The Value Analysis of Lean Processes in Target Value Design and Integrated Project Delivery

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EXECUTIVE SUMMARY

Objective

The objective of this research was to 1) assess the value of applying lean process improvement tools in design and project delivery by conducting a plus/delta analysis, and 2) create an inventory of metrics to develop a foundational framework to aid future Return-on-Investment (ROI) studies. By undertaking the case study of a health care facility project that implemented Lean-IPD and TVD, our intent was to make components of benefit and cost that are currently *implicit*, more *explicit*.

Method & Analysis

A detailed literature review was undertaken to understand the key components of the Lean-IPD process and Target Value Design (TVD). A case study was identified which followed the Lean-IPD process. To ensure our results were accurate, it was important for stakeholders to feel free to honestly and openly share feedback with our research team. Therefore, throughout this report, we refer to the project as Hospital X.

The case study project is a 364,000 square foot, 100-bed (75 +25 future) hospital that is currently under construction and will be occupied in spring 2015. To study the process, and the development of metrics that assess this process in detail, an organizational chart was developed based on Hospital X's team structure. Archival data from e-Builder, the portal for sharing information, was reviewed including the validation report, target value management logs, Success Metrics and A3s. A detailed Benefit Cost Analysis was conducted for first costs (analyzing data up to Dec 2013), taking into account the benefits (cost savings) and costs (additional costs) associated with the TVD process.

To understand *implicit* benefits and costs and to make them *explicit*, the following was conducted:

- a site visit to Hospital X
- a series of interviews with seven members of the Project Leadership Team. Members not present were interviewed via phone.
- a focus group with 16 members from the owner, architecture, construction, interior design, and various trade partner teams, who were present on site.
- a smaller focus group with four members of the Design Team to understand the architect's perspective.
- a survey was sent out to 79 stakeholders, including members of the owner, A/E, construction, and trade partner teams. A total of 47 stakeholders voluntarily participated and completed the surveys, yielding a nearly 60% response rate.

Survey data was analyzed using SPSS to determine correlations, one-sample t-tests, ANOVAs and Tukey's HSD tests. A thematic content analysis was conducted for the focus group and interview data. A plus-delta analysis was conducted for each set of data, and then combined across the data sets to develop an inventory of metrics for the implicit and explicit benefits and costs associated with the design decision making process. Additionally insights on successes, and opportunities for improvement, in the current process were identified.

A framework focused on the design decision-making phase was developed to assess the fiscal implications (Benefit/Cost Analysis and/ or Return on Investment) of the Lean-IPD model. Further investigations of similar types of projects will help determine the generalizability of these findings.

Results

It was found that the project saved $33,083,907 dollars from the estimate after validation. This was while accounting for an additional scope that was added to the project. While these figures are impressive, a common criticism of TVD and Integrated Project Delivery is the high level of commitment required from all team members, which translates to a large investment which is typically unaccounted for.

Typically project cost savings are not offset against the additional decision making cost. Looking at the archival data, the research team concluded that additional decision making cost could be divided up into labor, material, equipment and location costs - associated with key lean strategies such as mock-ups, and team-weeks requiring full team co-location costs. In Hospital X, when these costs are taken into account the total savings is $26,007,958 dollars. However, without a baseline to compare against what the cost for design decision-making would be in a traditional design-bid build project a true ROI cannot be considered. The study does provide a framework for additional decision making costs that should be taken into account in a typical TVD process, as follows:

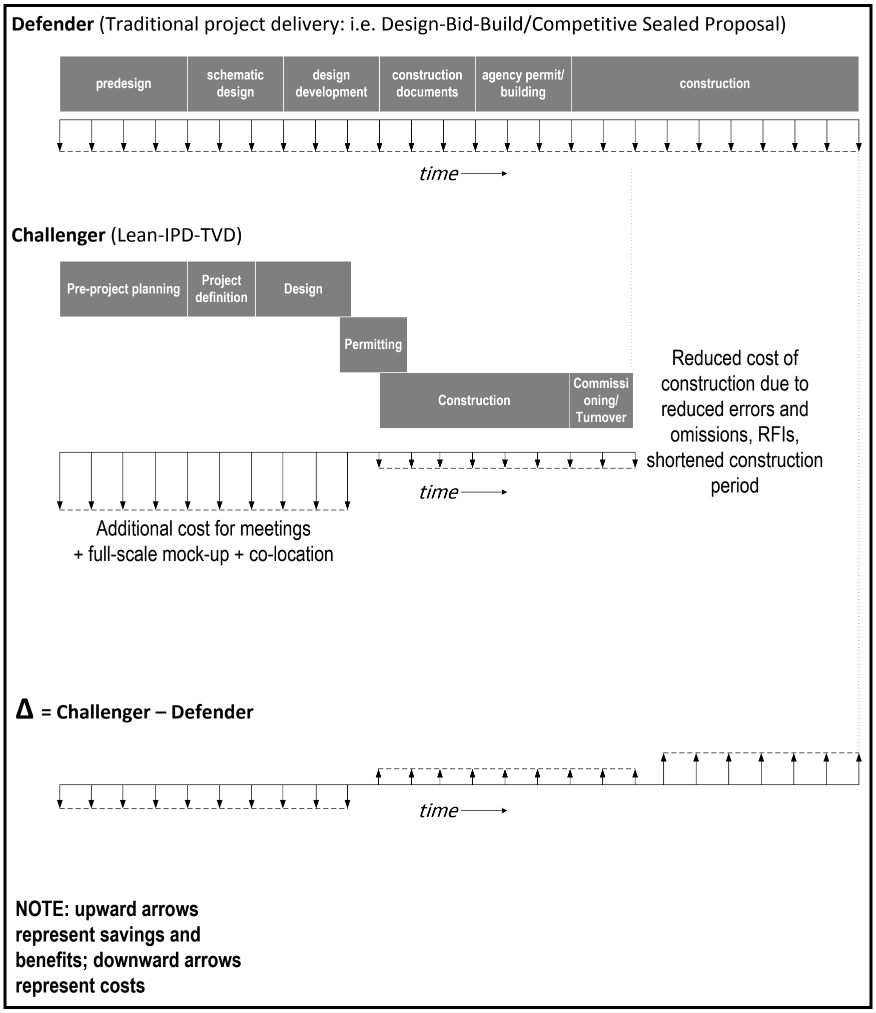


Figure 1. Proposed ΔIRR calculation model
Adapted from Ai (2014).

In the case of Hospital X, 6 Innovation teams were tasked with TVD - designing to target cost $25,997,279. Overall, all teams met their target, with different levels of reduction in initial versus final estimates. Our research team re-assessed the innovation logs that tracked these decisions, and the A3s, that provided the rationale for these decisions. By interviewing design team members, the research team assessed the "perception" of benefit versus cost for key decisions. It was found that although in a majority of the cases the design team felt that the value stayed constant (equal/increased benefit with equal/lower cost). The challenge of being able to track the implications of design decisions on post-occupancy outcomes is arguably one limitation of the current decision making models.

To address the more implicit benefits and costs survey, and interview data, was analyzed. Some key themes emerged about the value of the Lean-Integrated Project delivery model which are:

1. *Learning* is a large, implicit benefit that is not currently captured by any success metric. Not only do all the teams involved learn, but getting national experts to team

with regional teams also allows a community (including project delivery team) to build its own expertise, that has an immeasurable value for the community and the team, and stewards of the community.

2. The *cardboard mock-up workshop* was the most successful lean strategy which was consistently rated by all stakeholders to be higher than TVD, team weeks and co-location.

3. There were some concerns with the TVD process that pertained to: (1) the accuracy of original estimate, and (2) the addition of value in the TVD process. Analysis of design decision documents (A3s) revealed that for some decisions, reduced cost was also perceived as reduced value. The lack of a robust ROI tool which can address the operational implications of first cost decisions was identified.

4. Although a collaborative project, the level of influence of different stakeholder groups varied (or was perceived as such). The Owner was perceived as having the largest influence in the process, followed closely by the General Contractor.

5. There may be value in considering third party estimation and mediation, to address issues of bias and to enhance perception of a level playing field (although the counter argument is that third parties may not have the vested interest in having a lean project as the stakeholders do). There may also be value to include and co-lead lean engagements with design teams.

6. The biggest advantages of Lean-IPD were identified as:
    - Collaboration, team engagement and working towards common goals
    - Building positive professional relationships
    - User engagement and user buy-in
    - Learning & Education (of both the project teams and the larger community due to the large stakeholder engagement in the processes)

7. The biggest opportunities for improvement were identified as:
    - Inaccurate cost estimating
    - Perception of wasted time (too many meetings, too much time wasted in co-location without clear task or benefit)
    - Perception of imbalance of control/ influence, and need for facilitation which represents different points of view)
    - Difficulty in adaptation by team members (culture shift needed) Current measures of success still relate more to first costs, rather than quality, and improved outcomes after occupancy.

8. Quality is a key component of value but robust measures to access quality were lacking. Greater value can be a result of greater quality or same quality with lower costs. The hospital had developed some true north objectives (Quality and Care Transformation; Patient Experience; Market Position and Education and Discovery) (Vinas, Ed., 2014) however, these true north objectives were not currently captured in the project success metrics beyond a post occupancy survey.

9. Current evaluation of "value" is still primarily on first cost and does not take operational cost savings into consideration. This is something that needs to be developed.

10. To conduct a robust ROI for Lean-IPD process vis-à-vis a traditional Design Bid Build delivery process, baseline data needs to be collected. Industry-wide benchmarking of traditional Design Bid Build projects is essential to accurately assess project value.

Conclusion

A Benefit/Cost framework must contain first cost and life cycle costs beyond bricks and mortar. Our findings indicate that although the first cost framework is becoming more sophisticated, and material life cycles are occasionally taken into consideration, the inclusion of post- occupancy performance metrics (such as satisfaction, safety, and efficiency) in the initial assessment of Benefit/Cost analysis remains a challenge.

Benefits of the Lean-IPD process that were tracked and linked to the team profit based on Hospital X case study, are termed as success metrics and include:

- project cost ($ saved against original and revised estimates),
- construction team safety (% of employees suffering from some type of injury),
- local employment participation (% of project team labor hours spent by local people),
- energy efficiency (% below national average energy consumption for health care facilities),
- LEED certification (silver goal),
- team performance (team pulse check surveys),
- schedule performance (number of calendar days earlier than expected),
- quality (number of working days to resolve project issues; number of punch-list items; use of contingency funds),
- value (increased benefit (better quality) for same cost or same benefit (similar quality) for lower cost), and
- staff and family satisfaction (workshop process, staff and family engagement, and post construction surveys)

To translate these success metrics into an ROI, three additional components are needed, namely:

1) A baseline of benefits and costs in comparable traditional Design Bid Build projects to allow a benchmark for comparison;
2) A more thorough documentation of incremental (additional) costs associated with the decision- making process involved in a Lean-IPD project.
3) An assessment of the long-term/ occupancy implications of design decisions. This links to the field of Evidence-based Design and must be investigated further.

A critical finding of this study was the emergence of **learning** as a benefit for both the owners and the teams, as well as the larger health community. This refers to the learning of local teams that worked on the project and availed of lean training that they previously would not have had (as per the leadership this means they can have more reliance on their local resources for future projects based on the knowledge acquired from national experts in this particular project). The learning also refers to what staff and family learnt about the design process and implications of the built environment on their own work and experience. This is a tremendous long term benefit which currently lacks metrics.

Also, while time and cost metrics are relatively developed, metrics that measure *quality*, *safety*, and *morale* remain problematic. Given that a project's success is determined by its service to its ultimate constituents—patients, families and staff—the ability to link post-occupancy performance metrics to design decision-making tools (such as the Choosing By Advantages) could further our field significantly.

Finally, the framework initiated in this study (see Table 1) begins to track metrics for both explicit and implicit costs and benefits associated with overall project delivery methods. Tracking and analyzing such data should enable better benchmarking in the future, which, in turn should, enable a more robust and for a comprehensive analysis of ROI.

Keywords: Lean, Integrated Project Delivery (IPD), Metrics, Return on Investment (ROI), Benefits/Costs, Target Value Design (TVD)

Table 1: Proposed Framework for Key Metrics

COST		**BENEFIT**			
TIME	**COST**	**SAFETY** Of people Involved in Design and Occupants of the building	**QUALITY** Of the project as it relates to people, the community and the organization	**MORALE** Of team including Design team/ Owner/ Family representation	**LEARNING** Of the team and the community
Production time [i] Decision time [ii] Schedule Variance (SV=Budgeted Cost of Work Performed - Budgeted Cost of Work Scheduled) [i]	First cost [i] Lifecycle cost [iii] Decision making cost [ii] (labor + materials) Energy Cost Operational savings [iii] (Note: use of CBA- Choosing by Advantage tools did take into account lifecycle cost and was used for some key design decisions as documented in A3s) Cost Variance (CV=Budgeted Cost of Work Performed - Actual Cost of Work Performed) [i]	Construction safety [i] Post-occupancy safety (employee injury, patient harm (infections, falls with injury, errors) [iii]	Efficiency of project (RFIs, changeorders, punchlist items) [i] Benefit to patient (clinical quality + safety + overall satisfaction) [iii] Benefit to employee (efficiency + safety + satisfaction) [iii] Benefit to organization (Community goodwill, market share, employee loyalty, patient loyalty etc., Energy Efficiency [i]) [iii] Benefit to community (local participation [i]) (Note: A3s currently capture some of these benefits but lack of metrics is a challenge) Number of RFIs (Requests for Information)[i] Number of E&O COs (Error and Omission Change Orders) [i]	Team satisfaction [i] Team collaboration [i] Employee engagement / satisfaction during design, construction, and transition [i] Family engagement / satisfaction during design and construction [i] Employee satisfaction post occupancy [i] Family satisfaction post occupancy [i]	Team learning [iii] Hospital employee learning (relates to change engagement) [iii] Community learning (local community that supports the hospital) [iii]

[i] Metrics exist
[ii] Metrics proposed in this study
[iii] Metrics to be determined (a probabilistic model may be needed to link design decisions to occupancy metrics, based on the likelihood of certain outcomes from a given body of evidence. Existing metrics currently captured by the organization should be taken into account.

Current Metrics List (*):
[S]: DART rate
[C]: Target cost vs. Actual Cost, Target Value Management Workbooks, Incentive Compensation, Use of contingency funds

[T]: No. of working days to resolve project issues, schedule increase of 2 weeks or more, no. of calendar days sooner than scheduled time
[Q]: Punch list items, LEED certification points, Energy Efficiency, Local Participation
[M]: Team performance survey, Staff and Family Satisfaction & Engagement Surveys with Workshops participants

INTRODUCTION

Problem Statement and Significance of Research

The healthcare industry is shifting from a volume-driven to a value-driven system. But how do we measure value? What information do we need to conduct a comprehensive Benefit/Cost analysis? Arguably consequences of decisions made during the design process can impact operational performance years after construction. *What information should we be tracking at the design stage to make this assessment possible at construction and post occupancy?*

This research is significant because it develops an "inventory of metrics" from a real-life project, and a framework to understand the fiscal implications of a value-driven approach to design and project delivery. Such an approach would allow all stakeholders in general, and architects in particular, to *systematically collect data during design,* that could allow a more rigorous benefit/cost analysis of the approach and the project.

In Phase 1 of a multi-phase study, the goal is to develop a framework of recommended metrics mapping not only the *explicit* benefits and costs related to design decisions, but also the *implicit* benefits and costs, that need to be measured to enable a comprehensive ROI. In Phase 2, an ROI tool will be developed based on input from multiple projects' teams, and tested on a single facility.

Accountability in the Health and Design Sector: Where are the metrics?

In 1999 the Institute of Medicine published a report called "To Err is Human: Building a Safer Health System", that concluded that between 48,000 and 98,000 people die each year as a result of preventable medical errors (Kohn, Corrigan, & Donaldson, Eds.,1999). This report and the following report on "Crossing the Quality Chasm" became the inspiration for a widespread awareness of patient safety (Institute of Medicine, 2001). With changing reimbursement models and the advent of the Affordable Care Act, the push to manage, measure, and be increasingly accountable, is stronger than ever before.

In keeping with the era of accountability, in 2013, the AIA launched an industry-wide initiative titled "The Cost of Imperfection: Costs due to Errors, Omissions, and Coordination Issues in Building Design and Construction (AIA, 2013)." This initiative acknowledges the complexity of design and construction projects and proposes to describe the costs of construction changes related to errors, omissions, and coordination issues that should be anticipated in building projects. This effort is timely because it will provide an objective framework for managing the design and project delivery process to reduce cost and increase value.

Arguably though, much of the value of design, particularly in the context of healthcare, is evident only once a facility is operational. Within healthcare design there is now a strong body of evidence to establish that facility design can create latent conditions that foster error producing or unsafe behaviors (Chaudhury, Mahmood, & Valente, 2004; Reason, 2000). A growing body of evidence links design elements to both improved outcomes, and reduced risk (Ulrich et al., 2008). Many papers have been written to make the case that sometimes evidence-based design decisions may require a larger first cost, but more than pay for themselves once the hospital is operational (Sadler et al., 2011; Ulrich et al., 2008). However, testing this hypothesis in a real life study remains problematic (Sadler et al., 2011). It is difficult to link single interventions (such as single patient rooms, positive distractions, natural light etc.) to operational outcomes across a facility, in a real life project, because many factors need to be controlled for, and to do so, they must be tracked and measured. A comprehensive comparison of benefits versus costs, or understanding of "value" can only be attempted when the implications of the design and construction process are considered in terms of both capital (first-cost) and life-cycle (operational) costs. This is a highly complex undertaking, and can be difficult to achieve, without the presence of a robust framework and clearly defined metrics (Joseph and Nanda, 2013).

In a complicated endeavor such as the building of healthcare facilities, identification of metrics is perhaps the largest stumbling block, and it is this first hurdle that this research seeks to overcome. The case study of a Lean-Integrated Project Delivery (Lean-IPD) for a healthcare project provides a unique opportunity to do so for the following reasons:

1. All stakeholders come together in the decision making process and target values are clearly defined
2. There is extensive documentation on a common platform to enable the integrated approach
3. There is transparency in the decision making process that enables the tracking of quality metrics

These are compelling reasons from a research perspective because they provide "data" into the design and project delivery process which has been elusive as a measure in the past. Taking a case study approach is useful because confounding variables across sites can be minimized.

BACKGROUND

Integrated Project Delivery

The American Institute of Architects (AIA 2007) defines IPD as a "project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harness the talents and insights of all project participants to optimize project results, increases value to the owner, reduces waste and maximizes efficiency through all phases of design, fabrication and construction." According to Sive (2009), several characteristics differentiate IPD from traditional delivery methods and include:

- a multi-party contract;
- early involvement of key participants;
- collaborative decision making and control;

- shared risks and rewards;
- liability waivers among key participants; and
- jointly developed project goals.

Currently there are many IPD-like practices that actualize a few of these characteristics. However, because these practices do not implement the full IPD methodology, they also may not reap full benefits.

Risk sharing with an IPD contract

One of the greatest risks to any stakeholder is that work will be performed without that stakeholder being paid, so that the stakeholder would be operating at a loss. However, in Target Value Design (TVD), the Owner, Architecture, Engineering and Construction (OAEC) stakeholders are covered by either an Integrated Form of Agreement (IFOA) or a type of Integrated Project Delivery (IPD) contract that ensures risk is shared by all parties. Either all or a portion of each party's profit is placed into a risk pool that will revert to that party once an agreed Allowable Cost has been reached. If the estimated cost cannot be sufficiently lowered to reach the Allowable Cost and the project is cancelled, it is true that stakeholder team members forfeit part or all of their profits—but at least their direct costs are covered. This phase is sometimes called "pain-sharing" because both the Owner (the one that holds the purse strings) and the partner stakeholders must be willing to face possible loss during this phase of TVD. If the estimated cost has been lowered to the pre-determined Allowable Cost, the project can proceed, and the contract incentive scheme enters a new phase sometimes called "gain-sharing." At this point, any further savings in first cost are shared by both the Owner and the stakeholder team, based on pre-arranged percentages.

Lean Project Delivery

It has long been recognized that the cost of completed building projects often exceed their approved budget. Building projects may experience substantial delays and/ or may be vulnerable to falling short of quality and safety standards that had originally been intended and desired. Furthermore, stakeholders associated with a project, particularly from the owner's side, tend to work in a state of continual stress, spending extended working hours beyond their "regular jobs" in a reactive state of problem solving, colloquially called "firefighting."

Some practitioners consider time, cost, quality, safety and morale problems to be reparable through the automation and mechanization of the industry. However, although software programs (e.g. word processing, AutoCAD, MS Project and P6 for scheduling, On-Screen Take-off for estimating, etc.) and the development of advanced types of equipment (e.g. concrete pumps, total station, etc.) have led to incrementally improved efficiencies for individual activities, the overall productivity of the construction industry has actually declined over the past 50 years—a phenomenon which has been shown *not* to be true for other non-farm-related industries, such as manufacturing (Figure 2). The persistence of low productivity, despite a plethora of technological advances, has led some stakeholders to accept that relatively poor performance in terms of time, cost, quality, safety and morale, is simply an inevitable consequence of working in construction. However, a group of stakeholders—those who practice in the realm of *Lean Construction*—have not been willing to accept the explanation that low productivity in construction is unavoidable.

Lean construction advocates argue that the continuing decline of overall productivity despite technological advancements suggests that a systems-wide transformation is needed. In fact, as technological improvements do not appear to provide the answer, it seems increasingly likely that the hurdle to overcome may be more cultural than mechanical in nature.

Historically, the building industry has operated according to the seemingly immovable dictates of the "time-cost trade-off," meaning that for the three-legged stool of time, cost and quality, attempts to improve one "leg" of the time-cost-quality triumvirate sacrifices performance of one or more of the remaining two legs (Feng, Liu, & Burns, 1997; Hegazy 1999; Jackson 2010). For example, speeding up a project usually forces an increase in cost and/or decrease in quality. Similarly, overtures to save on first cost may demand either lengthening the time to project completion or loosening controls on quality. Lean construction advocates argue that it is necessary to rethink project delivery entirely if we are to make any significant improvements to overall productivity. In fact, when Lean-IPD is practiced rigorously, managers report simultaneous improvement to all three legs of the stool. This is why Lean-IPD has been considered, by some, to represent a paradigm shift.

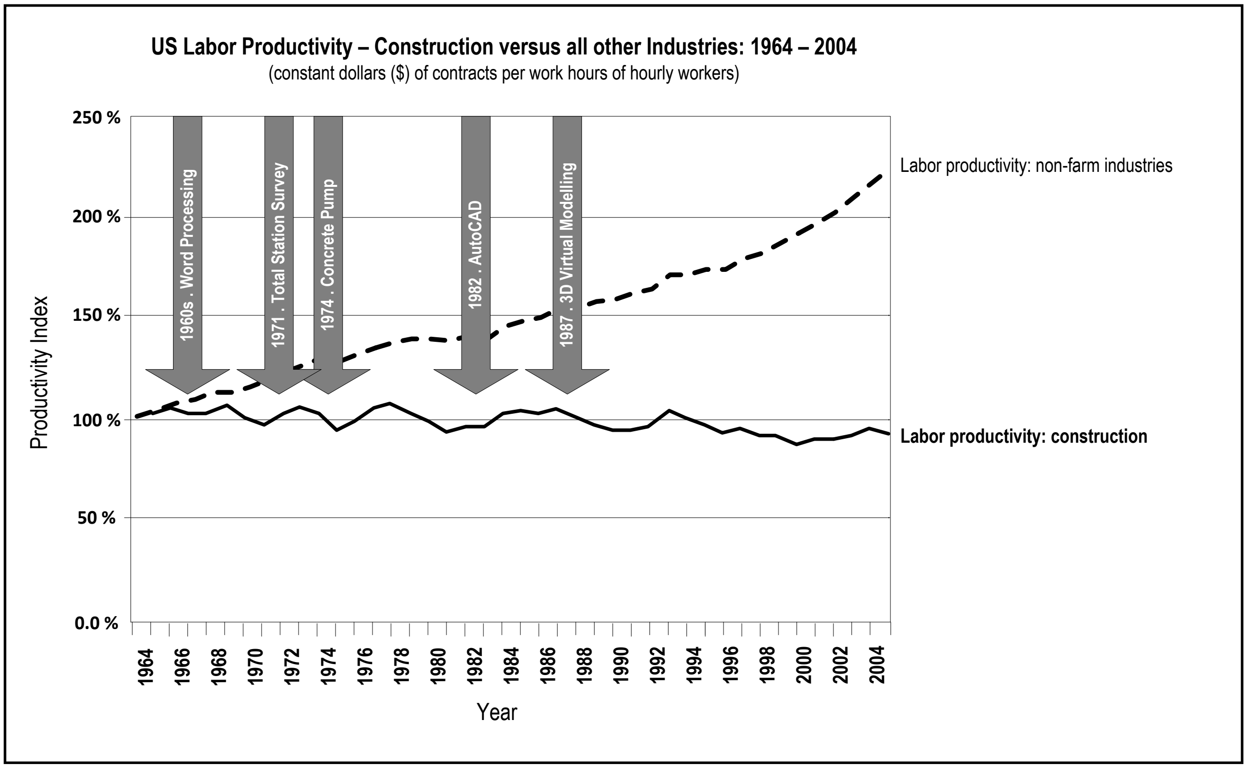


Figure 2. Indexes of labor productivity for construction and non-farm industries, 1964-2004
Downward arrows indicate approximate dates various technologies were first invented.
Adapted from Paul Teicholz at CIFE, as cited in Figure 1-3, p. 8, Eastman, Teicholz, Sacks, and Liston (2008); Teicholz (2001); Teicholz (2013); Source: US Bureau of Labor Statistics, Department of Commerce.

When antecedent pioneer to lean thinking, statistician W. Edwards Deming visited post-WWII Japan, his recommendations to Japanese business entrepreneurs helped the nation rebuild more rapidly than had previously been thought possible. Later, at his well-attended workshops for US businessmen in the 1980s, Deming illustrated the need for a systems change by engaging participants in the playing of his "red bead game" simulation. During the simulation, Deming asked volunteers to dip a paddle with 50 depressions into a bin full of red and white beads, completely filling the paddle, which was then examined by a mock supervisor. Red beads signified problems which Deming then instructed participants to attempt to minimize. Despite threatening exhortations should participants fail, as well as offers of generous rewards and bonuses should they succeed, most volunteers could not avoid collecting red beads with any level of reliability. Unbeknownst to most participants, the game was rigged because the number of red beads included in the bin made repeatable success statistically impossible. Deming used the game to symbolically illustrate the inherent structural flaws of many US business practices. Deming felt most companies do not work *with* their employees in a way that enables them to succeed. He argued that business processes need to be completely re-thought so that motivated employees are able to consistently excel should they choose to do so. Underlying the Deming's writings is an appeal to engage the skills, abilities, and wisdom of the individual (Dawson-Pick, 2004).

Akin to the spirit of Deming, subscribers to Lean Project Delivery (LPD) fundamentally respect the individual worker. In his now seminal *Technical Report Number 72*, Lauri Koskela (1992) called for an "application of the new production philosophy to construction." This novel philosophy had been applied to the manufacturing industry, and the Japanese automobile manufacturing industry (most specifically, Toyota) was enjoying remarkable levels of success. Similarly, in the construction industry, Glenn Ballard and Greg Howell recognized that variability in the delivery of individual tasks in construction was a root cause of the problems experienced, such as cost overruns, delays, rework, excessive Requests for Information (RFIs), and avoidable Change Orders due to errors and omissions. Ballard and Howell developed the *Last Planner System of Production Control™* (LPS) to help eliminate the root causes of variability (Ballard, 2000a), recognizing that much variability was due to systemic cultural problems entrenched in the building industry.

Implementing LPS demands a cultural change because many managers refuse to recognize that those who actually perform a task are often the most qualified to be calling out decisions with respect to time, cost and quality. The experience and training of frontline workers equips them with a depth of understanding that no manager—regardless of length of experience—can achieve. The mantra, "with every pair of hands comes a free brain," makes LPS substantially different from efficiency strategies that aim to increase productivity by equipping a lone manager with novel software programs that simply make him or her a more forceful dictator. Some lean theorists depict Lean Project Delivery as an inverted triangle, where management exists to support and assist the experienced "boots on the ground" worker. An underlying assumption of Lean Project Delivery philosophy is that most employees derive satisfaction from their work and *want* to do a good job. When those who perform a task are invited to take part in the decision-making process, those decisions are not only better informed and more accurate, the individuals involved tend to take ownership of the task, making greater effort to deliver what they had promised.

LPD adherents argue that the adversarial nature of construction has emerged in part, because of the risk-shedding strategy of most construction contracts, where stakeholders who have financial wherewithal distribute risk onto those who are least able to carry it. By contrast, in Lean Project Delivery, legal contracts, such as the Integrated Form of Agreement (IFOA), are drafted to share risk and reward with all parties involved. Teams that engage in Target Value Design (TVD) often use either an IFOA or another type of Integrated Project Delivery contract.

