METRICS OF PUBLIC OWNER SUCCESS IN LEAN DESIGN, CONSTRUCTION, AND FACILITIES OPERATIONS AND MAINTENANCE

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ABSTRACT

The design and construction industry is hungry for metrics and proof of concept for Lean in the public sector. San Diego (California) Community College District has completed two-thirds of a US$1.6 Billion capital improvement program (2002-2019) during which – at the one quarter complete stage in 2008 – Lean design and construction principles and practices were introduced, thus offering a pre- and post-Lean comparative opportunity. Contemporaneously, the Facilities Management department also launched a Lean initiative. This paper identifies some key owner metrics to measure the value of identified Lean principles and tools, examines the comparison of various pre- and post-Lean metrics, analyzes these in relation to value-creation and waste-reduction, and analyzes how these metrics are associated with core Lean principles as identified in prior literature. These design, construction, and operations/maintenance functions influenced each other during the study period (2008-2013) and this paper offers some insights into the value of Lean to the design, construction and maintenance process for public agencies.

KEYWORDS

Lean in Public Sector (LIPS), indicators, Lean metrics, education sector.

INTRODUCTION

Among community colleges, the San Diego Community College District (SDCCD), is the 2nd largest in California, and the 6th in the United States. SDCCD "*serves approximately 130,000 students annually through three two-year colleges and seven Continuing Education campuses*" (SDCCD description on Twitter, 1/9/14). A US$1.6 Billion capital improvement program (2002-2019) allowed the District to expand and retrofit its facilities while creating a need for resources to operate and maintain its facilities in a time when operating budgets have been slashed all over California. Within this environment and a change in leadership at SDCCD, the Lean implementation was viewed as a potential new paradigm to help the District to become more efficient to face the challenges of operating such a large portfolio in years to come.

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This paper identifies some key owner metrics to measure the value of identified Lean principles and tools, examines the comparison of various pre- and post-Lean metrics, analyzes these in relation to value-creation and waste-reduction, and analyzes how these metrics are associated with core Lean principles as identified in prior literature.

LEAN IN THE PUBLIC SECTOR (LIPS) INITIATIVES

The economic depression starting in late 2008 forced austerity on public sector organizations challenged to deliver more and/or better services amid severe budget cuts. The public sector in many cases has no competitors for the services it provides and it is a supplier-led sector without much incentive to change (Bathia and Drew 2006). Additionally, rules and regulations related to the operational systems of public sector organizations might hinder their ability to quickly adapt to new ways of doing business. For instance, public sector organizations cannot engage in full-fledged Integrated Project Delivery (IPD) contracts because public owners cannot engage in profit sharing and risk sharing with other project stakeholders.

However, there are drivers that encourage public sector organizations to implement Lean and might include, but are not limited to: change of (executive) leadership, demand for increased efficiency, service expansion with limited resources, the introduction of a new technology, and struggle with performance indicators (Radnor and Walley 2008). In their research of eight Scottish organizations in the public sector Radnor and Walley (2008, p.16) also observed that: "*The scale of the adoption of Lean was not necessarily linked to the scale of the crisis. If there was any pattern, more ambitious Lean implementation was linked to the commitment of newly-introduced chief executives who perceived large-scale benefits over a longer timescale.*" The identification of potential long-term benefits and the definition of improvement programs might start with activities aiming at unveiling waste and discovering the true capacity of processes. Along these lines, Bathia and Drew (2006) indicate three main sources of losses in the public sector namely: *waste* (e.g., long waiting times, idle or overworked resources due to poor scheduling); *variability* (e.g., lack of consistency and standards to develop work); and *inflexibility* (e.g., mismatch between unchanged capacity of resources and demand that fluctuates throughout the days).

Examples of initiatives to identify and banish waste in the construction industry related to the public sector can be found in the proceedings of the International Conference of Lean in the Public Sector (LIPS 2009). The topics addressed in the event tackled changes in procurement and contract legislation, as well as case studies where Lean was implemented. However, examples of actual implementation of Lean in the public sector are scarce when compared to its implementation in private organizations. Early results of the SDCCD Lean migration were shared with the greater Lean construction community at the LCI Congress held in Pasadena in October 2011 (Umstot 2011).

