A Comparative Analysis of Continuous Improvement Approaches Among Trade-Contractors

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Executive Summary

Continuous improvement methods are increasingly adopted in the execution of construction projects, with several general contracting companies applying a wide variety in their organizations. However, the adoption of these methods by trade contractors is lagging. To fill this gap, the current study compares how trade contractors adopt and sustain continuous improvement processes, training, and methods, based upon a framework of continuous improvement principles in their organizations. For this purpose, seven case studies were selected from successful adopters among trade contractor companies. These cases illustrate how a trade contractor can employ continuous improvement initiatives to improve their operations and construction processes. The paper presents a comparative analysis of the approaches each contractor applies in its organization to present common elements of successful contractors and highlight some variations among the firms. By highlighting similarities and differences in how each pursues their methods and improvement process, the path to achieving continuous improvement for the trade contractor community can be more clearly identified.

The results of the comparative analysis indicate that although there are many similarities in how each company consolidates continuous improvement approaches into their tasks and activities, some variations in how they implement these approaches were recognized, differentiating a highly successful firm from its peers. These attributes are embedding continuous improvement into the mentality and culture of the company, incorporating training programs into an active culture of coaching and mentoring to provide employees with a comprehensive insight into the company's culture, processes, and standards, empowering field leaders to take responsibility for CI initiatives, defining standard processes for their operations and balancing empowerment of their personnel with standardization, high emphasizing on identification and elimination of waste for the entire production process, using the PDCA concept to evaluate the effectiveness of their processes or approaches to pursue continuous improvement, highlighting small improvements rather than trying to achieve large transformational changes, widely using Visual Management to enhance information sharing and raise awareness, and ultimately, searching for ways to simplify their operations by breaking processes into smaller manageable pieces. All trade contractor organizations can consider the provided approaches to start their transformation or become more successful adopters.

1. Introduction

Despite the wealth of literature concerning continuous improvement (CI) in construction, more work must be performed targeting trade contractors. We have yet to find a comprehensive analysis of the continuous improvement methods and practices most applicable to this community. However, the question of how a trade construction company can adopt and maintain these practices needs to be clarified. This study investigates how successful adopters currently use production methods and continuous improvement principles among trade contractors.

During the past few years, several case studies of construction companies recognized for their production approaches and continuous improvement emphasis have been conducted. In most cases, these studies offer limited generalizations outside of the specifics of one case or firm. This limits the ability of others to benefit from the findings that apply to a broader range of organizations. To fill this gap, the present study offers a broader and varied base for discussion based on seven case studies from successful continuous improvement adopters within the trade contractor community. For this purpose, data collected from the case studies were used for a comparative analysis to understand how and why different strategies and continuous improvement methods contribute to that success. The analysis and compilation of the methods used should be of value and interest to trade contractors. Practical recommendations to guide trade contractors in their continuous improvement efforts are presented.

2. Background Research

Continuous improvement principles offer notable benefits to company operations while simultaneously improving quality, costs, and cycle times of production. Therefore, many construction companies employ these principles and methods for their projects to improve the quality of their work and the efficiency of their operations. However, the degree to which a construction company can benefit from adopting CI practices varies. The general pattern within the industry reveals that prominent methods are primarily adopted by general contractors (GC) or construction management companies (CM), with trade contractors lagging in adoption.

Based on the current status of continuous improvement methods by trade contractors in the construction industry, several barriers prevent their widespread adoption (Asadian et al., 2023), including cultural and human factors, management commitment and support, skills and knowledge, fragmentation and procurement, and resources. This suggests the need for a deeper dive into the pathways and approaches that may better resonate with the trade community. Despite this need, little previous research has attempted to explore CI practices and initiatives that trade contractors can use to boost their performance and business outcomes. Depicting how successful trade contractors embark on continuous improvement in their organizations can help new adopters understand and customize the adoption and selected methods for their own companies. As a result, this report aims to perform comparative analyses of implementation in practices, developments, and specifications across seven case studies among trade contractors in the United States.

Conducting a comparative study among seven successful adopters, the study will help the construction community understand the similarities and differences in how various trade contractors can implement CI practices for their projects from a practical point of view. This study does not intend to offer a guideline to explain how a construction company should adopt these initiatives or propose the best approach for a particular construction organization to take. Still, it will provide additional knowledge regarding how an array of methods, training approaches, and

processes can be employed. Meanwhile, the lessons derived from the practices of these construction companies can provide further context and insight to trade peers on.

3. Methodology

This section explains the background for the research approach used to compare initiatives across trade contractors' implementation. First, this section provides an overview of the comparative analysis between different case studies. A brief description of the seven case studies is provided, and a discussion of the selection criteria follows. Finally, the data collection process and case study protocol are described to explain how the authors gathered data and analyzed the adopted parameters.