Target Value Design evolved as part of the Lean Project Delivery. A key goal of lean construction is to reduce waste and add value using continuous improvement in a culture of respect (Rybkowski, Abdelhamid, & Forbes, 2013). Prior to the introduction of TVD, LPD primarily focused on the efficient scheduling and construction of projects *after* they were already designed. By contrast, TVD emerged as a recognition of the need to rethink processes upstream of construction—in other words, during design.

"Lean production" was a phrase coined by John Krafcik—a then graduate student at MIT. Womack, Jones, and Roos (1990) and then Liker (2004) studied the productivity and quality gains made in the Japanese automobile company Toyota. Lean is a production system used to create better quality products in less time. This involved new production techniques such as Just-in-Time delivery, and pull scheduling (Ballard and Howell, 2003).

In 1992, the first *International Group for Lean Construction* (IGLC) conference was held, and in 1997, the *Lean Construction Institute* (LCI) opened its doors (Alarcón, Ed., 2013; Forbes and Ahmed, 2011; Lean Construction Institute, 2013). Koskela, Howell, Ballard, & Tommelein (2002) established three seminal principles on which lean construction theory is built, namely: Transformation, Flow, and Value generation. This triumvirate has come to be known as the “value generation model.” According to Bertelsen and Koskela (2004), the TFV model suggests that construction should be understood as generation of value for the client. In addition to Koskela’s TFV model, Tommelein (2015) offered two more definitions for Lean including: (a) pursuing the ideal to do what the customer wants, in no time, and with nothing in stores, and (b) reducing unnecessary or bad variation.

A community-based definition of Lean Construction is continuously evolving. “The Cocktail Napkin” exercise by Rybkowski et al. (2013) offered a graphical definition of Lean Construction (Figure 3). Lean Construction removes waste and adds value using continuous improvement in a culture of respect. In other words, if improvement happens in a Lean way, measurable metrics of time, cost, quality, safety and morale should all improve simultaneously. The graphic suggests that lean can either deliver a project of equal value for a lower capital cost than was originally planned, or of greater value for the same capital cost as was originally planned.

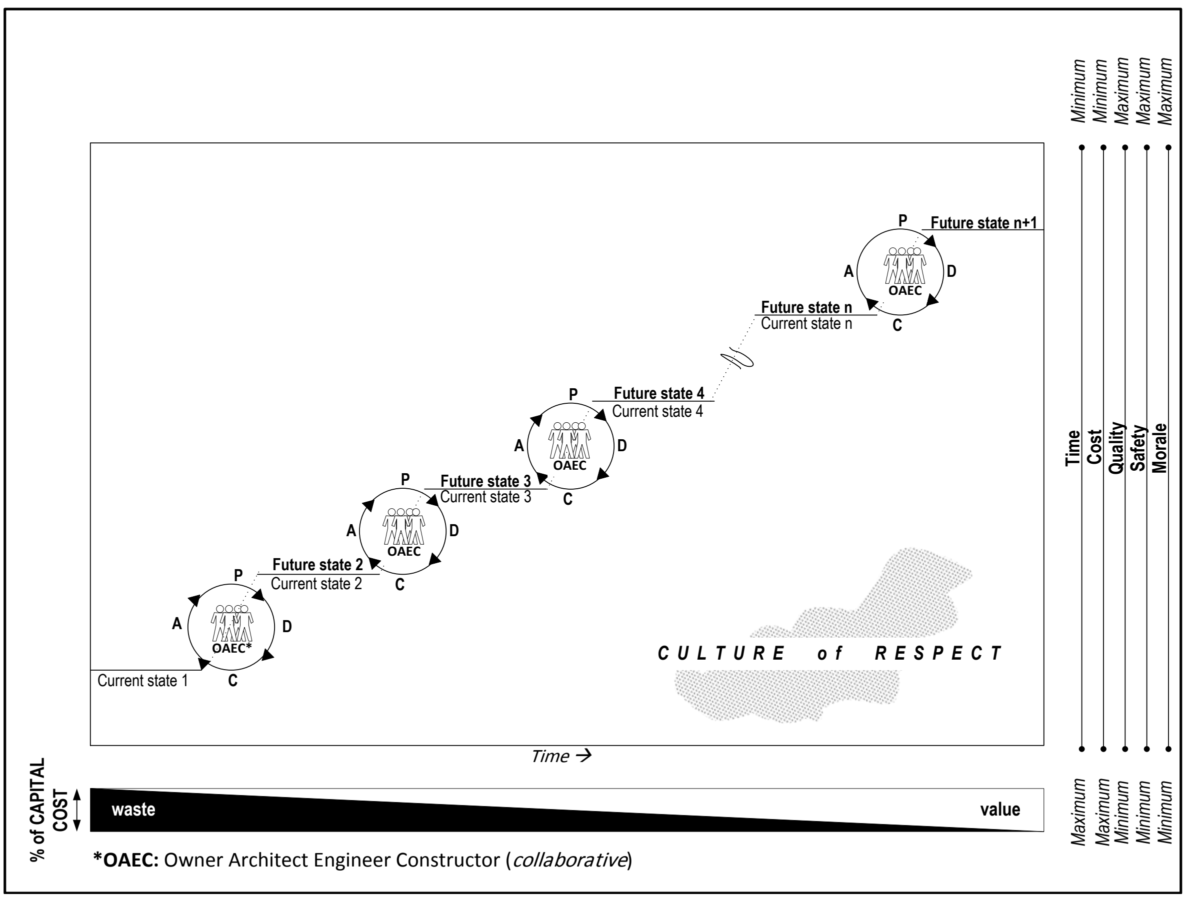


Figure 3. Diagram of Lean Construction showing current state to future state process including the plan (P), do (D), check (C), act (A) cycle.
Reprinted from Rybkowski et al. (2013) and adapted from Fernandez-Solis and Rybkowski (2012).

Value Engineering

According to Nicolini, Tomkins, Holti, Oldman, & Smalley (2000), "value engineering is not aimed at reducing cost, but at enhancing value. This can be achieved either by improving functionality without increasing costs, or by diminishing costs without affecting the functionality of the product." Nicolini et al. (2000) state that, value engineering is a series of processes where waste is eliminated and value is added. This occurs during the design phase, which is when most expenditure occurs.

What is Value?

Saxon (2005) proposed an equation to suggest a definition of value:

$$\text{VALUE} = \frac{\text{What you get}}{\text{What you give}}$$

According to Saxon (2005), positive value exists when benefits are larger than what is given up, while negative value exists when sacrifices exceed benefits. According to Mossman, Ballard, & Pasquire (2010), value is the *raison d'être* behind lean project delivery process and that which distinguishes Lean-IPD from traditional methods. Garrido, Pasquire, & Torpe (2010) state that value has been commonly related to factors such as cost, function, quality, and so forth, and correspondingly several definitions, equations and models revolving around this concept have been formulated. Despite ongoing efforts by researchers to define or develop a theory for value in the construction industry, a common definition has not materialized. Garrido et al. (2010) state that, in Lean Construction, value is strongly influenced by lean production.

Value is a relative term or a comparative term. Value of money is always relative to time. For example, a dollar in hand today is worth more than a dollar tomorrow because it can be invested and grow. This concept is known as the *present worth analysis*. Time value of money, developed by Leonardo Fibonacci in 1202, is an important concept in financial management (Goetzmann, 2004). Time value of money is used to compare investment alternatives because the decision-maker is able to convert all investments to the same point in time, allowing the proverbial apples to be compared to apples, and oranges to be compared to oranges.

Target Value Design

TVD is an adaptation of target costing in the construction industry. Target costing ("Genga Kikaku") is a Japanese concept which has been a management practice for profit planning in the manufacturing industries since 1980's (Monden and Hamada, 1991). Today target costing is being applied to the field of construction along with lean construction processes. Ansari, Bell, & CAM-I Target Cost Group (1997) put it in a simple equation as:

$$\text{Target Cost} = \text{Target Price} - \text{Target Profit}$$

Ansari et al. (1997) define target costing as "a system of profit planning and cost management that ensures that new products and services meet market determined price and financial return." According to Shank and Fisher (1999), target costing begins with the product planning stage and is used to systematically reduce product cost. It is in the planning and designing stages that opportunities for reducing costs are highest. The Tostrud Fieldhouse Project at St. Olaf's College in Northfield, Minnesota, led by the general contractor, Boldt Construction, and completed in 2002, is the first published successful work that applied target costing to construction (Ballard and Reiser, 2004). This project describes the application of target costing in construction field and the complications associated with it. Clifton, Bird, Albano, & Townsend (2004) (Figure 4) state that, to achieve an established target cost, a core team of stakeholders engage in a series of value engineering exercises and re-estimate cost at every successive step. In this way waste is eliminated and value is added continuously throughout the process.

A fundamental assumption of Target Value Design is that it is both pointless and financially dangerous to design and build a facility that exceeds an owner's ability to repay capital financing. In other words, unlike other forms of project delivery that start with architectural plans loosely tied to an expected cost, Target Value Design kicks off with a rigorous validation study that identifies what a facility owner can actually pay. This amount establishes what is known as an *Allowable Cost*. In TVD, a team loaded with critical stakeholders then works collectively and collaboratively over time to iteratively design and redesign the project until the project's estimated capital cost meets the pre-determined allowable cost. Figure 5 represents the basic concept of Target Value Design. Although specific terms may vary by team and project, fundamental concepts of cost reduction to and beyond a critical point are similar on most TVD projects.

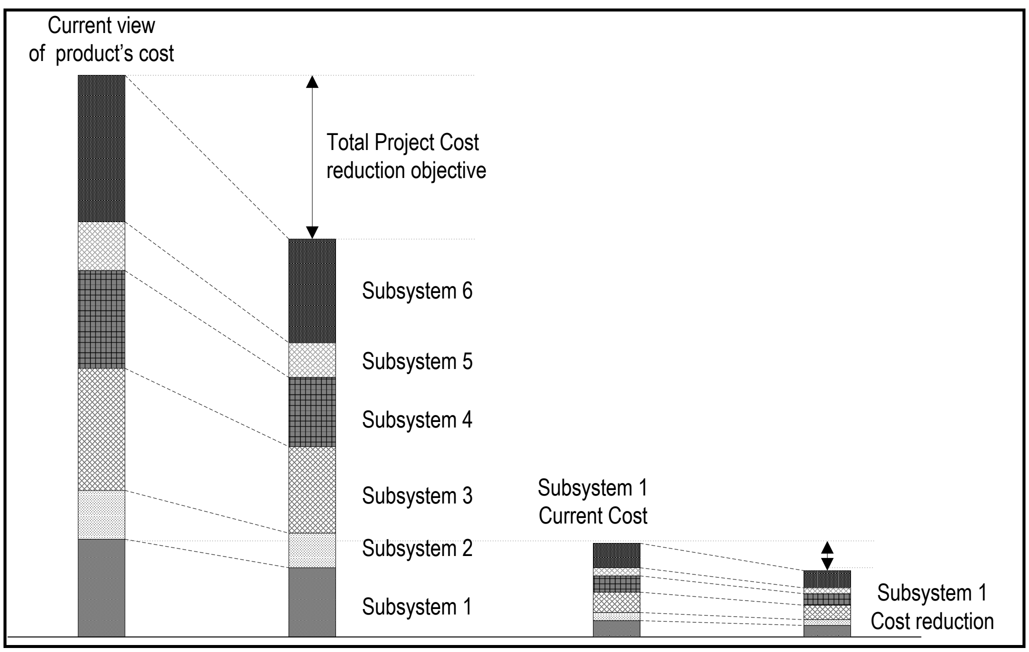


Figure 4. Cost savings shared by subsystems, as a result of Target Costing exercises.
Adapted from Clifton et al. (2004; Figure 5.2, p. 73) and Rybkowski (2009; Figure 48, p. 132)

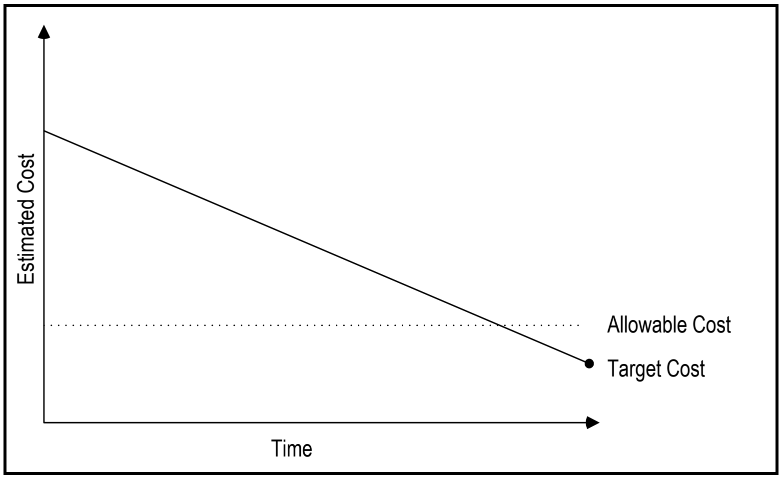


Figure 5. Progressive reduction of estimated first cost during Target Value Design exercises. Adapted from Rybkowski (2009).

A cardinal rule of Target Value Design—that the allowable cost must *not* be exceeded—is sacrosanct because surpassing the allowable cost may result in a project that is not financially viable and potentially exposes the owner to financial ruin. This is the reason why a diagram of the TVD methodology sequence includes intermittent “Go/No-Go” nodes—stopping points for the stakeholder team to systematically assess the viability of the project and to discontinue further development of project plan, if necessary (Figure 6).

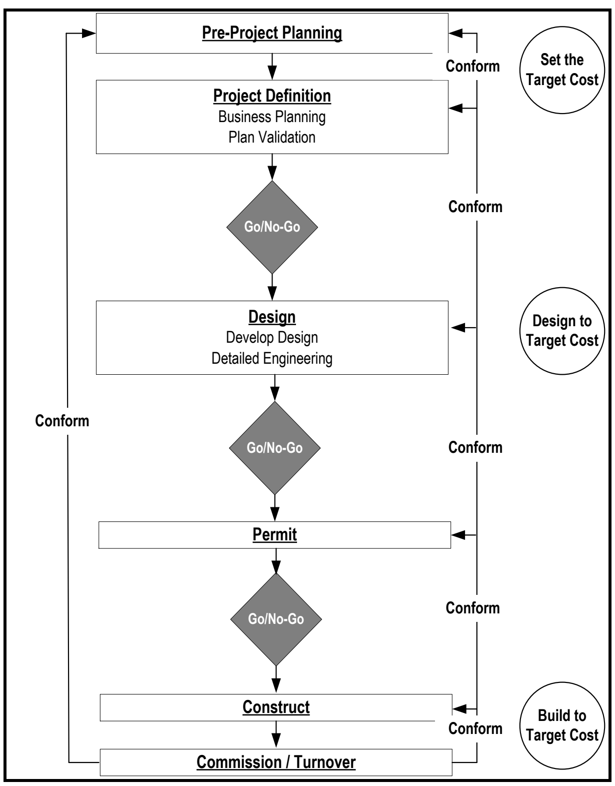


Figure 6. Flow chart of Target Value Design processes indicating “Go/No-Go” decision points. Adapted from Ballard (2008).

Naturally, reducing a project's capital cost requires key stakeholders to continually identify new design alternatives. Ideally, the process demands inclusion of a facilitator who is perceived as fair, unbiased and meritocratic. It also requires sufficient time for the stakeholder team to systematically brainstorm and create new alternatives. Understanding the impact of providing design decision alternatives during the TVD process necessitates provision for continuous estimating and re-estimating.

According to Ballard (2009a), "TVD is a management practice that motivates designers to deliver customer value and develops design within project constraints." It is a "Lean tool" and therefore may be included as a part of the "Operating System" in the LCI triangle model (Thomsen, Darrington, Dunne, & Lichtig, 2009). (Figure 7).

In the triangle 'Organization' refers to the way people communicate with and report to each other in order to deliver the project. 'Operating system' refers to the way work is managed and executed in the course of producing the project. 'Commercial' establishes a framework to allocate risks and compensation in order to align the parties' interests with a collaborative approach and with the overall success of the project (Alarcon, Christian, & Tommelein, 2011).

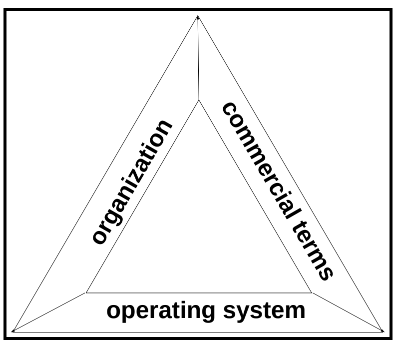


Figure 7. The LCI triangle model (Thomsen et al. 2009).
Adapted from Denerolle (2011) and Mossman (2014).

Since 2002, a number of institutional projects using TVD have been completed on or below budget, at record schedule and at a value desired by the customer (Do, Chen, Ballard, & Tommelein, 2014). Do et al. (2014) showed through statistical analysis of 47 TVD projects that the implementation of TVD:

1) reduces the likelihood of cost overruns; and
2) reduces the contingency percentage in project budgets.

Do et al. (2014) developed a graphic representation (Figure 8) of project cost breakdown. The total project cost includes: cost of work, contingency, and profit. TVD projects use less contingency when compared to non-TVD projects. This is possible because in TVD projects the entire project contingency is pooled collectively instead of being carried individually by each participant. In this way, the project team is able to allocate less contingency to cover the same amount of uncertainty in the project (Do et al. 2014).

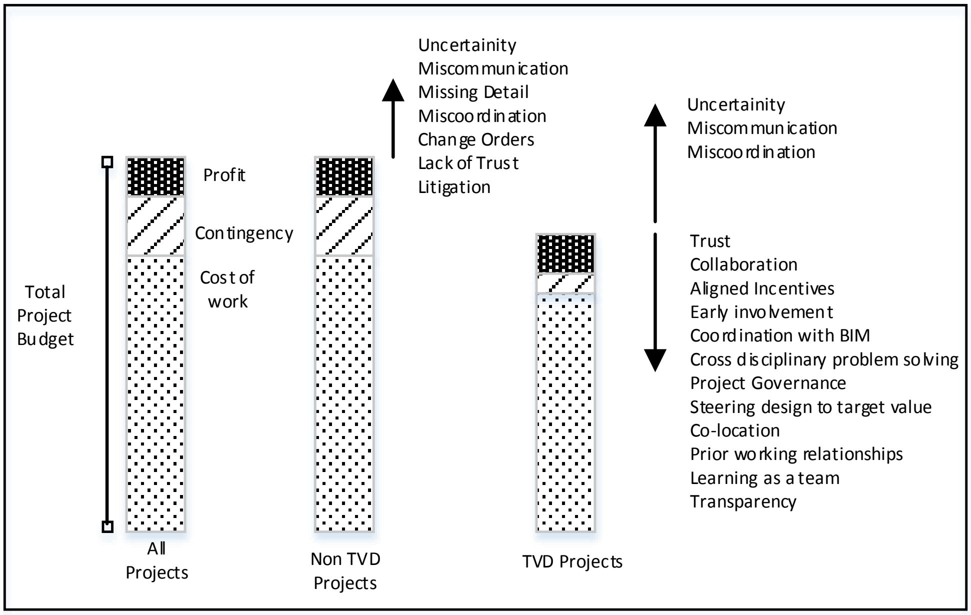


Figure 8. Cost Control Mechanism
Adapted from Do et al. (2014).

A benchmark report (Ballard, 2009b) on TVD outlined the overall steps involved in the process. This resulted in a few radical changes to traditional practice. For example:

- Time and money spent during the project definition phase of a project is higher than what is traditionally spent;
- Value-based proposals are preferred over competitive bidding;
- Architects and customers interact more openly and directly;
- Design professionals, suppliers and builders collaborate and explore problems and solutions jointly;
- All stakeholders in a project respect each other and learn how to contribute and participate in the project definition and design process;
- Design solutions are developed with cost, schedule, and constructability as design criteria; and
- The incentives of all team members are aligned with the pursuit of project objectives.

There have been challenges associated with the adoption of TVD. For example, making decision by consensus can be difficult. A few advanced practices in TVD have helped to rectify these issues.

Recommendations include:

a. Engage the client as a key performer;
b. Design in small batches;
c. Use A3 reports to capture and share learning; and
d. Model the space-in-use prior to design (Macomber, Howell, & Barberio, 2007).

According to Nguyen (2010), to achieve a design that satisfies maximum customer needs, TVD uses fundamental lean tools and principles such as Set Based Design (SBD), Production

System Design (PSD), Target Costing, IPD (collaboration), and co-location. The Integrated Project Delivery (IPD) approach allows early participation of contractors and suppliers in the design phase. Co-location improves communication and facilitates consensus decision-making. Multiple design alternatives can be generated using SBD, while PSD helps to integrate product- and process design. Target Costing helps to close or at least diminish the expected-allowable cost gaps. The application of TVD often results in multiple design alternatives with different product costs, process costs, as well as product features.

Cost reduction with TVD

In order for the most creative design ideas to emerge, costs must be allowed to flow freely between subsystems of a project. In other words, reduction of subsystem costs is not necessarily equally proportioned. During TVD for the Cathedral Hill Hospital Project in San Francisco, CA, for example, some subsystem providers ultimately took on greater value for their provided services than had originally been planned, while others took on less; this occurred even though the overall cost of the project had decreased (Figure 9). In TVD, it is critical that funds be permitted to flow freely across subsystem boundaries so the owner and team can feel free to select the best alternative under consideration, regardless of how funds are redistributed across subsystems. Under a traditional contract, stakeholders might resist this type of cost flow in an attempt to suboptimize. By contrast, with an IFOA or many forms of IPD contracts, the shared Allowable Cost goal helps motivate stakeholders to optimize the whole project, rather than simply their own part of it. A key principle of Lean thinking is that value to the overall project must be optimized.

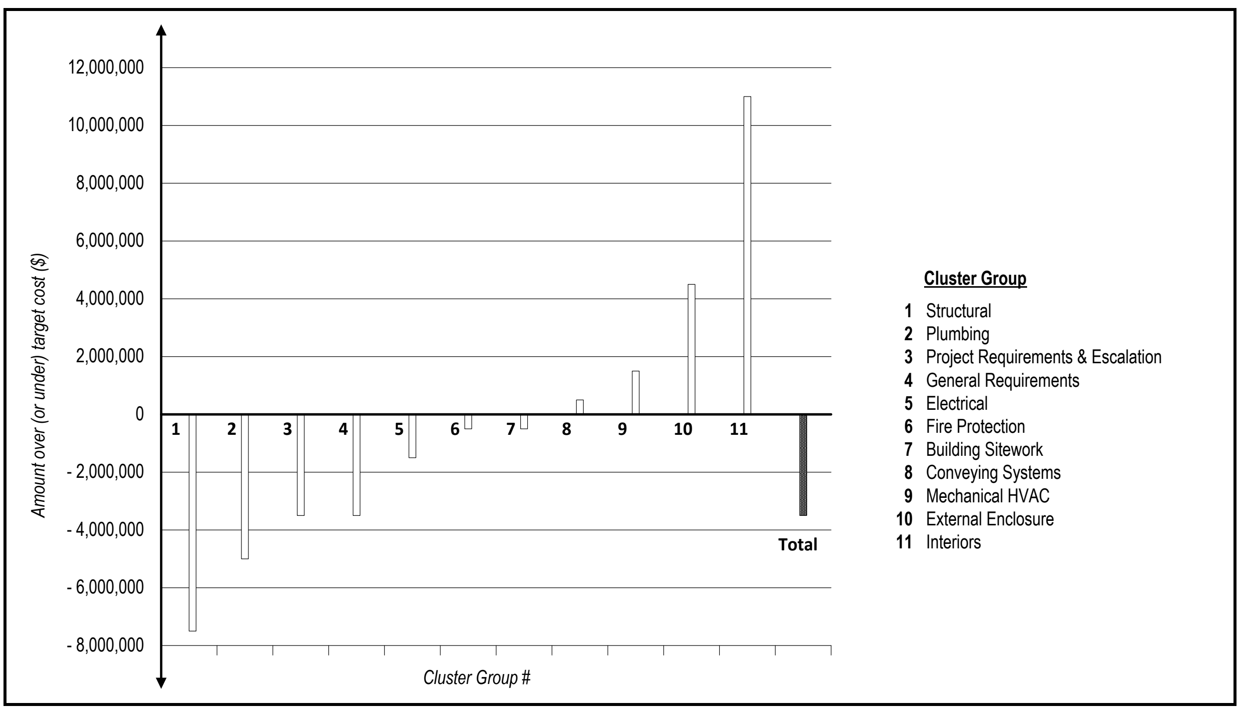


Figure 9. The flow funds across boundaries during an interim point of the Cathedral Hill case study TVD project. Although the total project cost was reduced, individual subsystem cost components both increased and decreased in value.
Adapted from Rybkowski (2009; Figure 55, p. 149).

Mock-Ups and TVD

Cardboard mockups offer a very simple but effective way to rigorously test proposed design alternatives before a building is actually constructed. Any new idea when visualized as a full scale cardboard mock up gives a clear understanding about space and equipment needs. The mock-up concept is consistent with construction rules of thumb—that is, it is better to measure twice and cut once to avoid wastage. Projects sometimes spend considerable money and time developing mock-ups during the design phase. There are several approaches to mock-ups, but full scale allows users to inhabit and more accurately visualize space. To make a mock up a value addition to TVD, Bykowski (2014) offers the following advice:

- Only mock-up what is important and space which has not been tested before;
- Use actual equipment and simulate the space usage for better understanding;
- Mock-up and repeat. As the design evolves, return to the mock-up, test the changes; and
- Invite and encourage a cross-section of all providers and staff involved with the workflows that impact the space. Have them all come to review the mock-up together.

Owners engaging in TVD have recently been opting to develop full-scale cardboard mockups of healthcare facility rooms and corridors complete with critical medical equipment. Members of the clinical team (physicians,, nurses, techs, and therapists) and members of the support services who will be using the final space are invited to move equipment through the mockups during and to engage in scenario simulations in order to advise architects about locations where walls need to be moved, removed, or cut (Figure 10). While many owners are finding it possible to secure a donated empty warehouse space for week of the mock-up, the exercise can be expensive in terms of materials and medical personnel hours required. Nevertheless, the benefits—in terms of being able to develop a much more functional healthcare facility design—can be considerable.

Figure 10. Full scale cardboard mockups with medical team and architects.
Images source: Beikmann, Knox, & Mamer, (2013).

In other words, TVD demands a heavily loaded and highly committed team consisting of the owner, architects, engineers, contractors, key trade partners, and vendors. These team members need to meet frequently in a structured fashion to ensure that design decisions made are fully informed. It is true that asking stakeholders to partake in so many upfront meetings, as well as in developing a full-scale mockup and then testing that mockup with real medical personnel conducting real action scenarios, can be costly. But the implicit promise of Target Value Design is that money spent early is money spent wisely. It makes intuitive sense that a building designed well will incubate fewer surprise problems later on, so that owners can more than recoup the additional funds that were spent on mockups and meetings. The now well-referenced MacLeamy Curve graphically illustrates how the cost of design changes increases with time. With traditional project delivery methods, such as Design-Bid-Build, much of the consultant team arrives too late in the process, driving up costs due to unnecessary change orders, requests for information, and errors and omissions. The MacLeamy Curve illustrates that the stakeholder team should arrive early in the conversation instead of at mid-stream, when ability to impact cost and function is highest (Figure 11).

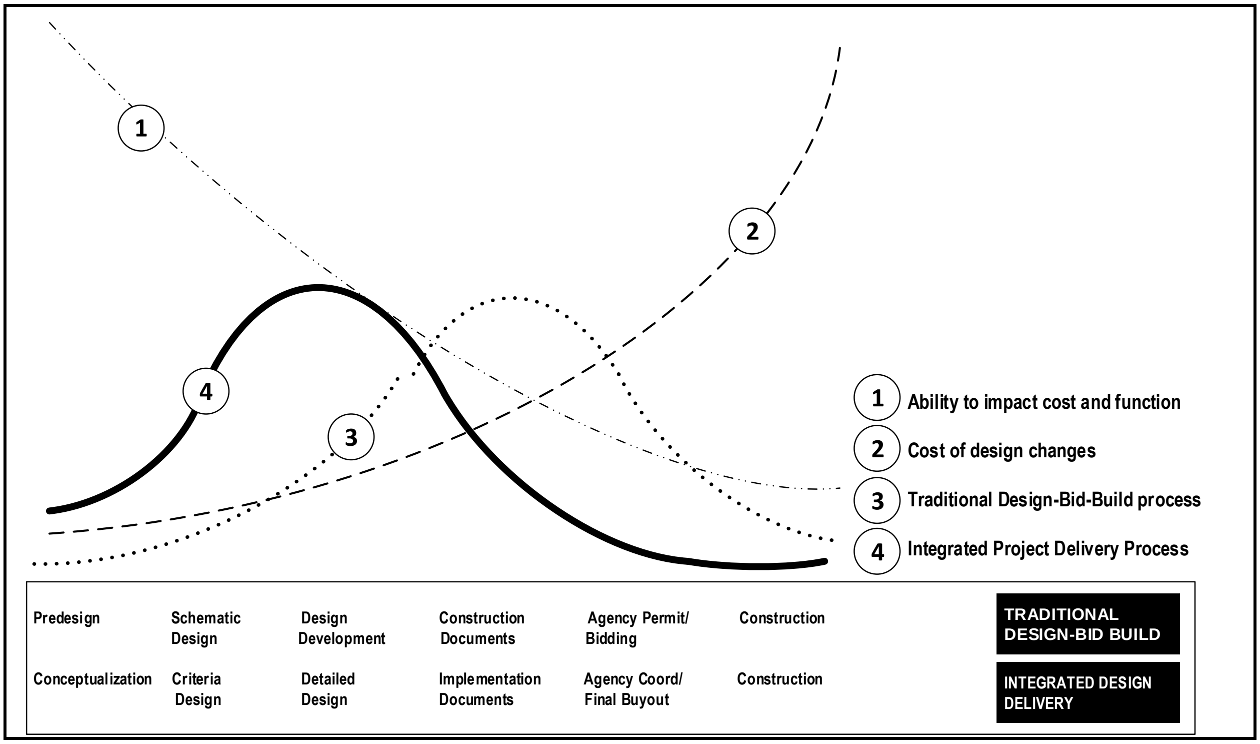


Figure 11. MacLeamy Curve.
Adapted from MSA (2004).