As a contribution to the existing literature, the case and related indicators discussed in this paper address the drivers of change and sources of waste as SDCCD worked to map processes and gain visibility of value streams across departments, developed and implemented standards, worked to reduce processing lead times and variations in changes, and reorganized its resources to better match existing and future demand.

CASE STUDY AT SDCCD

This section describes the study developed at SDCCD. It starts with a description of SDCCD's background and how the SDCCD construction program created a need to devise new ways to run a large capital projects program and later to efficiently operate the built environment it helped create (Stahl 2012, SDCCD 2014a,b). The description presented herein provides the reader with important background information so that the extent of the work performed can be put in perspective.

Prior to 2008, design-bid-build and construction management multiple prime (CMMP) delivery were the only project delivery contract vehicles available under the governing codes in California. At that time, all public works projects at SDCCD were delivered on a design-bid-build basis with projects consistently delivered late, change orders trending to ten percent of the awarded contract value, multiple claims and associated litigation. This had been the case for 27 years. With a new vice chancellor hired in August 2007 with a background in both the private and public sectors and a fresh perspective on how to achieve greater success with delivery of capital programs, a review of the existing system and processes begged for a better way to deliver projects.

STARTING A LEAN JOURNEY

Effective January 1, 2008, legislation in California granted authority to community colleges to use design-build contracting to deliver capital projects exceeding $2.5M in value. In 2008, SDCCD decided to move away from design-bid-build contracting to new delivery methods. Concurrently SDCCD decided to require all new projects to be designed and constructed using Building Information Modeling (BIM) (BakerNowicki Design Studio 2012). Projects that had existing architects assigned and under design were directed to proceed using the Construction Manager Multiple Prime (CMMP) method with the selection of a Construction Manager on a qualifications basis to participate in pre-construction services for BIM coordination, budget validation, trade scope coordination, and constructability reviews. The goal was better integration of the design through a higher degree of collaboration. Projects that had not been assigned architects were slated to be procured using design-build with the idea that this contracting method would foster an even greater degree of collaboration, enable Lean behaviors, and produce better outcomes. "Design-Build is a method of project delivery in which one entity, the design-build team, works under a single contract with the project owner to provide design and construction services. This allows unified flow of work from initial concept through completion thereby re-integrating the roles of designer and constructor" (DBIA 2014).

Working towards an Integrated Project Delivery

SDCCD was inspired with what Sutter Healthcare was achieving with Integrated Project Delivery (LCI 2014) at the time and wanted to emulate this to the extent allowed within the existing constraints of the California contracting codes. To that extent SDCCD adopted an approach of Target Value Design (LCI 2014) publishing the target budget for each project as part of the design-build Request for Proposals

(RFP) and asking the teams to work with SDCCD and the user representatives to maximize the value delivered within the available budget. Selection criteria used to select design-build entities included technical expertise, price, design excellence, life cycle costs, safety record, availability of labor, and subcontractor small and disadvantaged business outreach. Technical expertise, price and design excellence were equally weighted 20% and the other factors 10% apiece, respectively. Price was evaluated on the basis of design fee, preconstruction services fee, general conditions staffing costs, and overhead and profit percentage on the final guaranteed maximum price. This allowed the design-build entity to work in concert with SDCCD to design a building that met the budgetary constraints, yet yielded value as defined by SDCCD stakeholders. The final guaranteed maximum price was typically set when design was completed to reduce the risk and associated contingency that would be integrated into pricing.

To foster greater collaboration SDCCD shared through the design-build RFP process that integrated project delivery behaviors were highly desired by the respondents. SDCCD required that all major specialty trade contractors and design and engineering consultants be named at the time of proposal with the expectation that they would participate in the design process to enhance the value proposition. SDCCD also adopted a desired approach to set-based design (Sobek, Ward and Liker 1999) and Choosing by Advantages (Suhr 1999) to make more informed decisions with respect to life cycle cost analysis and total cost of ownership.

Changing the Planning Methods

As the Lean practices became more integrated into project delivery, it also became apparent that traditional scheduling methods were not achieving the desired outcomes of reliable, predictable workflow and ultimately timely contract completion. This will be discussed in more detail below, but based on an analysis of the completed projects to date in 2012, the decision was made to require implementation of pull planning (Ballard 2000a, LCI 2014) on projects that had not started construction effective January 2013. The contract language was revised to remove all mention of critical path method scheduling and replace it with pull planning. SDCCD hosted a workshop for all its project management team and its design-builders and construction managers in January 2013 to introduce this concept and conducted a Villego™ (Villego 2013) Last Planner® (Ballard 2000b) simulation to demonstrate its benefits.