3.1. Comparative Analysis

A comparative analysis is a subtype of analysis in which two conditions must be met (Pickvance, 2001):

- More than one case must be assessed.
- Rather than simply describing something, an attempt should be made to explain the observed differences or similarities.

In this respect, a comparative analysis examines similarities and differences in several ways: values of variables, patterns of relations between variables, and occurrences of events or patterns of events. According to Pickvance (2001), the purpose of comparative analysis is to examine a small number of cases holistically to understand the processes that underlie observed similarities and differences. One can attain this goal from examples where similar conditions would predict similar outcomes or determine if similar or different outcomes could be explained by differences in conditions.

It should be noted that the study's goal is to establish a framework to identify key aspects of continuous improvement implementation within trade contractor organizations. A better understanding of the similarities and differences between different contractors can provide insights into how adopters can begin their efforts at improvement and possibly company transformation.

3.2. Case Studies: Selection Criteria and Companies' Characteristics

Yin (2003) defines a case study as a study in which a single case or a small number of cases are selected in their real-life context. Data obtained from these cases are analyzed in a qualitative manner, without manipulation. This method is often valuable in understanding a phenomenon in greater detail. According to Dul and Hak (2007), practice-oriented case studies describe the design, implementation, and evaluation of some interventions, such as the adoption of continuous improvement methods, to illustrate the usefulness of an approach to a specific

company or situation. Such studies use theories in practice to contribute to industry knowledge and support actions. Therefore, research into continuous improvement would be considered a practice-oriented case study.

Using seven different trade contractors, this section examines the adoption process and alignment of continuous improvement for business outcomes in different contexts. Case studies attempt to capture trade contractor experiences, including both challenges and successes, resulting from their approaches. To understand how adopting these methods aligns with a company's performance and workforce outcomes, the authors gathered observational field notes, interview transcripts with personnel, written documentation of firms' performance, and other material objects, such as photos or brief videos. Using direct evidence from current adopters, these cases help to gauge how continuous improvement has impacted their operations.

The selection of appropriate cases is critical to developing valid research that can provide guidance to other construction firms. Therefore, finding good representative companies to study is critical in selecting cases. Choosing multiple case studies from different disciplines and locations helped the authors reach more compelling results, making the overall analysis more robust. To evaluate the possible instances of the case study, the following criteria were considered:

- Be a trade contractor
- Have previous experience with continuous improvement methods (minimum five years)
- Identify different firms with a balance across disciplines and specialties (Diversity)
- From different geographical locations in the US (Generalization)

The selection of trade contractors is fairly self-explanatory in the focus of the research. An important note is an emphasis on having trade contractors with more than five years of experience using continuous improvement methods. Having conducted a preliminary discussion with the Industry Advisory Group (IAG) on the selection criteria, it was decided that five years seems an appropriate minimum criterion. It might take several years for a company to implement changes and realize the benefits across the organization. Since the research wants to study this adoption, a longer time frame is required. Furthermore, by pursuing three or more case studies, the diversity of experiences and ability to compare the consistency, or variability, in the different methods and processes is expected to be richer for understanding the adoption process. The selection of geographical variation is intended to help control for potential market or cultural factors that may influence how the adoption of continuous improvement within a specific community may skew results, as well as support broader interest in results.

Once the case study criteria and a list of potential companies were identified, the next step was to reach out to each in order of descending priority to ensure access to necessary information, interviews with key personnel, and documentation to successfully complete each case study. To verify this information, a kick-off meeting was held with the firm contacts to discuss the research

goal and steps, as well as confirm access to the information needed. The logistics for conducting the case study with the point of contact were then planned if all was approved and appropriate. Ultimately, seven case studies were conducted, with the firm details summarized in Table 1.

Table 1. Case Studies Overview

Characteristics	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Company Longevity (years)	100+	30+	50+	40+	100+	90+	100+
Headquarter	CA	CA	OH	PA	IA	MN	IA
# offices across the US	16	6	17	2	3	4	8
Specialty	Electrical	Framing & Drywall	Concrete	Electrical	Electrical	Electrical	Piping + Sheetmetal

Technical memos capturing the full case studies in detail and how each company implements continuous improvement methods in their organization can be found at: https://fieldcrewhuddle.leanconstruction.org/resources/

3.3. Data Collection

Data collected from case studies were developed into a report for each trade contractor studied. These technical reports serve as a baseline for the comparative analysis to understand how and why different adoption strategies and methods contribute to performance. We expect this step's findings to help validate the capability assessment for trade contractors using continuous improvement principles, with the potential to help them navigate the possible methods. Ultimately, practical recommendations to guide trade contractors in their continuous improvement efforts will be summarized.