It is easy to forget how many stakeholders are actually involved in the design and construction of a project. Besides the owner, architects, engineers, general contractors, and trade partners, there are suppliers, vendors, financiers, bonders, building inspectors, permitting agents, attorneys, insurance providers, utility companies, political and social organizations, and trade unions (Figure 12). With traditional delivery, the risk that any one of these players is working in the dark or with outdated knowledge about the project at any one time is great.

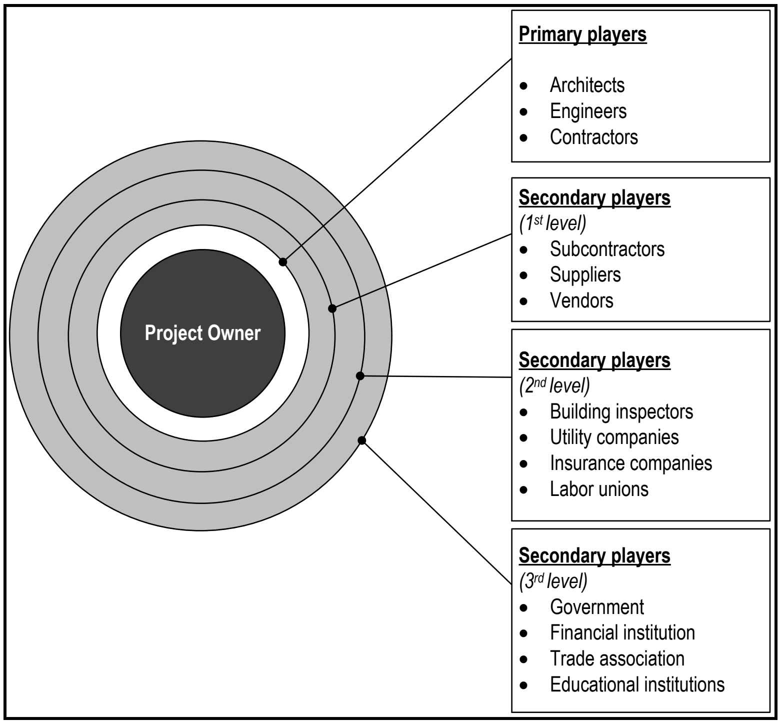


Figure 12. Stakeholders involved on a construction project and their traditional level of influence
Adapted from Jackson (2010, p. 26)

The potential impact of meeting early and often with critical stakeholders cannot be overstated because doing so ensures that key individuals are kept in the know at all times, reducing the likelihood that one or more stakeholders will be making decisions based on incomplete or outdated knowledge. The conceptual diagrams in Figure 13 compares amount of knowledge sharing during a traditional Design-Bid-Build project versus that which occurs on a project using Target Value Design. The diagram helps remind practitioners of the value of holding so many meetings. The greater the knowledge that is shared, the lower is the probability of error later in the process.

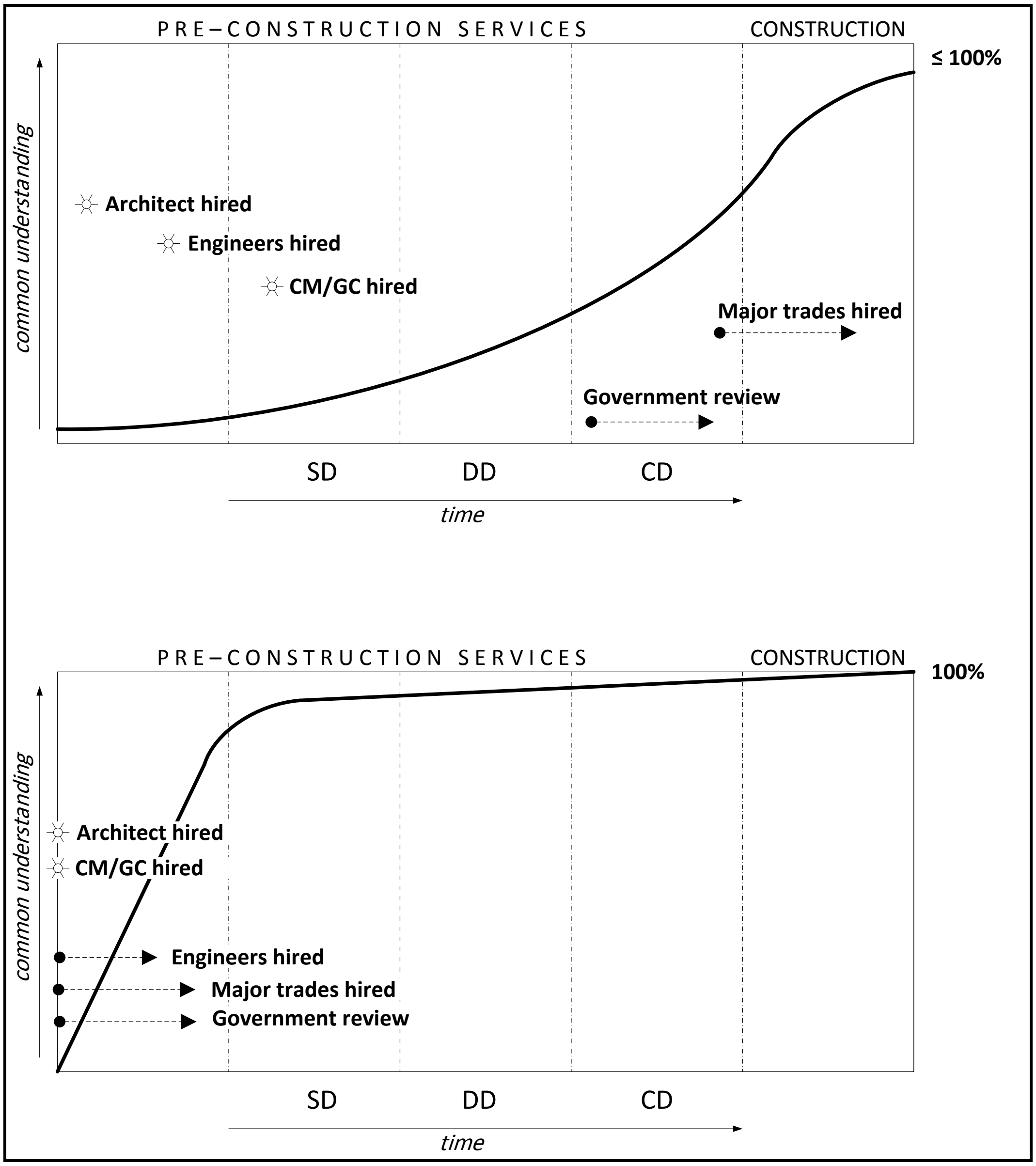


Figure 13. Shared project knowledge by team members during typical Design-Bid-Build project delivery (top), and during Lean Project delivery (bottom), as speculated by Will Lichtig (2008). Note that shared project understanding is much greater toward the beginning of a project during Lean Project delivery.
Adapted from Lichtig (2008), as presented in Feng and Tommelein (2009) and reprinted with permission (W. Lichtig, personal communication, February 13, 2015).

To appreciate the difference that in-person, face-to-face communication makes, one need only consider how restrictions in communication dictated by traditional contractual agreements can clog the flow of a project, creating delays. Swimlane diagrams illustrate how much time is saved when stakeholders are permitted to discuss project concerns during co-location or in "Big Room meetings" (Figure 14).

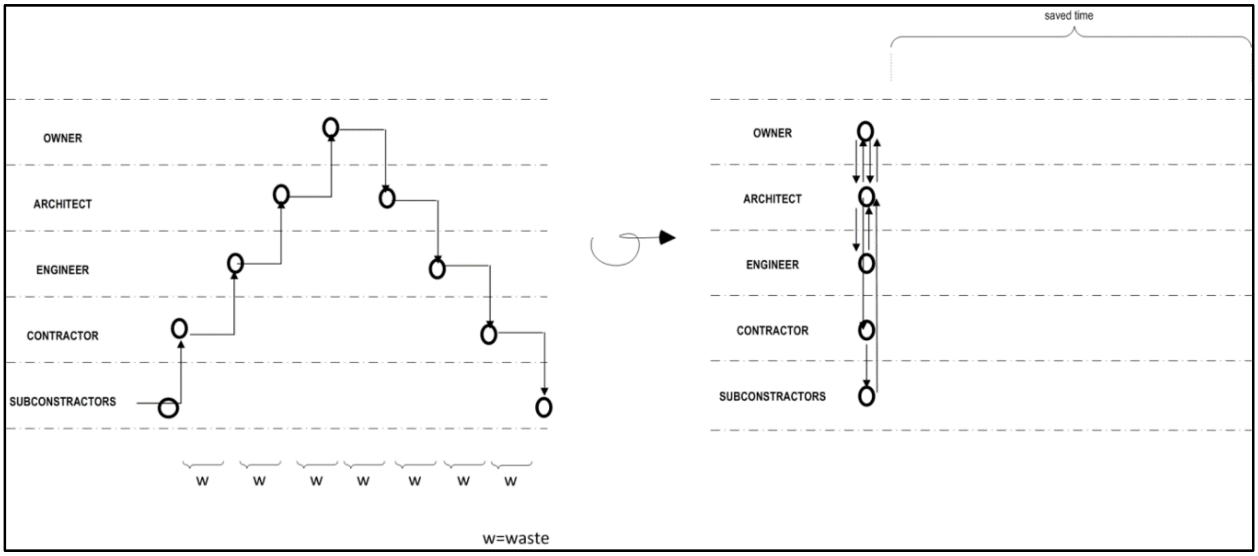


Figure 14. Swimlane diagrams compare the legally restricted communication process of traditional Design-Bid-Build projects (left) versus a typical Lean Project Delivery big room meeting (right). The horizontal axis represents time.
Adapted from Rybkowski (2012).

The Choosing by Advantages Decision-making System

The Choosing by Advantages Decision-Making System by Suhr (1999) has been adopted by the Target Value Design community as an aid to helping a design team align its output with an owner's needs. The basic premise is that attributes of a superior alternative offer advantages that can be rated by an owner in terms of the level of importance those combined attributes hold for the owner. When two or more alternatives are being considered, the rating of each advantage can be added together to give a final score for that alternative. When graphed on an x-y coordinate where the x (dependent) variable represents cost, and y (the independent variable) represents importance, the alternative that offers the steepest slope from the origin offers the owner the greatest value--or "bang for the buck." In the example shown in Figure 15, Alternative A has the steepest slope and therefore offers the greatest value when measured against Alternative B; Alternative C offers the greatest value when measured against Alternative A.

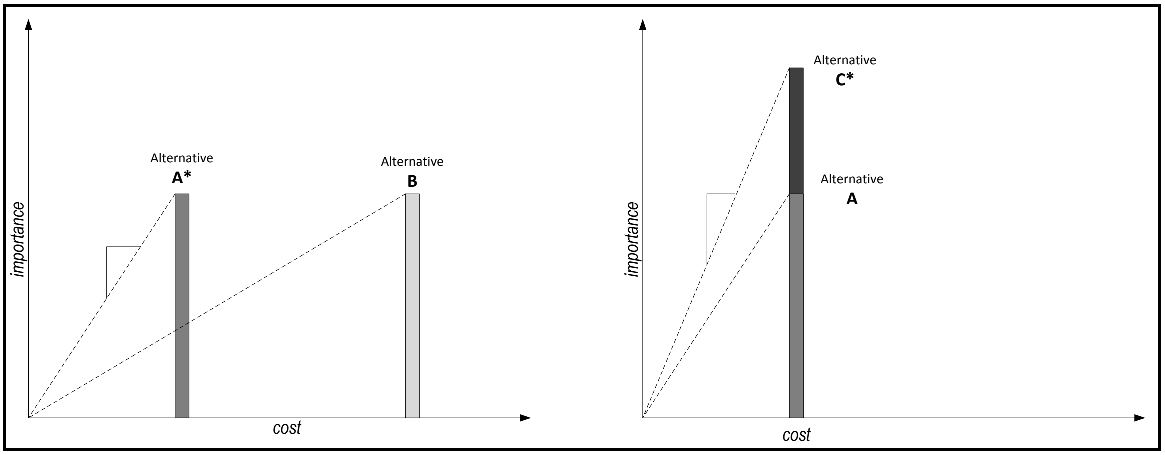


Figure 15. The Choosing by Advantages Decision-making System. The alternative with the steepest slope offers the greatest importance per cost ratio for the project, as defined by the owner.

Who, What, Where, How, When and Why of TVD

In summary, one might say the "**who**" of Target Value Design are the key stakeholders of the OAEC (e.g. Owner, Architect, Engineer, and Constructor) team and associated participants. The "**what**" of TVD is the systematic reduction of the first cost of construction in such a way that value—benefits per unit cost—are increased. The "**where**" of TVD represents the ideal way to situate the team, i.e. through co-location and holding Big Room meetings. The "**how**" of TVD is the methodology of Lean thinking, where teams brainstorm alternatives in collaborative cluster groups, present and post these alternatives on A3-sized posters, and then select high-value alternatives using decision-making tools such as *Choosing by Advantages*, or test design alternatives using full-scale cardboard mock-ups. The "**when**" of TVD is "regularly" and "often" —sometimes holding Big Room meetings as frequently as every one or two weeks, or co-locating for the full duration of the project. Finally, the "**why**" of TVD is because the project validation suggests that in order to support a viable business, the Owner must ensure that a facility's capital cost is one that is financially feasible.

The ultimate objective of this research is to serve as a basis for construction of a benefit and cost analysis model that allows a robust value analysis. The benefit and cost analysis model will lay the foundation of a more detailed economic model that accounts for a more robust and comprehensive rate of return analysis.

CASE STUDY: HOSPITAL X

Hospital X, which adopted Lean IPD, was identified as the case study for this research study. A large international architectural firm and general contractor were contracted by Hospital X to design and construct their new 364,000 square foot, 100-bed addition. Currently under construction, expected is spring 2015. The project includes a 75-bed Neonatal ICU (NICU), a high-risk delivery area using LDRs, a new outpatient surgery center, and an enclosed concourse enabling patients and staff to move between a new 1,250-space parking garage, the new building, and the existing hospital.

It is a unique setting for this research study because lean thinking has been incorporated into the project's programming, design, and construction processes. Design workshops held over 9 months in warehouse space enabled the design to be tested operationally as it was developed. A key component of the Hospital X is the implementation of Target Value Design (TVD) - a management practice that drives design to deliver value to the customer value, and develops design within the project constraints. The foundational principles of TVD include concurrently designing the product and process in design sets, collaborating in small and diverse groups and meeting regularly in a "big room" environment of co-location to facilitate communication and develop creative synergies (Suhr 1999).

At Hospital X, this process was followed by Innovation Teams that were concurrently evaluating constructability and value for every building system and product as the building was being designed. Design solutions were challenged by the innovation teams to enable the project to have the highest value for the lowest cost possible. Multiple design solutions were recorded on an innovation log, with teams making recommendations based on "Choosing by Advantage" analysis. "e-Builder", an electronic database was used to store all design documentation by various stakeholders including architects, interiors, and the engineers the mechanical, electrical, plumbing and structural systems for the project. The documentation for each key decision is stored in an "A3" (see Appendix H) outlining the value proposition and the documentation of the Choosing by Advantage findings. The project is currently under construction with an estimated finish date of April 2015.

The owner hoped to strengthen the hospital's brand and market penetration by applying TVD to the creation of the new facility within the following true north objectives:

1. Quality and Care Transformation
2. Patient Experience
3. Market Position
4. Education and Discovery

To study this project delivery model, and the development of metrics that assess the Lean IPD process in detail, an organizational chart was developed based on Hospital X project team's structure which is described below and illustrated in Figure 16, and in Appendix (A).

A three-level project organization was developed to support the Lean IPD process. The top level, Senior Executive Committee (SET) consisted of five members: one from ownership, one from each architectural firm, and one from each general contractor. The middle level, Project Leadership Team (PLT), included seven members: two from ownership, one from the owner's representative construction management company, one from each architectural firm, and one from each of the two general contractors. The bottom levels comprised the Innovation, Production and Workshop teams; these teams included personnel from O/A/E/C group as well as sub-contractor and vendors. The IPD contract was intentionally developed to include all the key participants for an integrated agreement for Lean Project Delivery. The contract was a five-party agreement executed by the owner, local/national architects, and local/national construction managers. Representatives from all teams met for three days to discuss the IPD method, project goals, parameters, and expectations that would be included in the contract. The discussion on building a strong team and sharing risk and reward laid the foundation for the contract; it was agreed that all the decisions would be made for the best interest of the project, and not the individual team members.

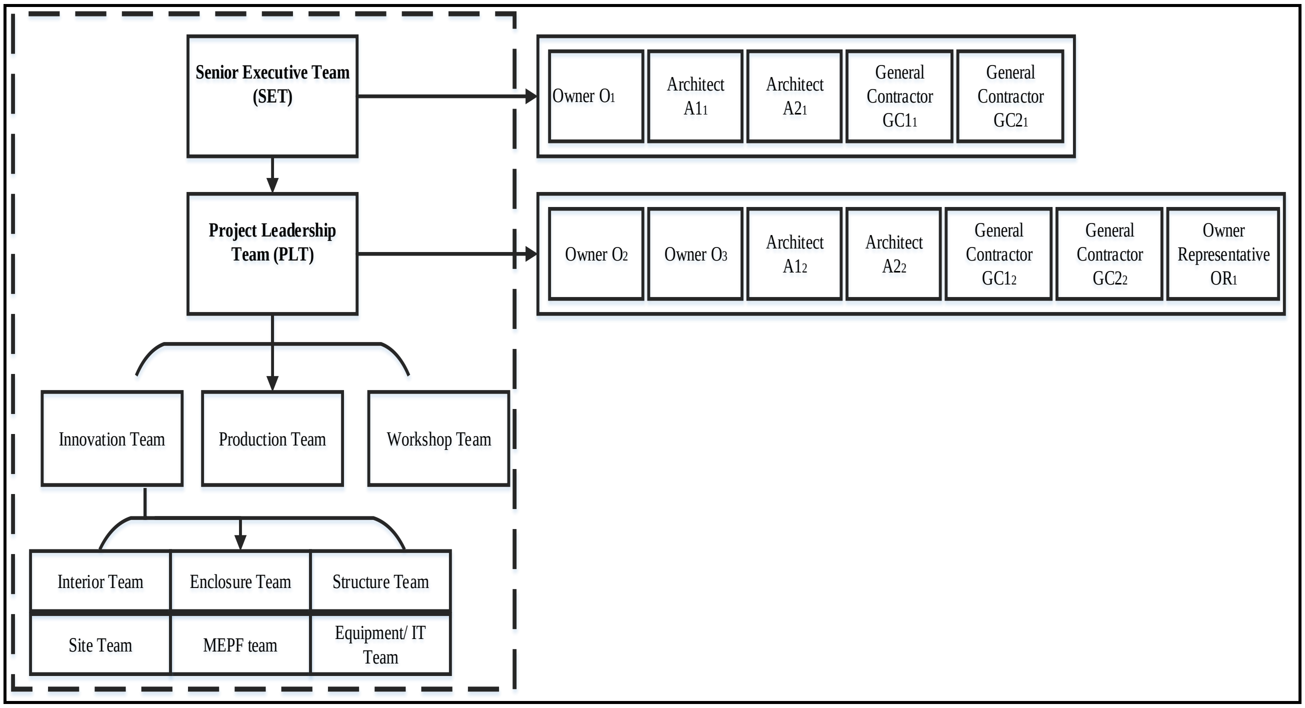


Figure 16. Organizational chart of team structure for Hospital X

RESEARCH QUESTIONS

To assess the value of Lean-IPD and TVD it was necessary to identify implicit benefits and costs and to make them implicit. The research team asked the following questions:

1. What do key stakeholders consider to be the advantages and the disadvantages of using lean thinking and tools in the IPD process?

2. How do key stakeholders define "value" and track their quality metrics?

    a. What are the *explicit* benefits and costs that are currently reported/ tracked?
    b. What are the benefits and costs that are currently *implicit* (not measured/reported)

3. How can a framework for collecting quality metrics be put together that can allow benefit-cost (B/C) and/or Return On Investment (ROI) calculations, based on metrics currently tracked? How can the implicit benefits/costs be made explicit?

4. How can A/E firms track the benefits/costs related to *design decision making* to enable an ROI for both first costs and operational costs?

To answer these questions, the study took a case study approach.

METHODOLOGY

A multi-method data collection approach was used for this research study to capture the vast range of information from literature, documents, and team members, and streamline it into a cohesive report.

A detailed literature review was undertaken to understand the key components of the Lean IPD process and Target Value Design (TVD) (see background section).

An electronic database known as "e-Builder" was used to store and share all design documentation by various stakeholders, including owner, architects, interiors, mechanical, electrical, and plumbing (MEP) engineers, and general contractors. The e-Builder database also stored documents, reports, and photos related to lean processes, such as the Big Room meetings, schedule, etc. Furthermore, e-Builder provided a place where each delivery team member could find related design decisions. The e-Builder database was accessible to all participants in order to find lean process-related design documents and A3 files.

The lean processes adopted by Hospital X project were explored and documented. The principles and practices of these lean processes were recorded. Although various lean strategies were used, the following lean processes were identified which had significant fiscal implication: Target Value Design, Big Room Meetings, Co-location, and Full scale Mock-ups. The following figure presents a snapshot of these lean processes:

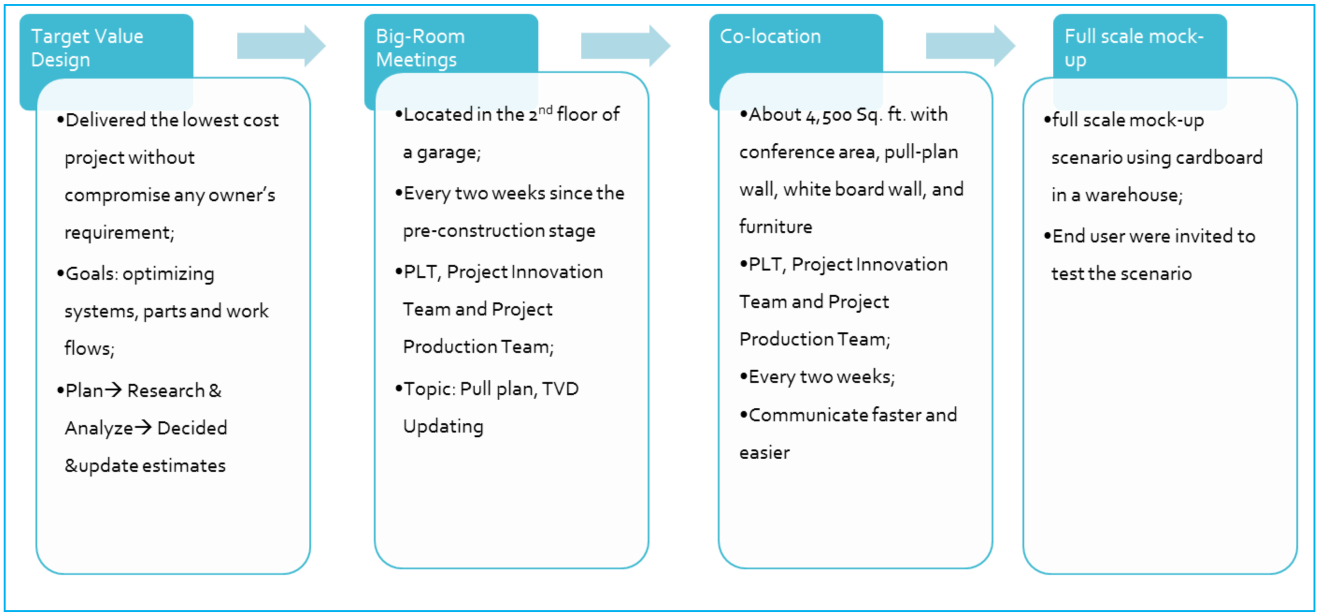


Figure 17. Lean processes used in the Hospital X project

For this study, data was also collected from the project documents of the architectural firm that adopted Lean-IPD and lean processes for the project. Benefit and cost analysis tools were utilized to analyze data. Based on archival data, a detailed Benefit Cost Analysis was conducted for first costs (analyzing data up to Dec 2013), taking into account the potential benefits (cost savings) and costs (additional costs) associated with the TVD process. A total cost framework was developed taking into account all additional costs associated with a TVD process.

To understand *implicit* benefits and costs, a site visit was conducted to Hospital X and a series of interviews were conducted with seven members of the Project Leadership Team. Members not present were interviewed via phone. A focus group was also conducted with 16 members from the owner, architectural, construction, including various trade partner teams, who were present on site. All the participants were asked to write their responses/comments on notecards with particular colors corresponding to their stakeholder groups. Then all the notecards were categorized on a board, organized into columns as plusses (+) and deltas (Δ). Note that Lean principles require brainstorming groups to itemize deltas instead of minuses (-) because, unlike a minus, a delta is positive. It helps the group to envision actualizing an improved future state the next time a similar activity is undertaken.

A smaller focus group was conducted with four members of the Design Team to understand the architect's perspective. In this focus group, the facilitators/researchers recorded comprehensive notes throughout the session on a board with plus and delta categorization. All the boards from both focus groups were digitalized and they are included in Appendices J and K. Finally, an online survey was administered, wherein the questionnaire (Refer

Appendix I) was sent via email to 79 stakeholders from the owner, A/E, construction firms, and trade partner teams. Survey data was analyzed using SPSS to determine correlations, conduct one-sample t-tests, ANOVAs and Tukey's HSD tests. The data obtained from the focus groups, interviews, and open-ended survey questions were analyzed using content analysis by organizing the data, coding and categorizing them as pluses and deltas, and building over-arching themes. This analysis formed the basis of the inventory of metrics for the implicit and explicit benefits and costs associated with the design decision making process. Additionally insights on successes, and opportunities for improvement, in the current process were identified.

A framework to assess the fiscal implications (B/C and/or ROI) of the Lean- IPD model, focused on the design decision-making phase was developed, which now needs to be validated by using multiple Lean IPD and Traditional Design Bid Build Projects.

In the Hospital X project, each key design decision made by the delivery team was stored in an A3 document that mapped the project goals, supporting research, Choosing By Advantages (CBA) table, specific cost savings, and final recommendations. In some cases, cost savings were outweighed by proposed value (meeting a specific organizational/ healthcare goal), and these decisions were documented as well. Cost and value analyses were conducted for all the design innovation interior and exterior A3s. Cost as an explicit factor was evaluated based on how much each design decision increased or decreased associated cost. Value as an implicit factor was evaluated by discussing each decision with a member of design innovation team who was directly involved in the decision making process; participants were asked to evaluate value from a designer perspective without giving them any preconceptions about the meaning of value.

Necessary approval was obtained from the IRBs of Hospital X and Texas A&M University before the start of data collection.

RESULTS

Part 1: Explicit Benefits and Costs (looking at first costs)

Fiscal Benefits from Reduced Target Cost (taking into account the increased cost in the more extensive decision making process).

For Hospital X, an original estimate ($240 million) and a revised estimate ($211 million after a validation report) were developed based on the general contractor's historical cost data and the similar scope of work of the project. The original estimated construction cost was $548/ sq ft, and the estimated construction cost after validation is $416/ sq ft. For Hospital X, market construction cost per square foot was identified at $400 dollars. The target construction cost was lower than the market cost, while the initial estimated construction cost was higher than the market cost. The gap between the market cost and the Target Cost equals the benefits gained by the owner conducting the TVD (assuming that the project comes under target cost). Figure 18 shows a conceptual figure for how estimated, market and target costs are defined in a TVD project. Figure 19 shows how Hospital X achieved their target cost. Figure 20 shows how each innovation team reduced costs by engaging in Target Value Design using strategies such as Choosing by Advantage and documenting the decisions on an A3. However, these benefits do not take into account the additional cost associated with the time taken to make these decisions.

