comprising CI sustainability

Based on the new structure found for factors influencing CI sustainability, the first construct analyzed is change management [29]. This construct was represented by nine items prior to the EFA analysis. Once the new structure was defined, the CM construct was represented by 16 items, including four items initially associated with learning construct, seven items from change adoption construct, two items from training construct, and three items from operational management construct.

a. Change Management

One of the objectives of this study was to determine if time has an effect on how the respondents perceived the different constructs affecting sustainability of the CI process. According to the results obtained, the average perception for Change Management within Company A shows an increasing trend with a minimum value of 3.63 on Time 1 and a maximum value of 4.52 during Time 4. These results can be observed in Figure 23.

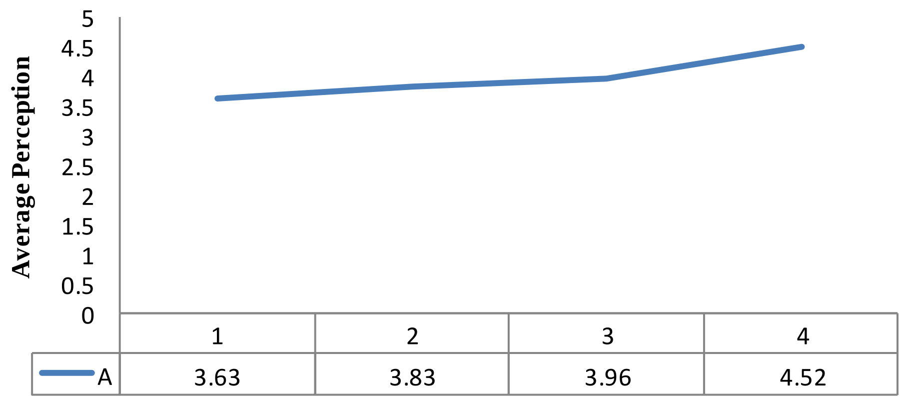

Figure 23. Perception of Change Management per Company A

These results show the effect of the several activities taking place in the organization. According to the interviews conducted at Company A, the organization developed a training plan for all the associates. This plan started with a leveling class about CI as a philosophy, and followed up with specific classes about CI techniques, such as root-cause analysis for those in charge of improving the current processes.

When analyzing the level of significance for these differences, evidence suggests that the perception at Time 4 is significantly different from Time 1 and Time 2. This finding suggests that after one year of implementing the training process and the information deployment within the organization, there was a positive effect on associates' perceptions regarding the management the CI process and the change resulting from its implementation.

Table 47. ANOVA results for mean value of CM construct over time for Company A

Ho	P-value	Result
H_o: $CM_{A1} = CM_{A2}$	0.2959	Accept H_0
H_o: $CM_{A1} = CM_{A3}$	0.2448	Accept H_0
H_o: $CM_{A1} = CM_{A4}$	0.0002	Reject H_0
H_o: $CM_{A2} = CM_{A3}$	0.6630	Accept H_0
H_o: $CM_{A2} = CM_{A4}$	0.0092	Reject H_0
H_o: $CM_{A3} = CM_{A4}$	0.1026	Accept H_0

For Company B, the maximum value observed was during Time 1. However, the values observed during Times 2, 3, and 4 do not show a large difference. These results can be observed in Figure 24.

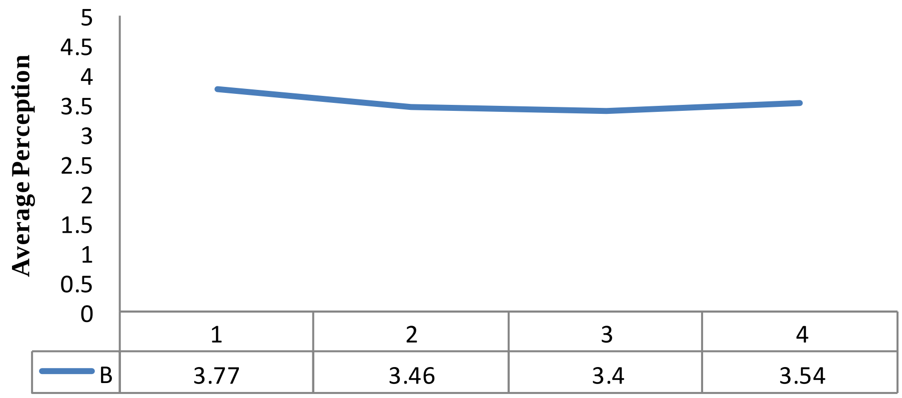

Figure 24. Perception of Change Management per Company B

Company B is a company which has been involved in the CI process for the past eight years and the CI initiatives are continuously held through a yearly defined schedule; however, the CI itself is not a novelty within the company. This might be the reason why there is not enough evidence to conclude that there is a statistically significant difference for this construct over time. The results for this test are shown in Table 48.

Table 48. ANOVA results for mean value of CM construct over time for Company B

Ho	P-value	Result
H_o: $CM_{B1} = CM_{B2}$	0.1419	Accept H_0
H_o: $CM_{B1} = CM_{B3}$	0.1797	Accept H_0
H_o: $CM_{B1} = CM_{B4}$	0.3886	Accept H_0
H_o: $CM_{B2} = CM_{B3}$	0.8165	Accept H_0
H_o: $CM_{B2} = CM_{B4}$	0.7663	Accept H_0
H_o: $CM_{B3} = CM_{B4}$	0.6574	Accept H_0

Within Company C, values were very close to 3.6, but in Time 3, the perception of change management decreased to 2.95. Figure 25 depicts these results.

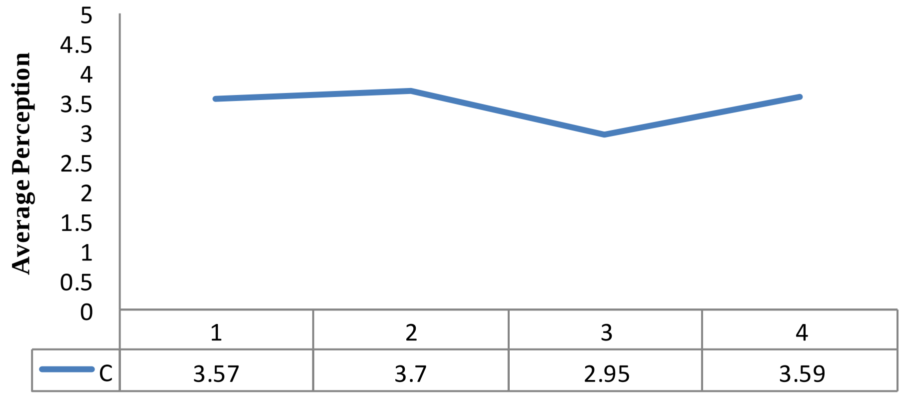

Figure 25. Perception of Change Management per Company C

According to the statistical analysis, the change shown in Time 3 is significantly different from the perception on Change Management in Time 1, 2 and 4. Based on the interviews performed, it was observed that during Time 3, Company C was implementing a manufacturing site-wide measurement system, and during this implementation, no projects such as Kaizen events were run. The results for this test are shown in Table 49.

Table 49. ANOVA results for mean value of CM construct over time for Company C

Ho	P-value	Result
H_o: $CM_{C1} = CM_{C2}$	0.3931	Accept H_0
H_o: $CM_{C1} = CM_{C3}$	<0.0001	Reject H_0
H_o: $CM_{C1} = CM_{C4}$	0.9086	Accept H_0
H_o: $CM_{C2} = CM_{C3}$	<0.0001	Reject H_0
H_o: $CM_{C2} = CM_{C4}$	0.4834	Accept H_0
H_o: $CM_{C3} = CM_{C4}$	<0.0001	Reject H_0

The perceptions of Change Management within Company D have similar values ranking from 3.84 to 3.96. These results are shown in Figure 26.

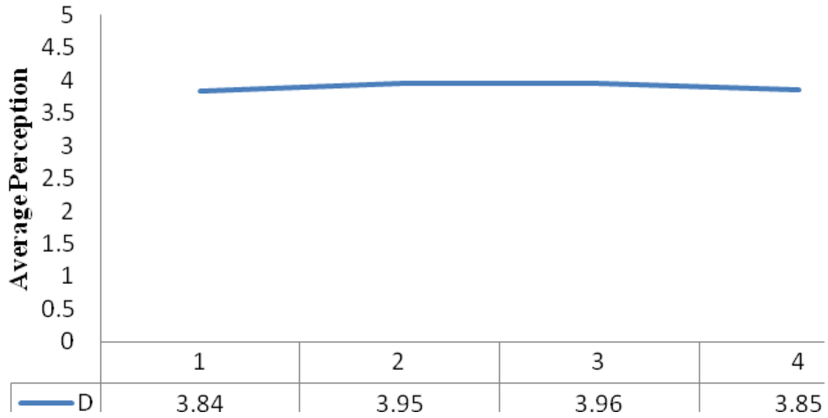

Figure 26. Perception of Change Management per Company C

According to the statistical analysis, there is no evidence that indicates that the change in perception is statistically significant over time within Company D. The results for this analysis are shown in Table 50.

Table 50. ANOVA results for mean value of CM construct over time for Company D

Ho	P-value	Result
H_o: $CM_{D1} = CM_{D2}$	0.4905	Accept H_0
H_o: $CM_{D1} = CM_{D3}$	0.6561	Accept H_0
H_o: $CM_{D1} = CM_{D4}$	0.9393	Accept H_0
H_o: $CM_{D2} = CM_{D3}$	0.9832	Accept H_0
H_o: $CM_{D2} = CM_{D4}$	0.6500	Accept H_0
H_o: $CM_{D3} = CM_{D4}$	0.7321	Accept H_0

b. Strategic Planning

When conducting the longitudinal analysis for strategic planning, the researcher observed that, within Company A, the perception of how SP affects CI increased from 3.95 in Time 1 to 4.51 in Time 4. These results are shown in Figure 27.

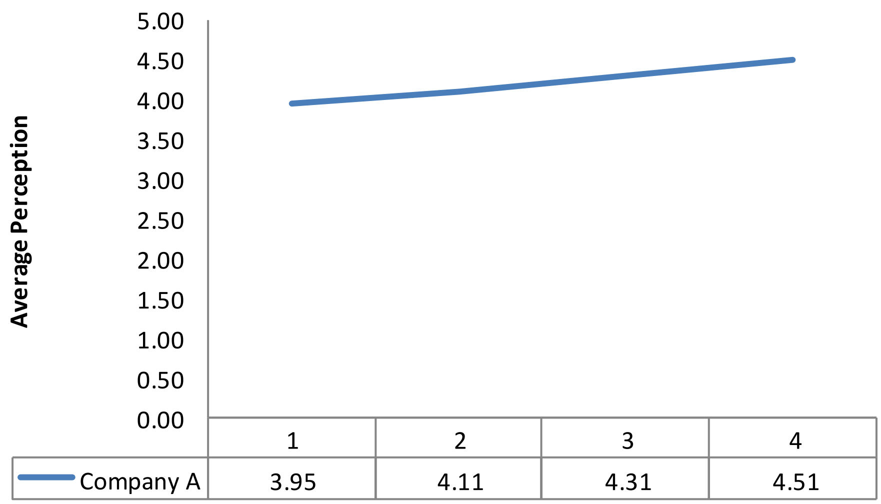

Figure 27. Perception of Strategic Planning at Company A

This increasing trend shows the results of management group actions toward incorporating CI as a working philosophy. These actions include the creation of a job position for a CI leader and the reorganization of manufacturing, including CI projects among the tasks led by supervisors and manufacturing engineers.

The perception on Time 4 is significantly different from Time 1 and Time 2. This might be interpreted as a positive result after one year of implementing the training process and information deployment within the organization. The results for these tests are shown in Table 51.

Table 51. ANOVA results for mean value of SP construct over time for Company A

Ho	P-value	Result
H_o: $SP_{A1} = SP_{A2}$	0.9994	Accept H_0
H_o: $SP_{A1} = SP_{A3}$	0.9739	Accept H_0
H_o: $SP_{A1} = SP_{A4}$	0.1775	Accept H_0
H_o: $SP_{A2} = SP_{A3}$	1.0000	Accept H_0
H_o: $SP_{A2} = SP_{A4}$	0.8946	Accept H_0
H_o: $SP_{A3} = SP_{A4}$	1.0000	Accept H_0

At Company B, the perception of SP decreased from Time 1 (3.87) to Time 3 (3.59); however, during Time 4, the perception increased to 3.75. These results can be observed in Figure 28.

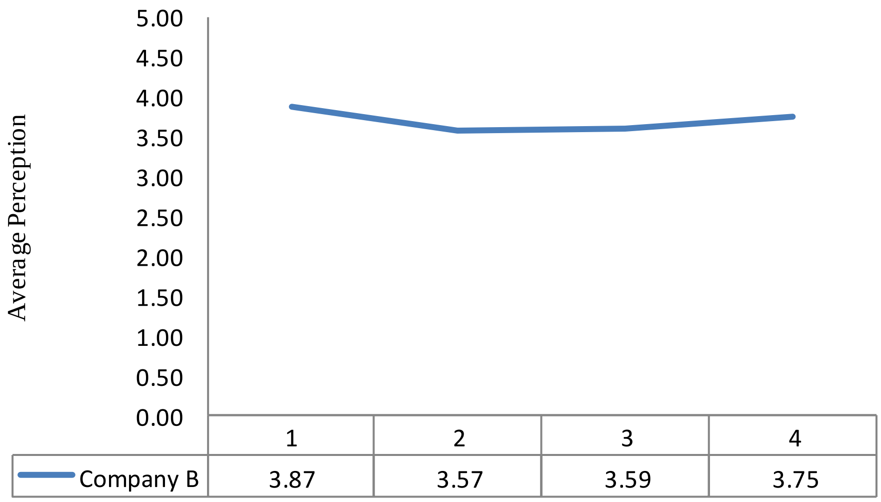

Figure 28. Perception of Strategic Planning at Company B

Even though there is change in the perception of SP at Company B over time, results from the statistical analysis show that there is not enough evidence for these differences to be statistically significant. The results for this test are shown in Table 52.

Table 52. ANOVA results for mean value of SP construct over time for Company B

Ho	P-value	Result
H_o: $SP_{B1} = SP_{1B2}$	0.9893	Accept H_0
H_o: $SP_{B1} = SP_{B3}$	0.9998	Accept H_0
H_o: $SP_{B1} = SP_{B4}$	1.0000	Accept H_0
H_o: $SP_{B2} = SP_{B3}$	1.0000	Accept H_0
H_o: $SP_{B2} = SP_{B4}$	1.0000	Accept H_0
H_o: $SP_{B3} = SP_{B4}$	1.0000	Accept H_0

At Company C, values ranged between 3.06 and 3.81, showing an increase from Time 1 (3.64) to Time 5 (3.75). These results are shown in Figure 29.

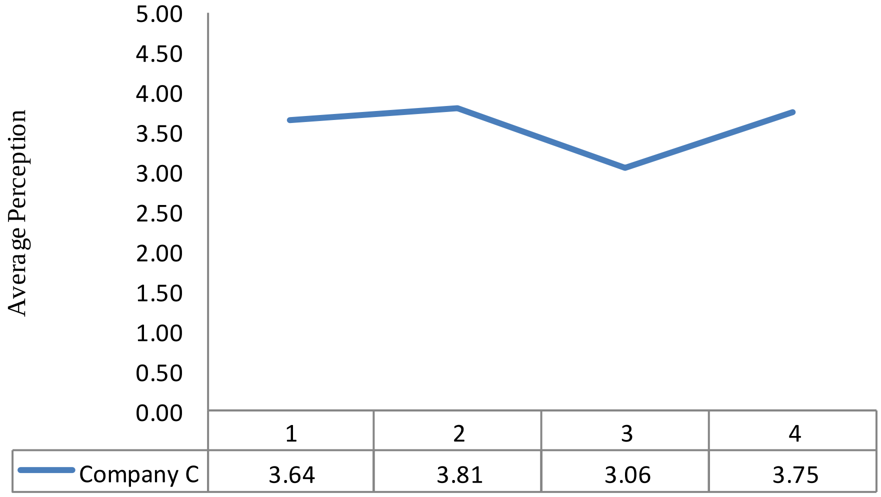

Figure 29. Perception of Strategic Planning at Company C

Based on the results from the statistical analysis shown in Table 53, evidence indicates that perceptions of SP as a construct are statistically significant at Company C in Time 3. This finding might have originated in the absence of CI initiatives that occurred during the period in which observations were made. This absence was caused by the focus of the company in a plant-wide measurement system implementation.

Table 53. ANOVA results for mean value of SP construct over time for Company C

Ho	P-value	Result
H_o: $SP_{C1} = SP_{C2}$	0.9975	Accept H_0
H_o: $SP_{C1} = SP_{C3}$	0.0025	Reject H_0
H_o: $SP_{C1} = SP_{C4}$	1.0000	Accept H_0
H_o: $SP_{C2} = SP_{C3}$	<0.0001	Reject H_0
H_o: $SP_{C2} = SP_{C4}$	1.0000	Accept H_0
H_o: $SP_{C3} = SP_{C4}$	0.0004	Reject H_0

The perceptions of Strategic Planning within Company D showed values ranking from 3.75 to 3.87, but there is no change on perception over time since the initial and final value is 3.75. These results are shown in Figure 30.

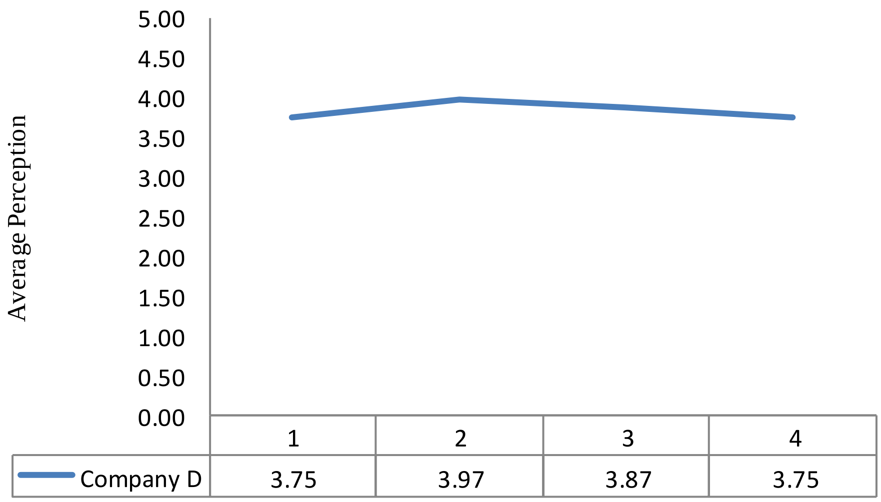

Figure 30. Perception of Strategic Planning at Company D

The results of the statistical analysis performed on perceptions on SP over time are shown in Table 54. According to these results, the changes observed on perceptions of SP are not statistically significant.

Table 54. ANOVA results for mean value of SP construct over time for Company D

Ho	P-value	Result
H_o: $SP_{D1} = SP_{D2}$	0.9899	Accept H_0
H_o: $SP_{D1} = SP_{D3}$	1.0000	Accept H_0
H_o: $SP_{D1} = SP_{D4}$	1.0000	Accept H_0
H_o: $SP_{D2} = SP_{D3}$	1.0000	Accept H_0
H_o: $SP_{D2} = SP_{D4}$	0.9995	Accept H_0
H_o: $SP_{D3} = SP_{D4}$	1.0000	Accept H_0

c. Knowledge Management

The KM construct shows an increasing trend within Company A. The value for this construct increases from 3.63 in Time 1 to 4.51 in Time 4. These results are shown in Figure 31.

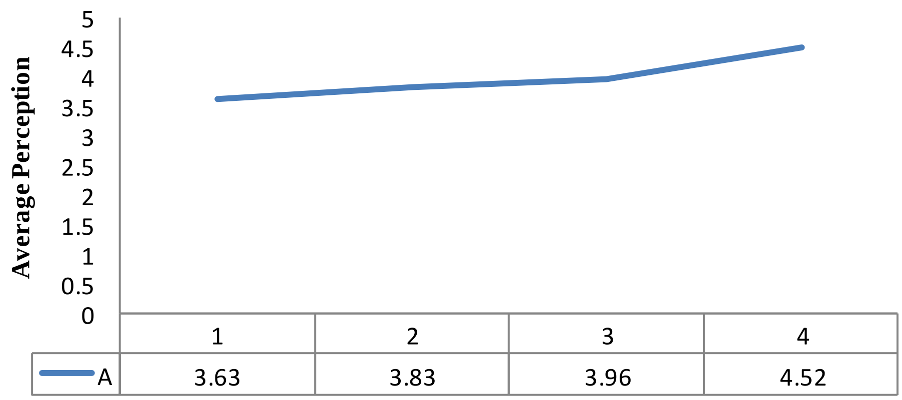

Figure 31. Perception of Knowledge Management at Company A

This increasing trend shows how associates at Company A rated this construct and its importance to sustaining the CI process. At Company A, efforts to communicate the initiatives of the CI process and their results are continuously displayed on information boards available for employees to access. These boards are located on the main hall in front of the production room. Also, metrics and results are revised daily by the production shift supervisor to follow up on pending actions, and are frequently reported to management. Also, based on the results from the ANOVA, the researcher concluded that a significant difference exists between the perceptions of how KM supports the CI process over time. The responses obtained show a significant difference between the initial perceptions of how KM affects the sustainability of CI and perceptions after one year. The results for this test are shown in Table 55.