Data collection consisted of two main steps: observation of the offices, job sites, and shop facilities to understand how these construction companies adopt continuous improvement principles into their operations, as well as how they incorporate these principles into their projects. The research team then conducted interviews with several individuals to obtain a more in-depth understanding of the company's approach and confirm the findings from direct observations. Each case study was undertaken through a two-day visit to the company's offices and included visits to a project, headquarters, and production innovation/prefabrication facilities. During the visit, the researchers interviewed personnel from the field, project management, company leadership, and leaders from several departments, including payroll, IT, safety, and construction design. In addition to interviews, the tours of the project site, office, and production facility served as observational data collection to capture ongoing operations, document how methods were implemented, and observe the behaviors of personnel in implementing continuous improvement principles.

At least eight interviews were conducted for each company to obtain as much information as possible, typically lasting 45-60 minutes. These interviews were used to explore themes of interest to these successful adopters. In addition to the two main steps, the data collection also used other documents, such as the company's course descriptions, the performance tracking metrics, and the operational models, which incorporated continuous improvement principles to better understand how each organization implements its initiatives. These documents also allowed the researchers to confirm and verify the information obtained from observations and interviews. The general information about 7 cases is presented in Table 2.

Table 2. Details of cases and interviews

Description	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Specialty	Electrical	Framing & Drywall	Concrete	Electrical	Electrical	Electrical	Piping + Sheetmetal
*Location (State)	Arizona	California	Washington	Pennsylvania	Iowa	Minnesota	Iowa
# of Observation							
Office	2	1	1	1	1	1	1
Job site	2	2	2	1	3	1	2
Shop Facility/ Prefab Facility	1	1	1	1	1	2	3
Interviews Conducted							
Higher Management	1	1	3	5	3	6	7
Lean Director / Coach	2	2	1	0	0	0	1
Field Leaders	2	2	2	2	3	9	7
Shop Manager	1	1	1	0	1	1	4
Safety Manager	0	1	0	0	0	0	1
IT Manager	0	1	0	0	0	0	0
Financial Manager	0	1	0	1	0	0	0
BIM Experts	2	0	0	1	1	0	3
Project Engineer	0	0	1	0	1	0	3
Total # of Interviews	8	9	8	9	9	16	26

4. Results and Discussion

The case studies aim to understand what it means to successfully implement continuous improvement methods and principles within a trade contracting firm. Each organization is unique; thus, no two companies will implement principles and methods in the same fashion. Therefore, the depth of the research is in understanding how these principles can be framed or aligned to any trade contractor and how that framework might be used to support the elimination of wasteful practices and create momentum for continuous improvement in

delivering successful projects. This can be achieved by searching for similar themes that these cases adopted to support methods and behaviors in their organizations.

The comparative analysis among the case studies started with an in-depth study of technical reports, interview notes and other observations to capture similarities across companies' approaches that help them apply continuous improvement. This step helped identify eight capabilities among these companies that commonly help them to succeed. To understand how these observable capabilities were aligned with management principles from Toyota Way (Liker, 2004), a comparison was made and summarized in Table 3.

Table 3. Observable Capabilities and related Continuous Improvement Principles

Observable Capabilities	Principle (Liker,2004)
Cultural and Organizational Values (Company attitude towards continuous improvement)	Become a learning organization through reflection and continuous improvement.
Training (Invest in their people)	Develop exceptional people and teams who follow the company's philosophy.
Mentoring and Cultivating Field Leader (Engaging & Empowering)	Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.
Standardization (Standard Tasks/ Assemblies)	Standardized tasks are the foundation for continuous improvement & employee empowerment.
Process-based Approach (Process Mapping)	Create continuous process flow to bring problems to the surface.
Visual Management	Use visual control so no problems are hidden.
Access to better tools/equipment/organizing	Use only reliable, thoroughly tested technology that serves people and processes.
Systematic Process (Empowering problem-solving mentality)	Make decisions slowly by consensus, thoroughly considering all options, implement decisions rapidly.

In the next step, to compare the implementation status of these observable capabilities within each case study, the rating system, shown in Table 4, was used. This rating system was suggested to analyze common processes and key aspects of continuous improvement implementation in case studies.

Table 4. Rating System for Implementation status

Status	Mark	Explanation
Not Observed	○	Evidence of adoption was not noted or directly observed during the case study.
Partially Implemented	◒	Evidence of the approaches was noted in some interviews or partially observed – suggesting some use but not standard across operations.
Fully Implemented	●	The approaches were commonly noted in interviews and/or observed as standard elements in company operations.

In the following sections, the authors discuss each of the capabilities across the seven case studies, focusing on the approaches they pursued, as well as the degree to which they implemented those approaches. This will help to highlight the similarities and differences between these companies' approaches that help them apply continuous improvement principles and methods. Observed instances were also provided to help better realize how each approach is being observed in the organizations.

1- Culture and Organizational Values

The first observable capability among these organizations is their culture and organizational values, which implies the companies' attitudes toward continuous improvement. These principles have affected their relationships with both their employees and customers. Using the rating system, each approach's implementation status was identified based on the evidence observed in each case study. In Table 5, each column represents each company and the cases were arranged based on their implementation status, from "Fully Implemented" to "Not Observed."