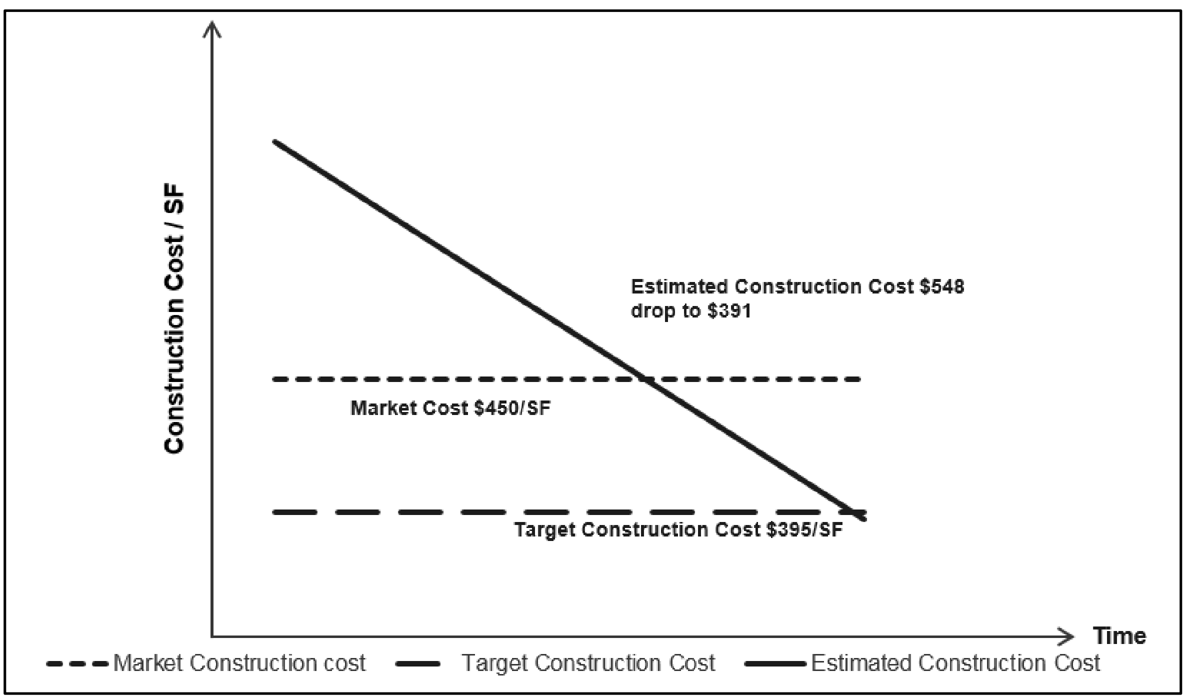
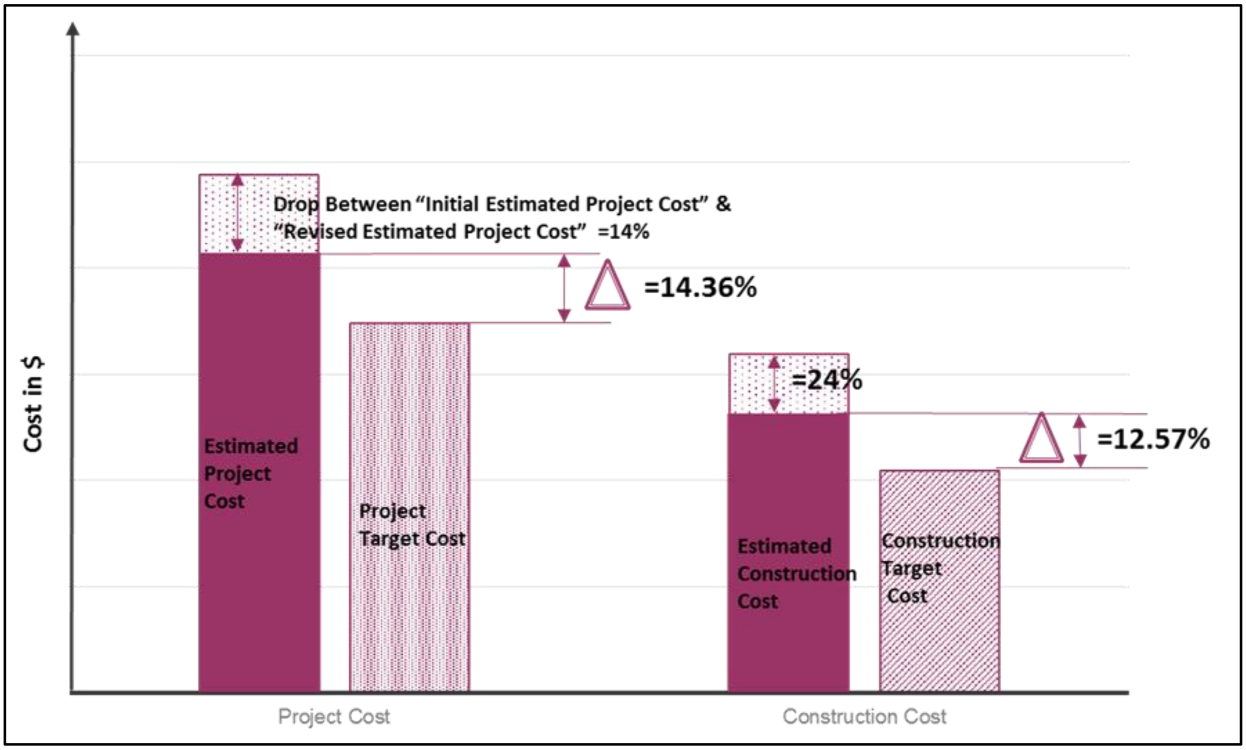


Figure 18. Benefits associated with TVD in Hospital X



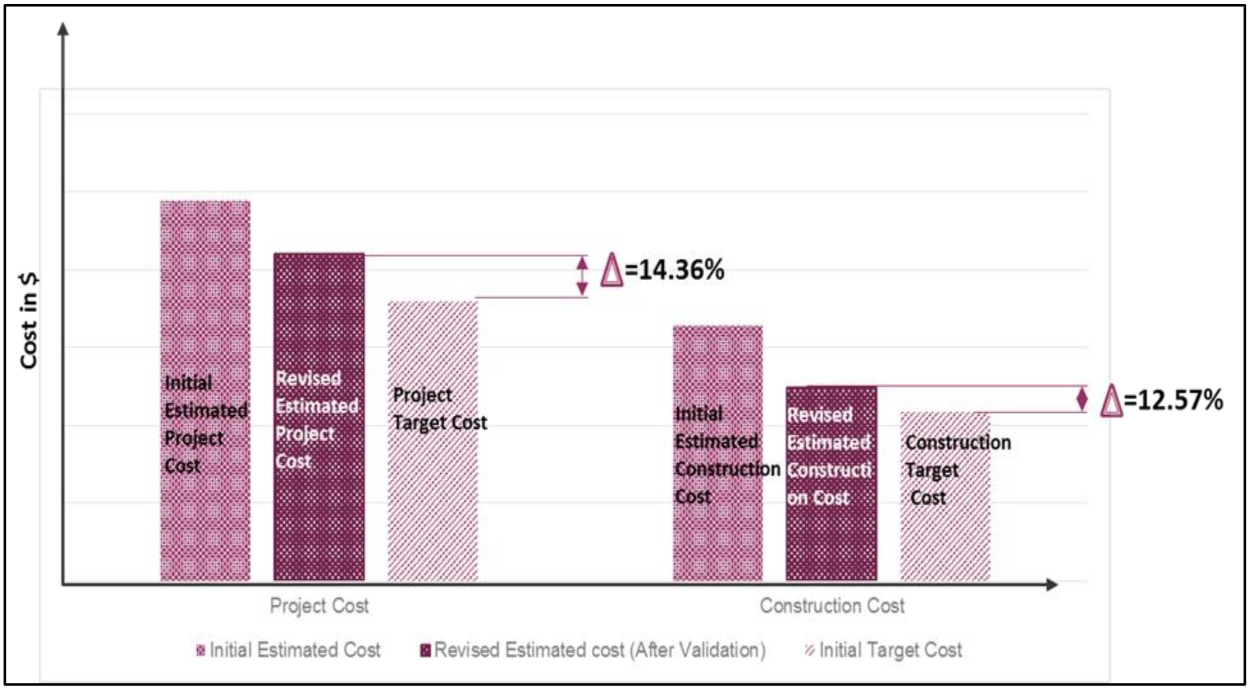


Figure 19. Benefits associated, accounting for first costs only, with TVD for Hospital X Project

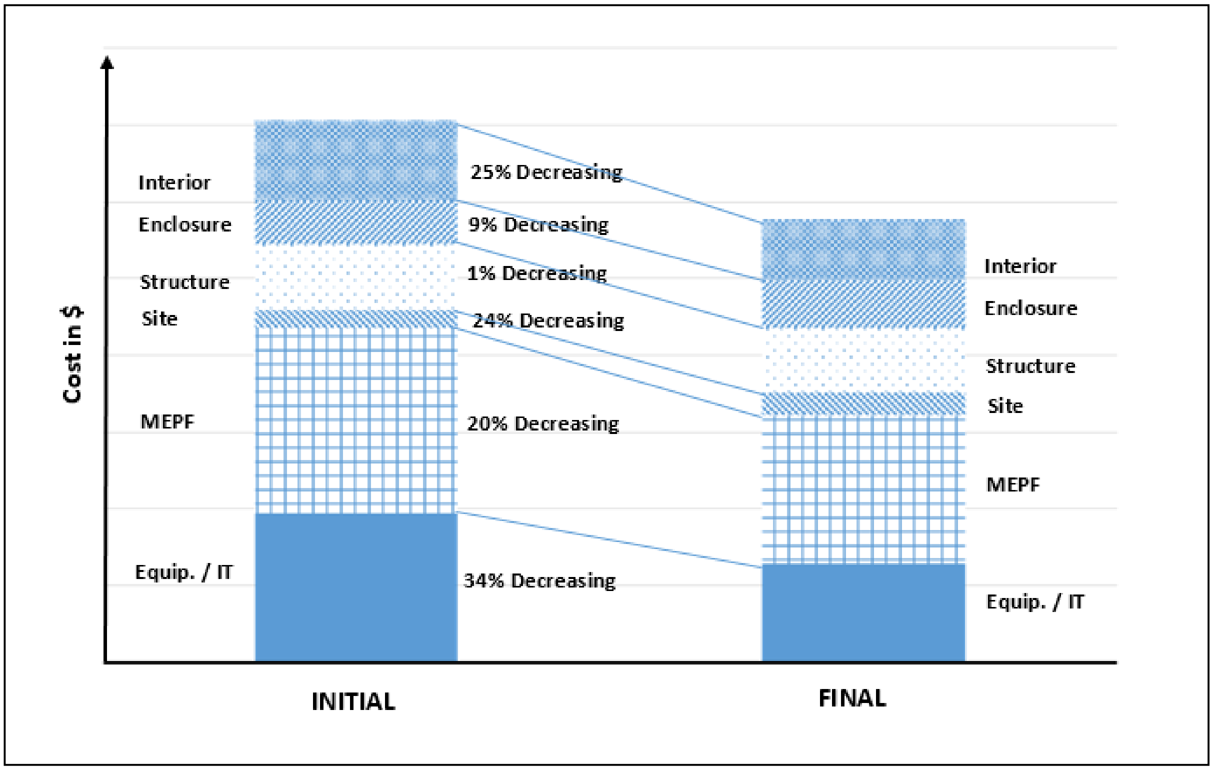


Figure 20. Benefits associated with TVD for Hospital X Project based on the Target Value Management Logs by the six innovation teams (as of Dec 2013)
Note: This data represents the Target Value Management (TVM) log from the six innovation teams. The left column in the above figure represent the initial cost before conducting any lean activities. And the right column represents the cost after conducting lean activity (TVD).

To identify how these benefits were potentially offset by the additional costs in the decision making process, the costs associated with Lean-IPD, that are not typically seen in a Design Bid Build (DBB) project were assessed. These include the labor, material, equipment and location cost associated with Team Week Meetings and Co-location, as well as the cost associated with Full Scale Mock-ups (Refer Table 2).

Table 2. Additional costs of Lean processes compared with DBB projects.

	Team Week Meeting[1] and Co-location	Mock-up
Labor	X	X
Material	X	X
Equipment	X	X
Location Cost	X	X

[1]Team Week meetings included PLT meetings, Innovation Team Cluster meetings and workshop meetings.
Note: A warehouse was donated for the full scale Mock-up to Hospital X; so the rent as a category for the Mock-up was not included in this comparison.

The purpose of this study was not to look at actual cost savings but to develop a framework. Table 3 gives us a framework to analyze the additional **FIRST** costs associated with the project which can help assess a true ROI in "first cost" estimates.

Table 3. Total cost framework of TVD processes

			Cost items
I	**Team Week Meetings and Co-location[1]**	A. Material	White board
			Supplies (large Post-It® notes, markers, flipcharts, push pins, masking tape)
			Floor plans of existing hospital
			Rolls of paper
		B. Labor	Owner and owner representative
			Architects
			General contractors
			Structural engineer
			MEP engineer
			Sub-contractors
			Vendors
		C. Equipment	Speakers
			Projector
			Conference call equipment
		D. Location Cost	Co-location space rent or build cost
II	**Full Scale Mock-up[2]**	A. Material	Cardboard
			Tape and nail to fix cardboard
			Furniture for mock-up scenario
			Food and Warehouse Amenities
		B. Labor	Lean facilitator
			Architects
			Healthcare administrators
			Physicians
			Nurses
			Clinical Staff Costs
			Former patients and their parents
		C. Equipment	Equipment for mock-up scenario
			Warehouse Rent
			Warehouse Construction labor
		D. Location Cost	Utility

[1] Team week meetings and Co-location include lean training workshops, Big-Room Meetings, Project Leadership Team meetings and Innovation Team meetings.
[2] Full scale Mock-up includes workshop that designs and builds full scale cardboard mock-up of hospital interior.

Value Determination by Cost/Benefit Analysis of Design Innovation A3s (Architects' Perspective)

In the Hospital X project, A3 documents were implemented to record and track each key design decision made by the design innovation team. All A3 documents included the project goals, supporting research, CBA table, specific cost savings, and final recommendation. There were 50 A3s developed by the enclosure innovation team, and 97 A3s developed by the interior innovation team. Cost and benefit analysis was conducted for all the design innovation interior and exterior A3s. Cost as an explicit factor was evaluated based on how much each design decision increased or decreased associated cost. Even though some design alternatives were rejected by PLT, the accepted alternatives associated with exterior and interior A3s accumulated approximately $2,100,000 and $3,850,000 in savings, respectively.

Benefit as an implicit factor was evaluated by discussing each decision with a member of design innovation team who was directly involved in the decision making process; participants were asked to evaluate benefit from a designer perspective without giving them any preconceptions about the meaning of benefit. The results from cost and benefit analysis showed that designers evaluated benefit associated with each decision based on how the new decision addressed the main goal that the particular item was aimed to serve or address. If the new decision served the primary goal at the same level, they assigned neutral/unchanged benefit associated with it; if it violated the primary goal, it affected benefit negatively and if it added more benefits in addition to serving that primary goal, it affected benefit positively. This assessment was based on the perception of designers. Decisions that added value to the project were those in which benefit stayed at the same level or increased along with a cost reduction. Value decreased when cost reduction led to a decrease in benefits.

The results showed that, out of the 85 interior initiatives, there were 7 instances of increased perceived benefit, 13 of decreased perceived benefit, 22 where there was no change in perceived benefit, and the rest were rejected. Cost decreased for all the items with decreased or no change in perceived benefit. For 5 of the 7 cases where there was a perceived benefit increase, there was also a cost decrease. In two cases, the perceived benefit increased without any changes in cost. Here are some examples:

- A decision was made to eliminate doors in PACU rooms which resulted in cost-saving of $95,400; however, the innovation team believed that it reduced benefit by increasing the noise level for patients and staff although some nurses believed it enhanced their visibility and accessibility to patients; this decision has both negative and positive implications for facility HCAHP scores by increasing the level of noise and on the other hand, enhancing patient visibility and monitoring.

- A decision was made to eliminate the niches from family spaces in patient rooms that were designed to provide a convenient location to set personal belongings, cell phones, tablets, etc. to charge and rest when not in use. The niche was evaluated as a "nice-to-have" feature and added to the "value added list". The decision saved $23,000 but designers believed that it was a benefit reduction since now families don't have a specific area and have to use the window sill ledge next to the sofa to set their belongings and charge them.

A decision was made to replace NF sheet vinyl in lieu of rubber floor finishes at patient treatment areas which reduced cost by $190,000 while it did not change the benefit because the replaced finish material provided the same look, functionality, durability, and maintenance. The safety consequences of this decision for patients and staff were not weighed.

- Since a daylighting study was not conducted for this project, a decision was made to keep light filtering shades for offices, but not for the staff lounges. The designers believed that this decision reduced cost while not affecting benefit since shades can be added to staff lounges, if needed anytime in future.

- In lieu of installing proposed waterproof panels on the wet walls in patient/family toilet rooms, a decision was made to use epoxy paint. This provided a cost-saving of $27,000 as well as a benefit increase because epoxy paint provides easier maintenance/repair, a broader range of colors, and adequate cleanability.

- One of design decision which added benefit by having the same cost was to simplify the design of nurse stations which led to a better accommodation of frameless windows to enhance patient visibility.

The results also showed that, out of the 50 exterior initiatives, there were 4 instances of increased perceived benefit, 5 of decreased perceived benefit, 18 where there was no change in perceived benefit, and the rest were rejected. For the items with no change in perceived benefit, costs decreased in 16, and the remaining 2 had no change in cost. For 3 of the 4 cases where there was a perceived benefit increase, there was also a cost increase. In one case, the perceived benefit increased without an increase in cost. These results, based on the perceptions of the members of the design team, are summarized in Table 4. Here are some examples:

- As the innovation team mentioned, one of the main design decision was made for the hospital building exterior, by adding façade integrated lighting fixtures which had a cost premium of $384,000 while adding benefit by significantly enhancing the design esthetics of building facades/exterior. One can argue that the benefit add also translates to being a beacon in the community, and better site level wayfinding. Unfortunately, there is no way to quantify the benefits of such initiatives.

- Another example of increased benefit by increasing cost was to design and build a larger helipad to accommodate bigger helicopters, lending future flexibility in aircraft handling capacity.

- A major design decision to reduce cost was to eliminate all the green roofs from the project which led to a decrease in benefit. A concession made was to provide the appropriate roof system to accommodate a green roof in future.

- Another example of cost and benefit reductions was to eliminate all the exterior shading elements to save $350,000. This decision could potentially lead to higher levels of heat gain and glare in interior spaces. An ROI analysis of first costs versus life cycle costs (energy costs and thermal comfort implications) was not conducted, but would be recommended to better support this decision.

- One of the decisions to reduce cost but keep the benefit at the same level was to reduce the amount of spandrel glass in the window design of patient rooms. The benefit did not change because the decision did not affect the size of window aperture to capture daylighting and outdoor views.

- Likewise a decision was made to implement curtain wall reduction strategy to reduce costs. The designers believed that the benefit did not change since they provided enough openings to capture ample daylighting and outdoor views. Thus overall "value" was increased, because the project received the same benefit for lower cost.

Table 4. Summary of Cost & Value Analysis of Design Innovation A3s

	Benefit -	Benefit 0	Benefit +	Accepted Decisions	Rejected Decisions	Total Decisions
Interior A3s				42	43	85
Cost -	13	22	5			
Cost 0	-	-	2			
Cost +	-	-	-			
Exterior A3s				27	23	50
Cost -	5	16	-			
Cost 0	-	2	1			
Cost +	-	-	3			

Part 2: Explicit Benefits and Costs (based on Pre-Defined Success Metrics)

In the Hospital X project, metrics were developed to track and document Measure of Success including Safety, Local Participation, Energy Efficiency, Team Performance, Schedule, Quality, LEED, and Staff and Family Satisfactions. For each metric, a specific goal was determined. Table 5 shows success goals, metrics, person responsible, data collection timeline, and method of calculation.

Safety

To measure Safety, contractors tracked and documented DART (Days Away Restricted Transferred) rates monthly from construction start to completion dates. DART rate is a national safety metric recognized by OSHA and is defined as the percentage of employees suffered from some type of injury requiring days away from work, days of restricted work activity, and/or days of job transfer. The national average of DART rate is 2.2 for the working trades involved in healthcare projects. In this project, DART rates less than 1.5 and higher than 3.1 were assigned to highest (18 points) and lowest (0 point) level of success respectively.

Local Participation

Contractors also tracked and documented the Local Participation metric, on a monthly basis from construction start to completion dates. The metric for local participation was the percentage of project team labor hours spent by people living, as defined by their W-2, in a zip code listed as local counties (see Appendix G). The project goal was to achieve local participation of 85% or more labor hours (14 points). Local participation of 70% labor hours or less was considered as failed or 0 point.

Energy Efficiency

Engineers were responsible for the building energy modelling at CD (Construction Documents) stage after the design was complete. Energy consumption was measured based on the completed and approved energy model submitted to USBGC for LEED certification and the metric for Energy Efficiency was considered as the percent savings when comparing against the National Average of 280,000 BTUs/SF/Year for Health Care Facilities. Highest and lowest levels of success were determined as 30% and 10% energy consumption below national average (12 and 0 points) respectively.

LEED®

The architectural team was responsible for project documentation and submission for LEED® (Leadership in Energy and Environmental Design) certification to the U.S. Green Building Council (USGBC). As part of a two-step submission, the project was submitted for design review at the end of Design Development stage and once for construction review four months after construction was completed. The target goal was to achieve LEED® Silver certification.

Team Performance

The Center for Operations Excellence[1] (COE) and PLT have chosen the monthly pulse point report as the metric to evaluate the overall Team Performance. The pulse point survey was developed and processed by a third party consultant, and it included 13 close-ended questions with 7-point scale response categories, from strongly disagree (1) to strongly agree (7). The success metric was considered as the percentage of respondents that provide a score of 5 or higher. Cumulative average score of 90% and higher was considered as the targeted goal (12 points) and no points was considered for cumulative average score of 84% or less.

Schedule

To measure the level of success for Project Schedule, on a monthly basis, contractors tracked the number of calendar days sooner than the 24 month schedule that they can turn-over the building for owner move-in. The target goal was to complete and turn over the building 50 calendar days sooner (7% improvement) than the 24 month construction schedule.

Quality

To measure Quality, contractors tracked three different metrics to evaluate: 1) team approach for resolving project issues, 2) taking pride in producing quality workmanship, and 3) level of collaboration in designing and constructing the project.

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[1] The COE or Center for Operational Excellence is a comprehensive program developed by Hospital X to develop internal expertise and a culture that embraces continuous improvement. It included a physician, pharmacist, nurse, managers, data analysts, admin support and lean experts. All leadership in the COE eventually became deployment directors with Lean Six Sigma training and blackbelts (Vinas, Ed., 2014).

1. Quality through Issue Management was studied by examining project issues that were tracked weekly in the Project Issues Management Log (ProLog) and the success metric was the number of working days that the team spent to resolve an issue. The goal was to resolve 85% or more of total issues in 5 or less working days. Zero points were earned if 85% or more of total issues were resolved in 16 or more working days.

2. Quality through Workmanship was measured by examining the number of punch list items in areas that were ready for final inspection. The punch-list inspection team is made up of three representatives from owner, architect and contractor parties. Damage after final inspection and warranty issues were not counted against the metrics. The target goal was a punch list with less than 20 items (4 points) and a punch list with 51 or more items was considered as failed or 0 points.

3. The final metric sought to assess Quality through Collaboration was the number of major issues that resulted in a contingency draw over $100,000 and/or schedule impact (2) weeks or more. All the major issues were tracked continuously as they happened throughout the construction cycle and the main purpose was to avoid any major issues through collaboration and as a team. The target goal was to not use the contingency draws to fund work scope gaps that should have been covered through the design/construction process. Highest and lowest levels of success were assigned to 3 or less and 13 or more major issues (4 - 0 points) respectively.

Staff and Family Satisfaction

To measure Staff and Family Satisfaction, COE and PLT tracked three different metrics to evaluate family and staff involvement in design and construction process as well as their satisfaction with the overall facility after the building was occupied.

1. To measure the success of the workshop process, surveys were developed and distributed to staff and family representatives who participated in warehouse and workshop activities, once and after all workshops were completed. The main goal was to engage staff and family as a driving force throughout the design process.
2. To measure engagement of staff and family members during construction, surveys were developed and distributed four times to the attendees of the Service Line Monthly Planning Meetings (ED, ASC, NICU). The main goal was to keep staff and family engaged and informed throughout construction.
3. To measure staff and family satisfaction with the overall facility, post construction surveys have been developed and will be distributed to workshop staff and family participants, two months after the building was (is) occupied. These surveys were designed for specific departments and referred to the following guiding principles:

   1. Physical environment speeds up recovery.
   2. Physical environment improves effectiveness of treatment.
   3. Patients believe environment improves the sense of “wellness”.
   4. Physical environment improves the sense of "wellness."
   5. Natural light promotes “wellness”.
   6. External views promote the Hospital X campus.
   7. Way finding is well defined and easy to understand.
   8. Color schemes are warm, welcoming and appropriate for the Hospital X Project.
   9. Landscaping aid to the building design.

In all the above survey instruments, questions were evaluated on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree). The metric was considered as the percentage of respondents that provide a score of 5 or higher. The percentages were based on the number of surveys received, discarding the “No Opinion” responses. Cumulative average score of 90% and higher was considered as the targeted goal (highest points) and no points was considered for cumulative average score of 79% or less.

Additionally, for ED and NICU, those environments that will change substantially, the facility is conducting pulse point surveys to track changes and engagement of staff (upcoming report). This is not part of the success metrics.

Table 5. Measure of Success for the Hospital X Project

Measure of Success	Explicit Benefits & Costs (Currently Reported)				
	Success Metrics	Person Responsible	Data Collection Frequency/ Timeline	Metric Calculation	
				Measure	Points
SAFETY Goal: Deliver the project safely with 0 Lost Time, 0 Days Restricted/ Transferred (Based on the DART rate from the Bureau of Labor Statistics). DART Rate 2.2 is the National Average for the working trades involved in healthcare projects.	DART Rate (Days Away Restricted Transferred): % of employees suffered from some type of injury requiring days away from work, days of restricted work activity, and/or days of job transfer.	Contractor	Monthly from construction start to completion dates	0-1.5	18
				1.6-2.0	12-17
				2.1-3.0	6-11
				3.1<	0
LOCAL PARTICIPATION Goal: 85% of (ICL) project team labor hours spent by people living, as defined by their W-2, in certain counties. Participation is considered for all workers, not just ICL participants.	% of project team labor hours spent by people living in local counties	Contractor	Monthly from construction start to completion dates	85% <	14
				75%-84%	10-13
				71%- 74%	5-9
				70% >	0
ENERGY EFFICIENCY Goal: Achieve top 10% hospital nationally.	% below national average of 280,000 BTU's/SF/Year for health care facilities	Engineers	Based on computer modeling at CD Stage (Construction Documents)	30% Below	12
				20% Below	6-11
				10% Below	0
LEED® Goal: Achieve LEED Silver certification	LEED® Silver certification	Architect – HKS Green Group	Two-step submission: Design Review: DD (Design Documents) stage Construction Review: Four months after construction completion	Silver Certified.	6
				Certified	3
				Not Certified	0
TEAM PERFORMANCE Goal: Highly Effective Team - Team Pulse Check	% of respondents with high level of agreement (score of 5 or higher on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree))	COE & PLT	Monthly from construction start to completion dates	90% <	12
				85%-89%	6-11
				84% >	0
SCHEDULE Goal: Turn-Over Building 50 Calendar Days Sooner than 24 Month Schedule to Owner for Move-In	Number of Calendar Days Sooner than 24 Month Schedule to	Contractor	Monthly from construction start to completion dates	50 < Days	10
				36-49 Days	8-9
				18-35 Days	6-7

Measure of Success	Explicit Benefits & Costs (Currently Reported)				
	Success Metrics	Person Responsible	Data Collection Frequency/ Timeline	Metric Calculation	
				Measure	Points
	Turn-Over Building for Owner Move-In			9-17 Days	4-5
				8 > Days	0
QUALITY Goal 1: Want Team Approach to Resolving Project Issues Quickly & Efficiently Through Collaboration	Number of Working days to Resolve Project Issues	Contractor	Weekly from construction start to completion dates	5 > Days	4
				6-10 Days	3
				11-15 Days	2
				16 < Days	0
QUALITY Goal 2: Want Project Team To Take Pride In Producing Quality Work	Number of Punch list Items	Contractor - Design team has some involvement.	Towards Completion	0–20 Items	4
				21–35 Items	3
				36–45 Items	2
				46–50 Items	1
				51 < Items	0
QUALITY Goal 3: Want Collaborative Team Approach In Designing & Constructing the Project.	Number of Major Issue that results in a Contingency Draw over $100,000 and/or Schedule Impact (2) Weeks or more.	Contractor	As It Happens/ Continuously Tracked	0-3 Issues	4
				4-6 Issues	3
				7-9 Issues	2
				10-12 Issues	1
				13 < Issues	0
STAFF AND FAMILY SATISFACTION Goal 1: Staff and Family that have been integral to the process and a driving force throughout the project and a team that listens to their input.	Workshop Process Survey % of respondents with high level of agreement (score of 5 or higher on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree))	COE & PLT	One time, after all the workshops were completed	90% <	6
				80% - 89%	3-5
				79% >	0
STAFF AND FAMILY SATISFACTION Goal 2: Keep the Staff and family engaged and informed throughout construction.	Staff and family Engagement Survey % of respondents with high level of agreement (score of 5 or higher on a scale of	COE & PLT	Four times, distributed to attendees of the Service Line Monthly Planning Meetings (ED, ASC, NICU)	90% <	6
				80% - 89%	3-5
				79% >	0

Measure of Success	Explicit Benefits & Costs (Currently Reported)				
	Success Metrics	Person Responsible	Data Collection Frequency/ Timeline	Metric Calculation	
				Measure	Points
	1 (Strongly Disagree) to 7 (Strongly Agree))				
<u>STAFF AND FAMILY SATISFACTION</u> Goal 3: Post Construction Survey refer to the 9 Guiding Principles	Post Construction Survey % of respondents with high level of agreement (score of 5 or higher on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree))	COE & PLT	One time, two months after the building was occupied	90% <	4
				80% - 89%	2-3
				79% >	0

Part 3: Survey Results

The online survey link was sent to 79 stakeholders via email and it was open for three months to be completed. Three of these emails bounced, and the email of one stakeholder had been duplicated. Of the 75 stakeholders who received the surveys, 47 voluntarily participated and completed the surveys – totaling a response of 62.67%. Appendix I shows all the questions along with their response rates and key findings. Of all the participants, there were 15 Architects, 8 Owners and Owner Representatives, 8 General Contractors, 6 Sub-contractors, 5 Engineers, 1 vendor, and 4 other stakeholders (1 healthcare consultant, 1 interior designer, 1 IT Technology representative and 1 consultant) (Figure 21). The responses of three groups of stakeholders which had the most representation in the survey are being analyzed here. These stakeholders are 1. Owner, 2. Architect, and 3. General Contractor.