Table 55. ANOVA results for perceptions KM construct at Company A

Ho	P-value	Result
H_o: $KM_{A1} = KM_{A2}$	0.5031	Accept H_0
H_o: $KM_{A1} = KM_{A3}$	0.5135	Accept H_0
H_o: $KM_{A1} = KM_{A4}$	0.0065	Reject H_0
H_o: $KM_{A2} = KM_{A3}$	1.0000	Accept H_0
H_o: $KM_{A2} = KM_{A4}$	0.9119	Accept H_0
H_o: $KM_{A3} = KM_{A4}$	1.0000	Accept H_0

The perception of KM decreases over time at company B. At Time 1, the average is 3.77 and at Time 4 the average decreased to 3.54. These results are shown in Figure 32.

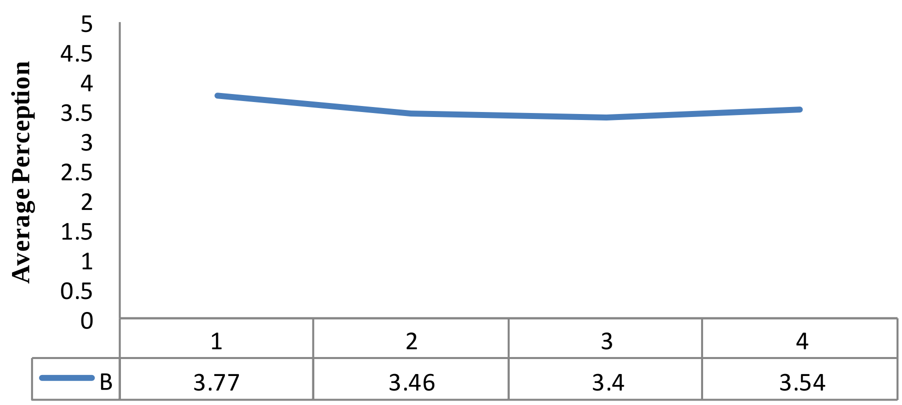

Figure 32. Perception of Strategic Planning at Company B

Although a decreasing trend is observed, these changes do not show a significant difference. According to the interviews conducted, this similar perception on how KM is important to sustain the CI might be caused by the stability of the program inside the company. However, as one of the managers interviewed stated, the lack of novelty in the

CI process might be holding the company from seeing information and knowledge management as crucial to sustain CI. The results for this test are shown in Table 56.

Table 56. ANOVA results for perceptions KM construct at Company B

Ho	P-value	Result
H_o: $KM_{B1} = KM_{B2}$	1.0000	Accept H_0
H_o: $KM_{B1} = KM_{B3}$	1.0000	Accept H_0
H_o: $KM_{B1} = KM_{B4}$	1.0000	Accept H_0
H_o: $KM_{B2} = KM_{B3}$	0.9998	Accept H_0
H_o: $KM_{B2} = KM_{B4}$	0.9998	Accept H_0
H_o: $KM_{B3} = KM_{B4}$	1.0000	Accept H_0

At Company C, values ranged between 3.7 and 3.59; there is significant change in Time 3 where the perceptions decrease to 2.95. These results are shown in Figure 33.

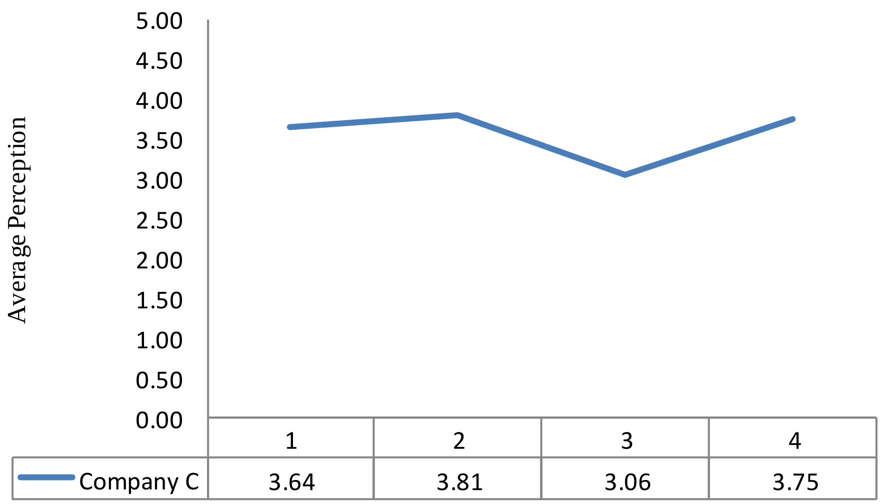

Figure 33. Perception of Strategic Planning at Company C

According to the interviews conducted, the significant difference might be caused by the reduction of CI activities in the period where Observation 3 was taken. However, this reduction was part of the implementation of a new measurement system, which was running by the time Observation 4 was taken. This new information management system allows the company to obtain process performance data in real time. This new system to manage information also might be the reason that perceptions of KM as a critical element to sustain CI increased to a similar value as was measured before the implementation. Table 57 shows the results for this ANOVA.

Table 57. ANOVA results for perceptions KM construct at Company C

Ho	P-value	Result
H_o: $KM_{C1} = KM_{C2}$	1.0000	Accept H_0
H_o: $KM_{C1} = KM_{C3}$	<0.0001	Reject H_0
H_o: $KM_{C1} = KM_{C4}$	1.0000	Accept H_0
H_o: $KM_{C2} = KM_{C3}$	<0.0001	Reject H_0
H_o: $KM_{C2} = KM_{C4}$	1.0000	Accept H_0
H_o: $KM_{C3} = KM_{C4}$	<0.0001	Reject H_0

The perceptions on Strategic Planning within Company D showed very similar values, and there is no change from Time 1 to Time 4. These results are shown in Figure 34.

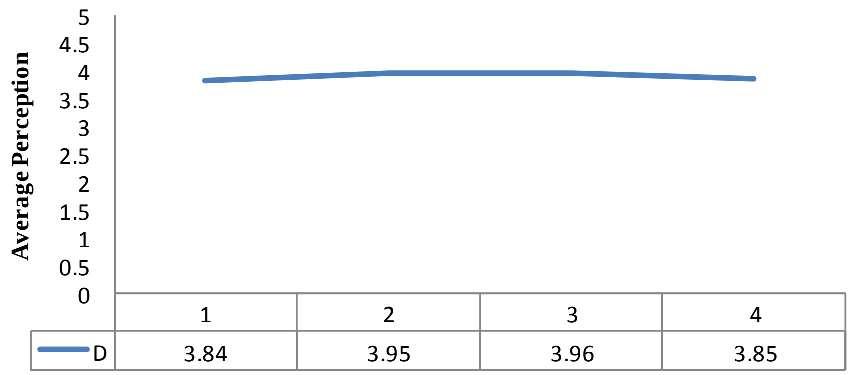

Figure 34. Perception of Strategic Planning at Company D

Based on the statistical analysis, the low change observed in the values also means no significant difference on how associates perceive the contribution of KM construct to sustain CI. These results are shown in Table 58.

Table 58. ANOVA results for perceptions KM construct at Company D

Ho	P-value	Result
H_o: $KM_{D1} = KM_{D2}$	0.9714	Accept H_0
H_o: $KM_{D1} = KM_{D3}$	1.0000	Accept H_0
H_o: $KM_{D1} = KM_{D4}$	1.0000	Accept H_0
H_o: $KM_{D2} = KM_{D3}$	0.9977	Accept H_0
H_o: $KM_{D2} = KM_{D4}$	0.9999	Accept H_0
H_o: $KM_{D3} = KM_{D4}$	1.000	Accept H_0

d. Performance Measurement

Within Company A, the PM construct shows an increasing trend over time. Initially, perceptions of PM indicated that associates neither agreed nor disagreed, but at the end of the observation period, respondents agreed on PM as a construct to sustain CI. These results are shown in Figure 35.

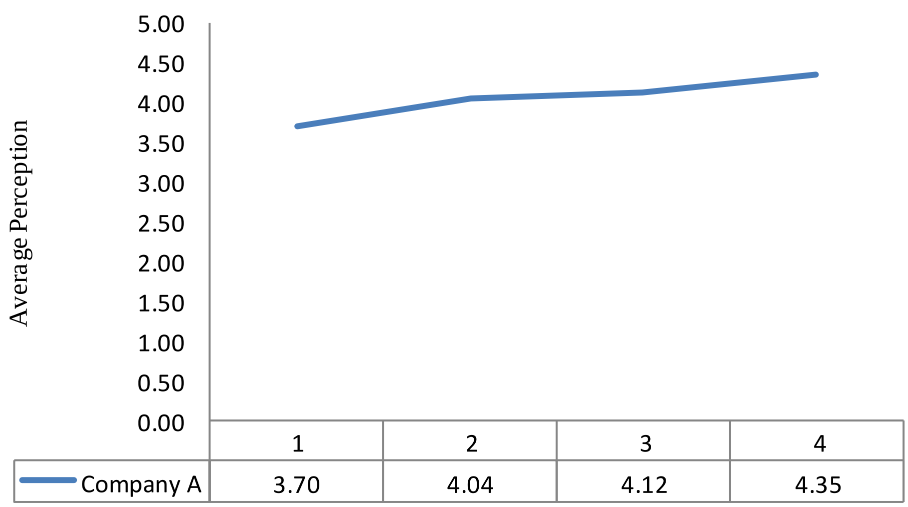

Figure 35. Perception of Performance Measurement at Company A

According to the ANOVA test conducted on the perceptions on PM construct, it was found that although a change is observed, this change is not statistically significant over time. The results for this test are shown in Table 59.

Table 59. ANOVA results for perceptions PM construct at Company A

Ho	P-value	Result
H_o: $PM_{A1} = PM_{A2}$	0.9668	Accept H_0
H_o: $PM_{A1} = PM_{A3}$	0.9960	Accept H_0
H_o: $PM_{A1} = PM_{A4}$	0.5117	AcceptH_0
H_o: $PM_{A2} = PM_{A3}$	1.0000	Accept H_0
H_o: $PM_{A2} = PM_{A4}$	0.9997	Accept H_0
H_o: $PM_{A3} = PM_{A4}$	1.0000	Accept H_0

In the analysis performed to isolate the PM construct within Company B, it was observed that perceptions on how PM sustains CI over time are very similar. The value observed in Time 1 is 3.77 and the value observed at Time 4 is 3.74, which shows a minimal change of responses. These results are shown in Figure 36.

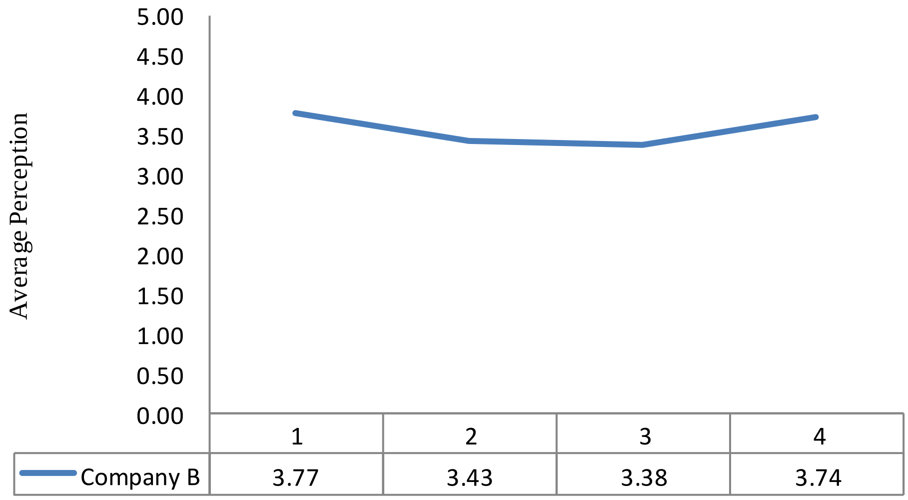

Figure 36. Perception of Strategic Planning at Company B

When conducting ANOVA on these values, the researcher found that there is no evidence to consider this change statistically significant. This also can be interpreted as no effect of time on the perceptions of PM as a contributing construct of the CI process. The results for this test are shown in Table 60.

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Table 60. ANOVA results for perceptions KM construct at Company B

Ho	P-value	Result
H_o: $PM_{B1} = PM_{B2}$	0.9782	Accept H_0
H_o: $PM_{B1} = PM_{B3}$	0.9933	Accept H_0
H_o: $PM_{B1} = PM_{B4}$	1.0000	Accept H_0
H_o: $PM_{B2} = PM_{B3}$	1.0000	Accept H_0
H_o: $PM_{B2} = PM_{B4}$	0.9993	Accept H_0
H_o: $PM_{B3} = PM_{B4}$	1.0000	Accept H_0

At Company C, values ranged between 3.69 and 3.82. The lowest value is observed at Time 3 with an average rate of 3.13. These results are shown in Figure 37.

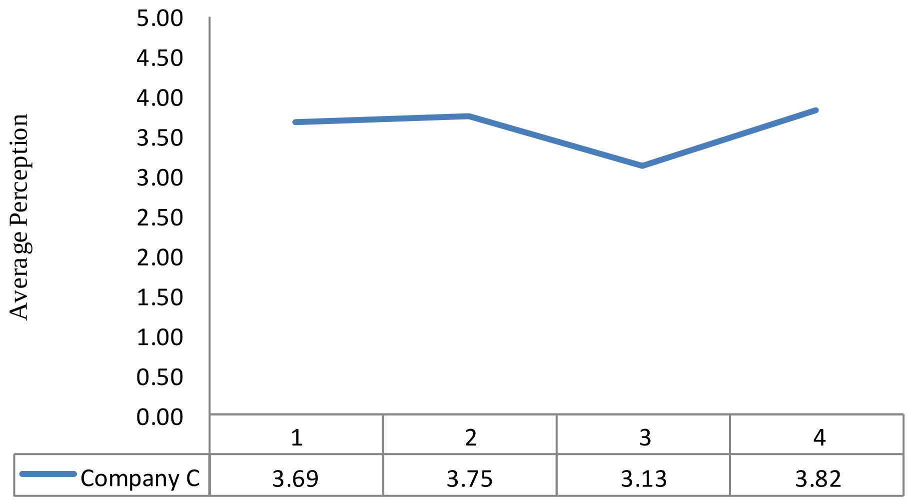

Figure 37. Perception of Strategic Planning at Company C

According to the results from the ANOVA, the researcher found that there is enough evidence to conclude that the value observed in Time 3 is different from those perceptions observed at Times 1, 2 and 4. This significant change might originate in the lack of CI initiatives due to the implementation of the new plant-wide measurement system. Table 61 shows the results for this ANOVA.

Table 61. ANOVA results for perceptions PM construct at Company C

Ho	P-value	Result
H_o: $PM_{C1} = PM_{C2}$	1.0000	Accept H_0
H_o: $PM_{C1} = PM_{C3}$	0.0316	Reject H_0
H_o: $PM_{C1} = PM_{C4}$	1.0000	Accept H_0
H_o: $PM_{C2} = PM_{C3}$	0.0187	Reject H_0
H_o: $PM_{C2} = PM_{C4}$	1.0000	Accept H_0
H_o: $PM_{C3} = PM_{C4}$	0.0042	Reject H_0

Within Company D, perceptions of PM as a contributor construct to sustain CI shows a little change over time, increasing from 3.40 at Time 1 to 3.42 at Time 4. These results are shown in Figure 38.

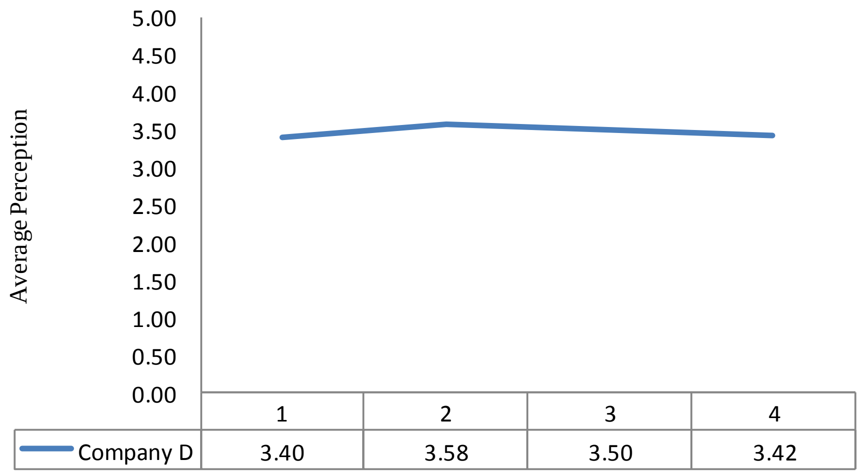

Figure 38. Perception of Strategic Planning at Company D

Based on statistical analyses conducted for these values, no statistical significance was found for the observed change of the response rate. These results are shown in Table 62.

Table 62. ANOVA results for perceptions PM construct at company D

Ho	P-value	Result
H_o: $PM_{D1} = PM_{D2}$	0.9999	Accept H_0
H_o: $PM_{D1} = PM_{D3}$	1.0000	Accept H_0
H_o: $PM_{D1} = PM_{D4}$	1.0000	Accept H_0
H_o: $PM_{D2} = PM_{D3}$	1.0000	Accept H_0
H_o: $PM_{D2} = PM_{D4}$	1.0000	Accept H_0
H_o: $PM_{D3} = PM_{D4}$	1.0000	Accept H_0

e. Longitudinal Analysis of Sustainability

Within Company A, the S construct showed an increasing trend over time. However, the average response rating shows constant agreement of S as a construct contributing to sustain CI. These results are shown in Figure 39.

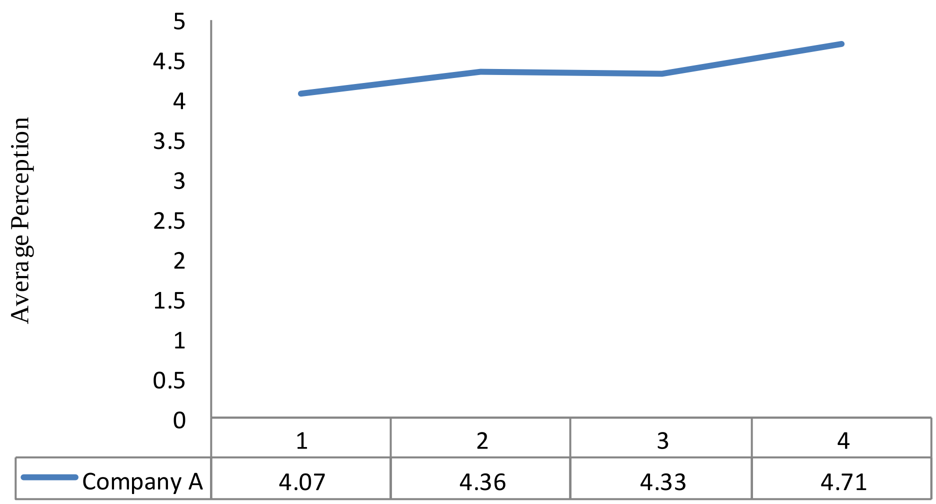

Figure 39. Perception of Sustainability at Company A

The results from the ANOVA test conducted indicate that the change in the average response for S is not significant over time. The results for this test are shown in Table 63.

Table 63. ANOVA results for perceptions PM construct at Company A

H_0	P-value	Result
H_o: $S_{A1} = S_{A2}$	0.9940	Accept H_0
H_o: $S_{A1} = S_{A3}$	1.0000	Accept H_0
H_o: $S_{A1} = S_{A4}$	0.5585	Accept H_0
H_o: $S_{A2} = S_{A3}$	1.0000	Accept H_0
H_o: $S_{A2} = S_{A4}$	0.9989	Accept H_0
H_o: $S_{A3} = S_{A4}$	0.9999	Accept H_0

Based on the average response rate obtained for SI construct at Company B, a decreasing perception on how SI contributes as a success construct to sustain the CI process was observed. These results are shown in Figure 40.