Table 5. Common Approaches in Culture and Organizational Values

Approaches	Highest						Lowest
Align continuous improvement principles with **organizational values**	●	●	●	●	◒	◒	◒
Adopt continuous improvement approaches in **long-term goals**	●	●	●	●	●	●	◒
Create an **organizational environment** that enables continuous improvement	●	●	●	◒	●	◒	◒
Empowering everyone to pursue continuous improvement	●	◒	◒	●	◒	◒	◒
Develop a **continuous improvement culture** in all divisions/ departments	●	●	●	●	○	◒	○
Consider employees as **internal customers**	●	●	●	◒	◒	○	○

*Note – company order changes for each table to re-order from highest to lowest observed adoption

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A review of all cases revealed several similarities partially or fully observed across all the firms. First, embedding continuous improvement principles with company core values creates a natural alignment that allows CI methods to be easily grounded in how each firm does business, treats people, and makes money. Closely aligned with this approach was having the methods and processes related to continuous improvement efforts embedded into long-term goals, creating an organizational culture that supports CI, and trying to decentralize efforts so that everyone across the company is engaged in or empowered to pursue CI in their work. Many elements are needed to sustain these approaches. Still, the clear references to the principles in the company's core values serve as guiding directions for all the company personnel to behave and create company routines that align with company values. Taking this further, defining company goals that support method adoption and creating a supportive environment are logical extensions for operationalizing those core values into company culture within the office or through jobsite team environments.

For example, one of the firm's core values was focused on setting their own direction. In their goals, they emphasized field leader training on certain planning methods that allow foreman to plan their work and empower each worker through daily huddles. The result is that the foreman is able to come to project meetings with general contractors with a very clear understanding of the work their crew performed, constraints affecting their production, and any safety concerns, as well as a clear plan for where and how they want to work. That puts them in a strong position when planning and coordinating with the GC or other trades. That process is ingrained in their values but trickles down to the culture, goals, training, and daily routines of crews in the field.

While less common, the cases that stood out from other companies were more successful at empowering their employees to engage in the continuous improvement process. By constantly presenting and communicating fundamental concepts and ideas that build on core values, leadership empowers employees to do their work better, encouraging creative solutions to improve daily tasks in incremental steps. One electrical contractor coined the simple phrase, *"fix what bugs you,"* to make the CI culture simple to understand and easy for employees to be empowered. A great example was observed in a payroll office process that used CI to reduce craft workers' paperwork time. As the accounting lead framed it – they are in the construction business – so they make money when the craft workers are in the field, building the project. It's the payroll's job to make the paperwork as simple and streamlined as possible, so workers do not have to take extra time to fill it out or need to return from the field to a job trailer to correct mistakes. To fix it, they developed targeted training for the project leads responsible for helping craft workers fill out employment papers, such as I9 forms, to reduce errors. Over several iterations, they developed a streamlined but simpler electronic form that allowed the workers to cut down on filling out extra or redundant information that occurred throughout the complex forms. This view of the craft as the customers they serve allowed a different lens to save time and money but hints at the potential benefits of embedding these values and approaches across the different operating units of the firm.

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While the change or specific approach adopted by one company may not be the perfect fit for the other, the similarities mentioned above have been recognized in how successful adopters align the adoption of continuous improvement within their organizations. If a trade contractor company wants to fully benefit from deploying CI, workforce engagement should be emphasized. Otherwise, if they change their direction without implementation, as Roth (2006) explained, benefits will diminish from their change program investments.

2- Training

As part of the CI implementation process, the organization should ensure that all employees understand the importance and proper use of company culture, methods, and tools (Cudney & Elrod, 2011). To ensure that all employees understand how to employ various methods or tools, all seven companies pay attention to the training programs provided for their employees. The approaches they employed in this respect can be found in Table 6. Similar to Table 5, each column represents one company, and the cases were arranged based on their implementation status, from "Fully Implemented" to "Not Observed."

Table 6. Common Approaches in Training

Approaches	Highest						Lowest
Develop **training portfolios** as an integral part of their operations.	●	●	●	●	◐	◐	◐
Training is **a core activity** for all employees	●	●	●	●	◐	◐	○
Balance of **CI training** with **technical methods training**	●	●	●	●	●	◐	◐
Invest in internal training and ongoing improvement of training quality	●	●	●	●	◐	◐	○
Provide training programs **beyond the industry standard** for **craft workers**	●	◐	●	○	◐	○	○
Define **specific certifications** for training programs	●	●	○	○	○	○	○

*Note – company order changes for each table to re-order from highest to lowest observed adoption