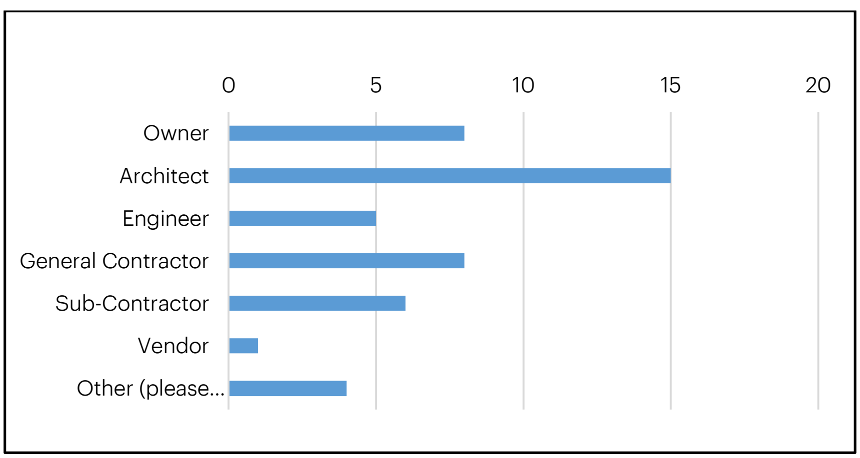

Figure 21. Profession of the Respondent/ Stakeholder Representation

The participants were asked how long they have been working in their profession (Figure 22). Of the 47 stakeholders, 37 had been practicing their profession for over 10 years, 7 had been in the profession between 6 and 10 years, while only 3 had been in the their respective profession between 3 and 5 years. Three of the fifteen architects and three of the eight Owners had been in their respective profession between 6 and 10 years, while the rest (12 architects, 5 owners, and 8 general contractors) had been in their professions for over 10 years.

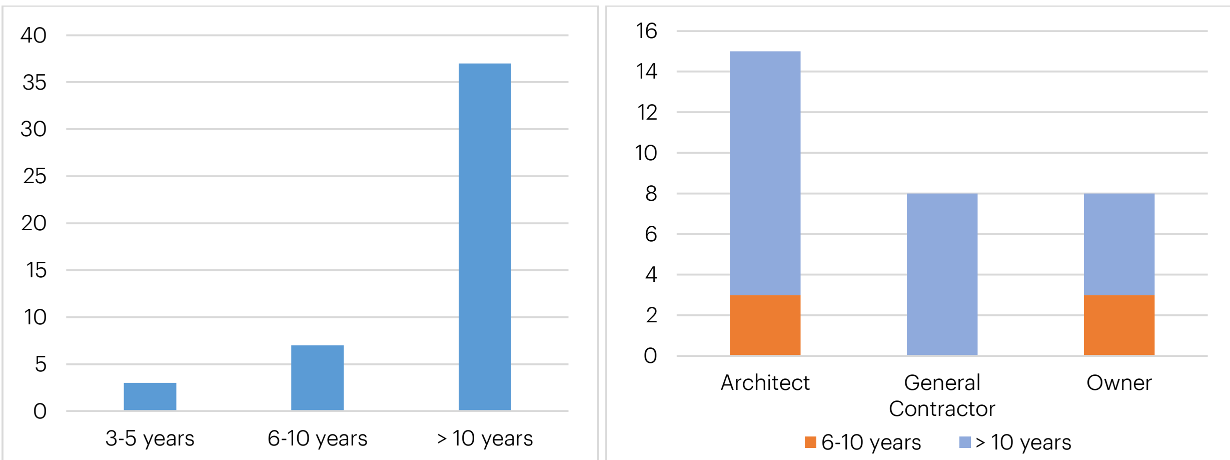

Figure 22. Number of years in profession

The participants were asked if the Hospital X project was the first contractual Lean- IPD project in which they have participated (Figure 23). Of the 47 respondents, this was the first Lean-IPD project for 36, while 11 had participated in lean-IPD projects before. Among the 15 participating architects, this was the first project for 12, while 3 had worked on lean-IPD before. Of the 8 General Contractors, it was the first project for 5 of them while 3 had participated in such projects before. For all 8 of the owner respondents, this was the first Lean-IPD Project. They were also asked if they have worked on a non-Lean-IPD project before (Figure 24), and 41 out of all stakeholders had worked on non-Lean-IPD projects before, while six had not. 12 of the 15 architects, 7 of the 8 general contractors, and 7 of the 8 owners had worked on non-Lean-IPD projects before.

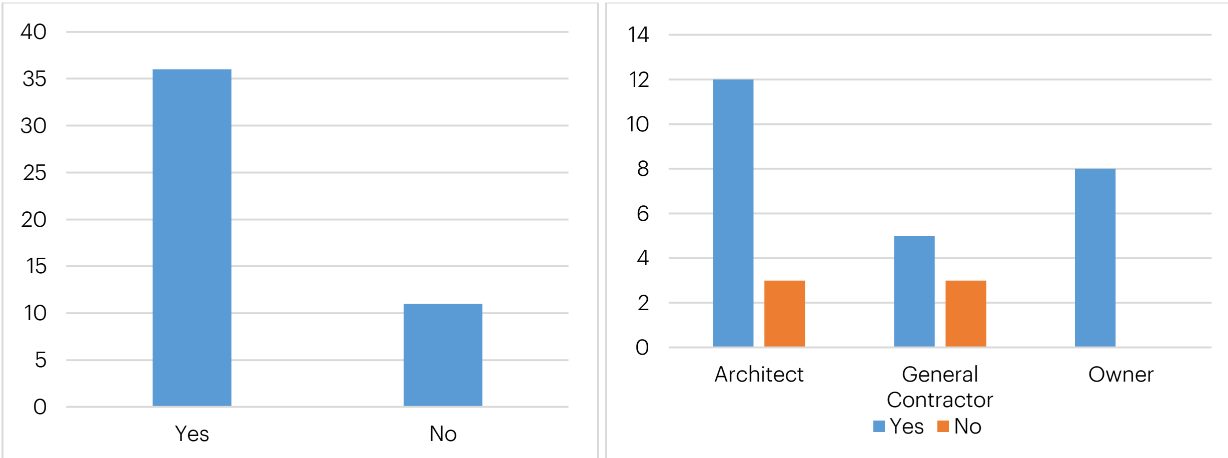

Figure 23. Whether First Lean-IPD Project or Not

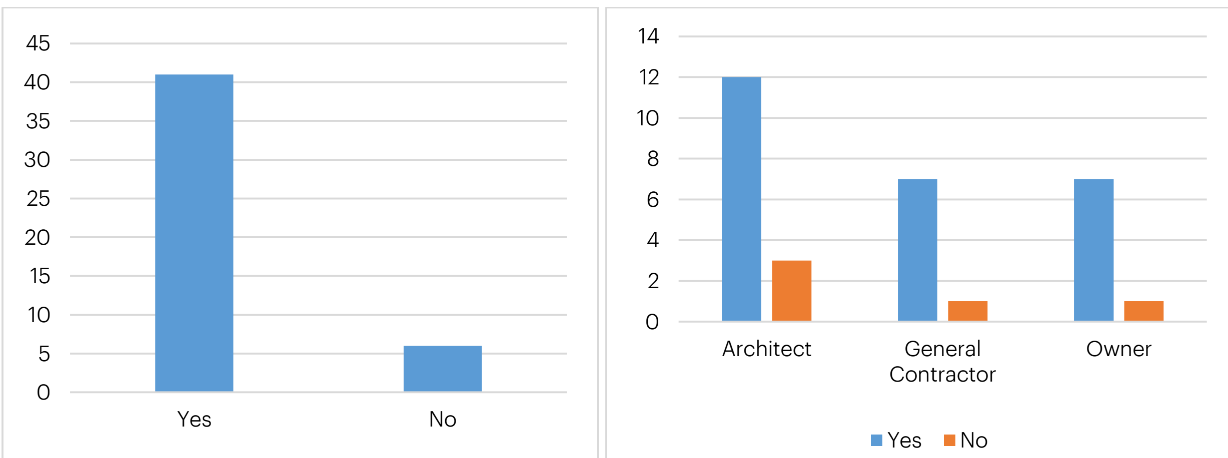

Figure 24. Whether Worked on Non-Lean-IPD Projects or Not

Survey participants were asked if they have worked on other Lean-IPD projects before, how similar the Hospital X project was compared to their experience with those projects (Figure 25). Only 17 participants (36.17%) answered this question. In reply to question 4, which asked if Hospital X was their first Lead-IPD project, 36 participants (76.6% of the respondents) had answered in the affirmative. So only 23.4% of respondents or 11 participants) could answer this comparison question adequately – so these are the responses that have been analyzed. Of the 11 stakeholders for whom Hospital X project was not the first Lean-IPD project, two thought the Hospital X project was similar to Lean-IPD projects they had done in the past, six thought it was somewhat similar, and three thought that it was not at all similar. Of the three architects with past experience in Lean-IPD projects, two thought that Hospital X was somewhat similar to their previous Lean-IPD projects, while one thought that it was not at all similar. Of the three general contractors who had participated on Lean-ID projects earlier, two thought that Hospital X was very similar to theses past projects, while one thought that it was somewhat similar. For all the Owners, Hospital X was the first Lean-IPD project.

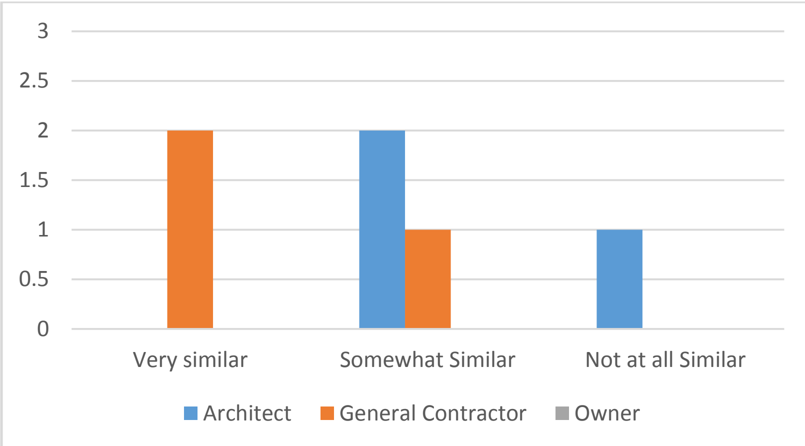

Figure 25. Comparing the Hospital X with other Lean-IPD Projects

Participants were asked to which team they belonged on the Hospital X project (Figure 26). The Project Innovation team had the most stakeholders, and most of the architects (8 out of 15) worked on this team. Architects and General Contractors were present on all the teams – the project leadership and the project production teams had the more General Contractor representation than architects and owners.

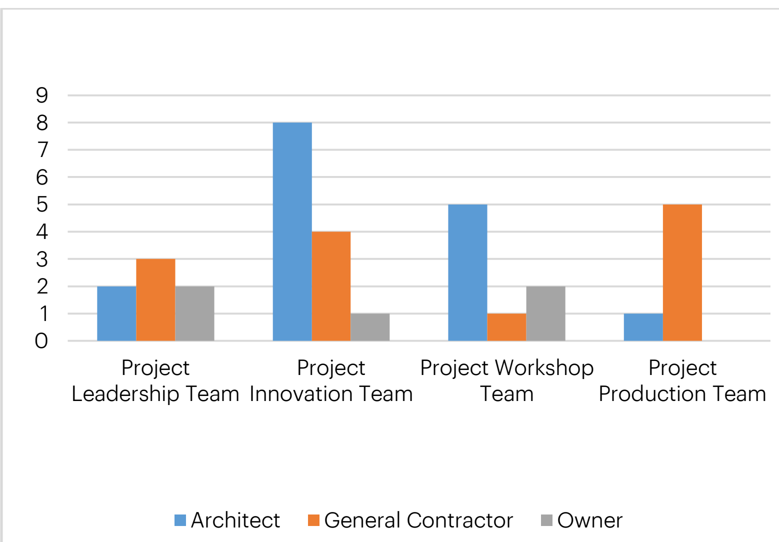

Figure 26. Team Participation by Stakeholders

Survey participants were asked how often they attended Team Week meetings and how long these meeting usually took (Figure 27). On average, the stakeholders met for Team Week meetings was once a month. The average meeting time for Project Leadership Meetings, Recurring Meetings and Cluster Group Meetings was between 1-2 hours as reported by all respondents. Architects, General Contractors and Owners all reported that the average time for these meetings was took 1-2 hours. This was also the average time for other meetings that included Superintendent Huddles, PMCT meetings and calls, project wide safety meetings, Direct Owner Interface, Update sessions, Kaizen Events, Pull plan meetings and sessions, Daily check-in meetings and huddles, Workshops, Speed Dating Innovation meetings, User group meetings, BIQ walks, Weekly Connected Decision Huddles, Engineer-sub-contractor direct meetings, System or Issue specific meetings, TPOG (Trade Partner Oversight Group) meetings, and Owner's meeting. According to the Architect respondents the average time spent in other meetings was 2-3 hours. General Contractors and Owners opinion on the average time matched that of rest of the respondents – 1-2 hours.

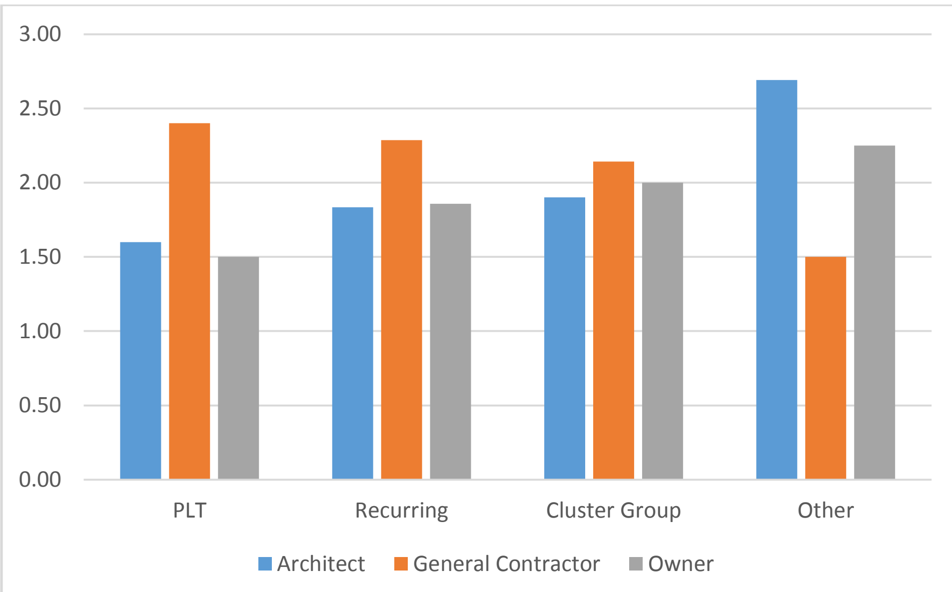

Figure 27. Time spent in meetings

Lean IPD Compared To Non-Lean Projects

Survey participants were asked to evaluate their level of agreement with the statement, "Lean- IPD process for project delivery is better than non- Lean- IPD processes" for schedule, cost, quality, safety, morale and learning (Figure 28).

Overall, all stakeholders strongly agreed/ agreed that Lean-IPD was better than non-Lean-IPD project delivery vis-à-vis:

- Overall Schedule
- Overall Cost
- Overall Quality
- Safety during Construction
- Morale of the Stakeholders
- Learning of the Stakeholders

Although architects agreed that Lean-IPD was better than non-Lean-IPD project delivery with regard to Schedule; Cost; Morale and Learning of stakeholders, their agreement was much lower for *Overall Quality or Safety during Construction*.

On the other hand General Contractors strongly agreed that Lean-IPD was better than non-Lean-IPD project delivery vis-à-vis Overall Schedule; Overall Cost; Overall Quality; Safety during Construction; and Learning of the Stakeholders. However, their agreement was lowest for morale.

Figure 28 summarizes these findings.

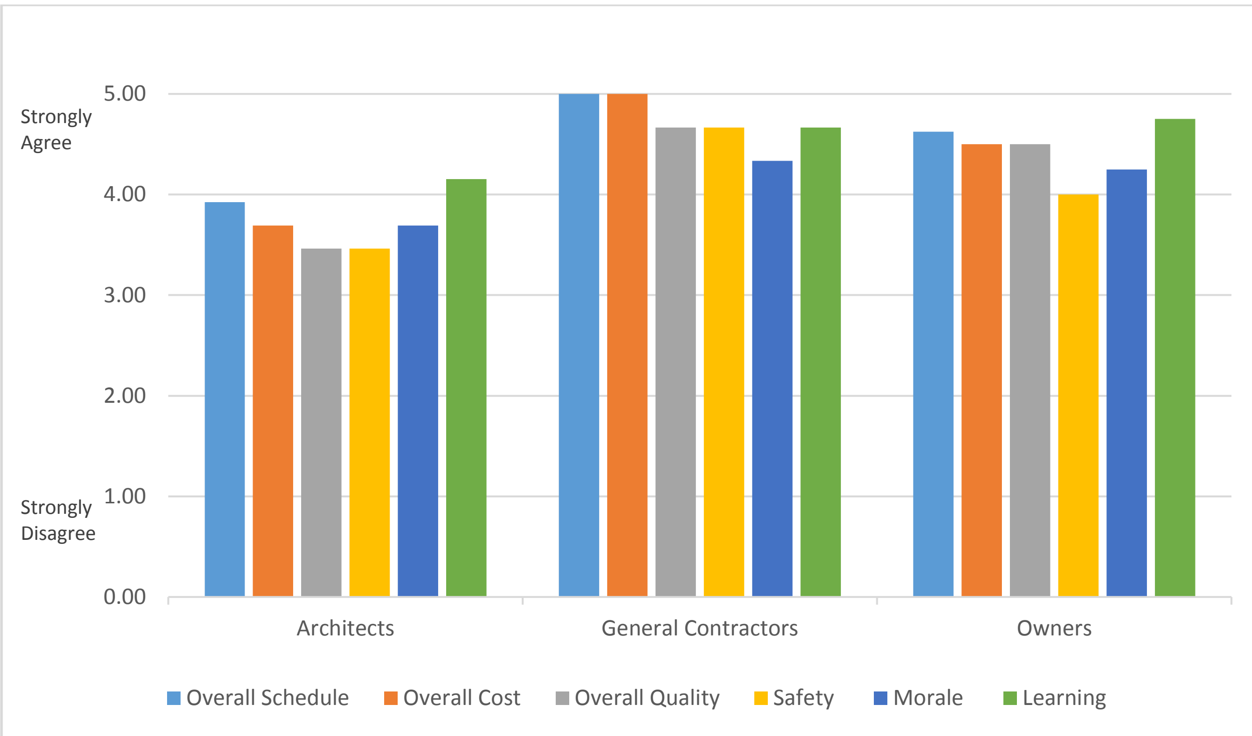

Figure 28. Architects, General Contractors, and Owners' Perceptions about Lean IPD versus non-Lean IPD

ANOVA and Tukey HSD tests were conducted in order to examine if the Lean IPD process for project delivery was perceived significantly better than traditional project delivery process by different groups of stakeholders (Figure 29). Overall, statistical analysis showed that Lean-IPD was rated significantly higher in terms of schedule, cost, quality, safety, morale and learning compared to traditional project delivery process. However, learning has the highest and safety has the lowest average ratings. The analysis also showed that schedule and learning were rated significantly higher than safety in comparing Lean-IPD and traditional project delivery processes ($p = .054$, $p = .027$ respectively).

Statistical analysis showed a significant discrepancy on how owners, architects and general contractors perceived the value of Lean-IPD process in terms of overall Schedule, Cost, Quality and Safety during construction (P-value = 0.046, 0.006, 0.011, 0.015, respectively). However, across different groups of stakeholders, there was a consistency on the perceived value of Lean-IPD process in terms of Morale and Learning of the stakeholders.

Compared to architects, general contractors significantly perceived more value of Lean-IPD process in terms of overall Cost and Safety during construction (P-value = 0.007, 0.027, 0.012, respectively). Moreover, comparing to architects, both owners and general contractors significantly perceived more value of Lean-IPD process in terms of overall Quality for the project (P-value = 0.038, 0.027, respectively).

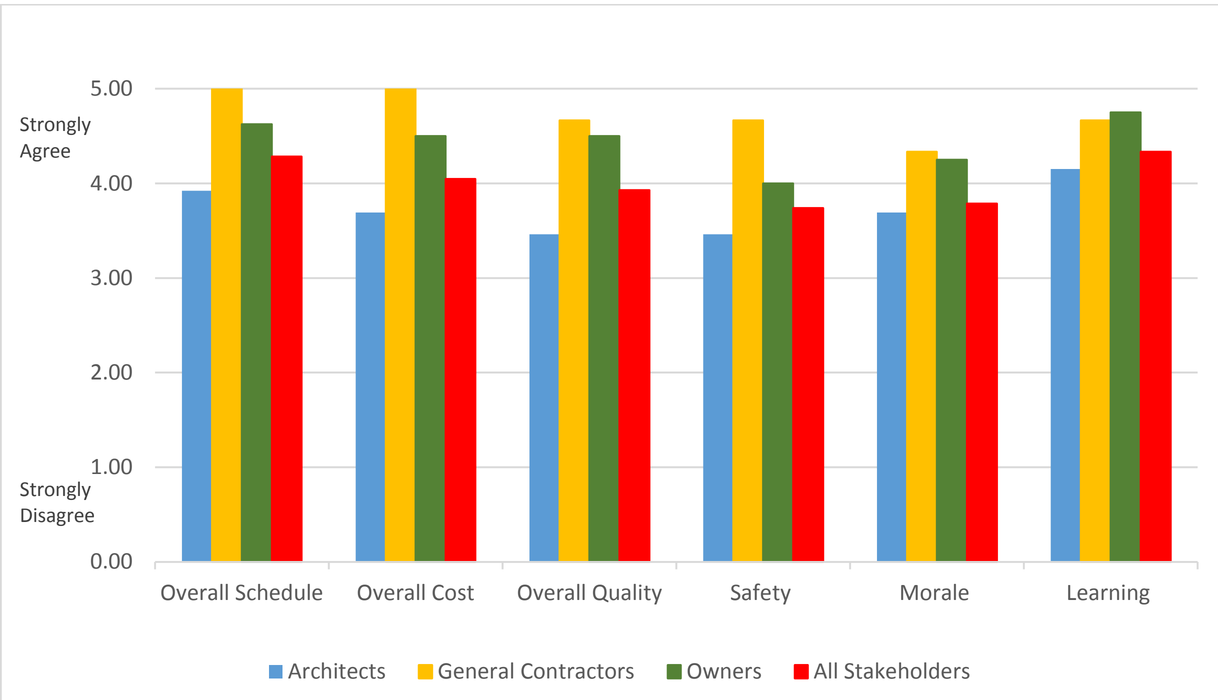

Figure 29. Lean IPD versus non-Lean IPD Perceived by Different Groups of Stakeholders

The perceived "Value-Add" of different Lean strategies

Participants were asked, on a scale of 1-5, to rate the Value that co-location, full scale mock-up, TVD and Team Week meetings added to the overall project (Figure 30). The three strategies/ team exercises of Team Week Meetings (38 out of 47), Target Value Design (37 out of 47), and Co-location (36 out of 47) were rated on average to have a 'high' value, while the team exercise of Full Scale Mock-up (39 out of 47) was rated on an average to have a 'very high' value by all stakeholders. Architects (12 out of 15 for all exercises; 10 out of 15 for Full Scale Mock-up) followed the same rating as all stakeholders. Owners rated Co-location and Full Scale Mock-up to have an average 'very high' value while Target Value Design (6 out of 8) and Team Week Meetings (5 out of 8) were rated to have an average 'high' value. The General Contractors on an average found all team exercises (6 out of 8), except Team Week Meetings, to have a 'very high' value; the Team Week meetings were rated to have a 'high' value.

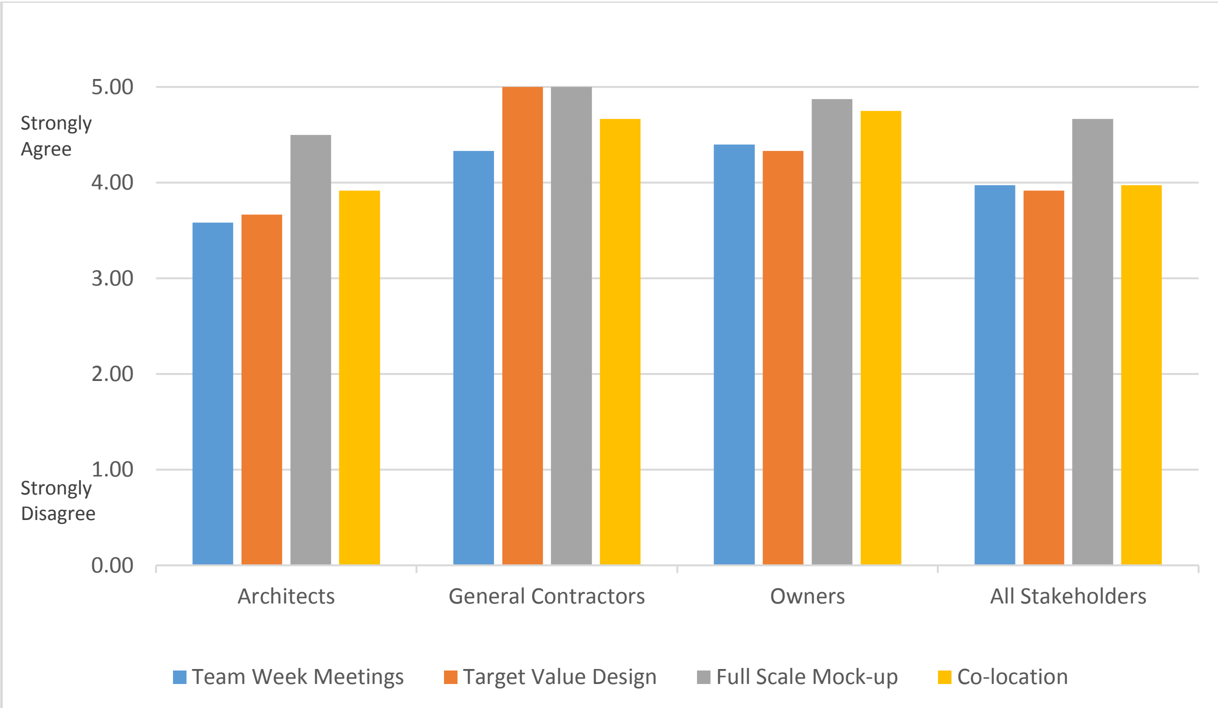

Figure 30. Stakeholders' Perceptions about Value of Different Lean Strategies

ANOVA and Tukey HSD tests were conducted in order to examine if the value of different LEAN strategies were perceived significantly different by all or particular groups of stakeholder (Figure 31 and Table 6). Overall, statistical analysis showed that different LEAN strategies were rated significantly higher than the average rating (3 out of 5). However, full scale mockups has the highest and target value design has the lowest average ratings. In addition, full scale mockups was rated significantly higher than all other strategies including team week meetings, target value design, and co-location (p = .022, p = .012, p = .022 respectively).