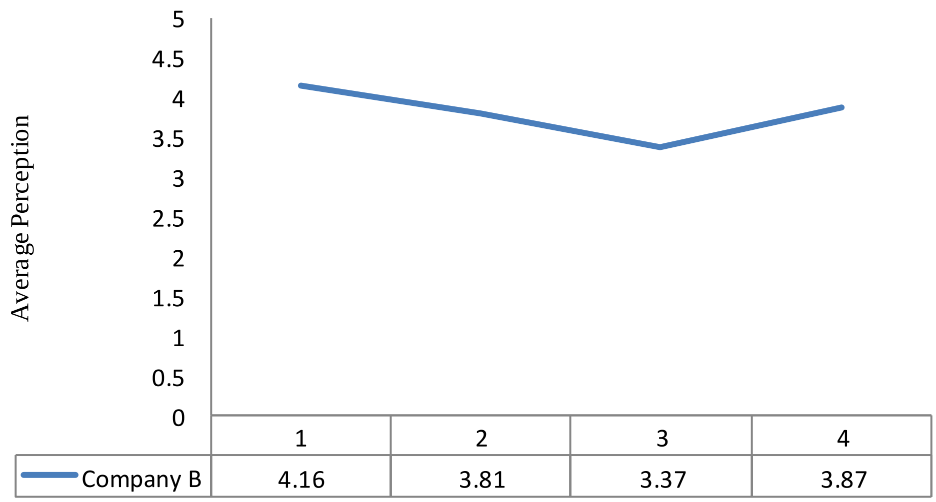

Figure 40. Perception of Sustainability at Company B

Although a change is observed, after running the ANOVA analysis, is the researcher concluded that there is no evidence indicating that these changes were statistically significant over time. The results from the ANOVA test are shown in Table 64.

Table 64. ANOVA results for perceptions S construct at company B

H_0	P-value	Result
H_0: $S_{B1} = S_{B2}$	0.9617	Accept H_0
H_0: $S_{B1} = S_{B3}$	0.2712	Accept H_0
H_0: $S_{B1} = S_{B4}$	0.9995	Accept H_0
H_0: $S_{B2} = S_{B3}$	0.9691	Accept H_0
H_0: $S_{B2} = S_{B4}$	1.0000	Accept H_0
H_0: $S_{B3} = S_{B4}$	0.9781	Accept H_0

Within Company C, the average response rate shows a small change over time. The average response rate is 4.07 at Time 1, decreases to Time 2 and 3, and increases again during the last observation to 3.9. These results are shown in Figure 41.

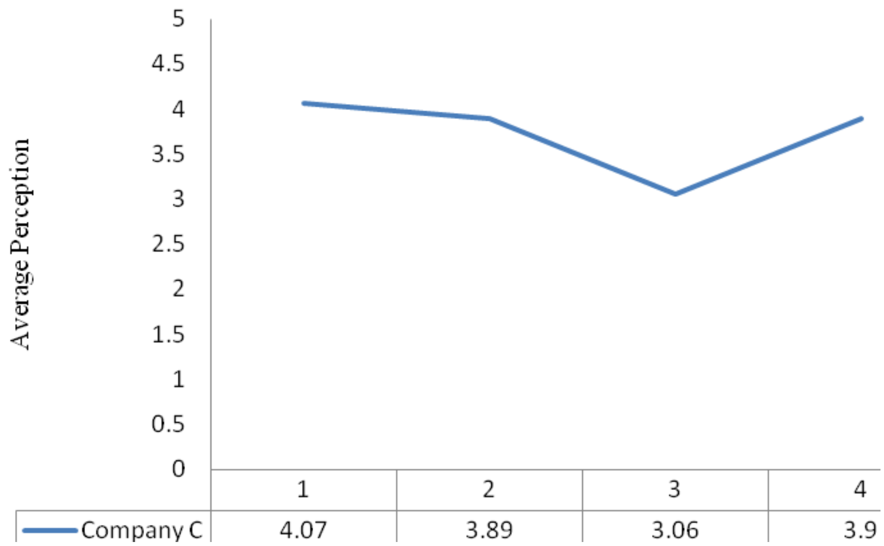

Figure 41. Perception of Sustainability at Company C

Based on the ANOVA conducted, the change that occurred in Time 3 was significanlty different from the remaining observations. As explained in the previous constructs, Company C was experiencing the implementation of a plant-wide measuremnt system which might have caused the perception of respondents to be lower. The results from this analysis are shown in Table 65.

Table 65. ANOVA results for perceptions S construct at Company C

H_0	P-value	Result
H_0: $S_{C1} = S_{C2}$	0.9873	Accept H_0
H_0: $S_{C1} = S_{C3}$	<0.0001	Reject H_0
H_0: $S_{C1} = S_{C4}$	0.9924	Accept H_0
H_0: $S_{C2} = S_{C3}$	0.0090	Reject H_0
H_0: $S_{C2} = S_{C4}$	0.9750	Accept H_0
H_0: $S_{C3} = S_{C4}$	1.000	Accept H_0

For Company D, the average response rate for the S construct shows a little change over time. At Time 1, the value for the average response rate is 3.35, while at Time 4 the value decreases to 3.15. Figure 42 shows the data corresponding to the average response rate for S at Company D.

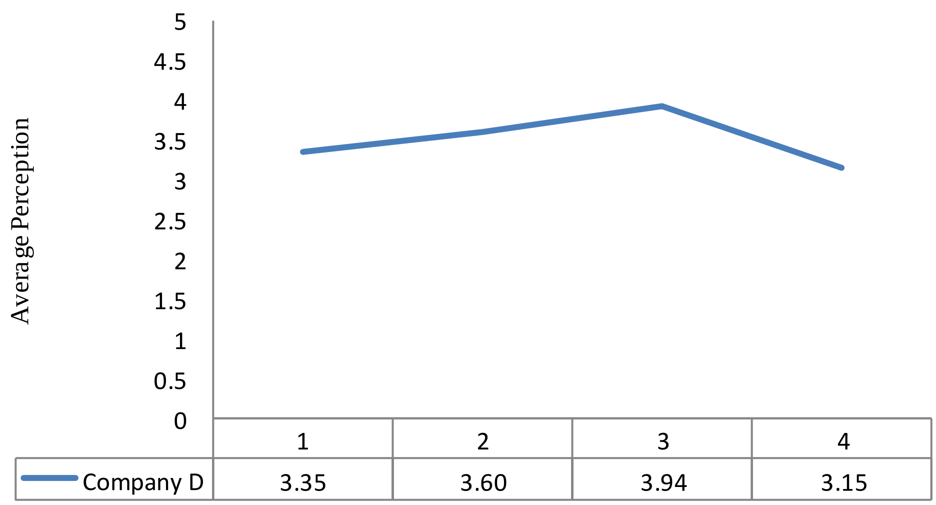

Figure 42. Perception of Sustainability at Company D

The results from the ANOVA test are shown in Table 66. These results indicate that the change observed for the average response within company D is not significantly different; therefore, the respondents' perceptions remained the same over time.

Table 66. ANOVA results for perceptions S construct at company D

H_0	P-value	Result
H_0: $S_{D1} = S_{D2}$	0.9950	Accept H_0
H_0: $S_{D1} = S_{D3}$	0.9750	Accept H_0
H_0: $S_{D1} = S_{D4}$	1.0000	Accept H_0
H_0: $S_{D2} = S_{D3}$	1.0000	Accept H_0
H_0: $S_{D2} = S_{D4}$	0.9868	Accept H_0
H_0: $S_{D3} = S_{D4}$	0.9040	Accept H_0

6.4.2. Analysis of Correlation

To determine the existing relationship among the constructs and how they affect CI sustainability, the following research hypothesis was developed:

H_0: Constructs have a positive and direct effect on sustainability of the CI

This testing was performed using the CORR procedure in SAS. The data was entered using the scores obtained for each construct. The results of the correlation analysis are shown in table 67.

Table 67. Result of Pearson Correlation Coefficients between constructs

Construct	SP	CM	KM	PM	SI
SP (F1)	1.00	0.79 <0.0001	0.79 <0.0001	0.64 <0.0001	0.64 <0.0001
CM (F2)			0.75 <0.0001	0.73 <0.0001	0.65 <0.0001
KM (F3)				0.68 <0.0001	0.59 <0.0001
PM (F4)					0.63 <0.0001
SI (F5)					1.00

According to these results, variables have a strong correlation between them, which was expected. These results also indicate that CM, SP, KM and PM contribute to building the sustainability of the CI process directly and strongly. The Figure 43 also shows the scatter plot matrix where these correlations can be observed.

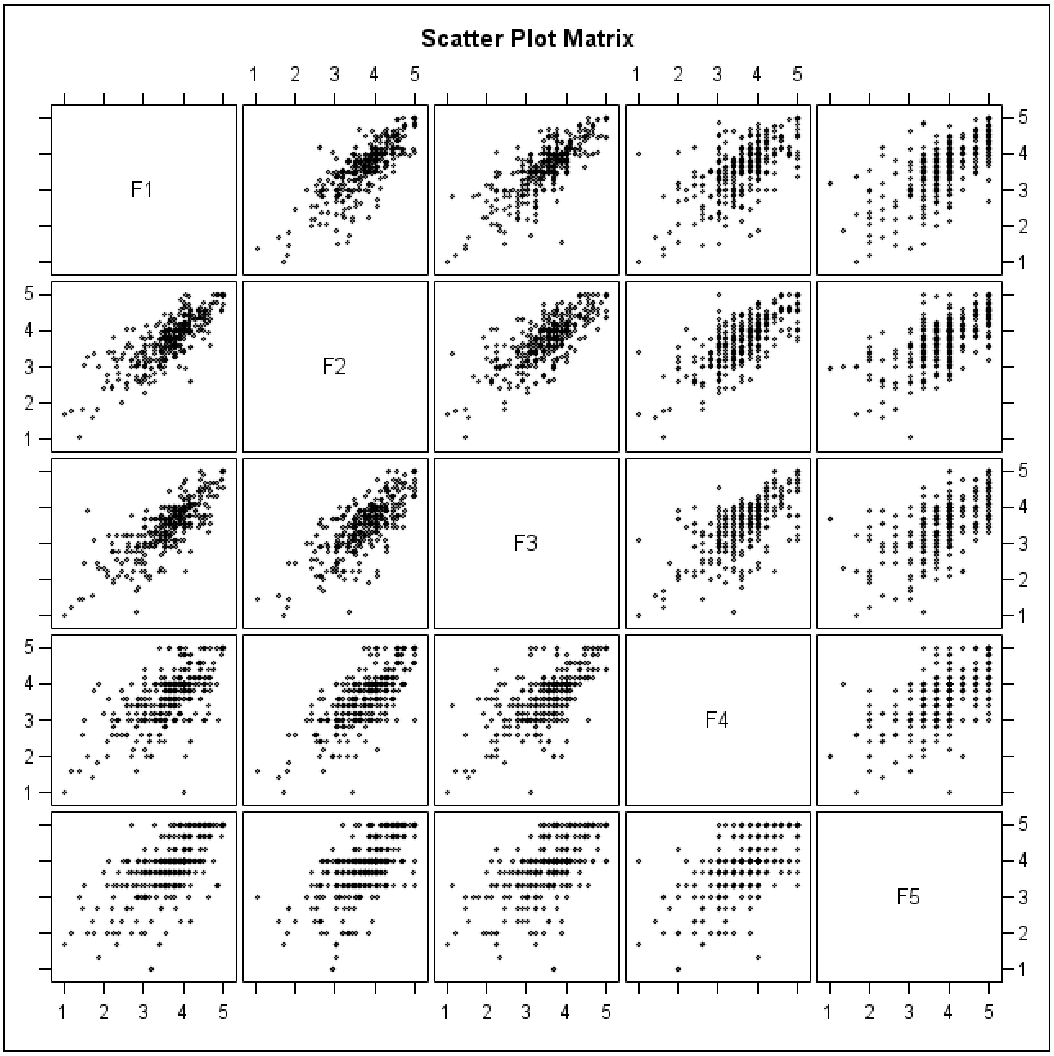

Figure 43. Scatter Plot Matrix

The results from the correlation analysis demonstrate the importance of SP as a construct to support CM. This is well recognized by authors such as Steiner *et al*. [30] who state that SP helps to preserve time and energy by directing organizational efforts into a designed and proactive CI plan rather than a merely reactive and disorganized response. By supporting CM, PM is also implicitly supporting KM since dynamics of knowledge, as mention by Drucker [31], requires that every organization has to build a CM structure led by managers and top executives. As indicated by Zastrow & Kirst-Ashman [32] SP and PM are linked so that information about improvement opportunities must be gathered, analyzed and interpreted in order to make effective decisions and proactively avoid failure of CI structures. Finally as cited by Bryson, Gibbons & Shayne [33] enterprises should be led by managers who always promote coherent and self-sustaining practices, such as CI, in addition to the competences and skills required to perform tasks and support growth in the organization.

CM also shows important correlations with the identified constructs to sustain CI. The observed results from the correlation analysis are also supported in the literature. As the literature indicates, CI is a never-ending cycle of change that provides useful knowledge promoting learning which is hard to copy from other organizations [34]. CM is also linked to PM, since PM aims to capture the effectiveness of the changes promoted through CI implementation and reflected as goals throughout the organization [35]. The KM construct shows evidence of existing links with the PM construct as well. This relationship is also considered in the literature where authors such as Heckl, Jürgen and Rosemann [36] indicate that a successful CI program is linked to a comprehensive system with adequate knowledge to produce transparent and measurable process metrics.

6.5. Discussion of Results

This chapter was developed to analyze the CI sustainability using three contexts: time, region, and type of industries. In order to do that, the study performed an analysis using a mix of methods to deliver quantitative and qualitative valid conclusions.

Various studies available in the literature represent longitudinal analysis of CI. Mitki, Shani & Meiri [37] evaluated how learning structure mechanisms impact continuous improvement over time in a single case study. This study was mainly a quantitative study, using a limited amount of descriptive statistics to characterize production and waste reduction ratios. Marin-García, Pardo del Val & Bonavía Martín [4] conducted a eighteen months research to evaluate how several CI initiatives were conducted in a single company. Results from this study are merely qualitative, and statistical significance of the effect of the events on the sustainability of the initiatives was not delivered as part of findings. Taylor & McAdam [38] conducted an exploratory multiple case study in the hotel management sector to evaluate various improvement methodologies. Through this study, the authors were able to qualitatively analyze and compare business management practices towards improvement. Lastly, a fourth purely qualitative study conducted by Savolainen [1] was able to characterize how industries are renewed by adopting quality management ideologies. As noticed from previous examples, the mix of qualitative and quantitative analysis to longitudinally observe CI is limited. Therefore, the contributions from this work strength this area of study.

6.5.1. Analysis of Constructs Per Company

The test conducted on the constructs enabled the identification of different behaviors based on the company type. The first finding is related to the change management factor. McAdam, Stevenson & Armstrong [39] state that CI involves several constructs which are not easily identified or defined, but are constantly changing. This is reflected in the average response from all participating companies, which showed an average response close to agreement with CM as a contributing factor to sustaining CI.

As cited in the literature, this constant change can only be successfully managed within a structure that shows ownership at every level since CI is not a change management philosophy itself, but brings an enormous quantity of change [40]. This finding clearly reflects what literature has previously claimed. The results indicated that Companies A and B which belong to highly regulated industries requiring protocols for changes in processes, showed higher mean responses (3.80 and 3.89). Companies C and D, which belonged to a much less regulated industry, showed lower average responses (3.57 and 3.47 correspondingly).

The strategic planning factor refers to the structure developed to help manage the CI process. This structure involved a defined mission and tool to assess the current status of CI to build goals for the mid- and long-term. The researcher observed that Company A shows the strongest perception of how the SP factor contributes to sustaining CI. This highest average response rate (4.07) might be caused by an intensive program to include CI initiatives in the company. This intensive plan has been developed by a group of new managers (less than three years in the company) who pointed out CI as the orienting goal. This intensive plan includes regular meetings, such as daily start-up meetings with the manufacturing floor personnel, as well as monthly meetings with the site personnel to communicate the different goals and their progress. These meetings also enable the supervisor and managers to connect and explain the relationship between the targets and the ongoing projects to meet them. Contrary to this situation, Company C (wood products industry) showed the lowest rank of SP as a contributor to sustaining CI. According to results from the questionnaires and interviews conducted, managers are not likely to communicate plans and how this will affect the CI initiatives. During the observations taken at Time 3, the researcher observed how respondents were resistant to the implementation of the new measurement system, and how they were unaware of the connection between this project and the CI process. Some of the statements from the respondents included phrases such as *"they do not tell us much of what is going on."* This lack of connection might be the cause behind this gap.

The third factor is knowledge management. The findings show that Company B and Company C show a lower perception of how KM supports the CI process (average response of 3.49 and 3.45 correspondingly). Meanwhile, Company A showed an average response of 3.52 and company D of 3.72. Although the numerical difference was not considered a large difference, there was a statistical significance among Companies B and C, and Companies A and D. Based on the interviews and site visits, the researcher observed that information was transformed into knowledge for employees at Companies A and D. These companies use information display boards as well formal meetings with the management team to transmit the status of the process but also lessons learned from current experiences. At Companies B and C, a formal process of communication that covers the entire site was not observed; however, a formal training system was developed for all employees. This formal training system lacks lessons learned from previous experience, but is robust in techniques such as root-cause identification. This methodology that converts past experiences into learning opportunities might be related to why Companies A and D show a stronger perception of KM as a contributing factor of the CI process.

The performance measurement (PM) factor shows the highest perception as a contributor to sustaining the CI process among all the participating companies. Company A (average response 4.05) is part of an industry regulated by the Food and Drug Administration

(FDA). The FDA defines a set of standards known as good manufacturing practices (GMPs). The GMPs establish a chapter that imposes strict control over the design, manufacturing, and distribution of products. These controls clearly specify the use of standards of operations and any other methods that define and control the manner of production [41]. The requirement of measurement and control tools to oversee the manufacturing might contribute to increasing the perception of respondents on how PM acts as a factor supporting CI sustainability. This finding is supported by previous literature that indicates operating standards requested from regulatory parties are influencing the creation of more CI approaches within the processes. This condition was also observed in the average response rates in Companies B and C. These companies do not operate under regulated environments and showed lower average responses (3.50 and 3.60, respectively). Although Company D belongs to a regulated industry (health care providers), this industry displayed a lower average response (3.48). This might be caused by the novelty of CI in this industry to increase performance as recognized by authors in the literature [42, 43].

The last factor is sustainability (S). This factor was used to evaluate what activities are strongly related to support CI sustainability. According to the results, respondents from Company A (average response rate of 4.23) indicated that long-term plans of initiatives, such as Kaizen events, are fundamental indicators of CI sustainability. However, Companies B, C and D showed a lower average response rate (3.87, 3.77 and 3.46) regarding the measurement of CI sustainability through these indicators. Although the values from Companies B, C and D are lower than Company A, these values are close enough to indicate an agreement of these statements.

6.5.2. Analysis of Constructs Per Region

Constructs SP, PM and S are different between Region 1 and Region 2 respondents. Among the possible causes for these differences is the observed leadership, mainly in Company A (Region 1). As many authors such as Brown *et al.* [44] suggest, leadership is critical for the success of any strategic plan. The strategic plan is where goals and expectations are set, and from which indicators are drawn. The observed style of leadership included continuous revision of objective progress, as well a high sense of responsibility for the CI process from each manager. Also, the structure observed in Company A and B (both from Region 1) designates a job position that oversees the CI performance. This CI leader in both cases is part of the management group and attends the management meeting on a weekly basis. This assistance enables all members of the management team to discuss the CI status on a regular basis and request actions to each department from top-down.

Also, another cause that might impact how regional context affects these three constructs is the relationship between pay and performance. Based on the interviews conducted, the annual raises and bonuses are directly linked to the results achieved for each objective. In the manufacturing department, which represents the largest source of responses, the percentage of the salary raise is defined based on how many indicators were achieved, and the annual bonus is based on the extra savings generated from the over achievement of the goals.

Companies C and D follow a different procedure to set salaries. At Company C, salaries have been increased an average of 2%, regardless of the performance. A similar situation is observed at Company D where much of the work done towards CI is neither linked to performance nor salary raises.