Comparing the common approaches these companies used to train their personnel illustrates that all seven organizations have developed well-defined training portfolios that include predefined training courses. They realized the value of investing in training employees and craft in CI principles and practices to improve their operations; thus, they view training programs as core activities rather than extracurricular activities, emphasizing the value of these programs for consistency and quality of how they perform their work. Adopting this mindset, all of these firms spent considerable time and investment in providing training to their employees. Many of them developed training content internally and employed CI in their training program topics, with a special concentration on balancing the CI principles and methods with the technical methods of their operations, as well as internal standards or operating procedures. To achieve this goal, they

provided prioritized training to their employees, containing both fundamental principles of CI and technical aspects of their operations. For example, in addition to offering training courses, another training approach that some electrical contractors implemented was through preparing in-house, brief recorded videos on CI concepts or examples to share with all employees. LinkedIn Learning was another resource for their personnel on selected topics to help them better comprehend fundamental CI principles and how they can be implemented in their activities.

Analyzing the training approaches across these companies revealed that for successful organizations, the training was further embodied in the ongoing pursuit of excellence in the continuous improvement processes. Embedding the methods and principles associated with CI into a training curriculum provides a consistent platform and message to spread values and culture to the entire organization. Under this mindset, the core values, such as respect for people, continuous improvement, trying to achieve perfection, and leadership, are embedded across operating units, divisions, and departments, from field personnel and project management to IT and Payroll. For example, one of the core features of one of the electrical contractors in implementing continuous improvement appears to stem from their ongoing dedication to training, notably field leadership, in CI principles and a shortlist of core methods they deploy on a consistent basis for their projects. In these companies, training on CI methods, namely 5S, Visual Management (VM), and Last Planning System (LSP)/ Weekly Work Planning and encouraging and empowering everyone to use them throughout the company activities was apparent. To encourage and support the implementation of these methods and concepts, several case studies employed a certificate or other similar system to recognize the completion of key levels of training. However, variations were observed among these firms in how they defined certification to help encourage and recognize training and advancement. For example, one of the electrical companies employed the belt program through the Global Leadership Institute. They developed a yellow and green belt program which comprised a deeper dive into CI principles and tools and how to apply them to construction projects. Another case study defined the Bronze Certificate all employees need to gain during their first year of employment.

The analysis also revealed some differences in their training approaches. Training programs vary in focus from specifically concentrating on CI principles and methods to having separate training programs for their operations and CI knowledge. As an illustration, the concrete contractor defined two separate "Five Quarters" and "Study Action Team" approaches for training their personnel; the former concentrates on their operational process, while the latter tries to help them understand the philosophy of lean using Toyota Way. They had a rotation program for all new employees to earn their 'field degree.' This rotated them through five roles, typically for two to three months at a time, to develop core knowledge of the value-adding processes at the heart of their business. In addition to this program, all team members participate in ongoing training to ensure all employees understand their operational model and procedures. They also employ the "Study Action Team" approach, with rolling training using the Toyota Way to introduce lean philosophy as personnel move toward leadership positions.

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In contrast, other cases tried to integrate CI principles' application within its operations in establishing the training portfolio. Comparatively, successful companies emphasized providing training programs beyond the industry standards for their craft workers. For instance, as a union contractor, one of the electrical companies defined training programs as a way to be an appropriate complementary resource to training provided to their union craft workers. They both supported and benefited from the training provided to union craft workers in their careers, moving from apprentices to master electricians. They started the training program by investing in fully understanding the skills and capabilities of each worker sent from the union hall to work for them by asking each worker to engage in a skill test and then supporting further training and mentoring above and beyond the high standards the union has already set. This helped instill the value of continuous improvement created through the union apprenticeship mentoring model, as well as provide value back to the workers directly by helping them grow their skillset and enhance theirs.

3- Mentoring and Cultivating Field Leader

Another common theme in continuous improvement approaches for all these cases is a strong emphasis on extending beyond training to active mentoring programs and efforts to cultivate leaders, especially field leaders, as indicated in Table 7.

Table 7. Common Approaches in Mentoring and Cultivating Field Leaders

Approaches	Highest						Lowest
Empowering people through guidance, standards, and flexibility	●	●	●	●	●	◗	◗
Courses for training **field leaders**	●	●	●	●	●	◗	○
Develop and **promote people** into leadership roles	●	●	●	●	●	◗	◗
Emphasis on both **technical and leadership training**	●	●	●	●	●	●	●
Different mentoring programs to **develop leaders and grow coaches**	●	◗	◗	◗	◗	○	○

*Note – company order changes for each table to re-order from highest to lowest observed adoption

A review of all cases revealed that they provide new hires mentors with thorough onboarding into the companies' culture, processes, and standards. Once personnel moves into their roles, they are provided with different mentors, such as receiving mentorship in those roles from their supervisors. For some companies, this approach and culture have been extended through an organic approach to succession planning that has encouraged all company leaders to consider their mentees as their future replacements. This compels leadership to use an empowerment model that encourages the mentees to more quickly and more thoroughly develop the capabilities and competencies needed for these future roles.