Addressing Facilities Management Challenges

Furthermore, SDCCD was in the process of adding an estimated 1.6 million square feet of built environment to its existing portfolio of approximately 2 million square feet through its capital program, causing a significant cost burden to SDCCD for additional utilities consumption, maintenance, custodial, and landscaping support. A 2009 analysis indicated that if the existing staffing and service model was maintained, the additional cost impact to SDCCD would be $25,863,512 over the period of 2009 through 2017. State budget cuts from 2007 through 2012 had actually reduced the operating funds for SDCCD, a state-funded public institution, by nearly $46 million. It had become apparent in 2008 that "business as usual" was not an option in maintaining and operating SDCCD's facilities assets.

Thus, SDCCD embarked on a Lean journey in its Facilities Services organization in January 2009 to benchmark its current state, establish standards, and set future state goals relative to maintaining or elevating the level of service provided within the existing and anticipated future funding constraints. At the same time, standards were integrated into the delivery of capital projects to help reduce the total cost of ownership through space efficiency, energy efficiency, water usage reduction and spaces designed for easier cleaning and maintenance. Representatives from facilities services were key participants in helping define value in the design process in concert with building occupant representatives. The SDCCD governing board adopted a green building policy to support this initiative with the intent that each project would be certified at the United States Green Building Council Leadership in Environmental and Energy Design (LEED) Silver level at a minimum.

The balance of this paper will focus on metrics that have been compiled and evaluated to measure the success of migrating away from traditional design-bid-build to more collaborative Lean project delivery and to continue delivering the equivalent or higher level service of maintenance and operations of the existing and new facilities.

INDICATORS COLLECTED TO EVALUATE PROGRESS

To evaluate the expected benefits of Lean for SDCCD, metrics were selected for assessing the pre- and post-Lean conditions. Table 1 contains the selected metrics, their definition and for what Lean principles they were used to evaluate.

Table 1: Metrics Evaluated in This Study

Metric	Definition of Metric	Lean Principle(s) Evaluated
Total Project Change Order Rates	% of change order costs of total project construction costs	Waste reduction
Change Orders caused by errors and omissions (as % of project construction costs)	% of change order costs due to errors and omissions of total project construction costs	Waste reduction, collaboration
Project Schedule Performance	Number and % of projects meeting the original contract completion date	Waste reduction, flow, enhanced communication and collaboration
Project Target Value Design	Number and % of projects meeting the published target budget	Value generation, waste reduction
Sustainability Value Generation	Number and % of projects that exceeded LEED Silver certification	Owner-defined value generation
Annual Maintenance Costs	Annual total maintenance costs divided by the square footage in the portfolio	Waste reduction, process improvement; value generation

Change Order Rates

Nearly 8000 change orders were reviewed for the period of 2008 through January 31, 2014 for this paper. Data for projects still actively under construction was excluded from the analysis as it does not represent the final change order totals for these projects. Change orders were coded for reason as part of the change management process and those coded design errors and omissions (E&O) and coordination omissions were segregated for analysis from the total to evaluate the anticipated reductions due to better collaboration and integration. Deductions from the contract for unused contractual allowances were excluded from the data analysis. The data set evaluated below results from change orders for 35 completed construction contracts totaling $584,731,760 in value. Of the 35 completed projects, 20 were completed without the use of BIM nor Lean behaviors. Fifteen (15) were completed using BIM and Lean approaches.

As evidenced by the data shown in Table 2, both the total change order rate and errors and omissions change order rates dropped when using BIM and Lean, a 42% and 38% reduction, respectively. What is interesting is that the rate of errors and omissions reduction was not reduced at the same rate as the total change order rate, actually representing a higher percentage of the total change orders on projects completed using BIM and Lean. This was unexpected. Therefore, the decision was made to explore this more fully using the ratio of errors and omissions change orders to total change orders metric. To evaluate whether there were significant differences in change order rates between new construction and renovation projects, the change orders were segregated into these categories for analysis in Table 3.