6.5.3. Longitudinal Analysis of Constructs

Regarding the analysis of constructs over time, the researcher observed that for most of the companies, time did not show an effect on how respondents perceived the contribution of the constructs towards the sustainability of CI.

Although no differences were observed in the majority of the cases, Company C showed different results. The constructs under study were significantly different between Time 3 and Time 1, 2 and 4 in the majority of the observations.

When conducting interviews, the researcher observed that during Time 3, Company C was undergoing a major change in the process of performance control and measurement.

This major change included the installation of a new plant wide system that collects data for process performance control at every working station. During this implementation, activities such as Kaizen events and CI projects were put on hold. In a few questionnaires, respondents expressed their discomfort with how communication was handled by stating phrases such as *"they don't tell us much of what is going on here."* This lack of information about the new system and how it was a major CI process might be the cause behind the decrease in perceptions. By the time the last questionnaires were administered, the project was already implemented and in used. The average response from observations taken at Time 4 showed a significant increase compared to observation from Time 3.

Company A also showed a different behavior. According to the observations made from Time 1 to Time 4, average response increased significantly. The main observed cause for this change is the merging of small and gradual CI initiatives and a continuous training plan. According to Swieringa, Weidrsma & Wokingham [45] and Bessant et al. [46], developing training plans with experiential learning through CI initiatives is critical for developing training plans with experiential learning through CI initiatives is critical for establishing a learning organization. This learning organization is synonymous with successful CI implementation and can be accomplished through cultural changes over short time periods, such as one year as demonstrated in this study.

6.5.4. Analysis of Correlations

Finally, this chapter emphasizes how the identified constructs are interrelated. The results enable practitioners with a holistic approach to sustain CI, since they demonstrate that in addition to impacts on CI sustainability, constructs also influence each other.

This finding leads the study to conclude that, for firms to successfully achieve CI, continuous improvement should respond to a strategic plan defined by top-level managers. This strategic plan must be linked to strategic and operational goals to ensure that actions are being taken to pursue CI as strongly suggested by Swinehart, Miller & Hiranyavasit [47] and Elmuti & Kathawala [48], among others. The results of the correlation analysis also suggest that knowledge management and change management are related. Knowledge management can educate employees to help them understand why change is required, and how this change will contribute to success through lessons learned both internally and externally. Knowledge management is also related to performance measurement since employees will acquire the necessary skills through training to achieve the new set goals, and will develop experiences that will become knowledge for the organization.

Another important identified relationship is change management and performance measurement; change needs to be tracked and evaluated to ensure that taken actions are actually contributing toward the defined CI goals. This finding is also reflected in the relationship observed between strategic planning and change management, which must support each other to reach the targets.

Lastly, the overall relationships identified help practitioners to understand that CI is a complex process which requires attention in various dimensions. The current proposed and validated framework brings a more straightforward model to support and sustain CI. This study summarized in fewer, yet valid, constructs as compared to previous work done by authors such as Bessant [49] and Upton [50], who developed frameworks using different levels and several constructs, which can be time consuming for managers and CI leaders.

6.6. Conclusions

From the previous discussion of results, the researcher is able to summarize the main conclusions below.

- The results provide enough evidence to conclude that time has no effect on CI sustainability. However, events like interruption of CI activities are perceived by employees within short periods of time. This can have an adverse effect on efforts to sustain CI if any change is not properly communicated and embraced by workers.

- Companies from the medical device manufacturing and healthcare sector are ruled by strict standards which identify and disseminate improvement strategies systematically, unlike the chemical and wood products manufacturing which are not as regulated. This might be a contributing element reflected in higher scores for strategic planning as a success factor to support CI in Company A and Company D.

- The wood products industry demonstrated a lower perception of knowledge management as a contributor to sustain CI. This finding is reflected in the reluctance of this industry to learn, adopt and capitalize knowledge.

- Regional context has an effect on how SP, PM and S constructs are believed to support CI. This difference might be influenced by how companies reward employees' efforts towards CI. The participating companies located outside the US tie CI goal performance to salary increases and end-of-the-year bonuses while the participating companies located in the US do not follow this practice. This, as mentioned by the CI leader in company D, makes some metrics harder to reach than to metrics directly associated with financial retributions.

- Finally, this study can conclude that combining previous frameworks in a model with five constructs can offer managers a simplified version to sustain CI with the same information.

6.7. References

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7. Contributions, Limitations and Opportunities for Future Research

Current frameworks to sustain CI may be expensive, some have not been applied widely and evaluated in a real setting, and others are focused on a specific CI methodology. This study contributes a research framework that was applied to a real setting and created a less complex framework that includes all the elements previously identified in the literature. Also, the study complements the research framework with a self-assessment questionnaire that allows practitioners to follow up with construct performace over time. This would involve a low cost investment since the tool is designed to be administered by firms without the need for external consulting. Finally, the frameworks proposed are not tied to any specific CI methodology; therefore, the framework can be applied and measured with any type of CI initiative.

This chapter summarizes other contributions of this study and provides a list of recommendations for industry practitioners, especially for the wood products industry, which has demonstrated an urgent need for improvement to become profitable and sustainable, and to highlight new opportunities for future research for academics.

7.1. Contribution to Innovation Management Practices

The wood products industry is, as many industries are, facing a fast-paced, evolving world. This culture results in an urgent need to find ways to improve performance. To help the wood products industry to sustain profitability, the study developed previous research to understand how innovation could be applied in the industry. This previous research conducted a multiple case study within industries from innovative and non-innovative manufacturing sectors to establish a set of standard management practices that lead toward successful innovation. The findings of this study revealed that innovative industries have four common innovation management practices:

- Include innovation as a strategic objective systematically deployed across all levels of the organization.

- Define a methodology to develop innovation, standardizing the process of collecting ideas and the process of evaluating the development of these ideas in the innovation pipeline.
- Establish cooperative initiatives with research centers, such as universities. In this way, industries have access to the latest research, support the education of hi-tech professionals and reduce research and development costs.
- The use of CI to support creativity and innovativeness.

These findings clearly identify research opportunities to support innovation, and ultimately help industries to remain profitable, such as the wood products industry. Figure 44 shows the proposed framework to achieve innovation.

Figure 44. Innovation management practices

7.2. Contributions to Continuous Improvement Sustainability

Building upon the previous research on innovation management practices, this study focused later on supporting CI sustainability based on the strong relationship recognized between CI and incremental innovation.

7.2.1. Continuous Improvement Sustainability Framework

Initially, the research framework included a total of seven constructs operationalized through 60 items. Validation of the proposed framework was performed and results showed that the new research framework contained 5 constructs and 50 operationalized measures. These constructs are: (1) strategic planning, (2) change management, (3) knowledge management, (4) performance measurement, and (5) CI sustainability. These findings are similar to the literature available, including authors like Cassell [1] who identified the lack of involvement, commitment, and resource allocation as the main barriers to overcome to reach CI sustainability.

Other authors such as Fryer, Jiju & Douglas [2] also suggest the importance of elements identified in the strategic planning construct in this study. These authors argue that a strong and committed leadership is required to sustain CI in the long run. Nilsson-Witell, Antoni & Dahlgaard [3] also recommend that managers are responsible to lead the CI process; however, employees must be included with defined and clear goals.

Knowledge management is often described as education and training in the literature. Gieskes & Ten Broeke [4]emphasize the strong relationship between a learning organization and successful CI-oriented firms, particularly bringing knowledge as well as creating knowledge from past experiences. Regarding performance measurement, the findings from this study clearly recognized that CI goals need to be measured. The results obtained from improving initiatives need to be quantified and diffused through the firm. This finding is also supported by authors such as Leonard [5] and Atkinson [6] who highly recommend the use of a structured measurement mechanism that raises awareness of management and employees regarding progress of CI, and the opportunities where different courses of action need to be taken. In terms of sustainability, Cassell [1] is very clear in stating that sustainability is represented by the achievement of goals; therefore, continuous achievement of simple indicators such as supplier performance, customer performance, and internal performance can describe a sustainable CI process.

This research presents an empirical effort to analyze the sustainability of the CI process considering time and regional dimensions. This research aimed to 1) identify the constructs that affect the sustainability of the CI process according to the literature, 2) validate the theoretical model developed, 3) evaluate the effect of time on the identified constructs, 4) evaluate the effect of regional context on the identified constructs, and 5) develop a tool to measure the constructs that affect the sustainability of CI. Few studies have validated the proposed theoretical framework with a longitudinal evaluation of constructs in different regions. Based on the responses from 352 participants within four different companies, this study contributes to our knowledge of CI in a number of ways.

First, the study developed a validated framework that identified five main dimensions to sustain the CI process. This framework provides a solid foundation for practitioners and the academy in terms of is the factors driving CI. Also, based on the data gathered through interviews and site visits, the study developed a set of recommendations for each supporting construct to achieve CI sustainability.

Strategic Planning. This construct is highly critical. At this level, companies explicitly express their commitment to pursuing CI in order to meet customers' requirements, while also remaining profitable. Thus, making CI part of the strategic plan will ensure resources are allocated all over the organization. In addition, top-down goals will be oriented to achieve CI initiatives. A second recommendation, especially for those who perform supervisory roles such as CEOs, managers, and supervisors is to serve as a role model for the CI philosophy. Continuous evaluation of metrics performance and direct involvement in identifying improvement opportunities and developing solutions is required to permeate CI into the organizational culture. Finally, a clearly defined structure that identifies CI leaders is needed. Although CI is every employee's responsibility, identifying a leader (usually the Manufacturing Director, according to the observations made) allows CI performance to be tracked by the top management level and defines required action to be taken to improve efficiency.

Change Management. This construct is vital to supporting CI. The need to meet customers' requirements is the direct cause for the implementation of change. Therefore, this direct link must be explicitly relayed to workers. When workers do not see a connection between the need and the methods, there is a high resistance to taking steps in a new direction. When deciding to pursue CI, firms must know that change becomes constant within the firm, thus resources such as company-wide meetings, company bulletins, and weekly staff meetings should become a setting to discuss current and future change. Change can result in fear, and workers want to feel safe; therefore, flow of information becomes crucial. Another observed practice benefiting change management is the reward of reached goals. Recognition of positive performance will raise awareness of positive results and increase the willingness to be part of a success story.

Knowledge Management. Knowledge must become an organization asset. Knowledge can be introduced in the organization through training, but also can be collected as lessons learned. As training, knowledge helps the organization acquire the desired skills to implement CI. Done in a continuous manner, training will ensure that the organization has access to latest improvement tools and techniques. Also, CI must become a required skill on every employee's development plan to perform their job effectively. As lessons learned, knowledge offers multiple benefits. Among the benefits is a *"knowledge pot"* sharing proven successful initiatives and reducing time in problem solving. Finally, a strong suggestion is the fusion of information technologies with education. Interactive training classes can be developed and made available to workers through a web-based company university.

Performance Measurement. Establishing a set of metrics is a foundational suggestion. Organizations that do not follow up on CI performance will not be successful. Moreover, metric boards must be accessible to workers. These metric boards not only will display performance but also list pending actions and responsibilities. This effort clearly defines accountability for the CI process. Employees in supervisory roles, especially at the operational level such as manufacturing floors, are required to follow up on a daily basis on these indicators. This way, everyone knows that delivering results is perceived seriously by the organization. Finally, the last recommendation is to link performance to reward. Even though CI bring benefits to the company, it is important for employees to feel appreciated and to know that all the hard work towards a goal benefit not only the organization, but the employees as well. In Figure 45, this framework and set of recommendations is graphically shown.

Figure 45. CI Sustainability Framework and Management Practices

7.2.2. Self-Assessment Tool: Evaluation Questionnaire

A second contribution of this study is the development of a self-assessment tool in the form of a questionnaire that will enable practitioners to apply the proposed framework and measure current status and progress of the constructs. This tool has been validated through the application of confirmatory factor analysis and exploratory factor analysis.. The use of this assessment tool aims to help practitioners with instrumentation to not only apply the concepts derived from this research, but also evaluate performance of actions taken in the framework constructs and how these actions are translated into sustaining CI. The validated self-assessment tool is provided in Appendix B of this document.

7.3. Contributions to Academia

The first contribution is expanding the body of knowledge in the CI management field. This study provides supporting evidence suggesting time itself does not have an effect on the constructs. Rather, it is the actions, such as the lack of CI initiatives considered over time, which are positively or negatively effecting how constructs contribute to the CI sustainability. This research demonstrates that leadership exercised through strategic planning and accurate evaluation of performance goals (where managers are accountable and associates at every level have the information) results in better perceptions held by employees of the sustainability of the CI process. The results also reveal that there is a component related to economic retribution which, when linked to performance, connects sustainability and the importance of reaching the defined goals.

The second contribution is made to the research field. When developing a study, validity is one of the most important characteristics to ensure a rigorous scientific contribution. Including qualitative and quantitative analysis methods increases validity. Also, the author is interested in providing a causal analysis of the event while also demonstrating that the observed events and effects are qualitatively significant.

7.4. Limitations and Recommendations for Future Research

While the current research contributed important findings to the already existing knowledge of the CI process, it still has some limitations, which are listed below.

Generalizability of Results. The selected methodology (i.e., case study research) observed a contemporary effect in a real setting. Although the responses were statistically validated and the results can be used as a reference for practitioners and academy, the results are not generalizable to all companies. A wider survey to test the developed tool should be considered to describe more generalizable results. To improve generalizability, the researcher recommends applying a survey to collect data and perform a deeper analysis of the constructs and how they impact CI sustainability. For future research, the proposed questionnaire in Appendix B can be used since it has been previously validated through rigorous statistical techniques.

Variables of Study. Although the research empirically tested the effect of time, region and type of companies, the study was also limited to 2 regions, 2 types of industries, and 12 months of analysis. This is understandable considering limited resources associated with doctoral research, such as money and length of the study. However, for a deeper analysis, it is highly recommended that future studies include companies located in several countries to understand additional factors such as politics, media, and economics that may drive CI sustainability. Although change was perceived in short periods (3 month intervals), it is recommended that other researchers develop a longitudinal study that can follow up on long-term CI goals and assess the dynamic nature of a CI strategic plan.

Wood Products Industry. Few firms in the wood products sector implement CI; therefore, future studies for the industry should allocate resources toward supporting CI. A third recommendation is to use the proposed framework in a real scenario, where a company which wants to pursue CI also utilizes the framework and the provided follow up tool periodically to evaluate the implementation process and the sustainability of CI. This future research will add value to the field of wood products business management, and provide opportunities for the industry to grow. This research also can be supported by the guidance of improvement experts, such as the Lean Management group from the Sustainable Biomaterials Department at Virginia Tech.

Diffusion of Findings. The last limitation of the study is regarding to the diffusion of results. Based on the time restriction of a doctoral research work, findings have not been diffused at this time. However, there is an opportunity to develop training workshops on CI and innovation management practices using the findings from this study. Also, translating this dissertation into peer reviewed papers will ensure the research is accessible to industry and academic practitioners. Finally, wood products companies must be targeted in future training processes associated with the CI philosophy to ensure that lessons learned from success stories within the industry are known and encourage the adoption of CI and, ultimately, innovation.

7.5. References

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Appendix A: Evaluation of Constructs to Support CI-Questionnaire

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants in Research Projects Involving Human Subjects

Title of the project: Assessing sustainability of continuous improvement through the identification of enabling and inhibiting factors

Investigators: Johanna Madrigal, Dr. Henry Quesada

1. Purpose of the research

This questionnaire is part of a research project, in which your company is participating. The purpose of the research is to study the effects of six different factors in the sustainability of the CI process, which has been proven as fundamental to foster innovation. The questionnaire questions will cover a number of different aspects of the CI process – planning, the event process, sustainability mechanisms - and it is designed to be answered by a sample randomly selected among all the associates in your company.

2. Procedures

Your role as a participant is limited to answer the questions given in the questionnaire. No additional task is required or expected from you during this research project. Your participation will consist in one session of 40-50 minutes approximately, and it will take place in your work place where the researcher will provide the questionnaire. You, as the participant, do not need to bring any additional material.

3. Risks

There is no physical or emotional risk expected from participating in this research, and your answers to the questionnaire will remain anonymous.

4. Benefits

The information collected will help researchers understand the context and process of the CI and Innovation within your company. This will help the researchers better interpret research findings and understand the similarities and differences between participating companies. Among the benefits, your company will get first access to the results, which will be useful to support the CI and the Innovation process.

5. Extent of Anonymity and Confidentiality

As mentioned in the section 3 of this informed consent document, you participation will remain anonymous. The demographic information collected at the beginning of the questionnaire is not linked to your name or any other form of personal identification. At no time will the researchers release the results of the study to anyone other than individuals working in the project without the written consent of your company.

6. Compensation

There is no compensation by participating in this research project for any participant.

7. Freedom to Withdraw

You as a participant have the right to not answer any question in this questionnaire without any penalization involved.

8. Subject's Responsibility

I voluntary agree to participate in this research, where my main responsibility is to fill the questionnaire provided by the investigator.

If you have any question about the research, or your rights as a participant please contact:

- Johanna Madrigal (Investigator), jmadriga@vt.edu, (540) 231-4991
- Dr. Henry Quesada (Faculty Advisor), quesada@vt.edu, (540) 231-0978
- Dr. Barry Goodell (Department Head), goodell@vt.edu, (540) 231-8853
- David Moore moored@vt.edu, (540) 231-4991
  Chair, Virginia Tech Institutional Review
  Board for the Protection of Human Subjects
  Office of Research Compliance
  2000 Kraft Drive, Suite 2000 (0497)
  Blacksburg, VA 24060

GENERAL INFORMATION
Which of the following options best describes your current role level inside the organization: □ Top management □ Management □ Supervisory □ Staff □ Operational □ Other: ____________________
In which functional are you currently employed: □ Management □ Manufacturing/Production □ Finance/Accounting □ Engineering □ Human Resources □ Maintenance/Facilities □Project Management □ Logistics □ IT □ Customer Care □Other:________________
The time you have worked in the firm falls within the following range: □ less than 1 year □ more than 1 year but less than 5 years □ 5 years or more
Please circle the response that best describes your opinion about the questions asked related to the continuous improvement process (from here on in CI). The scale is as follows: **1= Strongly Disagree, 2= Disagree, 3= Neither, 4=Agree, 5=Strongly Agree**

Our company has set a strategic business plan where CI objectives, and the strategies and time to accomplish them can be identified	1	2	3	4	5
Our CI department goals are aligned to fulfill the company overall CI objective	1	2	3	4	5
Our organization and department objectives are developed based on research about previous performance rather than arbitrary numbers	1	2	3	4	5
Our organization has a systematic process where CI goals are continuously revised and adjusted	1	2	3	4	5
In general, I believe that our company "true north" is to continuously improve to meet our internal and external customers needs	1	2	3	4	5
Our company communicates the CI goals/targets to all the personnel	1	2	3	4	5
Our company has an effective and quick CI goals review/change process, ensuring proper review, approval and communication	1	2	3	4	5
Our company has set accurate resources across the organization to support the CI process that I can easily access	1	2	3	4	5
Process improvements such as productivity, cycle time, and others are linked to the company goals, and effectively communicated	1	2	3	4	5
Performance of CI goals is frequently monitored	1	2	3	4	5
Our organization utilizes the CI goals to achieve day-to-day work, and managers are involved in the follow up activities	1	2	3	4	5
In general, I believe that our company CI goals are well communicated, and that personnel at every level has a good understanding of the CI requirements and performance	1	2	3	4	5