Similarly, it was observed in some cases that when they hire someone from another firm into a more senior role, they pair the new employee with an experienced person for approximately six months to support their transition. By developing objective, task-oriented mentoring programs, they concentrated on the foreman level, as they have the most influence over the workforce, in an attempt to support the development of their burgeoning management skills and related soft skills. However, the training did not start when workers reached foreman status, one unique program offered leadership and cross-functional training across all aspects of the company to apprentices in their final year. The company commented that the craft that was part of this program more quickly rose into leadership.

Another common attribute arising from these mentoring efforts was the link with internal promotions. This was apparent as many managers explained in interviews that they came from the field. By defining mentoring programs to include both the technical work of planning and installing work in the field, with aspects of management and leadership, those craft employees with natural leadership potential more quickly and consistently rose to the top. The effectiveness of these programs made some cases stand out from other companies concerning their mentoring approaches and internal development. Providing proper mentoring programs that boost their field leaders' technical and management skills empowers them to take ownership of the CI initiatives in the field. At the same time, they tend to naturally serve as a role model and mentor for their crews.

4- Standardization

Standardization was the next concept that widely being implemented by all case studies, used in creating consistent approaches, resources, agendas, or other processes that could be easily ported across projects (Table 8).

Table 8. Common Approaches in Standardization

Approaches	Highest						Lowest
The standardization of **work processes**	●	●	●	●	◐	◐	◐
Reduce variation whenever possible	●	●	●	●	◐	◐	◐
Track, share, and display key metrics that result from production standards and common work practices	●	●	◐	◐	●	◐	◐
Tactics for standardization embody the **nature of the work**	●	●	●	●	●	●	◐

*Note – company order changes for each table to re-order from highest to lowest observed adoption

Another common theme observed in all these case studies is their efforts to employ standards to make their work easier. To pursue this goal, in alignment with mentoring programs and cultivating leaders, all these companies commonly concentrate on balancing the empowerment of their people with standards and structure that provide both guidance and flexibility. Empowering their people allows them the authority and flexibility to make their own plans, decisions and, at times, mistakes. While at the same time, they encourage the use of company standards through onboarding and ongoing training. These provide structure and guidance regarding reference checklists for tasks, such as starting up a new project and standard processes, like production planning for prefabrication or modeling at the start of projects. Thus, teams are expected to use standards but are enabled to try new things regarding how they can mold or fit the company's processes to the unique project requirements.

The review of how these cases adopt standardization for their projects revealed that they match the scale of their work with the standardization approach as another common approach among successful adopters. For example, the electrical contractors use standardization in grouping parts and assemblies sent to job sites from their prefabrication facility. Using standardization as a solution to reduce variation, they prepare components in kitting packages for their field personnel. When sending the assemblies out to projects, the shop groups assemblies by area and puts them onto wheeled carts or cages. This standard approach enables workers to quickly gather the necessary items to work continuously in a room or building section without frequently pausing to find or even unbox materials. It also saves them time and effort by keeping their materials for current, and future tasks close at hand. However, due to the nature of other types of construction tasks, from concrete to Sheetmetal work characteristics, they did not follow the same standardization approach for their activities. Rather, they tried to standardize their operational procedures or documents but matched the principles for material movement and organization. By introducing the "best way" of their processes in the Operational Model, they make it a standard approach for their entire organization. In these companies, a standard agenda was created for daily stand-up meetings to ensure all key topics are touched on related to daily planning, constraints, CI mentality, and safety. Weekly work planning documents were standardized to keep them simple but structured to align with budget and material planning needs.

In the same way, the continuous improvement plans for training were standardized for core elements, with some targeted flexibility for individualized learning and improvement specific to each individual's role. Likewise, they defined how the process should work by creating SOPs for core tasks, such as modeling and prefabrication processes. At the same time, the SOPS further serves as training resources when personnel are onboarded into the company or change roles. These SOPs are hosted online, allowing QR codes for each to be easily embedded into relevant documentation; for example, the QR code for the rack fabrication SOP is a standard element in the template spool drawing for each rack sheet that is created.

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Another common standardization approach among all these cases is that they developed standard metrics related to production that were consistently tracked, shared, and displayed across their projects and sometimes across the organization. Having common dashboards was observed among all the cases; however, the more advanced version standardized the visuals and common planning elements so a new foreman or worker walking into a job trailer could, within 30-60 seconds, assess the status of the production against the goals, where the crew(s) are currently working, and what major constraints they are actively trying to resolve.

In conclusion, the comparative analysis between these cases demonstrates that a singular approach might not be applicable for all specialty contractors; rather, each company needs to implement standard work in alignment with the tasks and nature of their business. However, by balancing autonomy and standardization, they all used stable, repeatable methods to maintain process predictability, regular timing, and consistent, high-quality output.