Owners, architects, and general contractors had consistent perceptions about the value that team week meetings, full scale mockups, and colocations can add to the overall projects; in a scale of 1-5, the average perceived value were reported as 3.96 for team week meetings, 4.75 for full scale mockups, and 4.35 for colocations.

One of the key components of Lean IPD projects is the focus on Target Value Design with the fundamental assumption that it is possible to reduce cost without reducing value. Survey results revealed that significant differences in how owners, architects, and general contractors perceived the value of Target Value Design for the overall project (P-value = 0.049). Although owners' perceptions (4.33) were higher than architects (3.67) and lower than general contractors (5.00), the differences were not statically significant. However, compared to architects, general contractors' belief that Target Value Design can add more value to the overall project was significantly higher (P-value = 0.042).

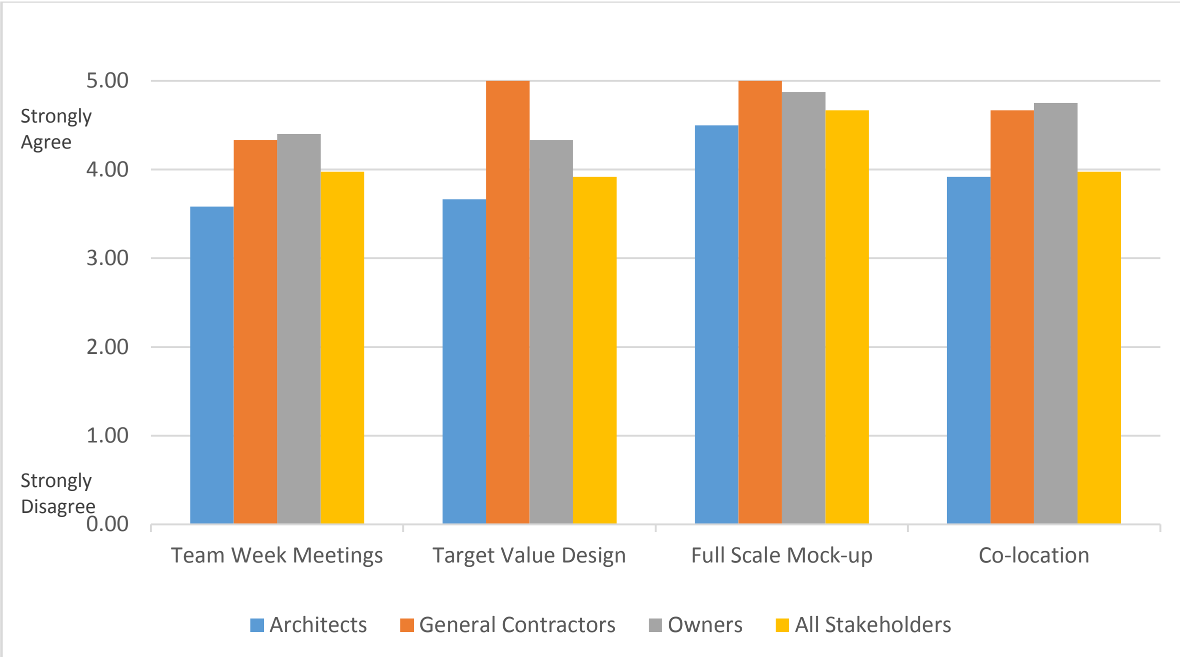

Figure 31. Value of Different Lean Strategies Perceived by Different Groups of Stakeholders

Influence of different stakeholders

The survey asked participants to use a scale of 1-5 to rate the influence different groups of stakeholders had in the decision making process (Figure 31).

Overall perception of all stakeholders.

Overall, across all subjects, all stakeholders thought that the owners had the highest influence (3.43) in the decision-making process, followed by the general contractors (3.24), architects (2.98), engineers (2.76), subcontractors (2.48), and vendors (1.69).

More specifically, owners, general contractors and sub-contractors thought that owners had the highest influence. Architects and engineers, on the other hand, thought that general contractors had more influence than the owners in the decision making process.

Except for general contractors, all other stakeholders thought that subcontractors and vendors had relatively low influence in the decision making process, compared to architects, general contractors and owner.

Table 6. Differences in Stakeholders' Perceived Value of Different Lean Strategies (Tukey HSD Test Results)

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Team Week Meetings	Owner	Architect	.817	.525	.287	-.51	2.14
		General Contractor	.067	.597	.993	-1.44	1.58
	Architect	Owner	-.817	.525	.287	-2.14	.51
		General Contractor	-.750	.493	.303	-2.00	.50
	General Contractor	Owner	-.067	.597	.993	-1.58	1.44
		Architect	.750	.493	.303	-.50	2.00
Target Value Design	Owner	Architect	.667	.512	.409	-.62	1.96
		General Contractor	-.667	.591	.508	-2.16	.82
	Architect	Owner	-.667	.512	.409	-1.96	.62
		General Contractor	-1.333*	.512	.042	-2.62	-.04
	General Contractor	Owner	.667	.591	.508	-.82	2.16
		Architect	1.333*	.512	.042	.04	2.62
Full Scale Mockups	Owner	Architect	.375	.406	.632	-.65	1.40
		General Contractor	-.125	.462	.961	-1.29	1.04
	Architect	Owner	-.375	.406	.632	-1.40	.65
		General Contractor	-.500	.442	.506	-1.61	.61
	General Contractor	Owner	.125	.462	.961	-1.04	1.29
		Architect	.500	.442	.506	-.61	1.61
Colocation	Owner	Architect	.833	.378	.091	-.11	1.78
		General Contractor	.083	.447	.981	-1.04	1.20
	Architect	Owner	-.833	.378	.091	-1.78	.11
		General Contractor	-.750	.414	.188	-1.79	.29
	General Contractor	Owner	-.083	.447	.981	-1.20	1.04
		Architect	.750	.414	.188	-.29	1.79

* The mean difference is significant at the 0.05 level.

ANOVA and Tukey HSD tests were conducted in order to examine if the influence of different groups of stakeholders in decision making process was perceived significantly different by all or particular groups of stakeholder (Figure 32). Statistical analysis showed a significant difference between how different stakeholders perceived owners, architects, and engineers' influences in the decision making process (P-value = 0.003, 0.013, 0.012, respectively). Compared to architects, general contractors perceived significantly higher influence of owners, architects, and engineers in the decision-making process (P-value = 0.003, 0.016, 0.008, respectively). The analysis suggests that although a collaborative project, the level of influence of different stakeholder groups does vary (or is perceived as such) with Owner having the largest perceived influence in the process, followed closely by the general contractors.

Self-perception.
By looking at how each stakeholders perceived their own influences, architects perceived themselves with lower levels of influence compared with owner and general contractors who perceived their own influences higher than average (3 out of 5).

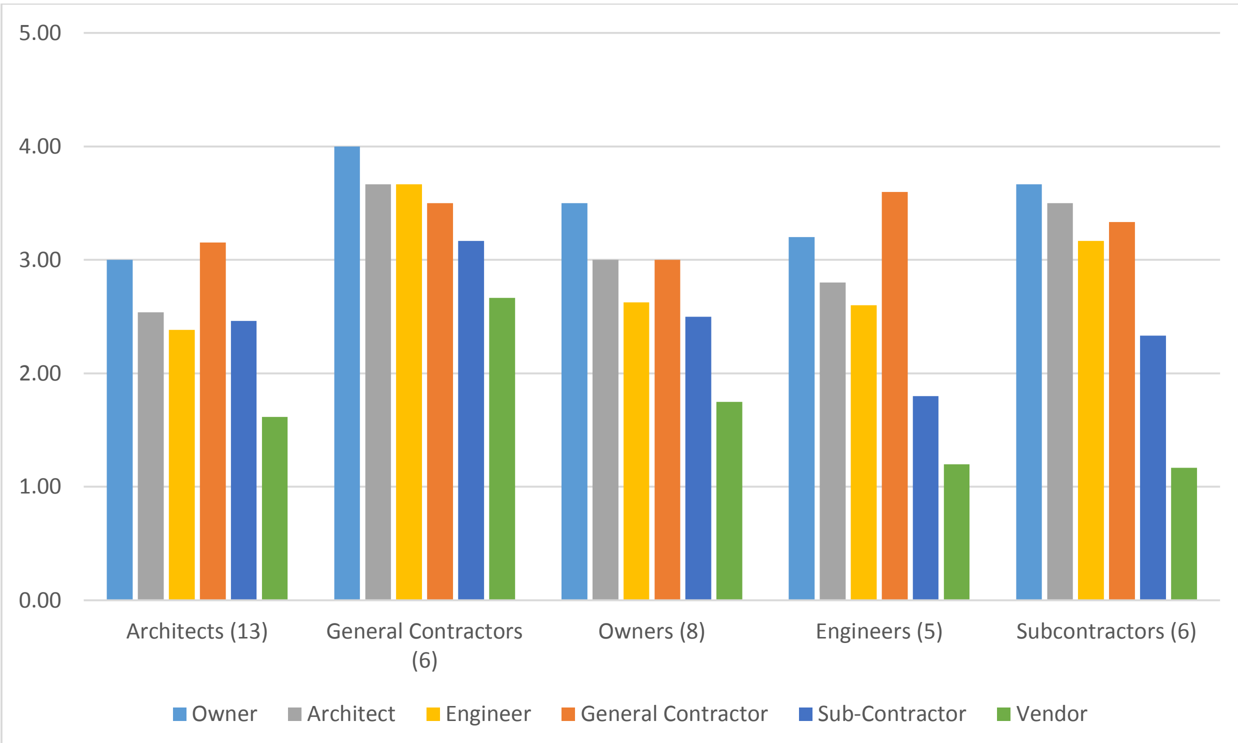

Figure 32. Architects, General Contractors, Owners, Engineers, and Subcontractors' Perceptions about the Influence of Different Groups of Stakeholders in Decision Making Process

Table 7. Stakeholders' Perceptions about the Influence of Different Groups **of** Stakeholders in Decision Making Process (Highlighted numbers show the self-perceptions of the different stakeholder groups)

Stakeholders		Q13_1_ Owner	Q13_2_ Architect	Q13_3_ Engineer	Q13_4_ GC	Q13_5_ SC	Q13_6_ Vendors
Owner	Mean	3.50	3.00	2.63	3.00	2.50	1.75
	N	8	8	8	8	8	8
	Std. Deviation	.535	.756	.518	0.000	.756	.707
Architect	Mean	3.00	2.54	2.38	3.15	2.46	1.62
	N	13	13	13	13	13	13
	Std. Deviation	.577	.660	.768	.689	.877	.961
Engineer	Mean	3.20	2.80	2.60	3.60	1.80	1.20
	N	5	5	5	5	5	5
	Std. Deviation	.447	.447	.894	.548	.837	.837
General Contractor	Mean	4.00	3.67	3.67	3.50	3.17	2.67
	N	6	6	6	6	6	6
	Std. Deviation	0.000	.516	.516	.548	.408	1.033
Sub-Contractor	Mean	3.67	3.50	3.17	3.33	2.33	1.17
	N	6	6	6	6	6	6
	Std. Deviation	.516	.548	.408	.516	.516	.753
Total	Mean	3.43	2.98	2.76	3.24	2.48	1.69
	N	42	42	42	42	42	42
	Std. Deviation	.590	.749	.790	.576	.773	.924

The Perception of "Value"

Survey participants were asked to explain what *Value* means to them. 40 of the 47 respondents (85%) answered this question. Results show that the definition of Value varies between the different stakeholders. All of them associated value primarily with the requirements of either the client or the end-user.

Architects alluded to value as

> *"what actually matters, and what the client's priorities are"*
> *"what the client feels will improve their ability to deliver quality care"*
> *"to provide the most appropriate building to meet the user's need without excess"*
> *"exceeding the conditions of satisfaction from the owner"*

They related it to life cycle cost, operational efficiencies, and future flexibility. Value, according to architects, was also,

"Most benefit for the least cost"
"a measure of benefit that can be realized through a process that leads to higher quality, lower costs, and increased efficiency".

Value, according to engineers, was
"providing the client with good to outstanding outcomes"
"values change based on both context and frame of reference. Some things are important to executives and unimportant to janitors, and vice versa"
"Value is a benefit or enhancement that comes as part of a product or service or at a low cost"

The General Contractors indicated that
"value as such meant nothing, but what it means to the owner"
"value for the client/ owner becomes value for the team and the project".

Sub-contractors indicated that value meant
"understanding what is important for the owner"
"the collective experience should be utilized to their advantage"
"getting expected results at the lowest possible cost via a convenient knowledge based process"
"simply, getting bang for the buck"; If I spend this dollar today, how many dollars will I save down the road..."
"a fair price for a product furnish and installed per contract documents"

To the Owner, the clients were their customers and end-users - their patients. Pursuant to this perspective, the owner defined value as
"*that which allows us to meet customer expectations";*
"Value is in the eyes of the customer. We were building this building for our patients, families but also our staff to provide the best care environment that allowed to staff to concentrate on care and not have the facility create barriers to that care".

The owner went on to say that value
"adds quality to project and reduces cost to project"

Other than the General Contractors, all other stakeholders also indicated that 'low cost' corresponding to a commensurate or higher benefit was also definitive of value. Some stakeholders also factored in higher quality, increased efficiency along with low cost as definitive of value. Teamwork, useful processes, optimal use of resources, time and money, and an end-product devoid of waste were some other factors that the stakeholders considered as significant to defining value.

Part 4: A Plus Delta Analysis of the Reported Benefits and Costs (based on surveys, interviews, and focus groups)

When the pluses and deltas of the key stakeholders (Owner, Architect and General Contractor) were compared, the data from surveys, interviews, and focus groups provided key advantages and opportunities for improvement in the Lean IPD process emerged. Tables 8 and 9 illustrate these.

Advantages

- Enhanced collaboration, team engagement and working towards common goals
- Building relationships
- User engagement and user buy-in
- Learning & Education (of stakeholders and the larger community)

Successful Strategies

- Mock-ups;
- Pull planning;
- Co-location/Team Weeks to allow more face time;
- Last Planner times,
- Incremental decision-making
- Transparent pricing allowed for more participative discussion on reducing price without compromising value

Opportunities for Improvement

- Inaccurate Estimating on the original estimate
- Wasted time (too many meetings, too much time wasted in co-location without clear task)
- Imbalance of control
- More opportunity for learning
- Optimal use of lean strategies
- Scope for better collaboration and relationship-building
- Logistics
- Cultural adaptation

Table 8. Plus Aspects of Lean-IPD in Hospital X Project, as indicated by Owners, Architects & General Contractors

		+ (Plus)	Methodology: Survey	Methodology: Interview	Methodology: Focus Group
Advantage	Engagement	Team engagement	✓		
		Early Sub-involvement			✓
		Stakeholder buy-in: • MEP • Interiors • IT • Medical Equipment		✓	
		Local Participation			✓
		Community/ Family and Patient engagement	✓		
		User buy-in			✓
	Collaboration	Collaboration with Trade Partners	✓		✓
		Team Collaboration			✓
		More face time with contractors, subcontractors and consultants			✓
		Enhanced remote participation			✓
		Construction and production teams' input on design			✓
	Relationship	Relationship building/ Relationships with clients, user groups	✓		✓
		Owner's trust	✓		
		Promise of transparency			✓
	Learning	Learning - continuous improvement/ Education	✓		✓
		Early knowledge and understanding of the project			✓
		Education of the Community		✓	
	Common Goal	Clear mission and common goal	✓		
		The satisfaction of providing the scope the client needed for the money they had to spend	✓		
		Developing vision together with owner for future campus	✓		
		Enhanced outcome			✓
		Enhanced output and reliability			✓
		Delivering a high value project to the owner with a team that cared.	✓		
		Owners gets what they truly need.			✓
	Schedule	On/ under Time	✓	✓	✓
		Delivering information just in time			✓
	Budget	Guaranteed Profit and Target Cost/ Under cost	✓		✓
		Greater cost transparency			✓
		Real time cost estimate			✓
	Budget and Schedule	Elimination of change orders (surgical space example)			✓
Strategy		Mock-ups	✓	✓	✓
		Assigning prices in mock-ups allow prioritizing			
		Last Planner System		✓	
		Effective pull planning			✓
		Incremental decision making			✓
		3 p 7 way			✓

Table 9. Delta Aspects of Lean IPD in Hospital X Project, as indicated by the Owners, Architects & General Contractors

	Δ (Delta)	Methodology		
		Survey	Interview	Focus Group
Budget	Improve accuracy of Estimation - estimation inaccuracy	✓		✓
	Known financial constraints upfront - material/staff time cost	✓		
	Contingency Funds Used up		✓	
	Make the finances more transparent.	✓		
Schedule	Time Commitment - time commitment/labor intensive	✓		
Leadership	Need for more Experienced Leaders	✓		
	Lean design should be co-led by architects to respect the iterative nature of design			✓
	Centralize coordination; - coordination to distribution	✓		
	Have architects and general contractors interview together; forced marriage doesn't always work.	✓		
	The perception of the process being driven by a contractor – being more inclusive		✓	
Learning	More training upfront and throughout: - inadequate training/ teaching - lack of knowledge (Lack of knowledge of contractor about Lean/IPD process) - more face-time education and earlier in the process - more resources to better some of the processes from our trade partners.	✓		✓
Strategy	Transparency of Target Value	✓		
	↓Meetings Too many meetings (perception)	✓		
	Make trips more productive/ worthwhile			✓
	Better preparation by team members coming to planning meetings	✓		
	Participation not always "willing/ focused"			✓
	True co-location - intermittent team weeks difficult	✓		
	Co-locate workshop & innovation teams - workshop & innovation teams separated	✓		
	Co-location - Being away from home base/friends & families			✓
	Include patients in design - more end-user engagement in design		✓	
	Better work plan			✓
	Simplify the CBA			✓
	Multiple design packages			✓

	Δ (Delta)	Methodology		
		Survey	Interview	Focus Group
Collaboration	Need earlier involvement of all parties in the project	✓		
	Need better communication	✓		✓
	Balance of control of the process to be worked out between design team and construction team	✓		
	Difficult to get Trade partners buy-in			✓
Relationship	Build more trust - lack of trust - actual transparency limited	✓		✓
Logistics	Third party determination of compliance - compliance open to interpretation	✓		
	Complexity of Contract	✓	✓	
	Bias in Success Metric		✓	
	Not enough space for Mission Control/ Big room not big enough	✓	✓	
	Quality Metrics related to quality of work needed		✓	
	Feeling left out - distance from mock-up/ Proximity and poor environmental quality of warehouse	✓		✓
	Technology (connecting others remotely RMS w/o Video)			✓
Culture	A more careful vetting of some of the stakeholders to insure their understanding of Lean and IPD.	✓		
	Equal voice	✓		
	Being open to new ideas	✓		
	A personality profile should be done prior to the start - some folks just didn't fit.	✓		
	Falling back to traditional mindset			✓

DISCUSSION & CONCLUSIONS

Review of the archival data demonstrated there were three primary sources for savings associated with Target Value Design on this project: (1) Project Validation, (2) Target Value Design exercises (including cardboard mockup); and (3) Construction Processes (Ai, 2014). The final overall capital cost reduction can be substantial, generally 15-20% (Ai, 2014) (Figures 33 and 34).

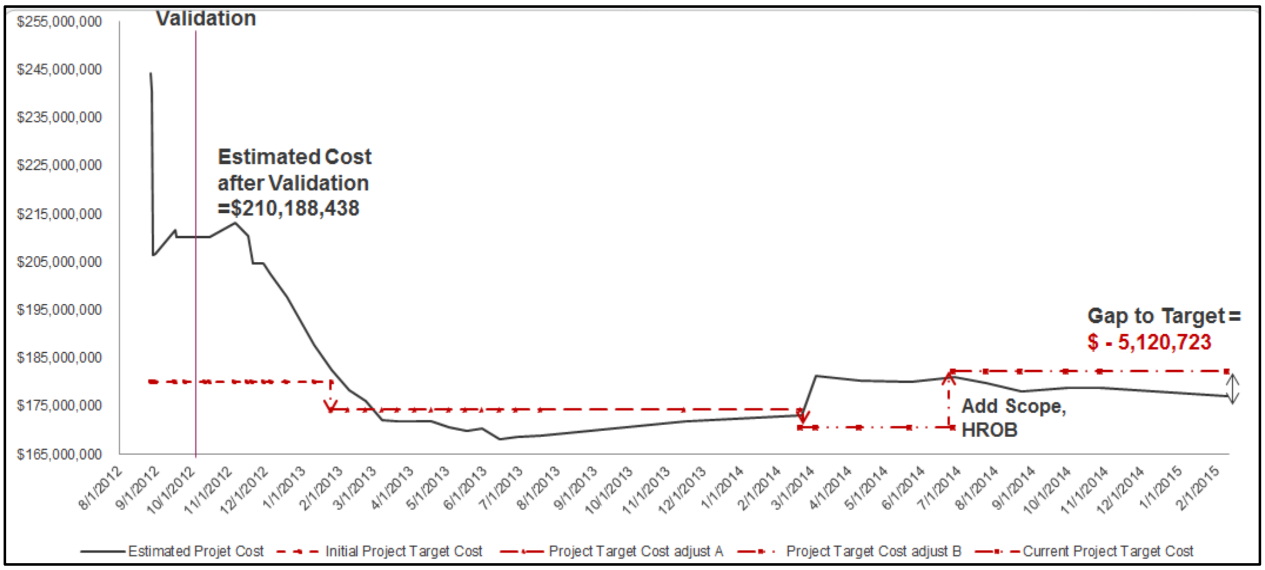

Figure 33. Estimated construction cost decrease diagram associated with TVD.
The x-axis represents time; the y-axis represents magnitude of estimated cost.

In other words, cost saving opportunities for design (i.e. prior to construction) manifested themselves in three phases:

1. Validation
2. Innovation (design)
3. Production

It may be recalled that during *Validation*, critical stakeholders met to rigorously determine what the facility owner could realistically pay for their proposed scope, thus establishing the *target cost*. During *Innovation*, key stakeholders met on a regular basis, co-locating at a Big Room to iteratively design and redesign the facility in increasingly greater detail; this involved brainstorming and documenting alternatives that would reduce waste while achieving desired owner value. During *Production*, the general contractor worked closely with subcontractors and vendors to introduce flow into the construction process by following lean principles.

Innovation/ design phase benefits and costs

In order to calculate Return on Investment, incremental costs must be itemized and considered as well. Target Value Design is not an inexpensive process: cost contributors include material (Lean facilitation in workshops and documentation, and mock-up construction), labor (considerable additional time for all participants), equipment (mock-up support), and real estate required for *team week meetings* and *co-location*, as well as a full scale cardboard mockup. There are also indirect and overhead costs associated with these items. Table 2 (in result section) itemizes direct costs that need to be considered when engaging in TVD exercises. (Refer Appendix D for detailed formula to incorporate labor costs)

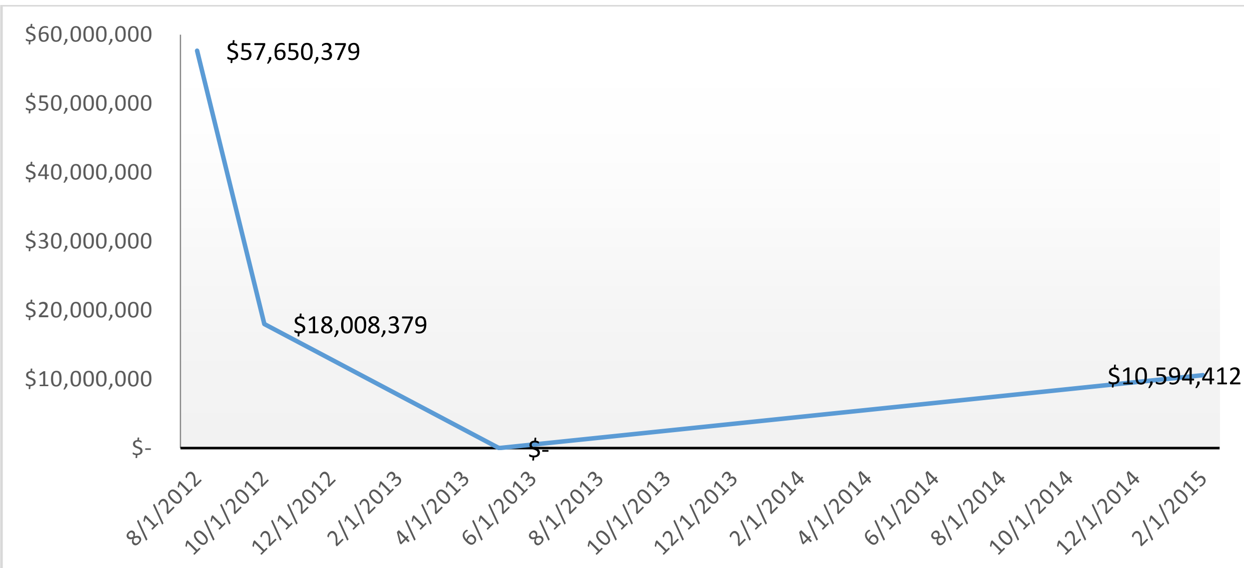

Figure 34. Decreases in estimated construction cost followed a pattern of initial sharp decline from Project Validation, moderate decline from Target Value Design exercise, and additional (although more shallow) decline, from Construction Processes.
Adapted from Ai (2014).

Stakeholders can sometimes become overwhelmed by the large number of meetings demanded during a full TVD process. It must be remembered, however, that stakeholder meetings are not exclusive to the TVD process. While there may be more labor hours and real estate dollars spent in meetings during TVD than during traditional project delivery processes, it is likely that additional costs associated with these meetings are largely offset by savings garnered from increased construction productivity, reduced requests for information, and reduced numbers of errors and emission change orders when the project is eventually constructed. The full-scale cardboard mock-up subjected to user tests virtually assures a higher level of satisfaction with the final building design. Also because stakeholders are rigorously engaged throughout the TVD process, there is both a higher level of stakeholder satisfaction (as measured by periodic pulse reports) and learning that benefits stakeholders on future projects.

A significant opportunity for improvement in the field is tying the TVD process, and the success metrics tied to the profit pool, to long term occupancy benefits. Although this can be a challenge, it is possible to use the existing evidence-base (Sadler et al., 2011) to create a probabilistic model for improved outcomes. Currently, very few of the success metrics were tied to occupancy outcomes. Since profit share was linked to the success metric the metrics, per force, had to be determined within a few months after occupancy. Table 10 lists the current measures of success for the project and how they relate to the core tenets of time, cost, safety, quality and morale. In addition we have added the tenet of learning, which was a key finding from the surveys and interviews. The table also has additional notes on metrics that are currently lacking and the implications for an ROI study in the future.

Development of a Benefit/Cost Framework

Table 10. Benefit/cost framework

Time	Cost	Safety	Quality	Morale	Learning	Measure of success	Metric	Implicit	Explicit	Tracked	Not tracked	Success	Notes & implications for ROI
✓						Project is completed on/ before schedule	Number of calendar days before schedule		✓	✓		✓	ROI framework should address additional time needed for IPD. (additional labor through user groups/ mock-ups/ co-location) Additional time invested by teams
✓			✓			Project issues are resolved within a timely schedule (as compared to other comparable projects)	Number of working days to resolve project issues		✓	✓		✓	Requires robust baseline from non-IPD projects
	✓					Project is completed on/ under budget	$ saved from original estimate		✓	✓			Original budget must be validated
	✓					Project designed and constructed efficiently in terms of energy	$ saved from BTU/SQ.FT/YR (%below national average)		✓	✓		✓	
	✓					Project design and construction resulted in lower square footage	$ saved from reducing sq.ft		✓		✓		Does not take into account the implicit benefits such as increased satisfaction and safety implications Consider occupancy metrics (satisfaction, patient safety, employee satisfaction and efficiency)
	✓					Target costs is lower than market costs	$ estimated costs - target cost		✓		✓		If original estimates has errors than perceptions of savings maybe higher/ lower

Time	Cost	Safety	Quality	Morale	Learning	Measure of success	Metric	Implicit	Explicit	Tracked	Not tracked	Success	Notes & implications for ROI
													Time invested in developing target costs
	✓					Target/ final costs is lower than initial/ estimated costs	(% decrease in cost between final and initial cost)		✓	✓			Initial estimate was validated and reused Cost/ time invested in validation report
	✓					Rework/ redo costs	No. of punch-list items		✓	✓		✓	Important to think of negative and positive rework. Need is to reduce "wasteful" rework.
		✓		✓			No. of change-orders and RFIs	✓			✓		
							Use of contingency funds ($)		✓	✓		✓	
	✓		✓			Increased benefit (better quality) for same cost Same benefit (similar quality) for lower cost	$ saved in design decisions without impacting design intent/project goals	✓		✓			First cost benefits and operational cost benefits Probability calculation and based on strength of evidence Current cost estimate is in just first cost alone. Operational savings are not taken into consideration TVD process and use of A3s is towards this intent. However, there is in many instances a reduction in perceived value- which is not captured because of the focus on first costs (does not include operational costs).
✓	✓	✓		✓		Worker safety (construction)	DART rate		✓	✓		✓	What about cost of injury? What about implications on EMR - experience modification rating/ company's safety rating
						Worker safety (hospital employees)		✓			✓		Employee injury rates are not included
						Patient safety		✓			✓		Patient injury rates must be included
						Patient satisfaction		✓			✓		
✓	✓					Local participation	% of project team labor hours spent by people living in local counties		✓	✓		✓	

Time	Cost	Safety	Quality	Morale	Learning	Measure of success	Metric	Implicit	Explicit	Tracked	Not tracked	Success	Notes & implications for ROI
✓	✓		✓	✓	✓	Team performance	Survey Tool % of respondents with high level of agreement (score of 5 or higher on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree))		✓	✓		✓	
			✓	✓	✓	Staff and family satisfaction 1. Workshop process 2. Engagement in design and construction 3. Post construction	% of respondents with high level of agreement (score of 5 or higher on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree))		✓	✓		✓	

The purpose of this study is not to make a case for lean processes or IPD systems (which would require a comparison/ baseline) - but to "study" this process from the perspective of defining clear metrics, and establishing foundational frameworks, that can aid both design and research, and facilitate the dialogue between the two. The framework below provides a starting point for this discussion.