Our firm set CI as one of the values for performing my job	1	2	3	4	5
Our vision and mission clearly links our future and our reason to exist to make things better every time	1	2	3	4	5
I believe that management model CI into their actions by looking for ways to improve our processes	1	2	3	4	5
In general, I believe our firm communicates our mission and vision clearly and concisely, making explicit the role of CI for the organization	1	2	3	4	5
Our organization has designed the appropriate organizational structure to support the CI process	1	2	3	4	5
Our organization allocates resources to departments to explore new ways to do things (such as R&D)	1	2	3	4	5
Our organization celebrates creativity and innovation when new ideas or great changes are derived from any CI initiative	1	2	3	4	5
Our organization have leader I can access with new ideas and possible solutions	1	2	3	4	5
I can identify who is a leader in the CI process, and who is the second person in charge of the CI process	1	2	3	4	5
Our organization has a scoreboard where CI metrics are tracked systematically, having updated and accurate data	1	2	3	4	5
The CI metrics in the scoreboard are consistent with the CI metrics targeted by my department, and easy to understand	1	2	3	4	5
The CI metrics include data from past and present, and are used to plan for future actions	1	2	3	4	5
The CI metrics include the impact on cycle time, productivity and efficiency	1	2	3	4	5
Our organization remarks practices from other departments that can be used by my department to achieve CI goals	1	2	3	4	5
In general, our organization CI scoreboard allows the organization to know the contributions to fulfill customers needs	1	2	3	4	5
Information technologies such as software, hardware, intranet are used to deploy information related to continuous improvement	1	2	3	4	5
CI reports are generated in timely fashion	1	2	3	4	5
Our organization supplies sources where best practices or lessons learned can be accessed to achieve CI, as well I can file a best practice or a lesson learned easily	1	2	3	4	5
In general, I believe CI data in properly managed using the available resources	1	2	3	4	5
Our organization has developed more flexible jobs by implementing CI initiatives	1	2	3	4	5
Our organization allows employees opportunities to suggest and implement new ideas to improve performance of current products and processes	1	2	3	4	5
Our organization evaluates employees continuous improvement in meeting customer	1	2	3	4	5

requirements					
Our organization has improved current processes in a way employees feel more empowered to make decisions	1	2	3	4	5
Our organization sets goals linked to CI across support departments such as Humans Resources, Information Technology, and Finance among others.	1	2	3	4	5
When a CI initiative take places, the leading team selects member from other supporting areas in addition to resources from the area conducting the initiative	1	2	3	4	5
Our organization involves all the functional processes in the CI programs so an integral preventive approach happens rather than a reaction to fix a problem	1	2	3	4	5
Our organization includes new technologies, such as software or equipment, to support improvement in processes and products	1	2	3	4	5
Our organization has an induction plan for every new employee covering CI initiatives	1	2	3	4	5
Our CI process constantly trains all employees in new ways to improve process and products, using problem solving techniques, best practices, and learned lessons	1	2	3	4	5
Our organization set a CI training goal in my personal performance evaluation to ensure my involvement in the CI process	1	2	3	4	5
In general, being trained in CI program is part of my knowledge development in the organization	1	2	3	4	5
Our organization have managers who are constantly searching for better ways to do things, and support employees when they propose new ideas to improve processes and products	1	2	3	4	5
Our organization perceives a value when failure occurs because it brings knowledge to the environment	1	2	3	4	5
Our organization embraces and promotes risk taking, creativity and innovation as part of our values to constantly improve	1	2	3	4	5
In general, I believe our organization is open to learn from continuous change resulting by implementing CI initiatives, and openly encourages employees to embrace this continuous learning	1	2	3	4	5
Our organization describes the working environment as group of ongoing, evolving, and cumulative changes	1	2	3	4	5
Our organization tends to build up mindful responses to problems rather than past responses embedded in routines	1	2	3	4	5
Our organization spread new ideas not by the persuasiveness of the author but for the successful result by implementing as response to needs	1	2	3	4	5
Our organization has a dynamics know-how repertoire which is constantly changing because of lessons learned	1	2	3	4	5
In general, I believe leaders in our organization model personal change by adopting CI initiatives to improve process and products	1	2	3	4	5

Our organization has a feedback system when changes resulting from CI initiatives take place to avoid backsliding	1	2	3	4	5
Our organization supports change adoption by using success stories previously held in the organization	1	2	3	4	5
Our organization takes time to explain employees the need to continuously improve, and how this continuous change is beneficial to the firm	1	2	3	4	5
In general, I believe our organization supports change by having systems that help to embrace small and cumulative changes in the long run	1	2	3	4	5
Our organization has a target of CI initiatives, such as Kaizen, 5s and Lean Events among other to accomplish in the short, mid and long term	1	2	3	4	5
Our organization has a defined a waste goal reduction to be accomplished in short, mid and long term	1	2	3	4	5
Our organizations has defined a goal to fully trained the employees with CI knowledge in the short and mid term	1	2	3	4	5
In general, I believe that the continuous improvement program in my organizations is sustainable (It will last in the mid and long term)	1	2	3	4	5

Appendix B: Self-Assessment Tool - Questionnaire

Please circle the response that best describes your opinion about the questions asked related to the continuous improvement process (from here on in CI). The scale is as follows: **1= Strongly Disagree, 2= Disagree, 3= Neither, 4=Agree, 5=Strongly Agree**					
CHANGE MANAGEMENT					
In general, I believe our organization is open to learn from continuous change resulting by implementing CI initiatives, and openly encourages employees to embrace this continuous learning	1	2	3	4	5
Our organization have managers who are constantly searching for better ways to do things, and support employees when they propose new ideas to improve processes and products	1	2	3	4	5
In general, I believe leaders in our organization model personal change by adopting CI initiatives to improve process and products	1	2	3	4	5
Our organization have leader I can access with new ideas and possible solutions	1	2	3	4	5
Our organization has a dynamics know-how repertoire which is constantly changing because of lessons learned	1	2	3	4	5
Our organization tends to build up mindful responses to problems rather than past responses embedded in routines	1	2	3	4	5
Our organization embraces and promotes risk taking, creativity and innovation as part of our values to constantly improve	1	2	3	4	5
In general, I believe our organization supports change by having systems that help to embrace small and cumulative changes in the long run	1	2	3	4	5
Our organization perceives a value when failure occurs because it brings knowledge to the environment	1	2	3	4	5
Our organization supports change adoption by using success stories previously held in the organization	1	2	3	4	5
Our organization has improved current processes in a way employees feel more empowered to make decisions	1	2	3	4	5
Our organization celebrates creativity and innovation when new ideas or great changes are derived from any CI initiative	1	2	3	4	5
Our organization evaluates employees continuous improvement in meeting customer requirements	1	2	3	4	5
Our organization allows employees opportunities to suggest and implement new ideas to improve performance of current products and processes	1	2	3	4	5
Our organization describes the working environment as group of ongoing, evolving, and cumulative changes	1	2	3	4	5
STRATEGIC PLANNING					
In general, I believe our firm communicates our mission and vision clearly and concisely, making explicit the role of CI for the organization	1	2	3	4	5
In general, I believe that our company CI goals are well communicated, and that personnel at every level has a good understanding of the CI requirements and performance	1	2	3	4	5
Process improvements such as productivity, cycle time, and others are linked to the company goals, and effectively communicated	1	2	3	4	5

Our CI department goals are aligned to fulfill the company overall CI objective	1	2	3	4	5
Our company has an effective and quick CI goals review/change process, ensuring proper review, approval and communication	1	2	3	4	5
Performance of CI goals is frequently monitored	1	2	3	4	5
Our firm set CI as one of the values for performing my job	1	2	3	4	5
I believe that management model CI into their actions by looking for ways to improve our processes	1	2	3	4	5
In general, I believe that our company "true north" is to continuously improve to meet our internal and external customers needs	1	2	3	4	5
Our organization utilizes the CI goals to achieve day-to-day work, and managers are involved in the follow up activities	1	2	3	4	5
Our organization has a systematic process where CI goals are continuously revised and adjusted	1	2	3	4	5
Our vision and mission clearly links our future and our reason to exist to make things better every time	1	2	3	4	5
Our company has set a strategic business plan where CI objectives, and the strategies and time to accomplish them can be identified	1	2	3	4	5
Our organization has designed the appropriate organizational structure to support the CI process	1	2	3	4	5
Our company has set accurate resources across the organization to support the CI process that I can easily access	1	2	3	4	5
Our company communicates the CI goals/targets to all the personnel	1	2	3	4	5
Our organization and department objectives are developed based on research about previous performance rather than arbitrary numbers	1	2	3	4	5
KNOWLEDGE MANAGEMENT					
Our organization supplies sources where best practices or lessons learned can be accessed to achieve CI, as well I can file a best practice or a lesson learned easily	1	2	3	4	5
In general, I believe CI data in properly managed using the available resources	1	2	3	4	5
CI reports are generated in timely fashion	1	2	3	4	5
Information technologies such as software, hardware, intranet are used to deploy information related to continuous improvement	1	2	3	4	5
Our organization includes new technologies, such as software or equipment, to support improvement in processes and products	1	2	3	4	5
Our organization allocates resources to departments to explore new ways to do things (such as R&D)	1	2	3	4	5
Our CI process constantly trains all employees in new ways to improve process and products, using problem solving techniques, best practices, and learned lessons	1	2	3	4	5
In general, being trained in CI program is part of my knowledge development in the organization	1	2	3	4	5
Our organization involves all the functional processes in the CI programs so an integral preventive approach happens rather than a reaction to fix a problem	1	2	3	4	5

PERFORMANCE MEASUREMENT					
The CI metrics in the scoreboard are consistent with the CI metrics targeted by my department, and easy to understand	1	2	3	4	5
Our organization has a scoreboard where CI metrics are tracked systematically, having updated and accurate data	1	2	3	4	5
The CI metrics include the impact on cycle time, productivity and efficiency	1	2	3	4	5
In general, our organization CI scoreboard allows the organization to know the contributions to fulfill customers needs	1	2	3	4	5
The CI metrics include data from past and present, and are used to plan for future actions	1	2	3	4	5
CI SUSTAINABILITY					
Our organizations has defined a goal to fully trained the employees with CI knowledge in the short and mid term	1	2	3	4	5
Our organization has a defined a waste goal reduction to be accomplished in short, mid and long term	1	2	3	4	5
Our organization has a target of CI initiatives, such as Kaizen, 5s and Lean Events among other to accomplish in the short, mid and long term	1	2	3	4	5

Appendix C: SAS Code Lines

1. **Procedure CORR**

```
PROC CORR alpha DATA= alldata;
VAR F1 F2 F3 F4 F5 F6 F7;
RUN;
```

2. **Procedure CALIS**

```
PROC CALIS data=survey1;
var V1-V12;

    Lineqs

        V1 = LV1 F1 + e1,
        V2 = LV2 F1 + e2,
        V3 = LV3 F1 + e3,
        V4 = LV4 F1 + e4,
        V5 = LV5 F1 + e5,
        V6 = LV6 F1 + e6,
        V7 = LV7 F1 + e7,
        V8 = LV8 F1 + e8,
        V9 = LV9 F1 + e9,
        V10 = LV10 F1 + e10,
        V11 = LV11 F1 + e11,
        V12 = LV12 F1 + e12;

STD
e1-e12 = e_var1-e_var12,
F1 = 1;

PROC CALIS data=survey1;
var V1-V21;
lineqs
        V13 = LV13 F2 + e13,
        V14 = LV14 F2 + e14,
        V15 = LV15 F2 + e15,
        V16 = LV16 F2 + e16,
        V17 = LV17 F2 + e17,
        V18 = LV18 F2 + e18,
        V19 = LV19 F2 + e19,
        V20 = LV20 F2 + e20,
        V21 = LV21 F2 + e21;
```

```
STD
e13-e21 = e_var13-e_var21;
F2=1;

PROC CALIS data=survey1;
var  V22-V31;
lineqs
        V22 = LV22 F3 + e22,
        V23 = LV23 F3 + e23,
        V24 = LV24 F3 + e24,
        V25 = LV25 F3 + e25,
        V26 = LV26 F3 + e26,
        V27 = LV27 F3 + e27,
        V28 = LV28 F3 + e28,
        V29 = LV29 F3 + e29,
        V30 = LV30 F3 + e30,
        V31 = LV31 F3 + e31;
STD
e22-e31 = e_var22-e_var31,
F3=1;

PROC CALIS data=survey1;
var  V32-V39;
lineqs
        V32 = LV32 F4 + e32,
        V33 = LV33 F4 + e33,
        V34 = LV34 F4 + e34,
        V35 = LV35 F4 + e35,
        V36 = LV36 F4 + e36,
        V37 = LV37 F4 + e37,
        V38 = LV38 F4 + e38,
        V39 = LV39 F4 + e39;
STD
e32-e39 = e_var32-e_var39,
F4=1;

PROC CALIS data=survey1;
var  V40-V47;
lineqs
        V40 = LV40 F5 + e40,
        V41 = LV41 F5 + e41,
        V42 = LV42 F5 + e42,
        V43 = LV43 F5 + e43,
        V44 = LV44 F5 + e44,
        V45 = LV45 F5 + e45,
        V46 = LV46 F5 + e46,
```

```
        V47 = LV47 F5 + e47;

STD
e40-e47 = e_var40-e_var47,
F5=1;

PROC CALIS data=survey1;
var  V48-V56;
lineqs
        V48 = LV48 F6 + e48,
        V49 = LV49 F6 + e49,
        V50 = LV50 F6 + e50,
        V51 = LV51 F6 + e51,
        V52 = LV52 F6 + e52,
        V53 = LV53 F6 + e53,
        V54 = LV54 F6 + e54,
        V55 = LV55 F6 + e55,
        V56 = LV56 F6 + e56;
STD
e48-e56 = e_var48-e_var56,
F6=1;
PROC CALIS data=survey1;
var  V57-V60;
lineqs
        V57 = LV57 F7 + e57,
        V58 = LV58 F7 + e58,
        V59 = LV59 F7 + e59,
        V60 = LV60 F7 + e60;
STD
e57-e60 = e_var57-e_var60,
F7=1;
RUN;
```

3. Procedure FACTOR

```
PROC FACTOR SIMPLE CORR MSA  REORDER ROTATE=VARIMAX
  PRIORS=SMC scree NFACTORS=5 data=survey1 OUT=FACTORS;
var
v1-v60;
run;
```

4. Procedure for ANOVA Analysis

```
proc mixed data=input_data;
class company time region;
model f1= region time company company*time company*region company*time*region;
random region*time;
run;


proc mixed data=input_data;
	class COMPANY time;
	model f1=company time company*time;
	repeated /group=company;
	lsmeans company/adjust=tukey;
	lsmeans company*time/adjust=tukey slice=company;
run;
proc mixed data=input_data;
	class COMPANY region;
	model f1=company region company*region;
	repeated /group=company;
	lsmeans company/adjust=tukey;
	lsmeans company*region/adjust=tukey slice=company;
run;

proc mixed data=input_data;
	class COMPANY time;
	model f2=company time company*time;
	repeated /group=company;
	lsmeans company/adjust=tukey;
	lsmeans company*time/adjust=tukey slice=company;
run;
proc mixed data=input_data;
	class COMPANY time;
	model f3=company time company*time;
	repeated /group=company;
	lsmeans company/adjust=tukey;
	lsmeans time/adjust=tukey;
	lsmeans company*time/adjust=tukey slice=company;
run;

proc mixed data=input_data;
	class COMPANY time;
	model f4=company time company*time;
	repeated /group=company;
	lsmeans company/adjust=tukey;
```

```
    lsmeans company*time/adjust=tukey slice=company;
run;

proc mixed data=input_data;
    class COMPANY time;
    model f5=company time company*time;
    repeated /group=company;
    lsmeans company/adjust=tukey;
    lsmeans company*time/adjust=tukey slice=company;
run;
```

Appendix D: SAS Output on Simple Statistics

The SAS System
The FACTOR Procedure

Input Data Type	Raw Data
Number of Records Read	352
Number of Records Used	352
N for Significance Tests	352

Means and Standard Deviations from 352 Observations

Variable	Mean	Std Dev
V1	3.8551136	0.8088027
V2	3.9005682	0.8226146
V3	3.6306818	0.9306259
V4	3.7727273	0.8470128
V5	4.1278409	0.8823162
V6	3.6136364	0.9805146
V7	3.4545455	0.9109538
V8	3.6107955	0.9270837
V9	3.7045455	0.8561371
V10	3.7698864	0.8065981
V11	3.6107955	0.9483514
V12	3.4204545	1.0180322
V13	3.8778409	0.8502508
V14	3.9801136	0.8318119
V15	3.8806818	0.8489790
V16	3.7755682	0.9356350
V17	3.7244318	0.8774963
V18	3.4914773	0.9783620
V19	3.7102273	0.9554808
V20	3.6903409	0.9626163
V21	3.5511364	1.0282056
V22	3.7187500	0.8789340
V23	3.5312500	0.8467404
V24	3.5823864	0.8764257
V25	3.6647727	0.8646973
V26	3.5113636	0.9057501
V27	3.6676136	0.8542016
V28	3.7357955	0.8809943
V29	3.5340909	0.8956859
V30	3.4232955	0.9869937
V31	3.5284091	0.9147663
V32	3.3437500	0.9628517
V33	3.7500000	0.9152086
V34	3.6221591	0.9529489
V35	3.4403409	0.9823908
V36	3.6079545	0.8961738
V37	3.5312500	0.8764995
V38	3.3721591	0.8903521
V39	3.6534091	0.9332660
V40	3.5596591	2.3874954
V41	3.4062500	0.9650683

The SAS System

The FACTOR Procedure

Means and Standard Deviations from 352 Observations

Variable	Mean	Std Dev
V42	3.4517045	0.9945421
V43	3.5738636	0.9122146
V44	3.7414773	0.8859049
V45	3.5596591	0.8618987
V46	3.4886364	0.9666144
V47	3.7784091	0.8684333
V48	3.7357955	0.7852431
V49	3.5482955	0.9108072
V50	3.6278409	0.8709414
V51	3.5653409	0.9066031
V52	3.5625000	0.9376958
V53	3.3948864	0.9609332
V54	3.5681818	0.9188802
V55	3.6960227	0.9128310
V56	3.7357955	0.8874384
V57	3.8977273	0.8545474
V58	3.9034091	0.8717077
V59	3.6420455	0.9441645
V60	3.7954545	0.9109538

The SAS System

The FACTOR Procedure

Correlations

		V1	V2	V3	V4	V5	V6	V7
V1	V1	1.00000	0.67198	0.53054	0.60056	0.51709	0.53275	0.48792
V2	V2	0.67198	1.00000	0.56223	0.51948	0.47682	0.46440	0.49770
V3	V3	0.53054	0.56223	1.00000	0.49681	0.39770	0.42079	0.46071
V4	V4	0.60056	0.51948	0.49681	1.00000	0.55364	0.45656	0.57366
V5	V5	0.51709	0.47682	0.39770	0.55364	1.00000	0.33718	0.45919
V6	V6	0.53275	0.46440	0.42079	0.45656	0.33718	1.00000	0.63416
V7	V7	0.48792	0.49770	0.46071	0.57366	0.45919	0.63416	1.00000
V8	V8	0.42612	0.50574	0.37117	0.51107	0.49986	0.45780	0.60477
V9	V9	0.50168	0.52451	0.42763	0.46503	0.48011	0.51525	0.50146
V10	V10	0.45533	0.49785	0.42921	0.49454	0.47380	0.43121	0.48009
V11	V11	0.45371	0.45788	0.36931	0.49252	0.42395	0.47204	0.55823
V12	V12	0.49287	0.57397	0.48313	0.48118	0.42845	0.62272	0.58900
V13	V13	0.43405	0.52434	0.36049	0.51518	0.47660	0.44558	0.48019
V14	V14	0.44035	0.45510	0.34012	0.45455	0.56247	0.38877	0.45563
V15	V15	0.48924	0.49697	0.40924	0.50100	0.58713	0.44757	0.51239
V16	V16	0.53669	0.53727	0.45096	0.53941	0.49040	0.56358	0.56795
V17	V17	0.55776	0.51844	0.44718	0.54414	0.45409	0.50504	0.57415
V18	V18	0.32427	0.35471	0.36577	0.41021	0.32306	0.37670	0.50304
V19	V19	0.41372	0.43445	0.33427	0.48516	0.49353	0.39713	0.44962
V20	V20	0.45085	0.36756	0.28223	0.39913	0.42579	0.42828	0.45987
V21	V21	0.46286	0.46918	0.31753	0.43865	0.38376	0.43224	0.44962
V22	V22	0.44748	0.45376	0.31500	0.40756	0.34407	0.39587	0.39853
V23	V23	0.54536	0.48507	0.39793	0.44689	0.37026	0.42294	0.45800
V24	V24	0.54541	0.45991	0.42863	0.47432	0.40082	0.42835	0.46682
V25	V25	0.48845	0.44566	0.35553	0.51028	0.41109	0.39789	0.42909
V26	V26	0.50977	0.50434	0.38693	0.43415	0.38855	0.39633	0.44606
V27	V27	0.47855	0.51641	0.35047	0.45445	0.41187	0.44491	0.44735
V28	V28	0.42192	0.35677	0.38799	0.40418	0.33313	0.38610	0.43406
V29	V29	0.39814	0.42415	0.38770	0.35198	0.30631	0.42703	0.47329
V30	V30	0.36970	0.40990	0.36299	0.41189	0.29101	0.37555	0.47934
V31	V31	0.51195	0.46756	0.45077	0.49372	0.38201	0.45696	0.51097
V32	V32	0.45193	0.42815	0.40598	0.46636	0.31031	0.50321	0.54569
V33	V33	0.42818	0.45884	0.36628	0.42632	0.45249	0.42860	0.43399
V34	V34	0.50911	0.54070	0.40440	0.47217	0.47100	0.42874	0.52003
V35	V35	0.42474	0.43861	0.43704	0.45615	0.39832	0.46107	0.52384
V36	V36	0.45597	0.46869	0.38955	0.45278	0.29056	0.47558	0.48413
V37	V37	0.38216	0.40538	0.30409	0.43940	0.35769	0.36880	0.44602
V38	V38	0.43907	0.43187	0.41392	0.44115	0.39622	0.44257	0.52498
V39	V39	0.34469	0.30753	0.36721	0.37941	0.26156	0.27667	0.35339
V40	V40	0.27670	0.19088	0.19587	0.21805	0.21344	0.21798	0.25342
V41	V41	0.41872	0.35248	0.29125	0.43392	0.31357	0.48850	0.48610
V42	V42	0.42515	0.43811	0.39007	0.45704	0.41127	0.46579	0.53059
V43	V43	0.43738	0.38758	0.36111	0.42001	0.39353	0.46200	0.44975
V44	V44	0.40881	0.39857	0.28817	0.41506	0.46521	0.38650	0.40727
V45	V45	0.44360	0.37606	0.33656	0.43620	0.34772	0.38807	0.46611
V46	V46	0.37506	0.38374	0.41972	0.37265	0.41760	0.38613	0.43621
V47	V47	0.41251	0.40775	0.34615	0.43872	0.52788	0.43450	0.44460