5- Process-based Approach

The continuous improvement approach focuses on identifying and eliminating waste in production. As Cudney and Elrod (2011) highlight, waste is present throughout organizational functions, from procurement to invoicing and accounting. This is important for recognizing the "Process Management" approach to improvement. The authors witnessed this approach during the observations of all these seven companies, as illustrated in Table 9.

Table 9. Common Approaches in Process-based Approach

Approaches	Highest						Lowest
I**dentify and eliminate waste** to support organizational functions	●	●	◐	●	●	◐	○
Define processes for performing their tasks to bring consistency and clarity.	●	●	●	◐	◐	◐	◐
Document current processes and refine them into **best practices**.	●	●	●	◐	◐	◐	◐
Work packaging is **standard across phases** for planning, fabrication, tracking and reporting.	●	●	●	◐	◐	●	◐
Measure how effectively new **processes or approaches** are relative to the baseline.	●	●	◐	◐	◐	◐	◐

*Note – company order changes for each table to re-order from highest to lowest observed adoption

The comparative analysis of these cases revealed that these organizations constantly apply the concept of identifying and eliminating waste, with special emphasis on considering the whole

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production process. To achieve this goal, they build upon standards to create best practices that are then integrated into training and evolving standards. They structured work packages across phases and departments to create consistency and transparency in how work is estimated, planned, fabricated in a shop, kitted or palleted, sent to projects, and installed. A great example of this was using detailed week-level task production and combining it with the budget, schedule, and workforce planning such that the weekly task tracking directly aligned with budgets, prefabrication needs or orders, and billing.

Observing all these cases demonstrated that the process-based approach capability is not limited to incorporating various involved teams in defining their operational procedures; rather, they constantly measure how effectively new processes or approaches are relative to the baseline, using the PDCA concept. This enables them to revisit their operational procedures and apply required revisions to pursue continuous improvement. However, the frequency and extent of how often these companies measure and track their processes varied.

6- Visual Management

Visual management is a widely used continuous improvement method in all these cases. Using intuitive visual cues to make concise, accurate information within a workplace available at all times to those who need to know it was one of the common approaches the case illustrations adopted to enhance their information sharing and communication, as shown in Table 10. Taking it further, visual controls can be used to make problems visually apparent.

Table 10. Common Approaches in Visual Management

Approaches	Highest						Lowest
Apply VM **across operations** to support simple, effective **communication or tracking**.	●	●	●	◖	◖	◖	◖
VM is **built into the inventory management** system and processes.	●	◖	●	●	●	◖	◖
Extensive use of **color-coding**	●	●	◖	◖	◖	◖	◖
Use VM for **information sharing**, such as productivity reports and project standards	◖	●	●	◖	●	◖	◖
Use VM for **communication and raising awareness**	●	●	◖	◖	○	○	○

*Note – company order changes for each table to re-order from highest to lowest observed adoption

They mainly use Visual Management in three ways:

(1) Use it for information sharing, such as productivity reports and standardization information sharing within or across projects: such as productivity metrics, color-coding of tasks, systems, or status on weekly work planning boards.

(2) Use it for communication and raising awareness: installing pictures such as the 8 types of waste in their shop facilities and job sites to enhance awareness. This simple approach empowers the field to improve processes and remove waste before it impacts projects. Similarly, color coding spool drawings and providing 3D renderings consolidates information and reduces time trying to re-interpret information someone else has already planned.

(3) Using it to help identify problems, such as shadow boards to identify missing tools, or color coding under consumables such as screws to make it visual when stock is running low. By using orange stickers under screw boxes, the worker can immediately realize they have limited stock and need to request more.

Other examples include marking job boxes and codifying them with standard tools or equipment to make them easy to find or note if they were missing; or color-coding the daily tasks within the weekly work plan to create a quick visual link between the crew, task, area, and materials across the different visuals used to plan and coordinate work.

Overall, this comparative analysis indicates that visual management is an essential element that reduces the time and effort workers in the field need to spend on support tasks, like tracking tools or trying to guess if they have enough materials for the next few days' work. Using this powerful method, an organization can achieve employee engagement and generate ownership of goals and enthusiasm for progress that would otherwise be lacking. It further creates transparency in the goals and status of project information, removing the gap that sometimes arises between office and craft employees. As a result of shared visual management, no information is hidden, and the organization's goals and the team's shared status for achieving them are aligned.

7- Access to better tools/equipment

Another emphasis that was widely observed among all case studies was their relentless pursuit of better tools and equipment. Common approaches are listed in Table 11.