Table 1. Proposed Framework for Key Metrics: (Repeated from the Executive Summary)

COST		**BENEFIT**			
TIME	**COST**	**SAFETY** Of people Involved in Design + Occupants of the building	**QUALITY** Of the project as it relates to people, the community and the organization	**MORALE** Of team including Design team/ Owner/ Family representation	**LEARNING** Of the team and the community
Production time [i] Decision time [ii] Schedule Variance (SV=Budgeted Cost of Work Performed - Budgeted Cost of Work Scheduled) [i]	First cost [i] Lifecycle cost [iii] Decision making cost [ii] (labor+ materials) Energy Cost Operational savings [iii] (Note: use of CBA- Choosing by Advantage tools did take into account lifecycle cost and was used for some key design decisions as documented in A3s) Cost Variance (CV=Budgeted Cost of Work Performed - Actual Cost of Work Performed) [i]	Construction safety [i] Post-occupancy safety (employee injury, patient harm (infections, falls with injury, errors) [iii]	Efficiency of project (RFIs, changeorders, punchlist items) [i] Benefit to patient (clinical quality + safety+ overall satisfaction) [iii] Benefit to employee (efficiency + safety + satisfaction) [iii] Benefit to organization (Community goodwill, market share, employee loyalty, patient loyalty etc., Energy Efficiency [i]) [iii] Benefit to community (local participation [i]) (Note: A3s currently capture some of these benefits but lack of metrics is a challenge) Number of RFIs (Requests for Information)[i] Number of E&O COs (Error and Omission Change Orders) [i]	Team satisfaction [i] Team collaboration [i] Employee engagement / satisfaction during design, construction, and transition [i] Family engagement / satisfaction during design and construction [i] Employee satisfaction post occupancy [i] Family satisfaction post occupancy [i]	Team learning [iii] Hospital employee learning (relates to change engagement) [iii] Community learning (local community that supports the hospital) [iii]

[i] Metrics exist
[ii] Metrics proposed in this study
[iii] Metrics to be determined (a probabilistic model may be needed to link design decisions to occupancy metrics, based on the likelihood of certain outcomes from a given body of evidence. Existing metrics currently captured by the organization should be taken into account.

Current Metrics List (*):
[S]: DART rate
[C]: Target cost vs. Actual Cost, Target Value Management Workbooks, Incentive Compensation, Use of contingency funds

[T]: No. of working days to resolve project issues, schedule increase of 2 weeks or more, no. of calendar days sooner than scheduled time [Q]: Punch list items, LEED certification points, Energy Efficiency, Local Participation [M]: Team performance survey, Staff and Family Satisfaction & Engagement Surveys with Workshops participants

Final Take-Aways

1. Learning is a large implicit benefit that is not currently captured by any success metric. Not only do all the teams involved learn, but getting national experts to team with regional teams also allows a community to build its own expertise, that has an immeasurable value for the community, and stewards of the community.
2. The Mock-Up/ Workshop is the most successful lean strategy which was consistently rated higher than TVD, team weeks and co-location, by all stakeholders.
3. There were some concerns with the TVD process that pertained to 1) the accuracy of original estimate, and 2) the addition of value in the TVD process- analysis of design decision documents (A3s) revealed that for some decisions, reduced cost was also perceived as reduced value. The lack of a robust ROI tool which can address the operational implications of first cost decisions was identified.
4. Although a collaborative project, the level of influence of different stakeholder groups does vary (or is perceived as such) with Owner having the largest perceived influence in the process, followed closely by the GC.
5. There may be value in considering third party estimation and mediation, to address issues of bias and aid perception of a level playing field. They may also be value to include and co-lead with design teams.
6. The biggest advantages for Lean IPD were identified as:
   - Collaboration, team engagement and working towards common goals
   - Building relationships
   - User engagement and user buy-in
   - Learning & Education (of both the design teams and the larger community)
7. The biggest opportunities for improvement were identified as:
   - Inaccurate Estimation
   - Wasted time (too many meetings, too much time wasted in co-location without clear task)
   - Perception of imbalance of control/ influence, and need for facilitation which represents different points of view)
   - Adaptation by team members (culture shift needed)
   - Current measure of success still relate more to first costs, rather than quality, and improved outcomes post occupancy.
8. Quality is a key component of value but robust measures to access quality are lacking. Greater value can be a result of greater quality or same quality with lower costs. The true north objectives of the hospital are not currently captured in the project success metrics beyond a post occupancy survey.
9. Current evaluation of “value” is still primarily on first cost and does not take operational cost savings into consideration. This is something that needs to be developed.
10. To conduct a robust ROI for Lean IPD process vis-à-vis a traditional design bid build project, baseline data needs to be collected. Industry wide benchmarking is essential to accurately assess project value.

Finally, conduct a robust ROI for Lean IPD process vis-à-vis a traditional design bid build project, baseline data needs to be collected. Industry wide benchmarking is essential to accurately assess project value. That said, benefits and costs from TVD will remain in the realm of speculation unless we are able to benchmark the costs associated with traditional design-bid-build delivery processes, because ROI (Return on Investment) is calculated from an *incremental* cash flow analysis where cash flows from a typical *defender* delivery process (i.e. Design Bid Build) are subtracted from the *challenger* delivery process (i.e. Target Value Design/Lean Project Delivery). Only when this is done can any true claim be made about ROI with respect to Target Value Design.

This report throws down the gauntlet to future researchers to take up this challenge.

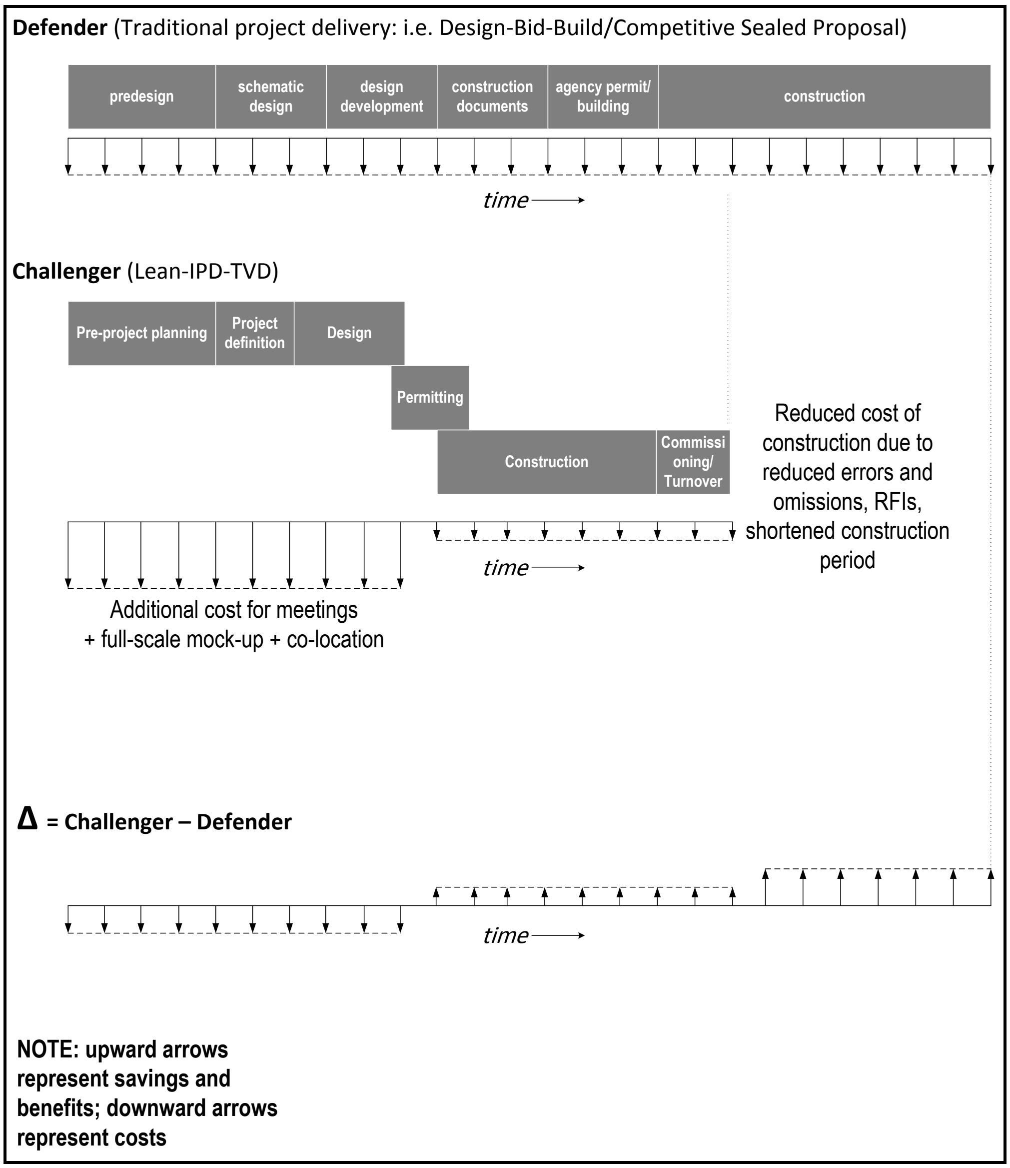

Figure 1. Proposed ΔIRR calculation model
Adapted from Ai (2014)

LIMITATIONS

A typical benefit and cost analysis model (see Figure 1) compares the cash flow between a defender project delivery process (DBB), and a challenger project delivery process, Lean-IPD. And then it calculates the delta (Δ) between challenger and defender by using cash flow of challenger minus the cash flow of defender. Each project phase of DBB and lean-IPD is situated along a time axis, and the significant benefit and cost value for owners is recorded in the time axis. Once a framework is established, and actual data are entered, an initial ΔIRR can be calculated.

In this research, we do not have a "defender" project - which would, in this case, be the traditional Design Bid Build project (DBB). Therefore the focus has been to develop the *framework for analysis*. In subsequent work, once baseline data is available for benchmarking a more thorough B/C analysis can be conducted with IRR.

GLOSSARY

CBA	Choosing by Advantages
CSP	Competitive Sealed Proposal
DBB	Design-Bid-Build
IPD	Integrated Project Delivery
IT	Information Technology
LRM	Last Responsible Moment
LPS	Last Planner System
MARR	Minimum Attractive Rate of Return
MEPF	Mechanical, Electrical, Plumbing and Fire
OAEC	Owners, Architects, Engineers, and Contractors
PDCA	Plan-Do-Check-Act
PLT	Project Leadership Team
SET	Senior Executive Team
TVD	Target Value Design
VSM	Value Stream Map
ΔIRR	Incremental Internal Rate of Return

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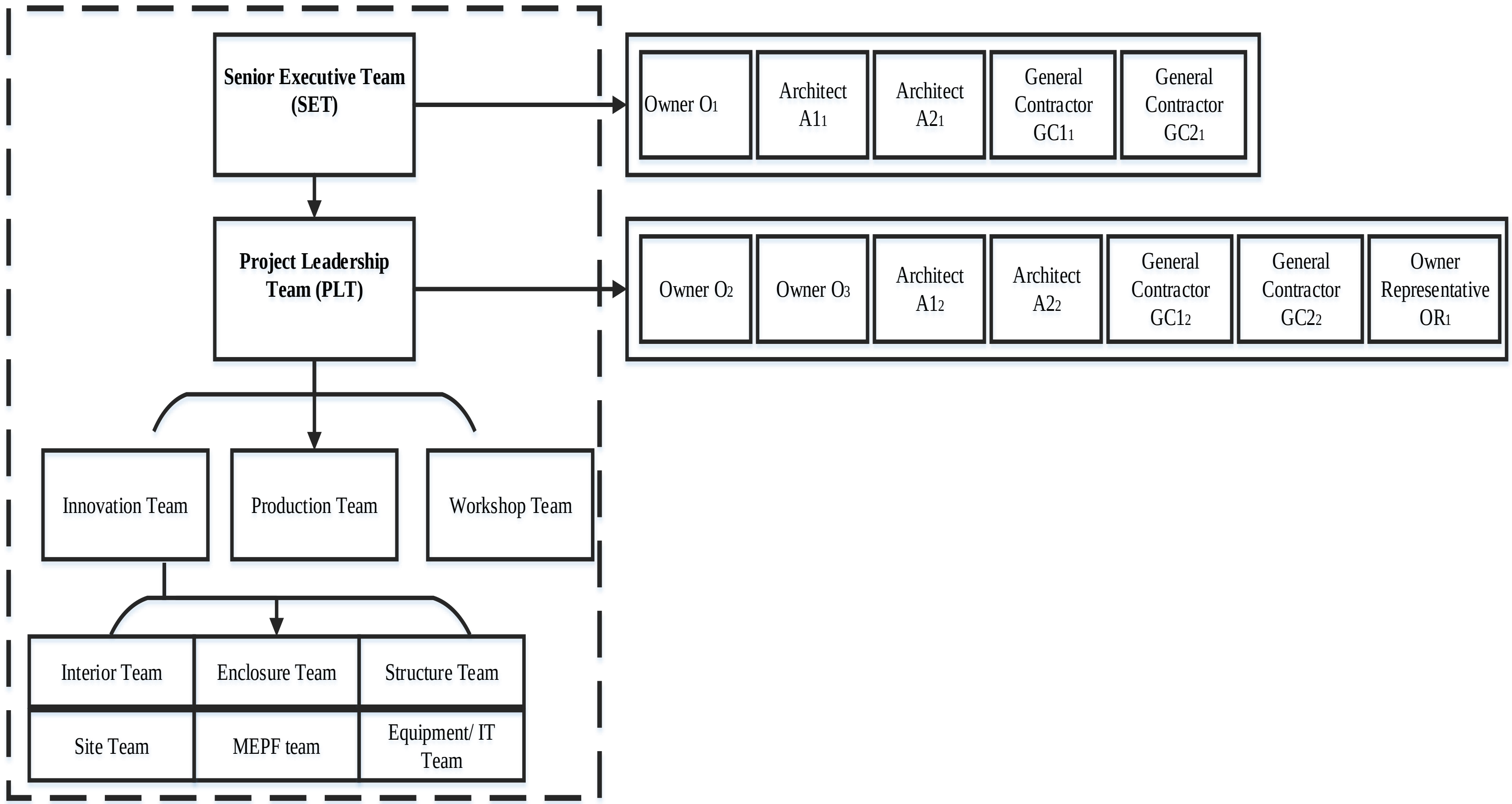
LIST OF APPENDICES

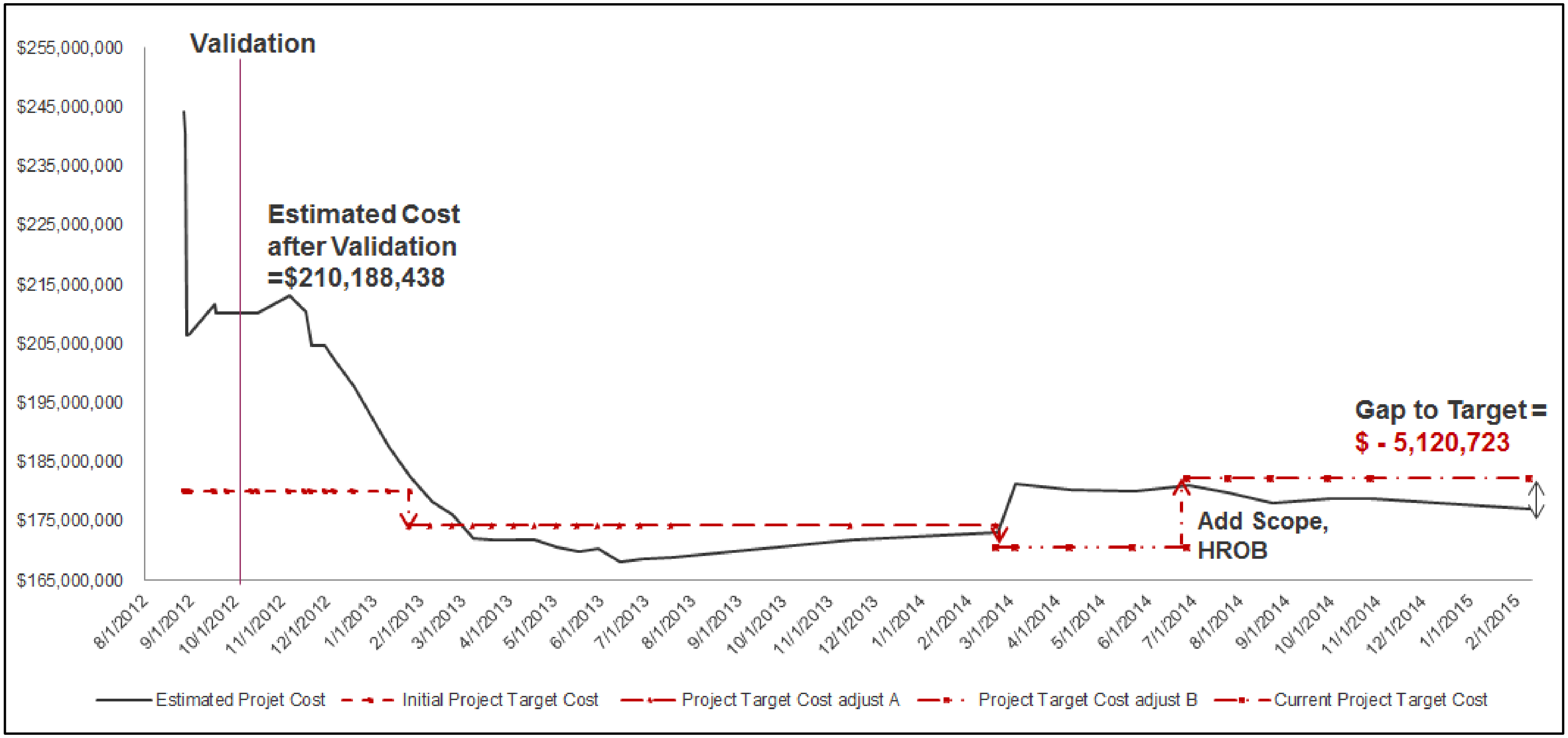
APPENDIX A

ORGANIZATIONAL CHART SHOWING TEAM STRUCTURE



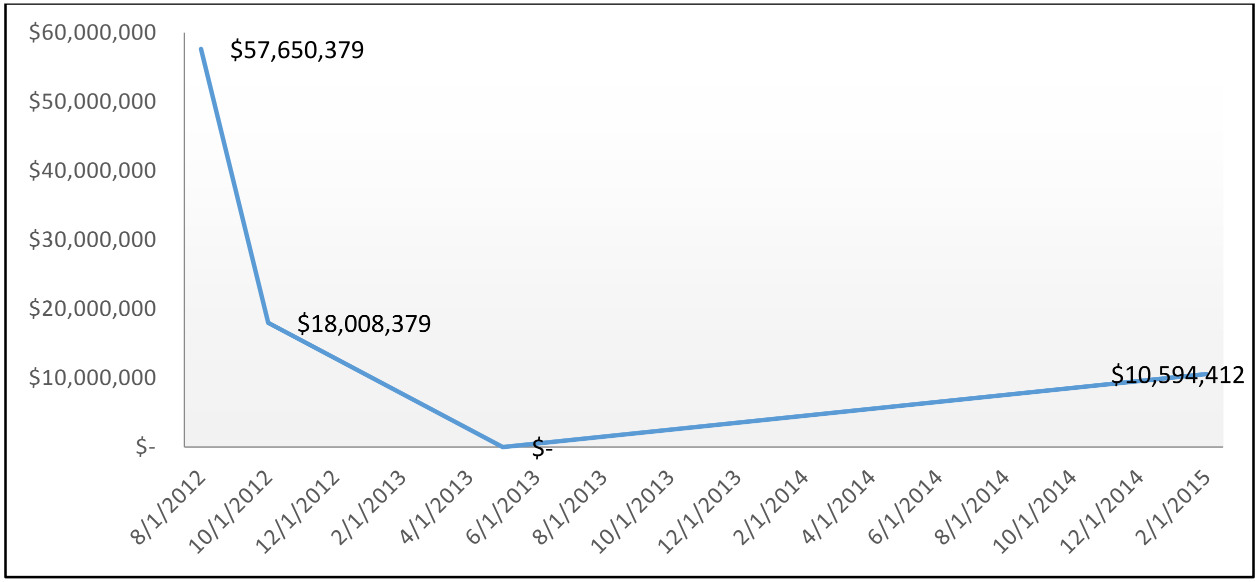
APPENDIX B

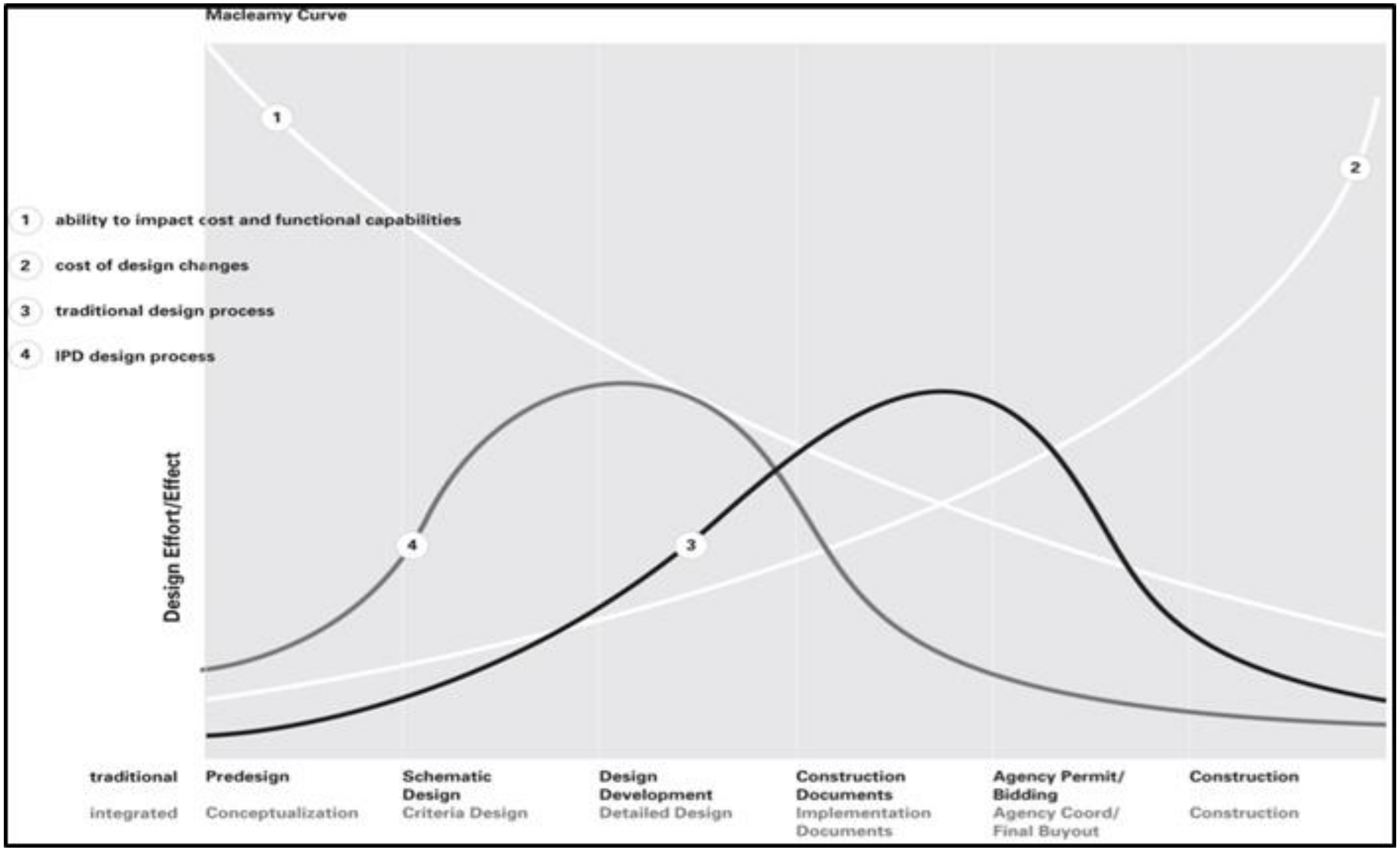
BENEFITS ASSOCIATED WITH TVD IN HOSPITAL X



APPENDIX C

BENEFITS/SAVINGS ASSOCIATED WITH TVD IN EACH PHASE IN HOSPITAL X





Macleamy Curve
1 ability to impact cost and functional capabilities
2 cost of design changes
3 traditional design process
4 IPD design process
Design Effort/Effect
traditional
integrated
Predesign
Conceptualization
Schematic Design
Criteria Design
Design Development
Detailed Design
Construction Documents
Implementation Documents
Agency Permit/ Bidding
Agency Coord/ Final Buyout
Construction
Construction

APPENDIX D

COSTS ASSOCIATED WITH LEAN-IPD IN HOSPITAL X PROJECT

Labor cost = Mean hourly wages X Number of participants X Number of hours spend

Table 6 Mean hourly wages

Occupation	Mean hourly wages from BLS (per hour)	Mean hourly wages from Children's Hospital X project (per hour)
Healthcare administrators	$42.59	$ 192.00-$250.00
Physicians & Surgeons	$90.00	$ 330.00
Nurses	$31.48	$ 192.00-$250.00
Clerical and technical staff from Owner	NA	$ 192.00-$250.00
Construction Managers	$39.80	NA
Architectural Managers	$60.03	$ 120.00-$137.00
Engineering Managers	$60.03	NA
Architects	$35.14	$ 82.00-$ 90.00

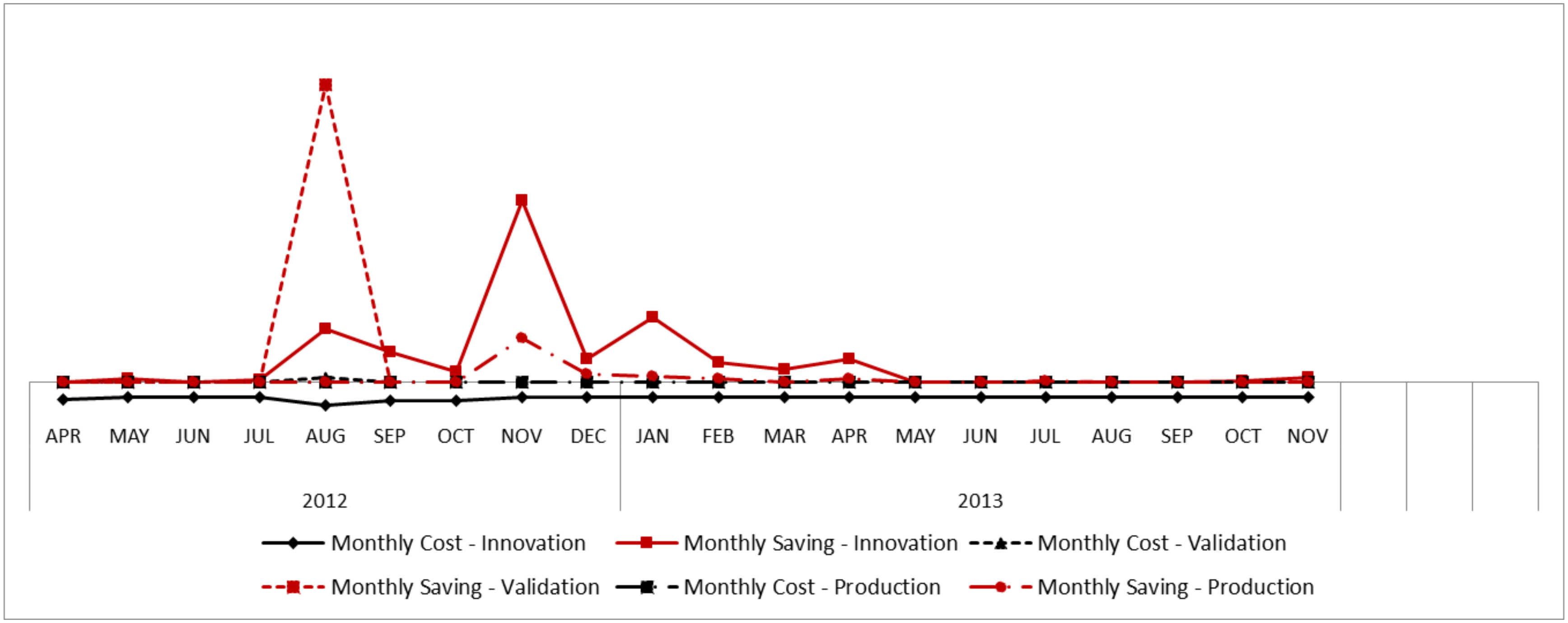
Table 7 Labor cost calculation (mean hourly wages adopted from Children's Hospital X Project) [1]

Category	Role	Mean hourly wages (per participant)[2]	Number of participants	Number of hours spent (per team week)	Number of team weeks per month	Sub-total cost (per month)
Big-Room Meetings	PLT members	$155.00	7	7.5	2	$ 16,275
	Innovation/ Production Team members	$113.00	90	7	2	$ 142,380
	All members	$113.00	103	10.5	2	$ 244,419
	Workshop Committee	$190.00	6	8	2	$ 18,240

[1] The mean hourly wages for Healthcare administrators, Physicians, Surgeons, Nurses, Clerical and Technical staff were obtained from Owner; Architectural Managers and Architects were obtained from Hospital X Project. The mean hourly wages for Construction Managers and Engineering Managers were obtained from the Bureau of Labor Statistics 2012.
[2] Mean hourly wages per participant were calculated by averaging all participants' mean hourly wages.