The FACTOR Procedure

Correlations

		V8	V9	V10	V11	V12	V13	V14
V1	V1	0.42612	0.50168	0.45533	0.45371	0.49287	0.43405	0.44035
V2	V2	0.50574	0.52451	0.49785	0.45788	0.57397	0.52434	0.45510
V3	V3	0.37117	0.42763	0.42921	0.36931	0.48313	0.36049	0.34012
V4	V4	0.51107	0.46503	0.49454	0.49252	0.48118	0.51518	0.45455
V5	V5	0.49986	0.48011	0.47380	0.42395	0.42845	0.47660	0.56247
V6	V6	0.45780	0.51525	0.43121	0.47204	0.62272	0.44558	0.38877
V7	V7	0.60477	0.50146	0.48009	0.55823	0.58900	0.48019	0.45563
V8	V8	1.00000	0.47928	0.47424	0.50771	0.53914	0.51057	0.53671
V9	V9	0.47928	1.00000	0.56962	0.48958	0.57115	0.49430	0.51980
V10	V10	0.47424	0.56962	1.00000	0.59768	0.55880	0.53218	0.46025
V11	V11	0.50771	0.48958	0.59768	1.00000	0.60082	0.56272	0.40188
V12	V12	0.53914	0.57115	0.55880	0.60082	1.00000	0.60259	0.49774
V13	V13	0.51057	0.49430	0.53218	0.56272	0.60259	1.00000	0.56454
V14	V14	0.53671	0.51980	0.46025	0.40188	0.49774	0.56454	1.00000
V15	V15	0.52723	0.51188	0.56721	0.52956	0.52629	0.56783	0.61388
V16	V16	0.56248	0.55007	0.50896	0.52739	0.61680	0.57426	0.58362
V17	V17	0.61724	0.50567	0.55016	0.60339	0.56381	0.54281	0.51160
V18	V18	0.54759	0.41875	0.44698	0.55680	0.51277	0.46282	0.40063
V19	V19	0.57668	0.41049	0.36793	0.47257	0.45072	0.46831	0.50175
V20	V20	0.48070	0.40376	0.28590	0.45432	0.41814	0.45142	0.50465
V21	V21	0.49167	0.36675	0.35603	0.40760	0.46115	0.40312	0.41591
V22	V22	0.41771	0.40417	0.51928	0.44594	0.41591	0.45712	0.40539
V23	V23	0.42383	0.43722	0.51322	0.48529	0.51353	0.44260	0.42359
V24	V24	0.44106	0.44260	0.51253	0.44830	0.50390	0.42837	0.41064
V25	V25	0.41252	0.47773	0.52631	0.46928	0.50040	0.47890	0.39869
V26	V26	0.38698	0.43420	0.45010	0.50102	0.49534	0.47349	0.42950
V27	V27	0.49094	0.44969	0.49238	0.47993	0.52155	0.46958	0.45178
V28	V28	0.47022	0.36081	0.42738	0.42217	0.40375	0.31811	0.36214
V29	V29	0.40544	0.42557	0.49002	0.47014	0.48103	0.41513	0.33933
V30	V30	0.47635	0.35747	0.42331	0.48697	0.50287	0.41487	0.34342
V31	V31	0.45148	0.42910	0.49733	0.46763	0.48580	0.42022	0.41073
V32	V32	0.49500	0.41042	0.42129	0.48702	0.50028	0.46557	0.42475
V33	V33	0.43567	0.43996	0.40427	0.45216	0.46479	0.46589	0.49493
V34	V34	0.52640	0.43897	0.46848	0.51775	0.56949	0.50547	0.49368
V35	V35	0.54845	0.47693	0.48059	0.50251	0.52937	0.40908	0.46050
V36	V36	0.43992	0.42044	0.42663	0.51051	0.51220	0.46790	0.42520
V37	V37	0.46554	0.34265	0.33863	0.42083	0.40669	0.40845	0.40139
V38	V38	0.51423	0.42871	0.45679	0.50607	0.53723	0.47420	0.36393
V39	V39	0.42318	0.28509	0.35927	0.37507	0.41170	0.32707	0.40947
V40	V40	0.21711	0.18984	0.21057	0.24999	0.24753	0.18816	0.16629
V41	V41	0.40331	0.39051	0.42787	0.43474	0.51291	0.40091	0.36500
V42	V42	0.49712	0.42152	0.39986	0.38629	0.52943	0.49669	0.42760
V43	V43	0.42993	0.38188	0.38907	0.36101	0.49107	0.42858	0.38304
V44	V44	0.47725	0.42113	0.32717	0.49029	0.43360	0.44209	0.42988
V45	V45	0.49800	0.35600	0.34970	0.44501	0.48110	0.40068	0.40898
V46	V46	0.47988	0.34708	0.42965	0.49088	0.45362	0.42989	0.47276
V47	V47	0.50830	0.45965	0.41913	0.52111	0.51817	0.44940	0.50265

The SAS System

The FACTOR Procedure

Correlations

		V15	V16	V17	V18	V19	V20	V21
V1	V1	0.48924	0.53669	0.55776	0.32427	0.41372	0.45085	0.46286
V2	V2	0.49697	0.53727	0.51844	0.35471	0.43445	0.36756	0.46918
V3	V3	0.40924	0.45096	0.44718	0.36577	0.33427	0.28223	0.31753
V4	V4	0.50100	0.53941	0.54414	0.41021	0.48516	0.39913	0.43865
V5	V5	0.58713	0.49040	0.45409	0.32306	0.49353	0.42579	0.38376
V6	V6	0.44757	0.56358	0.50504	0.37670	0.39713	0.42828	0.43224
V7	V7	0.51239	0.56795	0.57415	0.50304	0.44962	0.45987	0.44962
V8	V8	0.52723	0.56248	0.61724	0.54759	0.57668	0.48070	0.49167
V9	V9	0.51188	0.55007	0.50567	0.41875	0.41049	0.40376	0.36675
V10	V10	0.56721	0.50896	0.55016	0.44698	0.36793	0.28590	0.35603
V11	V11	0.52956	0.52739	0.60339	0.55680	0.47257	0.45432	0.40760
V12	V12	0.52629	0.61680	0.56381	0.51277	0.45072	0.41814	0.46115
V13	V13	0.56783	0.57426	0.54281	0.46282	0.46831	0.45142	0.40312
V14	V14	0.61388	0.58362	0.51160	0.40063	0.50175	0.50465	0.41591
V15	V15	1.00000	0.55440	0.53703	0.44467	0.48759	0.50547	0.43456
V16	V16	0.55440	1.00000	0.60459	0.45075	0.46563	0.52047	0.44582
V17	V17	0.53703	0.60459	1.00000	0.55311	0.54332	0.50580	0.50984
V18	V18	0.44467	0.45075	0.55311	1.00000	0.56117	0.45852	0.38419
V19	V19	0.48759	0.46563	0.54332	0.56117	1.00000	0.57743	0.45302
V20	V20	0.50547	0.52047	0.50580	0.45852	0.57743	1.00000	0.53561
V21	V21	0.43456	0.44582	0.50984	0.38419	0.45302	0.53561	1.00000
V22	V22	0.47415	0.43576	0.45332	0.34343	0.27585	0.30085	0.45258
V23	V23	0.44512	0.46379	0.49667	0.35455	0.36689	0.38766	0.51683
V24	V24	0.47655	0.43780	0.53898	0.43940	0.41644	0.44400	0.45531
V25	V25	0.47316	0.48778	0.48618	0.39400	0.33037	0.35754	0.39746
V26	V26	0.49083	0.49217	0.47532	0.43575	0.41203	0.38146	0.37871
V27	V27	0.49516	0.51240	0.51981	0.40057	0.40177	0.42191	0.50760
V28	V28	0.37292	0.40829	0.54680	0.50806	0.42324	0.38701	0.38451
V29	V29	0.38377	0.46980	0.54665	0.48963	0.40773	0.37080	0.46213
V30	V30	0.32905	0.39317	0.51336	0.55399	0.43556	0.31528	0.44323
V31	V31	0.38957	0.50511	0.59008	0.53666	0.47230	0.41606	0.43463
V32	V32	0.46507	0.47803	0.51708	0.53994	0.47091	0.52707	0.45558
V33	V33	0.43450	0.47993	0.47803	0.43670	0.50010	0.58452	0.44354
V34	V34	0.56390	0.55647	0.60764	0.49921	0.53962	0.52120	0.55333
V35	V35	0.50725	0.53247	0.57742	0.54488	0.57946	0.59048	0.53470
V36	V36	0.42139	0.41123	0.53609	0.45434	0.43257	0.41040	0.45468
V37	V37	0.39172	0.39246	0.50574	0.44218	0.48030	0.49943	0.52457
V38	V38	0.49236	0.45623	0.59111	0.54167	0.52565	0.45064	0.45375
V39	V39	0.36117	0.38376	0.48489	0.48039	0.47173	0.38126	0.36886
V40	V40	0.20452	0.21964	0.25197	0.25513	0.20243	0.17603	0.23261
V41	V41	0.41401	0.39785	0.50937	0.51211	0.43082	0.43634	0.48289
V42	V42	0.46555	0.47360	0.51193	0.49441	0.48891	0.48280	0.58889
V43	V43	0.43447	0.44508	0.53268	0.43964	0.48878	0.44303	0.56094
V44	V44	0.54222	0.40757	0.45416	0.38368	0.50699	0.58404	0.43836
V45	V45	0.40300	0.52009	0.46818	0.46009	0.49846	0.47388	0.48359
V46	V46	0.42189	0.48702	0.55555	0.47739	0.57018	0.50907	0.46497
V47	V47	0.51662	0.47859	0.54773	0.50410	0.58849	0.56521	0.50408

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Correlations

		V22	V23	V24	V25	V26	V27	V28
V1	V1	0.44748	0.54536	0.54541	0.48845	0.50977	0.47855	0.42192
V2	V2	0.45376	0.48507	0.45991	0.44566	0.50434	0.51641	0.35677
V3	V3	0.31500	0.39793	0.42863	0.35553	0.38693	0.35047	0.38799
V4	V4	0.40756	0.44689	0.47432	0.51028	0.43415	0.45445	0.40418
V5	V5	0.34407	0.37026	0.40082	0.41109	0.38855	0.41187	0.33313
V6	V6	0.39587	0.42294	0.42835	0.39789	0.39633	0.44491	0.38610
V7	V7	0.39853	0.45800	0.46682	0.42909	0.44606	0.44735	0.43406
V8	V8	0.41771	0.42383	0.44106	0.41252	0.38698	0.49094	0.47022
V9	V9	0.40417	0.43722	0.44260	0.47773	0.43420	0.44969	0.36081
V10	V10	0.51928	0.51322	0.51253	0.52631	0.45010	0.49238	0.42738
V11	V11	0.44594	0.48529	0.44830	0.46928	0.50102	0.47993	0.42217
V12	V12	0.41591	0.51353	0.50390	0.50040	0.49534	0.52155	0.40375
V13	V13	0.45712	0.44260	0.42837	0.47890	0.47349	0.46958	0.31811
V14	V14	0.40539	0.42359	0.41064	0.39869	0.42950	0.45178	0.36214
V15	V15	0.47415	0.44512	0.47655	0.47316	0.49083	0.49516	0.37292
V16	V16	0.43576	0.46379	0.43780	0.48778	0.49217	0.51240	0.40829
V17	V17	0.45332	0.49667	0.53898	0.48618	0.47532	0.51981	0.54680
V18	V18	0.34343	0.35455	0.43940	0.39400	0.43575	0.40057	0.50806
V19	V19	0.27585	0.36689	0.41644	0.33037	0.41203	0.40177	0.42324
V20	V20	0.30085	0.38766	0.44400	0.35754	0.38146	0.42191	0.38701
V21	V21	0.45258	0.51683	0.45531	0.39746	0.37871	0.50760	0.38451
V22	V22	1.00000	0.66837	0.56829	0.65156	0.50684	0.56956	0.36735
V23	V23	0.66837	1.00000	0.67220	0.63693	0.55118	0.63873	0.38729
V24	V24	0.56829	0.67220	1.00000	0.65308	0.59997	0.65889	0.49872
V25	V25	0.65156	0.63693	0.65308	1.00000	0.58690	0.64329	0.38829
V26	V26	0.50684	0.55118	0.59997	0.58690	1.00000	0.65483	0.38402
V27	V27	0.56956	0.63873	0.65889	0.64329	0.65483	1.00000	0.45842
V28	V28	0.36735	0.38729	0.49872	0.38829	0.38402	0.45842	1.00000
V29	V29	0.41211	0.51887	0.51722	0.44151	0.48766	0.53803	0.66675
V30	V30	0.36423	0.43582	0.48818	0.49055	0.49336	0.52218	0.59424
V31	V31	0.42632	0.47885	0.56032	0.53794	0.54290	0.51345	0.62976
V32	V32	0.42428	0.44981	0.48796	0.46046	0.47083	0.48225	0.48018
V33	V33	0.34443	0.40716	0.44487	0.39421	0.41586	0.48013	0.33479
V34	V34	0.39659	0.45073	0.50642	0.44053	0.53806	0.55927	0.46444
V35	V35	0.37811	0.47832	0.50869	0.41574	0.47944	0.50763	0.49032
V36	V36	0.44195	0.44045	0.46201	0.49169	0.48636	0.48803	0.47466
V37	V37	0.42379	0.45549	0.40089	0.41608	0.38892	0.42297	0.46638
V38	V38	0.41810	0.44368	0.49547	0.46225	0.44518	0.47403	0.44897
V39	V39	0.25593	0.35264	0.45647	0.33928	0.36867	0.41616	0.56747
V40	V40	0.16890	0.21329	0.23319	0.22500	0.24012	0.24933	0.22220
V41	V41	0.39371	0.41848	0.48747	0.42313	0.45590	0.43384	0.44159
V42	V42	0.41626	0.43484	0.48179	0.46149	0.44497	0.52601	0.44550
V43	V43	0.38665	0.44515	0.50017	0.45768	0.46103	0.53068	0.45862
V44	V44	0.33810	0.32793	0.38160	0.37747	0.39601	0.39061	0.37583
V45	V45	0.37385	0.41124	0.40080	0.36331	0.44984	0.44687	0.43917
V46	V46	0.28965	0.37115	0.45343	0.34651	0.45247	0.49401	0.43306
V47	V47	0.31003	0.39301	0.45078	0.40539	0.42336	0.46115	0.45948

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Correlations

		V29	V30	V31	V32	V33	V34	V35
V1	V1	0.39814	0.36970	0.51195	0.45193	0.42818	0.50911	0.42474
V2	V2	0.42415	0.40990	0.46756	0.42815	0.45884	0.54070	0.43861
V3	V3	0.38770	0.36299	0.45077	0.40598	0.36628	0.40440	0.43704
V4	V4	0.35198	0.41189	0.49372	0.46636	0.42632	0.47217	0.45615
V5	V5	0.30631	0.29101	0.38201	0.31031	0.45249	0.47100	0.39832
V6	V6	0.42703	0.37555	0.45696	0.50321	0.42860	0.42874	0.46107
V7	V7	0.47329	0.47934	0.51097	0.54569	0.43399	0.52003	0.52384
V8	V8	0.40544	0.47635	0.45148	0.49500	0.43567	0.52640	0.54845
V9	V9	0.42557	0.35747	0.42910	0.41042	0.43996	0.43897	0.47693
V10	V10	0.49002	0.42331	0.49733	0.42129	0.40427	0.46848	0.48059
V11	V11	0.47014	0.48697	0.46763	0.48702	0.45216	0.51775	0.50251
V12	V12	0.48103	0.50287	0.48580	0.50028	0.46479	0.56949	0.52937
V13	V13	0.41513	0.41487	0.42022	0.46557	0.46589	0.50547	0.40908
V14	V14	0.33933	0.34342	0.41073	0.42475	0.49493	0.49368	0.46050
V15	V15	0.38377	0.32905	0.38957	0.46507	0.43450	0.56390	0.50725
V16	V16	0.46980	0.39317	0.50511	0.47803	0.47993	0.55647	0.53247
V17	V17	0.54665	0.51336	0.59008	0.51708	0.47803	0.60764	0.57742
V18	V18	0.48963	0.55399	0.53666	0.53994	0.43670	0.49921	0.54488
V19	V19	0.40773	0.43556	0.47230	0.47091	0.50010	0.53962	0.57946
V20	V20	0.37080	0.31528	0.41606	0.52707	0.58452	0.52120	0.59048
V21	V21	0.46213	0.44323	0.43463	0.45558	0.44354	0.55333	0.53470
V22	V22	0.41211	0.36423	0.42632	0.42428	0.34443	0.39659	0.37811
V23	V23	0.51887	0.43582	0.47885	0.44981	0.40716	0.45073	0.47832
V24	V24	0.51722	0.48818	0.56032	0.48796	0.44487	0.50642	0.50869
V25	V25	0.44151	0.49055	0.53794	0.46046	0.39421	0.44053	0.41574
V26	V26	0.48766	0.49336	0.54290	0.47083	0.41586	0.53806	0.47944
V27	V27	0.53803	0.52218	0.51345	0.48225	0.48013	0.55927	0.50763
V28	V28	0.66675	0.59424	0.62976	0.48018	0.33479	0.46444	0.49032
V29	V29	1.00000	0.61367	0.64209	0.48355	0.38926	0.48744	0.50256
V30	V30	0.61367	1.00000	0.76132	0.59593	0.38242	0.52493	0.54179
V31	V31	0.64209	0.76132	1.00000	0.57273	0.47472	0.55651	0.54877
V32	V32	0.48355	0.59593	0.57273	1.00000	0.56336	0.61081	0.61660
V33	V33	0.38926	0.38242	0.47472	0.56336	1.00000	0.62638	0.62979
V34	V34	0.48744	0.52493	0.55651	0.61081	0.62638	1.00000	0.68037
V35	V35	0.50256	0.54179	0.54877	0.61660	0.62979	0.68037	1.00000
V36	V36	0.51360	0.51669	0.53839	0.50661	0.47067	0.52996	0.53320
V37	V37	0.49400	0.50665	0.53011	0.45816	0.40044	0.48659	0.49848
V38	V38	0.47170	0.55616	0.58339	0.56818	0.43267	0.56579	0.56453
V39	V39	0.51519	0.52469	0.55219	0.49440	0.42195	0.44497	0.49633
V40	V40	0.23553	0.27156	0.26729	0.27176	0.18026	0.23972	0.24203
V41	V41	0.50963	0.55773	0.55972	0.51155	0.42498	0.51125	0.59209
V42	V42	0.48639	0.57379	0.55423	0.61688	0.49063	0.59543	0.58899
V43	V43	0.52343	0.54899	0.56082	0.52406	0.42145	0.51561	0.53744
V44	V44	0.31094	0.38617	0.38701	0.45518	0.53147	0.55553	0.54037
V45	V45	0.41254	0.42403	0.47663	0.45069	0.42709	0.58772	0.56276
V46	V46	0.42824	0.48435	0.50300	0.46491	0.51206	0.58762	0.60383
V47	V47	0.44560	0.48866	0.51361	0.46955	0.54665	0.62149	0.62897