Table 2: Change Order Rates with/without BIM and Lean

	Number of Projects (n)	Total CO Rate	Errors & Omissions CO Rate	Ratio of Errors & Omissions Rate/Total CO Rate
Without BIM or Lean	20	7.73%	2.99%	0.33
With BIM and Lean	15	4.43%	1.88%	0.36

Similar trends are noted in the reduction of change orders for both new construction and renovation when using BIM and Lean (Table 3). Again the ratio of change orders from errors and omissions actually went up as a percentage of the total change orders when using BIM and Lean.

This suggests that BIM heads off many customer-requested changes, major trade conflicts, and reduces associated delays that reduce the overall change order rate, but does not always provide the level of detail necessary to eliminate all coordination issues. It might lead to the conclusion that the level of detailing required for successful implementation in the field goes beyond the typical level of development (LOD) in a building information model.

On a program of this scale, the cost savings on the 15 projects delivered using BIM and Lean is estimated to be approximately $13.6M using a reduced total change order rate of 4.43 rather than 7.73 percent. This equates to an average cost savings per project of more than $900,000.

Table 3: Change Order Rates for Projects with/without BIM and Lean – New Construction and Renovation

	Number of Projects (n)	Total CO Rate	Errors & Omissions CO Rate	Ratio of Errors & Omissions Rate /Total CO Rate
New Construction				
Without BIM or Lean	13	7.54%	3.04%	0.305
With BIM and Lean	13	4.38%	1.90%	0.355
Renovation				
Without BIM and Lean	7	8.00%	2.90%	0.367
With BIM and Lean	2	4.80%	1.79%	0.388

Schedule Performance

For the purposes of this paper, 34 completed projects were analyzed for schedule performance. The data on the exact number of days each was delayed was difficult to ascertain based on the available data, however, it was easily ascertained whether the project finished on time. "On time" as used for this analysis was on, or before, the contractual completion date in the signed construction contract for the project. The reasons for delay were not evaluated for their materiality but were certainly caused by a variety of factors including contractor performance, user changes, weather delays, failed contractors or subcontractors, impacts from other projects, and in some cases force majeure. Of these 34 projects, 33 used critical path method scheduling and only 4 (12 percent) completed on time.

To further explore how BIM and Lean practices impacted schedule performance, Table 4 shows the data.

Table 4: Impact of BIM and Lean on Schedule Performance

	Number of Projects	Completed on Time	Percentage
Without BIM nor Lean	19	1	5
With BIM and Lean	15	3	20

Earlier research on this topic in 2012 by SDCCD with a smaller data set of 20 completed projects (12 without BIM and 8 using BIM and Lean) indicated that the number of working days of delay was reduced from an average of 80 to 24 on projects that were completed without the use of BIM and with the use of BIM, respectively (Umstot 2012). Though BIM and Lean practices improved schedule performance, it was still far from acceptable. It was on the basis of this data analysis, SDCCD decided to require use of the Last Planner® System and specifically pull planning as its new scheduling standard effective January 2013. To date, only one project has been completed with pull planning. Thirteen (13) projects are still underway using pull planning and the results cannot be determined at this time, but improved scheduled performance is expected.

Target Costing Performance under Design-Build Lean approach

SDCCD has been using target costing on its projects being delivered via design-build since 2009. To date, 11 projects have used this approach with 6 having reached a point that the guaranteed maximum price has been established at design completion.

The projects ranged in value from $4,797,408 to $50,423,353 with an average value of $21,768,648. Of these 6 projects, 5 (83%) met the target value budget. Of these five, the projects averaged 7% under the target budget. For the single project which did not meet the target budget, the root cause analysis indicated that contemporaneous estimating did not occur during the design process resulting in a project over budget to meet the programming requirements. It was also discovered that the builder who was new to Lean project delivery and design-build had not fully integrated the specialty trades early in the process to utilize their expertise in selecting and costing systems and evaluating life cycle cost considerations. Subsequent to this project, SDCCD initiated a requirement to share the target cost status as the first part of any project briefing to avoid presenting design concepts that did not conform to the target cost model.