Table 11. Common Approaches in Access to better tools/equipment

Approaches	Highest						Lowest
Unbundling of complex methods to **simple and easily understood** concepts.	●	●	●	◐	○	◐	◐
Use better tools or equipment to **facilitate field operations**	●	●	●	●	●	◐	◐
In parallel with standardization, they **match their tools and equipment with their operations**.	●	●	●	●	●	◐	◐
Allocate a specific budget for providing better tools, which is **separated from the project costs**	◐	◐	◐	◐	○	○	○

*Note – company order changes for each table to re-order from highest to lowest observed adoption

Breaking processes into small manageable pieces serves as a way to unbundle bigger changes, software training, or learning of new procedures. Something as simple as making small steps for using a new software tool to help employees master one process at a time instead of using multi-day workshops to train large groups. Breaking the Last Planner System down into the component parts and training in each step in greater detail was observed in several cases, including fieldwork planning, visual tracking, communication with crews, and planning the logistics and space.

All of the firms were persistent in finding tools that make their work simpler, safer and improve the reliability of the resources provided for craft. The authors witnessed several instances of this approach through their visits, such as using carts on wheels to help facilitate sending the assembly parts to their projects, buying better saws for field employees to reduce small hand injuries, or investing in shop equipment to take slow or labor-intensive work out of the field.

8- Systematic Process (Empowering problem-solving mentality)

According to Liu et al. (2020), the shift from traditional organizations towards CI organizations results in a higher level of organizational integration, decentralized decision-making structures, flexible communication channels, and a flow-centered operating system. Common approaches in systematic process can be seen in Table 12.

Comparisons of these seven cases demonstrated that they constantly re-visited, checked, and analyzed their processes and monitored their operation. In some cases, they were pre-defined reviews or checks on production status or when projects hit a particular milestone. In others, they were structured as coaching and mentoring visits that met the same intent but engaged in using the events as moments for engaging with the project team, mentoring them, and supporting their path to improvement. Using some form for monitoring changes, such as A3s or

the PDCA process, was sometimes seen to help them refine and document standard operating procedures to ensure each step of their process is conducted in the "best way."

Table 12. Common Approaches in Systematic Process (Empowering problem-solving mentality)

Approaches	Highest						Lowest
Sustaining improvements to processes through **frequent reviews and coaching** to ensure they are being implemented.	●	●	◒	●	◒	◒	◒
Gathering **input from all company stakeholders** to agree upon or refine processes and methods	●	●	●	◒	◒	○	○
Focus on **small improvements and appreciate new ideas** for improvement from the workforce	●	◒	●	◒	◒	○	○

*Note – company order changes for each table to re-order from highest to lowest observed adoption

Through interviews, it became apparent that the companies emphasized small improvements that were shared and sustained rather than trying to achieve large transformational changes. This was the key aspect of their continuous improvement efforts. As an illustration, one firm described the number of changes they made to their tool carts, from adding power strips to changing how the doors swung to lock placement so the lock was less likely to hit a wall or door. As highlighted in previous capabilities, their ultimate goal was to make the field activities easier for their crews. As a result of this attitude, they constantly engage field crews in problem-solving to collect their ideas and get agreement on a path forward. Further, by making the small changes requested, they are engaging all people affected by that problem and showing that they are listening, opening a wider array of possible solutions.

5. Conclusion

To understand more about how trade contractors can apply continuous improvement principles and methods in their organizations, this report investigates various implementation approaches within seven successful adopters. The comparative analysis of real companies was conducted on seven trade contractors, providing valuable insight into what capabilities have enabled them to succeed in the adoption of continuous improvement practices. Eight capabilities were identified to explain what organizational, cultural, and operational characteristics have been found prevalent within these cases. Common approaches employed by the case illustrations to support these capabilities were then discussed.

This study focused on trade contractors' adoption of continuous improvement principles, methods, and practices. The procedures used to analyze the trade contractor capture a snapshot of the successful adopters' methods and practices throughout their operations. Conducting case studies of successful adoption helps us to profile the processes and business impacts. The seven case studies indicate some variation in the approaches they choose for their continuous improvement efforts, while a considerable extent of similarities.

Among common approaches that these companies pursued, the following attributes were observed in some cases that differentiated the most successful firms from their peers:

1) **Focus on Continuous Improvement**

Building upon the alignment of core values and strategic goals with continuous improvement, embedding CI into the mentality and culture of the company was observed through the methods used to constantly simplify their operations by breaking processes into smaller manageable pieces.

2) **Focus on People**

In successful companies, the emphasis went beyond providing training to creating an active culture of coaching and mentoring to ensure all employees have a comprehensive understanding of the company's culture, processes, methods, and standards. Through proper training and mentoring programs, field leaders are empowered to take responsibility for CI initiatives by enhancing their technical and managerial skills, further enabling them to serve as role models and mentors to their crews.

3) **Focus on Process**

In alignment with mentoring programs and cultivating leaders, successful adopters typically strive to balance empowering their people, standardizing their processes, and increasing transparency by using VM. Using company standards provides structure and guidance on organizational standard processes while, at the same time, promoting team autonomy to fit the company's processes to the unique project requirements.

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