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Correlations

		V36	V37	V38	V39	V40	V41	V42
V1	V1	0.45597	0.38216	0.43907	0.34469	0.27670	0.41872	0.42515
V2	V2	0.46869	0.40538	0.43187	0.30753	0.19088	0.35248	0.43811
V3	V3	0.38955	0.30409	0.41392	0.36721	0.19587	0.29125	0.39007
V4	V4	0.45278	0.43940	0.44115	0.37941	0.21805	0.43392	0.45704
V5	V5	0.29056	0.35769	0.39622	0.26156	0.21344	0.31357	0.41127
V6	V6	0.47558	0.36880	0.44257	0.27667	0.21798	0.48850	0.46579
V7	V7	0.48413	0.44602	0.52498	0.35339	0.25342	0.48610	0.53059
V8	V8	0.43992	0.46554	0.51423	0.42318	0.21711	0.40331	0.49712
V9	V9	0.42044	0.34265	0.42871	0.28509	0.18984	0.39051	0.42152
V10	V10	0.42663	0.33863	0.45679	0.35927	0.21057	0.42787	0.39986
V11	V11	0.51051	0.42083	0.50607	0.37507	0.24999	0.43474	0.38629
V12	V12	0.51220	0.40669	0.53723	0.41170	0.24753	0.51291	0.52943
V13	V13	0.46790	0.40845	0.47420	0.32707	0.18816	0.40091	0.49669
V14	V14	0.42520	0.40139	0.36393	0.40947	0.16629	0.36500	0.42760
V15	V15	0.42139	0.39172	0.49236	0.36117	0.20452	0.41401	0.46555
V16	V16	0.41123	0.39246	0.45623	0.38376	0.21964	0.39785	0.47360
V17	V17	0.53609	0.50574	0.59111	0.48489	0.25197	0.50937	0.51193
V18	V18	0.45434	0.44218	0.54167	0.48039	0.25513	0.51211	0.49441
V19	V19	0.43257	0.48030	0.52565	0.47173	0.20243	0.43082	0.48891
V20	V20	0.41040	0.49943	0.45064	0.38126	0.17603	0.43634	0.48280
V21	V21	0.45468	0.52457	0.45375	0.36886	0.23261	0.48289	0.58889
V22	V22	0.44195	0.42379	0.41810	0.25593	0.16890	0.39371	0.41626
V23	V23	0.44045	0.45549	0.44368	0.35264	0.21329	0.41848	0.43484
V24	V24	0.46201	0.40089	0.49547	0.45647	0.23319	0.48747	0.48179
V25	V25	0.49169	0.41608	0.46225	0.33928	0.22500	0.42313	0.46149
V26	V26	0.48636	0.38892	0.44518	0.36867	0.24012	0.45590	0.44497
V27	V27	0.48803	0.42297	0.47403	0.41616	0.24933	0.43384	0.52601
V28	V28	0.47466	0.46638	0.44897	0.56747	0.22220	0.44159	0.44550
V29	V29	0.51360	0.49400	0.47170	0.51519	0.23553	0.50963	0.48639
V30	V30	0.51669	0.50665	0.55616	0.52469	0.27156	0.55773	0.57379
V31	V31	0.53839	0.53011	0.58339	0.55219	0.26729	0.55972	0.55423
V32	V32	0.50661	0.45816	0.56818	0.49440	0.27176	0.51155	0.61688
V33	V33	0.47067	0.40044	0.43267	0.42195	0.18026	0.42498	0.49063
V34	V34	0.52996	0.48659	0.56579	0.44497	0.23972	0.51125	0.59543
V35	V35	0.53320	0.49848	0.56453	0.49633	0.24203	0.59209	0.58899
V36	V36	1.00000	0.51980	0.57257	0.51154	0.24398	0.56350	0.55407
V37	V37	0.51980	1.00000	0.61846	0.52178	0.22783	0.54237	0.57368
V38	V38	0.57257	0.61846	1.00000	0.55340	0.27031	0.51652	0.59145
V39	V39	0.51154	0.52178	0.55340	1.00000	0.24585	0.43198	0.50066
V40	V40	0.24398	0.22783	0.27031	0.24585	1.00000	0.28930	0.28558
V41	V41	0.56350	0.54237	0.51652	0.43198	0.28930	1.00000	0.68095
V42	V42	0.55407	0.57368	0.59145	0.50066	0.28558	0.68095	1.00000
V43	V43	0.51297	0.51912	0.57817	0.52544	0.29426	0.63733	0.77803
V44	V44	0.45331	0.51126	0.49075	0.40820	0.19118	0.48975	0.49831
V45	V45	0.47298	0.57075	0.54829	0.50039	0.22809	0.49654	0.48530
V46	V46	0.43226	0.47288	0.49983	0.51988	0.24288	0.47071	0.47805
V47	V47	0.48475	0.55933	0.54912	0.52365	0.24549	0.56663	0.54504

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Correlations

		V43	V44	V45	V46	V47	V48	V49
V1	V1	0.43738	0.40881	0.44360	0.37506	0.41251	0.45094	0.44075
V2	V2	0.38758	0.39857	0.37606	0.38374	0.40775	0.41791	0.39999
V3	V3	0.36111	0.28817	0.33656	0.41972	0.34615	0.33003	0.38411
V4	V4	0.42001	0.41506	0.43620	0.37265	0.43872	0.43205	0.42788
V5	V5	0.39353	0.46521	0.34772	0.41760	0.52788	0.35319	0.46913
V6	V6	0.46200	0.38650	0.38807	0.38613	0.43450	0.41098	0.39420
V7	V7	0.44975	0.40727	0.46611	0.43621	0.44460	0.39140	0.44733
V8	V8	0.42993	0.47725	0.49800	0.47988	0.50830	0.47277	0.60097
V9	V9	0.38188	0.42113	0.35600	0.34708	0.45965	0.40905	0.45679
V10	V10	0.38907	0.32717	0.34970	0.42965	0.41913	0.41203	0.43206
V11	V11	0.36101	0.49029	0.44501	0.49088	0.52111	0.40478	0.48854
V12	V12	0.49107	0.43360	0.48110	0.45362	0.51817	0.44942	0.45736
V13	V13	0.42858	0.44209	0.40068	0.42989	0.44940	0.39531	0.50981
V14	V14	0.38304	0.42988	0.40898	0.47276	0.50265	0.43247	0.47697
V15	V15	0.43447	0.54222	0.40300	0.42189	0.51662	0.43977	0.51224
V16	V16	0.44508	0.40757	0.52009	0.48702	0.47859	0.45807	0.52259
V17	V17	0.53268	0.45416	0.46818	0.55555	0.54773	0.51424	0.54962
V18	V18	0.43964	0.38368	0.46009	0.47739	0.50410	0.41055	0.46725
V19	V19	0.48878	0.50699	0.49846	0.57018	0.58849	0.37232	0.52683
V20	V20	0.44303	0.58404	0.47388	0.50907	0.56521	0.39274	0.53540
V21	V21	0.56094	0.43836	0.48359	0.46497	0.50408	0.50550	0.48258
V22	V22	0.38665	0.33810	0.37385	0.28965	0.31003	0.38738	0.41383
V23	V23	0.44515	0.32793	0.41124	0.37115	0.39301	0.41309	0.40809
V24	V24	0.50017	0.38160	0.40080	0.45343	0.45078	0.45604	0.49824
V25	V25	0.45768	0.37747	0.36331	0.34651	0.40539	0.48598	0.42577
V26	V26	0.46103	0.39601	0.44984	0.45247	0.42336	0.43885	0.48800
V27	V27	0.53068	0.39061	0.44687	0.49401	0.46115	0.51007	0.46561
V28	V28	0.45862	0.37583	0.43917	0.43306	0.45948	0.40536	0.41893
V29	V29	0.52343	0.31094	0.41254	0.42824	0.44560	0.41994	0.45023
V30	V30	0.54899	0.38617	0.42403	0.48435	0.48866	0.47555	0.44782
V31	V31	0.56082	0.38701	0.47663	0.50300	0.51361	0.48048	0.49246
V32	V32	0.52406	0.45518	0.45069	0.46491	0.46955	0.47844	0.51542
V33	V33	0.42145	0.53147	0.42709	0.51206	0.54665	0.42319	0.53061
V34	V34	0.51561	0.55553	0.58772	0.58762	0.62149	0.54392	0.55776
V35	V35	0.53744	0.54037	0.56276	0.60383	0.62897	0.53534	0.60502
V36	V36	0.51297	0.45331	0.47298	0.43226	0.48475	0.51635	0.49098
V37	V37	0.51912	0.51126	0.57075	0.47288	0.55933	0.46115	0.49773
V38	V38	0.57817	0.49075	0.54829	0.49983	0.54912	0.46296	0.61542
V39	V39	0.52544	0.40820	0.50039	0.51988	0.52365	0.46561	0.47222
V40	V40	0.29426	0.19118	0.22809	0.24288	0.24549	0.22802	0.23057
V41	V41	0.63733	0.48975	0.49654	0.47071	0.56663	0.55182	0.49459
V42	V42	0.77803	0.49831	0.48530	0.47805	0.54504	0.56184	0.54670
V43	V43	1.00000	0.43441	0.44552	0.46946	0.54938	0.52648	0.49119
V44	V44	0.43441	1.00000	0.57434	0.57047	0.67706	0.52814	0.57516
V45	V45	0.44552	0.57434	1.00000	0.60097	0.63814	0.53481	0.57699
V46	V46	0.46946	0.57047	0.60097	1.00000	0.72329	0.52340	0.59120
V47	V47	0.54938	0.67706	0.63814	0.72329	1.00000	0.61578	0.68352

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Correlations

		V50	V51	V52	V53	V54	V55	V56
V1	V1	0.44497	0.43063	0.51347	0.46239	0.36793	0.43797	0.41489
V2	V2	0.43334	0.39266	0.47530	0.45348	0.34256	0.45666	0.44003
V3	V3	0.35719	0.39337	0.46401	0.43116	0.32938	0.41748	0.43346
V4	V4	0.45273	0.46090	0.48784	0.53412	0.45557	0.49996	0.51874
V5	V5	0.43284	0.39377	0.48446	0.41073	0.42321	0.51178	0.51627
V6	V6	0.44500	0.45474	0.48804	0.46779	0.35818	0.44455	0.41932
V7	V7	0.45083	0.44344	0.49696	0.55270	0.44618	0.52295	0.51902
V8	V8	0.57519	0.50320	0.53768	0.54718	0.50447	0.57014	0.54299
V9	V9	0.42142	0.36631	0.52346	0.47121	0.38421	0.46439	0.47069
V10	V10	0.36846	0.40438	0.46920	0.45206	0.37295	0.53157	0.47204
V11	V11	0.42087	0.46872	0.56406	0.48176	0.43758	0.51128	0.52066
V12	V12	0.42762	0.48874	0.52751	0.50254	0.41088	0.54874	0.50804
V13	V13	0.40780	0.47423	0.50095	0.49509	0.38811	0.47694	0.46684
V14	V14	0.43021	0.45696	0.52210	0.38054	0.45466	0.46103	0.47144
V15	V15	0.48306	0.52837	0.58916	0.51540	0.45601	0.53759	0.53660
V16	V16	0.51604	0.50938	0.56321	0.45693	0.42048	0.54035	0.57002
V17	V17	0.50662	0.48288	0.57325	0.55514	0.46327	0.53535	0.51722
V18	V18	0.46603	0.51134	0.49901	0.53543	0.46809	0.44530	0.47812
V19	V19	0.53764	0.51197	0.54495	0.49113	0.53527	0.48015	0.52768
V20	V20	0.53500	0.55047	0.64487	0.44673	0.47970	0.41134	0.49092
V21	V21	0.49694	0.52362	0.52561	0.45672	0.46671	0.47041	0.48788
V22	V22	0.38020	0.38960	0.39645	0.36800	0.31836	0.38317	0.37930
V23	V23	0.42339	0.39815	0.44427	0.42773	0.36526	0.45648	0.41860
V24	V24	0.43778	0.47726	0.52239	0.52451	0.45467	0.45695	0.49876
V25	V25	0.43159	0.44232	0.46513	0.45464	0.38024	0.48414	0.50056
V26	V26	0.44779	0.51084	0.57948	0.48419	0.47488	0.44353	0.45212
V27	V27	0.50342	0.47511	0.52575	0.51439	0.46997	0.48754	0.47764
V28	V28	0.45815	0.48360	0.41837	0.43656	0.48159	0.42416	0.46071
V29	V29	0.44544	0.44458	0.42826	0.45932	0.41256	0.42563	0.45402
V30	V30	0.47213	0.52778	0.42539	0.56222	0.50683	0.50055	0.49235
V31	V31	0.52288	0.52507	0.52270	0.53981	0.48915	0.47268	0.48832
V32	V32	0.52670	0.56004	0.55202	0.58880	0.52891	0.48875	0.55338
V33	V33	0.49414	0.50732	0.57930	0.44624	0.46412	0.50215	0.59194
V34	V34	0.58528	0.60410	0.65620	0.54919	0.57448	0.60450	0.64299
V35	V35	0.60498	0.58978	0.62107	0.57883	0.59313	0.56270	0.62728
V36	V36	0.49511	0.52955	0.49710	0.45157	0.47886	0.46337	0.48554
V37	V37	0.58442	0.56748	0.52278	0.51806	0.49789	0.50864	0.49229
V38	V38	0.55754	0.57863	0.57095	0.62360	0.51388	0.54972	0.56830
V39	V39	0.47878	0.49825	0.48386	0.52156	0.50603	0.45119	0.48423
V40	V40	0.22102	0.24696	0.23185	0.26725	0.25073	0.24953	0.23135
V41	V41	0.54985	0.57686	0.51179	0.52082	0.51966	0.52220	0.52154
V42	V42	0.58603	0.56279	0.51801	0.55810	0.50398	0.50002	0.55524
V43	V43	0.52777	0.50227	0.51084	0.51753	0.44943	0.45301	0.47993
V44	V44	0.59498	0.59752	0.67627	0.48505	0.52394	0.55078	0.63039
V45	V45	0.60086	0.58930	0.58583	0.50294	0.59740	0.57896	0.58124
V46	V46	0.57873	0.57466	0.62000	0.51554	0.58145	0.58211	0.60594
V47	V47	0.65531	0.67341	0.68879	0.56946	0.66163	0.67310	0.70753

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Correlations

		V57	V58	V59	V60
V1	V1	0.41132	0.44884	0.46540	0.43915
V2	V2	0.41104	0.41963	0.46392	0.47083
V3	V3	0.24255	0.30358	0.41654	0.44162
V4	V4	0.41651	0.42936	0.53923	0.48974
V5	V5	0.40281	0.37912	0.44496	0.49697
V6	V6	0.31993	0.34620	0.41336	0.44394
V7	V7	0.34535	0.36400	0.52096	0.51061
V8	V8	0.37755	0.34466	0.50762	0.58353
V9	V9	0.39862	0.40448	0.42214	0.46659
V10	V10	0.42042	0.45048	0.47887	0.44757
V11	V11	0.37963	0.40241	0.46760	0.49460
V12	V12	0.35086	0.38941	0.50086	0.53538
V13	V13	0.42584	0.42609	0.49191	0.50468
V14	V14	0.40996	0.29989	0.39720	0.51724
V15	V15	0.47008	0.45789	0.49037	0.53566
V16	V16	0.34179	0.38554	0.48609	0.56103
V17	V17	0.38024	0.42323	0.50301	0.56726
V18	V18	0.29883	0.31639	0.45007	0.47114
V19	V19	0.36487	0.29810	0.40578	0.53398
V20	V20	0.29388	0.24945	0.36984	0.48638
V21	V21	0.38534	0.35836	0.47966	0.46137
V22	V22	0.47367	0.45528	0.45167	0.41899
V23	V23	0.43754	0.44027	0.48800	0.45893
V24	V24	0.41831	0.40573	0.50742	0.48864
V25	V25	0.47398	0.43694	0.54006	0.46608
V26	V26	0.42848	0.46327	0.54447	0.49659
V27	V27	0.42556	0.45416	0.55149	0.51649
V28	V28	0.30459	0.30798	0.43399	0.43656
V29	V29	0.30607	0.33628	0.45917	0.47995
V30	V30	0.31157	0.31257	0.53910	0.46731
V31	V31	0.35725	0.37502	0.50660	0.46171
V32	V32	0.40988	0.36214	0.53061	0.54488
V33	V33	0.41164	0.33033	0.39729	0.47841
V34	V34	0.47020	0.43609	0.55854	0.55725
V35	V35	0.36602	0.33592	0.52058	0.61667
V36	V36	0.46460	0.42184	0.52392	0.55060
V37	V37	0.37324	0.33955	0.46799	0.46475
V38	V38	0.37968	0.45758	0.53850	0.57536
V39	V39	0.30909	0.30193	0.45695	0.46261
V40	V40	0.19850	0.19169	0.26986	0.24666
V41	V41	0.40289	0.33464	0.55089	0.53877
V42	V42	0.39644	0.37581	0.59745	0.57083
V43	V43	0.38981	0.39236	0.57328	0.50507
V44	V44	0.45797	0.41028	0.46809	0.58033
V45	V45	0.34097	0.34139	0.43593	0.53085
V46	V46	0.31590	0.35034	0.47315	0.56033
V47	V47	0.47229	0.38562	0.52147	0.58358

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Correlations

		V1	V2	V3	V4	V5	V6	V7
V48	V48	0.45094	0.41791	0.33003	0.43205	0.35319	0.41098	0.39140
V49	V49	0.44075	0.39999	0.38411	0.42788	0.46913	0.39420	0.44733
V50	V50	0.44497	0.43334	0.35719	0.45273	0.43284	0.44500	0.45083
V51	V51	0.43063	0.39266	0.39337	0.46090	0.39377	0.45474	0.44344
V52	V52	0.51347	0.47530	0.46401	0.48784	0.48446	0.48804	0.49696
V53	V53	0.46239	0.45348	0.43116	0.53412	0.41073	0.46779	0.55270
V54	V54	0.36793	0.34256	0.32938	0.45557	0.42321	0.35818	0.44618
V55	V55	0.43797	0.45666	0.41748	0.49996	0.51178	0.44455	0.52295
V56	V56	0.41489	0.44003	0.43346	0.51874	0.51627	0.41932	0.51902
V57	V57	0.41132	0.41104	0.24255	0.41651	0.40281	0.31993	0.34535
V58	V58	0.44884	0.41963	0.30358	0.42936	0.37912	0.34620	0.36400
V59	V59	0.46540	0.46392	0.41654	0.53923	0.44496	0.41336	0.52096
V60	V60	0.43915	0.47083	0.44162	0.48974	0.49697	0.44394	0.51061

Correlations

		V8	V9	V10	V11	V12	V13	V14
V48	V48	0.47277	0.40905	0.41203	0.40478	0.44942	0.39531	0.43247
V49	V49	0.60097	0.45679	0.43206	0.48854	0.45736	0.50981	0.47697
V50	V50	0.57519	0.42142	0.36846	0.42087	0.42762	0.40780	0.43021
V51	V51	0.50320	0.36631	0.40438	0.46872	0.48874	0.47423	0.45696
V52	V52	0.53768	0.52346	0.46920	0.56406	0.52751	0.50095	0.52210
V53	V53	0.54718	0.47121	0.45206	0.48176	0.50254	0.49509	0.38054
V54	V54	0.50447	0.38421	0.37295	0.43758	0.41088	0.38811	0.45466
V55	V55	0.57014	0.46439	0.53157	0.51128	0.54874	0.47694	0.46103
V56	V56	0.54299	0.47069	0.47204	0.52066	0.50804	0.46684	0.47144
V57	V57	0.37755	0.39862	0.42042	0.37963	0.35086	0.42584	0.40996
V58	V58	0.34466	0.40448	0.45048	0.40241	0.38941	0.42609	0.29989
V59	V59	0.50762	0.42214	0.47887	0.46760	0.50086	0.49191	0.39720
V60	V60	0.58353	0.46659	0.44757	0.49460	0.53538	0.50468	0.51724

Correlations

		V15	V16	V17	V18	V19	V20	V21
V48	V48	0.43977	0.45807	0.51424	0.41055	0.37232	0.39274	0.50550
V49	V49	0.51224	0.52259	0.54962	0.46725	0.52683	0.53540	0.48258
V50	V50	0.48306	0.51604	0.50662	0.46603	0.53764	0.53500	0.49694
V51	V51	0.52837	0.50938	0.48288	0.51134	0.51197	0.55047	0.52362
V52	V52	0.58916	0.56321	0.57325	0.49901	0.54495	0.64487	0.52561
V53	V53	0.51540	0.45693	0.55514	0.53543	0.49113	0.44673	0.45672
V54	V54	0.45601	0.42048	0.46327	0.46809	0.53527	0.47970	0.46671
V55	V55	0.53759	0.54035	0.53535	0.44530	0.48015	0.41134	0.47041
V56	V56	0.53660	0.57002	0.51722	0.47812	0.52768	0.49092	0.48788
V57	V57	0.47008	0.34179	0.38024	0.29883	0.36487	0.29388	0.38534
V58	V58	0.45789	0.38554	0.42323	0.31639	0.29810	0.24945	0.35836