Value Generation (Sustainability)

The authors considered several options to evaluate value enhancement through use of BIM and Lean. As sustainability was a core value of SDCCD as discussed above, potential metrics of energy use intensity (Btu/square foot); reduced life cycle costs of the building; reduced water consumption; reduced maintenance costs, reduced custodial costs; creation of "nice-to-have" versus "need-to-have" enhancements; improved student success; and customer satisfaction were all considered. The data collection from a portfolio of this size for many of the potential quantitative metrics became overly challenging and the qualitative metrics were not normalized. So the authors elected to look at the level of LEED certification of each building as an overarching measure of meeting or exceeding SDCCD's desire for sustainable buildings (Table 5). Metrics related to reduced maintenance and custodial costs will be shared in later sections.

Table 5: Value Generation in Terms of LEED Certification

	Number of Projects	Number of Projects Exceeding LEED Silver Goal	% of Projects Exceeding LEED Silver Goal
Without BIM or Lean	9	5	55
With BIM and Lean	25	10	40
Direct Contracts with Architect	22	11	50
Target value design with Design-Builder	12	4	33

It had been expected that the percentage of projects exceeding the LEED Silver goal would actually increase using BIM, Lean and target value design. This was not, however, what the data indicated with this initial analysis. The analysis was refined to further evaluate and understand why. Projects were certified under different versions of the LEED rating systems with all of the projects above being certified using versions 2.1(2002), 2.2 (2004) or 3 (2009). As new versions of the LEED certification rating system have been adopted, the performance levels of buildings to attain the same level of certification have been raised. Looking at the data under this lens yielded the results shown in Table 6.

The data presented in Table 6 suggests that the use of target value design under the LEED rating system version 3.0 actually did increase the percentage of projects exceeding the desired LEED silver certification. For projects under direct contract with the architect without a formalized target value design process, 20% of projects exceeded LEED silver certification under LEED rating system version 3.0. Using BIM and Lean, the percentage of projects exceeding the LEED Silver certification level increased to 29% and with target value design to 44%. This suggests that target value design did indeed increase the sustainability value of the project within the targeted budget. It should be noted that not all projects were eligible for LEED certification as a structure needs to be occupied to be considered. Therefore projects related to utilities infrastructure, central cooling and heating plants and parking structures are not considered in this analysis as they were ineligible.

Table 6: Breakdown of Projects Certified in Different LEED Versions

	Number of Projects (LEED v2)	Number of Projects (LEED v3)	Number of Projects Exceeding LEED Silver Goal (LEED v2)	Number of Projects Exceeding LEED Silver Goal (LEED v3)	% of Projects Exceeding LEED Silver Goal (LEED v2)	% of Projects Exceeding LEED Silver Goal (LEED v3)
Without BIM or Lean	9	0	5	NA	56%	NA
With BIM and Lean	14	14	4	4	29%	29%
Direct Contract with Architect	21	5	9	1	42%	20%
Target value design with design-builder	1	9	0	4	0%	44%

Examples of sustainability features that were integrated into projects included higher building energy efficiency, extensive use of daylighting, use of natural ventilation tied to the building automation and energy management system, strategies to reduce water consumption by using reclaimed water to flush water closets and urinals and provide irrigation, low-water usage landscape, pint-flush or waterless urinals, dual-flush toilets, and use of reclaimed water in cooling towers, and solid flooring that does not require stripping and waxing.

Maintenance Performance

As shared in earlier discussion, SDDCD embarked on a Lean journey in its maintenance operations in January 2009 with the goal to benchmark the current state and define future state goals and a timeline to achieve these. In concert with this, design standards (SDCCD, 2014c) were more finely developed to assure that projects were being delivered with total cost of ownership in mind to reduce utility costs, future maintenance costs and reduced burdens on custodial operations.

The benchmarking study in 2009 (Fiscal Year 2009/10) identified the current state of maintenance costs to be $3.93 per square foot annually. SDCCD set a future state goal of reducing maintenance costs to $2.55 per square foot annually within a three-year period. Metrics towards the future state goal are provided in Table 7.