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Correlations

		V15	V16	V17	V18	V19	V20	V21
V59	V59	0.49037	0.48609	0.50301	0.45007	0.40578	0.36984	0.47966
V60	V60	0.53566	0.56103	0.56726	0.47114	0.53398	0.48638	0.46137

Correlations

		V22	V23	V24	V25	V26	V27	V28
V48	V48	0.38738	0.41309	0.45604	0.48598	0.43885	0.51007	0.40536
V49	V49	0.41383	0.40809	0.49824	0.42577	0.48800	0.46561	0.41893
V50	V50	0.38020	0.42339	0.43778	0.43159	0.44779	0.50342	0.45815
V51	V51	0.38960	0.39815	0.47726	0.44232	0.51084	0.47511	0.48360
V52	V52	0.39645	0.44427	0.52239	0.46513	0.57948	0.52575	0.41837
V53	V53	0.36800	0.42773	0.52451	0.45464	0.48419	0.51439	0.43656
V54	V54	0.31836	0.36526	0.45467	0.38024	0.47488	0.46997	0.48159
V55	V55	0.38317	0.45648	0.45695	0.48414	0.44353	0.48754	0.42416
V56	V56	0.37930	0.41860	0.49876	0.50056	0.45212	0.47764	0.46071
V57	V57	0.47367	0.43754	0.41831	0.47398	0.42848	0.42556	0.30459
V58	V58	0.45528	0.44027	0.40573	0.43694	0.46327	0.45416	0.30798
V59	V59	0.45167	0.48800	0.50742	0.54006	0.54447	0.55149	0.43399
V60	V60	0.41899	0.45893	0.48864	0.46608	0.49659	0.51649	0.43656

Correlations

		V29	V30	V31	V32	V33	V34	V35
V48	V48	0.41994	0.47555	0.48048	0.47844	0.42319	0.54392	0.53534
V49	V49	0.45023	0.44782	0.49246	0.51542	0.53061	0.55776	0.60502
V50	V50	0.44544	0.47213	0.52288	0.52670	0.49414	0.58528	0.60498
V51	V51	0.44458	0.52778	0.52507	0.56004	0.50732	0.60410	0.58978
V52	V52	0.42826	0.42539	0.52270	0.55202	0.57930	0.65620	0.62107
V53	V53	0.45932	0.56222	0.53981	0.58880	0.44624	0.54919	0.57883
V54	V54	0.41256	0.50683	0.48915	0.52891	0.46412	0.57448	0.59313
V55	V55	0.42563	0.50055	0.47268	0.48875	0.50215	0.60450	0.56270
V56	V56	0.45402	0.49235	0.48832	0.55338	0.59194	0.64299	0.62728
V57	V57	0.30607	0.31157	0.35725	0.40988	0.41164	0.47020	0.36602
V58	V58	0.33628	0.31257	0.37502	0.36214	0.33033	0.43609	0.33592
V59	V59	0.45917	0.53910	0.50660	0.53061	0.39729	0.55854	0.52058
V60	V60	0.47995	0.46731	0.46171	0.54488	0.47841	0.55725	0.61667

Correlations

		V36	V37	V38	V39	V40	V41	V42
V48	V48	0.51635	0.46115	0.46296	0.46561	0.22802	0.55182	0.56184
V49	V49	0.49098	0.49773	0.61542	0.47222	0.23057	0.49459	0.54670
V50	V50	0.49511	0.58442	0.55754	0.47878	0.22102	0.54985	0.58603
V51	V51	0.52955	0.56748	0.57863	0.49825	0.24696	0.57686	0.56279

The FACTOR Procedure

Correlations

		V36	V37	V38	V39	V40	V41	V42
V52	V52	0.49710	0.52278	0.57095	0.48386	0.23185	0.51179	0.51801
V53	V53	0.45157	0.51806	0.62360	0.52156	0.26725	0.52082	0.55810
V54	V54	0.47886	0.49789	0.51388	0.50603	0.25073	0.51966	0.50398
V55	V55	0.46337	0.50864	0.54972	0.45119	0.24953	0.52220	0.50002
V56	V56	0.48554	0.49229	0.56830	0.48423	0.23135	0.52154	0.55524
V57	V57	0.46460	0.37324	0.37968	0.30909	0.19850	0.40289	0.39644
V58	V58	0.42184	0.33955	0.45758	0.30193	0.19169	0.33464	0.37581
V59	V59	0.52392	0.46799	0.53850	0.45695	0.26986	0.55089	0.59745
V60	V60	0.55060	0.46475	0.57536	0.46261	0.24666	0.53877	0.57083

Correlations

		V43	V44	V45	V46	V47	V48	V49
V48	V48	0.52648	0.52814	0.53481	0.52340	0.61578	1.00000	0.57757
V49	V49	0.49119	0.57516	0.57699	0.59120	0.68352	0.57757	1.00000
V50	V50	0.52777	0.59498	0.60086	0.57873	0.65531	0.65565	0.70691
V51	V51	0.50227	0.59752	0.58930	0.57466	0.67341	0.59860	0.70002
V52	V52	0.51084	0.67627	0.58583	0.62000	0.68879	0.61255	0.68197
V53	V53	0.51753	0.48505	0.50294	0.51554	0.56946	0.48602	0.58198
V54	V54	0.44943	0.52394	0.59740	0.58145	0.66163	0.53242	0.59348
V55	V55	0.45301	0.55078	0.57896	0.58211	0.67310	0.53948	0.53343
V56	V56	0.47993	0.63039	0.58124	0.60594	0.70753	0.59866	0.63795
V57	V57	0.38981	0.45797	0.34097	0.31590	0.47229	0.43939	0.44927
V58	V58	0.39236	0.41028	0.34139	0.35034	0.38562	0.42461	0.44367
V59	V59	0.57328	0.46809	0.43593	0.47315	0.52147	0.59835	0.53367
V60	V60	0.50507	0.58033	0.53085	0.56033	0.58358	0.57344	0.63002

Correlations

		V50	V51	V52	V53	V54	V55	V56
V48	V48	0.65565	0.59860	0.61255	0.48602	0.53242	0.53948	0.59866
V49	V49	0.70691	0.70002	0.68197	0.58198	0.59348	0.53343	0.63795
V50	V50	1.00000	0.71102	0.68266	0.60162	0.54621	0.54534	0.62438
V51	V51	0.71102	1.00000	0.72074	0.63253	0.64613	0.59382	0.68193
V52	V52	0.68266	0.72074	1.00000	0.59699	0.59021	0.59309	0.63445
V53	V53	0.60162	0.63253	0.59699	1.00000	0.66475	0.61793	0.64053
V54	V54	0.54621	0.64613	0.59021	0.66475	1.00000	0.66164	0.69820
V55	V55	0.54534	0.59382	0.59309	0.61793	0.66164	1.00000	0.76926
V56	V56	0.62438	0.68193	0.63445	0.64053	0.69820	0.76926	1.00000
V57	V57	0.38510	0.44994	0.40977	0.41362	0.41527	0.46405	0.53530
V58	V58	0.40283	0.37572	0.43612	0.47081	0.35681	0.43919	0.46410
V59	V59	0.57897	0.59655	0.55631	0.60528	0.51422	0.60724	0.62125
V60	V60	0.60042	0.61302	0.55866	0.56771	0.58170	0.60682	0.66599

The SAS System

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Correlations

		V57	V58	V59	V60
V48	V48	0.43939	0.42461	0.59835	0.57344
V49	V49	0.44927	0.44367	0.53367	0.63002
V50	V50	0.38510	0.40283	0.57897	0.60042
V51	V51	0.44994	0.37572	0.59655	0.61302
V52	V52	0.40977	0.43612	0.55631	0.55866
V53	V53	0.41362	0.47081	0.60528	0.56771
V54	V54	0.41527	0.35681	0.51422	0.58170
V55	V55	0.46405	0.43919	0.60724	0.60682
V56	V56	0.53530	0.46410	0.62125	0.66599
V57	V57	1.00000	0.65601	0.62894	0.50007
V58	V58	0.65601	1.00000	0.62942	0.49528
V59	V59	0.62894	0.62942	1.00000	0.69968
V60	V60	0.50007	0.49528	0.69968	1.00000

The SAS System

The FACTOR Procedure
Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2	3	4	5
1	0.56660	0.51352	0.47714	0.35552	0.24738
2	-0.67933	0.50913	-0.14464	0.50572	0.05126
3	-0.34453	-0.45277	0.78274	0.22784	-0.10816
4	-0.08525	0.48248	0.27705	-0.45078	-0.69282
5	-0.30249	0.19824	0.24896	-0.60228	0.66669

Rotated Factor Pattern

		Factor1	Factor2	Factor3	Factor4	Factor5
V47	V47	0.72539	0.26001	0.28665	0.09050	0.22029
V44	V44	0.68943	0.25329	0.11792	0.15031	0.20719
V52	V52	0.66669	0.37336	0.21166	0.24401	0.13181
V50	V50	0.65840	0.19468	0.31438	0.21717	0.18551
V20	V20	0.65569	0.34492	0.15346	0.22245	-0.18066
V51	V51	0.65141	0.19670	0.34739	0.18611	0.24749
V49	V49	0.63713	0.27692	0.25698	0.19151	0.23024
V46	V46	0.61345	0.27492	0.33368	0.08032	0.11104
V56	V56	0.59817	0.33076	0.28256	0.09621	0.42227
V45	V45	0.59246	0.22454	0.32644	0.14606	0.12684
V54	V54	0.59073	0.20147	0.36559	0.06634	0.29681
V35	V35	0.56935	0.32668	0.41881	0.18400	0.04576
V19	V19	0.54278	0.40031	0.29730	0.06025	0.00480
V34	V34	0.53938	0.37413	0.32512	0.24611	0.14440
V33	V33	0.53795	0.37489	0.18512	0.23060	0.00411
V48	V48	0.51112	0.16249	0.30542	0.29621	0.29284
V60	V60	0.49145	0.35925	0.29754	0.18951	0.36451
V37	V37	0.48276	0.15416	0.43658	0.24877	0.09319
V55	V55	0.48168	0.39133	0.29772	0.08727	0.41376
V21	V21	0.46204	0.24352	0.28245	0.38384	0.02099
V16	V16	0.34679	0.62431	0.21822	0.21694	0.06250
V12	V12	0.24551	0.59884	0.35915	0.21977	0.10743
V9	V9	0.22917	0.59805	0.17517	0.22887	0.14843
V2	V2	0.19157	0.59495	0.19216	0.33461	0.12248
V7	V7	0.24569	0.58226	0.39137	0.13183	0.10995
V10	V10	0.10789	0.57311	0.28947	0.26768	0.26476
V13	V13	0.28687	0.56589	0.18367	0.24391	0.17276
V15	V15	0.39392	0.56255	0.09068	0.25422	0.21698
V5	V5	0.36676	0.56111	0.01590	0.15866	0.21080
V11	V11	0.27658	0.54759	0.31855	0.17236	0.15871
V4	V4	0.24624	0.54584	0.24838	0.21430	0.23860
V14	V14	0.42430	0.53918	0.08269	0.21855	0.04169
V1	V1	0.22419	0.53645	0.19625	0.41055	0.09224
V17	V17	0.33467	0.52457	0.42663	0.22099	0.07556
V8	V8	0.41478	0.52025	0.30071	0.09312	0.13865

The SAS System

The FACTOR Procedure
Rotation Method: Varimax

Rotated Factor Pattern

		Factor1	Factor2	Factor3	Factor4	Factor5
V6	V6	0.23689	0.51907	0.30653	0.22897	0.01980
V3	V3	0.14503	0.50442	0.30604	0.13270	0.12123
V30	V30	0.21922	0.19436	0.74299	0.19039	0.15322
V31	V31	0.24461	0.29811	0.66965	0.27822	0.07456
V29	V29	0.17748	0.27625	0.62958	0.30096	0.03547
V28	V28	0.23404	0.25584	0.61774	0.16164	0.06055
V39	V39	0.39341	0.13905	0.56548	0.09893	0.11331
V18	V18	0.33094	0.37054	0.52278	0.04862	0.06859
V41	V41	0.42132	0.15268	0.51331	0.26465	0.16087
V43	V43	0.39460	0.15705	0.50914	0.35588	0.10217
V38	V38	0.40823	0.29266	0.50212	0.17375	0.21826
V42	V42	0.46032	0.19760	0.49822	0.31313	0.12085
V32	V32	0.38957	0.31208	0.48350	0.23144	0.10001
V36	V36	0.32561	0.26687	0.45281	0.30973	0.18042
V53	V53	0.41962	0.33049	0.44824	0.11827	0.33791
V40	V40	0.13639	0.13744	0.25536	0.11076	0.10616
V23	V23	0.16413	0.34790	0.26622	0.64627	0.10990
V22	V22	0.12469	0.31812	0.18530	0.63678	0.19300
V25	V25	0.15091	0.33279	0.27385	0.59462	0.26043
V27	V27	0.27631	0.31100	0.31963	0.58024	0.14621
V24	V24	0.23518	0.31841	0.36433	0.55230	0.12264
V26	V26	0.25612	0.32825	0.29513	0.48996	0.19507
V59	V59	0.32874	0.26156	0.35983	0.31336	0.55834
V58	V58	0.19086	0.28172	0.13103	0.35528	0.54801
V57	V57	0.29132	0.23116	0.07453	0.38028	0.54415

Variance Explained by Each Factor

Factor1	Factor2	Factor3	Factor4	Factor5
10.511091	8.818038	7.771824	4.879708	2.813176

Final Communality Estimates: Total = 34.793836

V1	V2	V3	V4	V5	V6	V7	V8
0.55360971	0.55455303	0.40143660	0.52312457	0.51922381	0.47232884	0.58203105	0.56101788

V9	V10	V11	V12	V13	V14	V15	V16
0.51527899	0.56563665	0.53271999	0.60772027	0.52559137	0.52708872	0.59155747	0.60861109

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V17	V18	V19	V20	V21	V22	V23	V24
0.62373684	0.52718399	0.54689840	0.65456800	0.50033747	0.59382060	0.64859222	0.60950580

V25	V26	V27	V28	V29	V30	V31	V32
0.62991912	0.53856333	0.63328906	0.53162138	0.59601683	0.69759154	0.68009976	0.54649053

V33	V34	V35	V36	V37	V38	V39	V40
0.51739472	0.61802898	0.64223112	0.51075504	0.51799004	0.58224786	0.51649358	0.12623766

V41	V42	V43	V44	V45	V46	V47	V48
0.56022273	0.61181701	0.57668440	0.61889883	0.54540576	0.58202507	0.73267908	0.55442587

V49	V50	V51	V52	V53	V54	V55	V56
0.63834231	0.65180703	0.67959602	0.70558511	0.61440205	0.61570522	0.65260845	0.73462569

V57	V58	V59	V60
0.58456909	0.55950061	0.71590081	0.62789113

The SAS System

The FACTOR Procedure
Rotation Method: Varimax

Scoring Coefficients Estimated by Regression

Squared Multiple Correlations of the Variables with Each Factor

Factor1	Factor2	Factor3	Factor4	Factor5
0.90336221	0.87340472	0.87294974	0.82461084	0.79641064

Standardized Scoring Coefficients

		Factor1	Factor2	Factor3	Factor4	Factor5
V47	V47	0.19398	-0.04986	-0.05206	-0.09065	0.03481
V44	V44	0.13838	-0.03306	-0.11028	0.01209	0.02578
V52	V52	0.15766	0.01378	-0.10342	0.03794	-0.07915
V50	V50	0.13262	-0.08752	-0.02060	0.02523	-0.01517
V20	V20	0.17178	0.00765	-0.08056	0.06983	-0.26600
V51	V51	0.11481	-0.09887	0.01061	0.00476	0.02428
V49	V49	0.09756	-0.03077	-0.05904	0.00782	0.05010
V46	V46	0.08412	-0.00485	0.01823	-0.05518	-0.04519
V56	V56	0.07785	-0.00230	-0.03818	-0.13086	0.23943
V45	V45	0.08181	-0.05103	0.01912	-0.00715	-0.02012
V54	V54	0.07051	-0.05477	0.03271	-0.06847	0.08347
V35	V35	0.08071	-0.00489	0.03873	-0.01101	-0.11373
V19	V19	0.06504	0.05577	-0.00251	-0.06885	-0.08028
V34	V34	0.07147	-0.00158	-0.02770	0.02131	-0.03666
V33	V33	0.08015	0.02690	-0.05518	0.03463	-0.10530
V48	V48	0.04125	-0.07727	-0.00631	0.05571	0.05845
V60	V60	0.03495	0.01362	-0.01800	-0.04977	0.11768
V37	V37	0.04981	-0.06509	0.04320	0.04005	-0.03757
V55	V55	0.00337	0.03949	0.00117	-0.11121	0.16832
V21	V21	0.05936	-0.03973	-0.02913	0.10381	-0.08419
V16	V16	-0.00989	0.15627	-0.04512	-0.02763	-0.08065
V12	V12	-0.07124	0.15261	0.03812	-0.05259	-0.03496
V9	V9	-0.04225	0.11207	-0.02692	-0.01789	0.00830
V2	V2	-0.04966	0.12507	-0.04367	0.04343	-0.02545
V7	V7	-0.05717	0.13757	0.05155	-0.09153	-0.02556
V10	V10	-0.09966	0.12175	0.00938	-0.02932	0.09061
V13	V13	-0.01386	0.10546	-0.05039	-0.01168	0.01017
V15	V15	0.00564	0.10888	-0.09041	-0.00097	0.03800
V5	V5	0.00937	0.12482	-0.10367	-0.03209	0.02992
V11	V11	-0.05240	0.10400	0.03507	-0.05278	0.00548
V4	V4	-0.03927	0.10339	-0.00866	-0.04054	0.04464
V14	V14	0.05507	0.10119	-0.09753	0.01389	-0.07378
V1	V1	-0.02987	0.10189	-0.05262	0.09130	-0.04324
V17	V17	-0.02982	0.08166	0.06175	-0.03554	-0.05022
V8	V8	0.01507	0.10523	0.00827	-0.10153	-0.01965

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The FACTOR Procedure
Rotation Method: Varimax

Standardized Scoring Coefficients

		Factor1	Factor2	Factor3	Factor4	Factor5
V6	V6	-0.03668	0.09425	0.01974	-0.00250	-0.06435
V3	V3	-0.06434	0.09553	0.03952	-0.05897	0.00446
V30	V30	-0.09389	-0.05621	0.26909	-0.06284	0.01387
V31	V31	-0.08408	-0.01018	0.19718	0.00356	-0.04662
V29	V29	-0.07308	-0.01488	0.17067	0.03252	-0.07883
V28	V28	-0.05761	0.00304	0.15770	-0.04771	-0.03163
V39	V39	0.01009	-0.05576	0.12832	-0.05253	-0.00751
V18	V18	-0.02519	0.05027	0.10214	-0.09404	-0.02262
V41	V41	0.01513	-0.08095	0.08553	0.03183	0.00069
V43	V43	0.01723	-0.09374	0.08538	0.09532	-0.05122
V38	V38	-0.01001	-0.01665	0.09894	-0.05428	0.04482
V42	V42	0.05407	-0.09264	0.09334	0.07540	-0.06933
V32	V32	0.00103	-0.00199	0.06848	-0.00789	-0.03334
V36	V36	-0.01528	-0.02287	0.05708	0.02963	0.01885
V53	V53	-0.02925	0.02145	0.07386	-0.10762	0.13427
V40	V40	-0.00787	-0.00320	0.02218	-0.00689	0.01074
V23	V23	-0.03570	-0.02936	-0.03612	0.26076	-0.06104
V22	V22	-0.03380	-0.02577	-0.05061	0.21540	0.00713
V25	V25	-0.06189	-0.02754	-0.02959	0.21005	0.04218
V27	V27	-0.00496	-0.05194	-0.02859	0.22117	-0.03369
V24	V24	-0.03378	-0.03661	0.02030	0.17978	-0.05327
V26	V26	-0.02075	-0.01817	-0.01409	0.11920	0.01628
V59	V59	-0.07186	-0.06401	0.02449	0.00776	0.36041
V58	V58	-0.04171	-0.01937	-0.04596	0.04864	0.22120
V57	V57	-0.01138	-0.04305	-0.08547	0.09694	0.22317