Table 7: Benchmarking Study on Maintenance Costs

Year	Maintenance Cost per Square Foot	Delta from Target Goal ($/square foot)
Current State (FY 2009/10)	$3.93	$1.38 from goal
Desired Future State (FY2012/13)	$2.55	0
FY 2010/11 (Actual)	$1.91	$0.64 better than goal
FY 2011/12 (Actual)	$1.73	$0.82 better than goal
FY 2012/13 (Actual)	$1.46	$1.09 better than goal

The metrics show that actual progress made towards the desired future state goal was significantly faster than expected. A great deal of this can be contributed to the Lean process improvements implemented in the SDCCD facilities services organization as well as the enhanced design standards that addressed total cost of ownership considerations. Another significant contributing factor to the improved performance was removing buildings with high maintenance workloads due to their age and condition from the facilities portfolio and replacing them with new facilities that met current code and SDCCD standards. The third major factor was simply the increasing denominator of square footage the team was responsible for maintaining. Anticipated cost savings if the target future state was met was $12,590,000 over 8 years compared to the baseline model of how these services were performed in 2009. As the data trends indicate above, this cost savings will actually be substantially greater.

CONCLUSIONS

Based on the review of the metrics presented in this paper, it is clear that public agencies can greatly benefit from Lean principles and practices in capital project delivery and ongoing maintenance of capital assets. Table 8 contains a summary of the benefits that SDCCD derived from its adoption of the use of BIM and Lean project delivery practices in 2008. As an additional consequence of the above described owner-initiated requirements and resultant metrics, a panoply of these "Lean behaviors" were realized and mapped against the Lean behaviors identified by Fauchier and Alves (2013). Table 9 sets forth an assessment of Lean behaviors that resulted from SDCCD's post-2008 requirements and metrics.

Table 8: Potential Benefits to Public Agencies from Using Lean

Benefit	SDCCD Metric	SDCCD Experience
Reduced waste associated with change orders	Total and error & omission change orders as % of total construction cost	Total change orders reduced from 7.73 to 4.46% on average; average cost savings of $900,000 per project
Improved schedule performance	% of projects that completed within contractual completion date	Project schedule performance improved using BIM and Lean, but using critical path method scheduling only 20% of projects completed on time; this prompted abandonment of CPM scheduling and requirement to use the Last Planner® System
Meeting programmatic requirements and enhancing value with a constrained budget	# of projects that met target value design budget	Used target value design to enhance value and meet the target budget in 83% of the projects included in this study
Enhanced value generation through more sustainable buildings	# of buildings that exceeded LEED Silver certification	Using BIM and Lean improved this by a factor of 45% and using target value design improved this by a factor of 100% from projects where none of these tools were used.
Enhanced value generation through lower operational and maintenance costs	Maintenance cost per square foot	Major factor in helping reduce annual square footage maintenance costs from $3.73 to $1.46 over a 3-year period

Table 9: Assessment of resulting Lean behaviors at SDCCD

	Lean Principles																
SDCCD implemented practices	Value to the Customer	Reduction of Waste	Leadership	Teamwork	Collaboration	Transparency	Trust Building	Leanring	Continuous Improvement	Goal-Driven Behaviors	Systemic Thinking/Behavior	Construction Projects as Production Systems	Use of Pull	Promotion of Flow	Use of Small Batches	Continuously Adjust Planning	Clear Goals & Metrics
Owner Use of Lean Principles	✔			✔	✔		✔	✔	✔	✔	✔			✔	✔	✔	
Staff Training in Lean Behaviors	✔		✔	✔	✔		✔	✔		✔	✔	✔	✔			✔	✔
Required Use of BIM	✔	✔		✔	✔	✔			✔		✔	✔				✔	✔
Design Builder Selection Criteria	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔
Value Defined by Stakeholders	✔		✔	✔		✔			✔	✔	✔						✔
RFPs Request IPD Behaviors	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Reduction in Change Orders		✔										✔		✔	✔		
Reduction in Errors & Omissions	✔	✔				✔			✔		✔	✔		✔		✔	
Last Planner® System Required	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Use of Target Value Design	✔	✔		✔	✔			✔	✔	✔	✔					✔	✔
LEED-certified sustainablility	✔		✔						✔	✔	✔	✔					✔
FM Benchmarking & Goal Setting	✔	✔		✔		✔			✔	✔	✔			✔		✔	✔
Training FM Staff in Lean	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔			✔		✔	✔
Reduction in maintenance costs	✔	✔		✔	✔	✔		✔	✔	✔	✔			✔		✔	✔

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