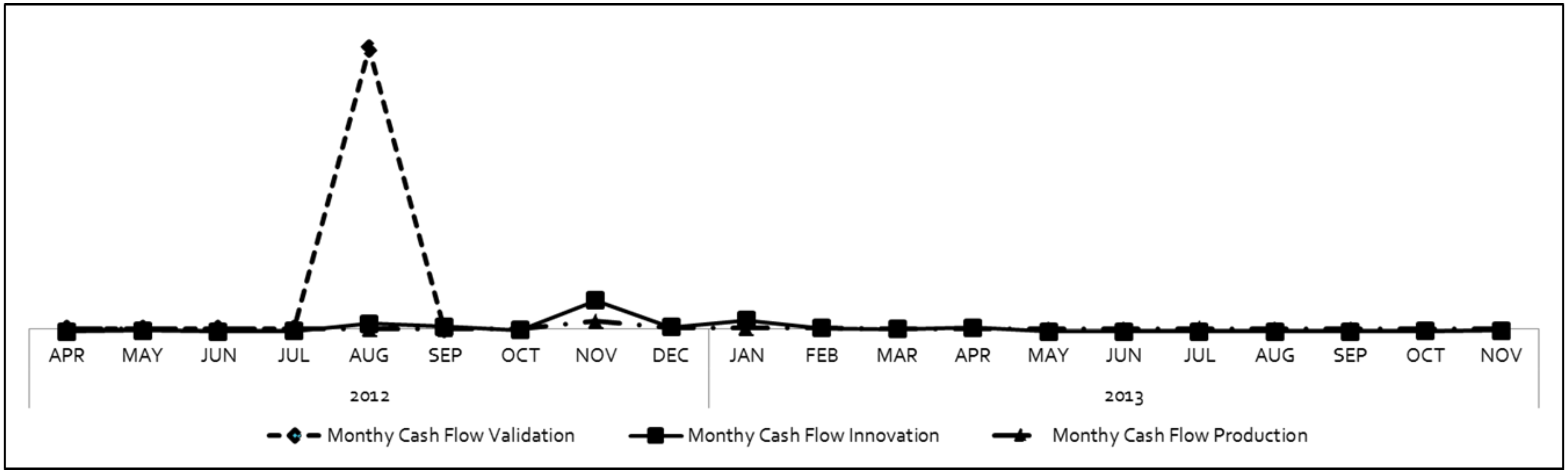
APPENDIX E

MONTHLY COSTS AND SAVINGS



APPENDIX F

SAVINGS MINUS COST



Saving minus Cost diagram of Validation, Target Value Design and Production for Hospital X. Revenues and expense from Figure 16 have been combined. The x-axis represents time; the y-axis represents magnitude of cash flow. For confidentiality reasons, actual dollar amounts are not shown.

- The validation process related significant cost saving, so the validation cash flow line has a peak in Aug. 2012
- In the first four months, Hospital X project had to pay the initial cost to establish necessary lean tools and lean working environment without any payback.
- However, starting from the fifth month, Hospital X project began to benefit from the lean processes with significant amount of money. And this trend continued to April 2013

APPENDIX G

SUCCESS METRICS SCORECARD

Children's Hospital X Success Matrix [DRAFT]

Project Vision

Promise 2030 – Children's Hospital X will create a distinctive healing environment in which medical staff and employees are empowered to transform the patient and family experience. Continuing to deliver on the promises that were written in 1890, our campus expansion will enhance the high quality, compassionate and family centered care that we have delivered to the communities we serve for over 120 years.

Guiding Principles

- Design facilities "through the eyes of a child" in order to create a uniquely satisfying patient and family experience
- Assure improved ease of access for all families and children to both the Children's Hospital X "system of care" and the physical facilities of the Children's Hospital X Campus
- Driven by the success of our regional growth and outreach strategies, provide an opportunity to expand the breadth, depth and volume of services delivered at the Children's Hospital X Campus
- Enhance Children's Hospital X's ability to recruit and retain the highest quality physicians and staff by creating state-of-the-art work environments in which the Children's Hospital X culture can be preserved.
- Develop a project that achieves an appropriate return on investment to ensure the long-term financial viability and autonomy of Children's Hospital X.
- As a valued community asset, create a positive economic impact for the local community by providing related jobs during the life of the project and giving local contractors and vendors opportunities for involvement.
- Operational excellence, efficiency and sustainability will be the foundations upon which we design our new facilities.
- Provide ample and appropriate communication to, and the opportunity for input from, key constituent groups and the community during the life of the project.

		Total Possible Points	Projected Points	Person Responsible	Standard	Data Collection Frequency	Explanation	Documentation	Metric Calculation
A SAFETY		TRENT		CONTRACTOR	INDUSTRY BENCHMARK	PULSE POINT			
Goal:	Deliver the project safely with 0 Lost Time, 0 Days Restricted/Transferred (Based on the DART rate from the Bureau of Labor Statistics). 2.2 Is the National Average for the Working Trades Involved in the Children's Hospital X Project.			Production team members: construction manager, trade partners, and subcontractors	National DART rate information form the Bureau of Labor Statistics; The average DART rate for classification 238 (North American Industrial Classification System-NAICS) is 2.2. It means that 2.2 employees out of 100 employees suffered from some	Monthly from construction start to completion dates	The DART Rate is national safety metric (recognized by OSHA) that scores this project against projects across the United States. This metric is calculated based upon labor hours involved with actually putting "the work" in place in the field. Therefore, the metric mainly involves the hours worked by the Construction Manager, its Trade Partners & Subcontractors (ie: Production Team)	The Production Team members will provide the following data as part of their monthy billings. -Listing of employees that worked on the project. -Each employee to have the following identified: Total hours worked, approved labor rates, and County/State residency. The labor hours for each Production Team member are tracked on an overall spreadsheet that provides the PLT with the total number of construction labor hours worked each month and in cumulative. The cumulative labor hours will be	18 Points = DART Rate 0 to 1.5 17 Points = DART Rate 1.6 16 Points = DART Rate 1.7 15 Points = DART Rate 1.8 14 Points = DART Rate 1.9 12 Points = DART Rate 2.0 11 Points = DART Rate 2.1 10 Points = DART Rate 2.2 9 Points = DART Rate 2.3
	0 to 1.5 = Achieved DART Rate	18							
	1.6 to 2.0 = Achieved DART Rate	12-17							
	2.1 to 3.0 = Achieved DART Rate	6-11							
	3.1 and Greater = Fail	0							
TOTAL (Max Points= 18)			18						
B LOCAL PARTICIPATION		PAT		CONTRACTOR	INTERNAL BENCHMARK	END OF PROJECT/ PULSE CHECK			
Goal:	85% of (ICL) project team labor hours spent by people living, as defined by their W-2, in a zip code in the following counties: Ashtabula, Trumbull, Mahoning, Columbiana, Jefferson, Lake, Geauga, Portage, Stark, Carroll, Harrison, Cuyahoga, Summit, Stark, Guernsey, Tuscarawas, Coshocton, Holmes, Wayne, Medina, Lorain, Ashland, Knox, Richland, Huron, Crawford. Participation is considered for all workers, not just ICL participants.			ICL participants, trade partners, and fixed price contractors	No more information found in the document!	Monthly from construction start to completion dates	Individuals that bill time against the project must live (as defined by their W-2's) in one of the following Ohio Counties: Ashland, Ashtabula, Carroll, Columbiana, Coshocton, Crawford, Cuyahoga, Geauga, Guernsey, Harrison, Holmes, Huron, Jefferson, Knox, Lake, Lorain, Mahoning, Medina, Portage, Richland, Stark, Summit, Trumbull, Tuscarawas and Wayne. Participation is considered for all workers, not just ICL participants.	Currently, all ICL participants, Trade Partners and fixed price contractors are providing monthly data that identifies all employees that have worked on the project the previous month. This information includes total hours worked during the past month, approved labor rates and State residency information. In order to validate the residency requirement, Jim Keesler, from BCG & Company, will spot audit all ICL participants, Trade Partners and fixed price contractors to verify residency	85% or more labor hours local= 14 pts. 84.99% - 82.50% = 13 pts. 82.49% - 80% = 12 pts. 79.99% - 77.50% = 11 pts. 77.49% - 75% = 10 pts. 74.99% - 74 % = 9 pts. 73.99% - 73% = 8 pts 72.99% - 72% = 7 pts 71.99% - 71% = 6 pts
	85% or more labor hours	14							
	75% - 84 % or more labor hours	10-13							
	71% - 74% labor hours	5-9							
	Fail - less than 70% labor hours	0							
TOTAL (Max Points= 14)			14						
C ENERGY EFFICIENCY		JOHN		ENGINEERS	INDUSTRY BENCHMARK	AT CD (CONSTRUCTION DOCUMENTS) STAGE			

1

		Total Possible Points	Projected Points	Person Responsible	Standard	Data Collection Frequency	Explanation	Documentation	Metric Calculation
Goal:	Achieve top 10% hospital nationally. Based on computer modeling after design is compete and CxA .				The national average of energy consumption, determined by the Energy Department for buildings by market sector.		The national average is determined by the Energy Department in conjunction with various other trade, professional, and technical organizations contributing data for buildings by market sector. The average does not account well for any particular market, age of building, operational systems, or level of maintenance, but averages the utility energy consumed based on the building areas served.	The documentation will rely on the completed and approved energy model submitted to USBGC for LEED certification. Actual energy efficiency can only be accounted for after a year or more of operation. Performance can then be reviewed and adjustments made to the systems as needed.	The LEED credits EAp2 and EAc1 require modeling the proposed systems as described in the issued documents and comparing it to a "Baseline Building" described by ASHRAE 90.1-2007. Completing this analysis is referred to as the energy model. The energy model calculates the energy used to condition the proposed and baseline buildings and compares the annual energy consumed based on building area. The proposed building's annual energy consumption per area will be compared against the national average to
	% Below National average of 280,000 BTU's/SF/Year for Health Care Facilities								
	30% Below = 196,000 BTU's/SF/Year	12							
	20% Below = 224,000 BTU's/SF/Year	6-11							
	10% Below = 252,000 BTU'S/SF/Year	0							
TOTAL (Max Points= 12)			12						
D	TEAM Performance	TRENT		C.O.E & PLT	INTERNAL BENCHMARK	QUARTERLY PULSE CHECK			
Goal:	Highly Effective Team - Team Pulse Check				No more information found in the document!	Monthly from construction start to completion dates	The Pulse Report has been chosen by the PLT to evaluate the overall performance of the Project Team. The purpose of the Pulse Report is to: Detect potential issues within the team. Monitor progress on key metrics. Assess the working climate on the project. The Pulse Report contains (13) close-ended questions to which the respondents can rank their response on a (7) point scale - (1)=Strongly Disagree to (7)= Strongly Agree. The	The Pulse Report is distributed and evaluated on a monthly basis. Each month, the PLT tallies the survey results by completing a spreadsheet that summarizes the respondents scoring of (5) and higher for each question. All (13) scores are averaged to come up with a monthly Pulse Survey score. Thepoint allocation for this metric will be the average cumulative score for all the Pulse Surveys conducted. At project completion, the scoring spreadsheet and copy of each Pulse Survey will be provided for the documentation of this	12 Points = Cumulative Average Score of 90% and higher 11 Points = Cumulative Average Score of 89% to 89.9% 10 Points =Cumulative Average Score of 88% to 88.9% 9 Points = Cumulative Average Score of 87% to 87.9% 8 Points = Cumulative Average Score of 86% to 86.9% 6 Points = Cumulative Average Score of 85% to 85.9% 0 Points = Cumulative Average Score of 84.9% and lower.
	90% or higher - Agree	12							
	85%-89%- Agree	6-11							
	84% or less - Agree	0							
	Scale Agree, Neutral, Disagree								
TOTAL (Max Points= 12)			12						
E	SCHEDULE	PAT		CONTRACTOR	INTERNAL BENCHMARK	MONTHLY/ PULSE CHECK			
Goal:	Turn-Over Building for Owner Move-In - (50) Calendar Days Sooner than (24) Month Schedule				No more information found in the document!	Monthly from construction start to completion dates	A 24 month Construction Schedule (Start of Construction = 4/15/13) provides 731 calendar days to attain a 4/15/15 Substantial Completion date. Substantial Completion day improvement will be measured against the Metric Calculation below.		(50) Calendar Day Improvement 10 points (43-49) Calendar Day Improvement 9 points (36-42) Calendar Day Improvement 8 points (27-35) Calendar Day Improvement 7 points (18-26) Calendar Day Improvement 6 points (14-17) Calendar Day Improvement 5 points (9-13) Calendar Day Improvement 4 points (8) Calendar Day Improvement or less 0 points
	(50) Calendar Days Sooner (7% Improvement)	10							
	(36) Calendar Days Sooner (5% Improvement)	8-9							
	(18) Calendar Days Sooner (2.5% Improvement)	6-7							
	(9) Calendar Days Sooner (1.25% Improvement)	4-5							
	(8) Calendar Days and Less	0							
	Metric Definition:								
	(24) Month Schedule defined as Start of Construction (4/15/13).								
	Team to develop 7% Improved Target Schedule and Develop Plan To Support								
	Calendar Days to include weekends and holidays.								
TOTAL (Max Points= 10)			10						

	Total Possible Points	Projected Points	Person Responsible	Standard	Data Collection Frequency	Explanation	Documentation	Metric Calculation
F QUALITY	TRENT		CONTRACTOR	INTERNAL BENCHMARK	WEEKLY			
Goal: **Want Team Approach to Resolving Project Issues Quickly & Efficiently Through Collaboration**			Mostly Contractor. Prolog is Contractor maintained. Design has some involvement.	No more information found in the document!		This project team is built on the process that through collaboration, decisions can be made at the Last Responsible Moment (LRM) so all appropriate data can be utilized to make the most informed decision. All items requiring a decision are managed through the project's Issues Managment Log (which is housed on ProLog). As an item comes up, it is put on the Issues Management Log and assigned a LRM date. The LRM is the date that a decision is needed to avoid holding up progress. The LRM date ties to progress, not to the date in	Each issue is entered into ProLog, assigned a tracking number and Last Responsible Moment date. When the issue was resolved, the resolved date is entered into ProLog. After inputting this information, ProLog can generate a report that shows the number of issues that fell into the following resolution time frames (based upon the LRM) in the Metric Calculation below. Resolved in (5) Working Days or Less. Resolved in (6-10) Working Days	4 Points = 85% and more of Total Issues are Resolved in (5) Working Days or Less. 3 Points = 85% and more of Total Issues are Resolved in (6-10) Working Days. 2 Points = 85% and more of Total Issues are Resolved in (11-12) Working Days 1 Point = 85% and more of Total Issues are Resolved in (13-15) Working Days. 0 Points = 85% and more of Total Issues are Resolved in (16)
Issues Resolved in (5) Working Days or Less, based upon Last Responsible Moment	4							
Issues Resolved in (6-10) Working Days or Less, based upon Last Responsible Moment	3							
Issues Resolved in (11-15) Working Days or Less, based upon Last Responsible Moment (LRM)	2							
Issues Resolved in (16) Working Days or More, based upon Last Responsible Moment (LRM)	0							
Metric Definition:								
Issues to be tracked in the Project Issues Management Log (ProLog).								
Tracking Date to be based upon Last Responsible Moment (LRM).								
Goal: **Want Project Team To Take Pride In Producing Quality Work**			CONTRACTOR	INTERNAL BENCHMARK	TOWARDS COMPLETION		PUNCH LIST	
			Mostly Contractor. Prolog is Contractor maintained. Design has some involvement.	No more information found in the document!		This project team is built on the premise that through collaboration, proper decision making, and team work, a better quality project will be produced - thus eliminating the need for an extensive traditional punchlisting process. As noted in the Metric Definition above, the project team will declare when an area is ready for the Final Inspection. A Punchlist Inspection Team will be assembled to perform all the punchlist inspections in a consistent methodology per an established protocol. The Punchlist Inspection Team will be	The Punchlist Inspection Team will keep a running tally on the number of Punchlist Items they discover per the Punchlist Protocol. The cumulative number of Punchlist Items on the tally will be used to determine the awarded points based upon the metric calculation below. PLT Directive #1 - Building Turn Over Definition is attached to clarify the level of completion for work in place during the Punchlist Protocol process.	4 Points = 0 to 20 Punchlist Items on the Punchlist Tally 3 Points = 21 to 35 Punchlist Items on the Punchlist Tally 2 Points = 36 to 45 Punchlist Items on the Punchlist Tally 1 Point = 45 to 50 Punchlist Items on the Punchlist Tally 0 Points = 51 and more Punchlist Items on the Punchlist Tally
0 - 20 Punch list Items	4							
21 - 35 Punch list Items	3							
36 - 45 Punch list Items	2							
46 - 50 Punch list Items	1							
51 Punch list Items and Over	0							
Metric Definition:								
Punch list Items are not measured until the project team states an area is ready for Final Inspection (we "dare you" to find something wrong).								
Team will have an opportunity to declare which items are not finished for future Final Inspection.								
Inspections will be allowed to be phased to meet the project requirements and schedule.								
Damage after Final Inspection will not be counted against this metric.								
Warranty Issues will not be counted against this metric.								
Goal: **Want Collaborative Team Approach In Designing & Constructing the Project.**			CONTRACTOR	INTERNAL BENCHMARK	AS IT HAPPENS/ CONTINUOUSLY TRACKED			
Do Not Want Contingency Draws to Fund Work Scope Gaps That Should Have Been Covered Through the Design/Construction Process.			Mostly Contractor. Prolog is Contractor maintained. Design has some involvement.	No more information found in the document!		The purpose of this metric is that if we are working together as a team and collaborating, we should not have a significant number of Major Issues (issues that otherwise cause consternation in traditional delivery methods).	Utilizing the Overall Target Spreadsheet and the Construction Target Cashflow,the PLT will generate a list of issues that could potentially impact this metric. This list will be reviewed and evaluated - with the PLT providing a final directive as to the number of items that fall into the "Major Issue" catagory. The number of Major Issues will translate into the metric calculation below.	4 Points = Project Team has (3) or Less Major Issues. 3 Points = Project Team has (4-6) Major Issues. 2 Points = Project Team has (7-9) Major Issues. 1 Points = Project Team has (10-12) Major Issues. 0 Points = Project Team has (13) or more Major Issues.
0 - 3 Major Issues	4							
4 - 6 Major Issues	3							
7 - 9 Major Issues	2							
10-12 Major Issues	1							
13 Major Issues and Over	0							
Metric Definition:								
Major Issue results that result in a Contingency Draw over $100,000 and/or Schedule Impact (2) Weeks or more.								
Contingency Tracking Graph to be main tracking tool.								

	Total Possible Points	Projected Points	Person Responsible	Standard	Data Collection Frequency	Explanation	Documentation	Metric Calculation
TOTAL (Max Points= 12)		12						
G LEED	JOHN		HKS Green	INDUSTRY BENCHMARK	TWO-STEP SUBMISSION: DESIGN AND CONSTRUCTION REVIEW			
Goal: Achieve LEED Silver certification				LEED (Leadership in Energy and Environmental Design) Certification	Design Review: DD (Design Documents) stage Construction Review: Four months after construction completion. It is contingent on the final submission and results given by USGBC next year.	The CCT project is seeking LEED (Leadership in Energy and Environmental Design) Certification under the LEED 2009 for Healthcare. The project has a goal to achieve LEED Silver.	The submission for LEED certification is being lead by HKS Green, the project has two components as Design submission and a Construction submission. To date the Design submission has been made and the team is in the process of seeking clarification to the response received on 07/30/12. To date the project has received 29 points towards the goal of 50 points to achieve a Silver rating. The point ratings are as follows. Certified: 40-49 Points	The points are evaluated via a submission process to the U.S. Green Building Council (USGBC). The project has chosen a two step submission process first is a Design Review followed by a Construction Review. The Design Review has been completed as indicated above. Once the Construction of the CCT is completed the second submission will be submitted for Construction along with any further clarification on Design credits. The current anticipated points based on the score card that HKS is maintaining are 52 points which would qualify the
Leed Certification								
Silver Certification	6							
Certified	3							
Not Certified	0							
TOTAL (Max Points= 6)		6						

	Total Possible Points	Projected Points	Person Responsible	Standard	Data Collection Frequency	Explanation	Documentation	Metric Calculation
H STAFF AND FAMILY SATISFACTION	MARGE		COE & PLT		DISCRETE EVENTS: WORKSHOP; ENGAGEMENT IN THE CONSTRUCTION PROCESS;			
Goal: **Staff and Family that have been integral to the process and a driving force throughout the project and a team that listens to their input.**				No more information found in the document!	One time, distributed to workshop user and family participants, after all the workshops were completed	To gauge the success of the Workshop Process, surveys were developed for the staff and family representatives who attended warehouse and workshop activities. Two separate surveys were developed due to the involvement level for each of these specific groups. SurveyMonkey was utilized for the online survey process. The surveys were developed with input from the PLT and SET. The COE was responsible for developing the list of participants and distributing the survey to both the Staff and Family team members. Staff survey	For each the Staff Survey and the Family Survey, the following documentation will be provided to validate results. SurveyMonkey Survey Summary identifying number of participants. SurveyMonkey Analyze Results Report identifying response percentages for agree, disagree and no opinion results. Summary Sheet identifying the average results scores for each group.	The survey was distributed one time after all workshops were completed to the User and Family participants. Percentages will be based on the number of surveys received, discarding the "No Opinion" responses from the calculation. The average agreement percentage for each survey question and for each survey group will be calculated individually. The average of the two survey groups will then determine the final point allocation. Point distribution for sliding scale results will be calculated as follows:
Workshop Process								
90% or higher - Agree with the workshop process	6							
80% - 89% - Agree with the workshop process	3-5							
79% or less - Agree with the workshop process	0							
Goal: **Keep the Staff and family engaged and informed throughout construction.**			COE & PLT					
90% or higher - Agree strongly that the teams stayed engaged during the construction project.	6			No more information found in the document!	Four times, distributed to attendees of the Serivce Line Monthly Planning Meetings (ED, ASC, NICU)	To measure engagement of the staff and family members during construction, a design team representative attended monthly meetings and provided ongoing construction updates to the staff participants. Surveys to assess the engagement of the staff were developed with input from the PLT. The survey was distributed at the beginning of the report out session. The Service Line administrative assistant or COE representative was responsible for collecting the surveys and provided the completed forms to the design representative following each	For each survey session, the following documentation will be provided: Survey Analysis Results Report identifying the number of participants and response percentages for agree, disagree and no opinion results. Summary Sheet identifying the average results scores for each survey session. Actual survey forms will be available for validation upon request.	The survey will be distributed four times to attendees of the Service Line Monthly Planning Meetings (ED, ASC and NICU). Percentages will be based on the number of surveys received, discarding the "No Opinion" responses from the calculation. The average agreement percentage for each survey question and for each survey session will be calculated individually. The average of the four surveys will then determine the final point allocation. Point distribution for sliding scale results will be calculated as follows:
80%-89% - Agree strongly that the teams stayed engaged during the construction project.	3-5							
79% or less - Agree strongly that the teams stayed engaged during the construction project.	0							
Goal: **Post Construction Survey refer to the Guiding Principals, or more dept specific.**			COE & PLT					
Post Construction Survey refer to the Guiding Principals, or more dept specific. 1. Physical environment speeds up recovery. 2. Physical environment improves effectiveness of treatment. 3. Patients believe environment improves the sense of "wellness". 4. Physical environment improves the sense of "wellness." 5. Natural light promotes "wellness". 6. External views promote the Children's Hospital X campus. 7. Way finding is well defined and easy to understand. 8. Color schemes are warm, welcoming and appropriate for Children's Hospital X. 9. Landscaping aid to the building design. Scale will be Strong Agree to Strongly Disagree. Based Surveys on Hospital Design, Michael Moxam Scoring				No more information found in the document!	One time, distributed to workshop staff and family participants, two months after the building was occupied	To determine the overall impact of the facility, a post occupancy survey will be conducted with the staff and the family members who participated in the Workshops. Separate surveys for ED, ASC, NROD and NICU staff and family members were developed to address the specific objectives for each department. SurveyMonkey was utilized for the online survey process. Separate surveys for each department were developed with assistance of the Service Line Leadership and respective COE representative, reviewed by the Success Metrics Evaluation Committee and approved by the PLT. The COE was responsible for developing the list of participants and distributing the survey to both the Staff and Family team members who were involved at the workshops.	For each Service Line Staff Survey and Family Survey, the following documentation will be provided to validate results: SurveyMonkey Survey Summary identifying the number of participants. SurveyMonkey Analyze Results Report identifying response percentages from strongly disagree (SD) to strongly agree (SA). Summary Sheet identifying the average result scores for each group.	The survey was distributed one time, two months after the building was occupied for use by patients and families. The survey was distributed to both Workshop staff and family participants. Percentages will be based on the number of surveys received. Each question (item) will be evaluated on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree). Each survey will be calculated with the mean for each item response. The mean averages for the overall survey will be calculated for each survey type and summarized for evaluation. Only the percentage of responses that provide a score of 5 or above will be counted as agreed. The overall mean average for all surveys will determine the final point allocation. Point distribution for results will be calculated as follows: 90.00 agreement rate and above = 4 points 85.00 to 89.99 agreement rate = 3 points
90% or higher Agree	4							
80%-89% Agree	2-3							
79% or less Agree	0							
Metric Definition:								
Percentages will be based on the number of surveys received, discarding the "No opinion" responses from the calculation.								
Survey questions will be developed by the PLT and submitted to the SET for approval.								
TOTAL (Max Points = 16)		16						
TOTAL (Max Points= 100)	100	100						
Unavailable Points		0						

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APPENDIX H

ENCLOSURE AND INTERIOR DESIGN INNOVATION LOGS

Enclosure Design Innovation Log (12/17/2014)

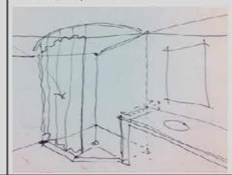
A3 #	Date Idea Added	Champion	System	Function	Description	In pull plan?	Status	Estimated Cost Savings	A3 Approved or Closed? Or Design Iteration Accepted?	Reflected in Current Estimate	Comments	COST	VALUE	NOTES
EX102	11/12/12	Mark Ohlinger	Curtain wall	Weather barrier	Consider alternative glass selection	Yes	closed	$0	Yes	Yes	PLT has agreed to use of higher performing glass, final cost still to be determined	—	↑	The glass selection didn't increase cost; however the value is increased since it helped with better natural lighting in the building while controlling for heat and glare.
EX103.1	04/04/13	Mike Mamer	Metal Panels	Weather Barrier	Metal Panel system selection.	No	closed	-$150,000	No	No	After considering insulation choices it was decided that all metal panel on the project would be architectural composite metal panel with 3" of mineral wool where required.			Rejected and Never Happened
EX105	11/12/12	Mike Mamer	Façade lighting	Illuminate enclosure	Façade integrated lighting	No	Closed	-	No	No	includes premium for clear mullion cap, consider reduction in scope. Initial cost $439,730 (see 105.2 for final decision)	↑	↑	Façade integrated lightings increased cost and value by enhancing the design aesthetically
EX105.1	02/21/13	Norio Tsuchiya	Façade lighting	Illuminate enclosure	Façade integrated lighting - cost reduction	yes	Rejected	$0	Yes	Yes	This price reflects color changing, less expensive fixture			Rejected and Never Happened
EX105.2	04/02/13	Norio Tsuchiya	Façade lighting	Illuminate enclosure	Façade integrated lighting	yes	closed		Yes	Yes		↑	↑	Façade integrated lightings increased cost and value by enhancing the design aesthetically
EX106B	12/03/12	Ramon Cavazos	Green Roof	Provide attractive roof/ enhance patient views from hospital	Eliminate the green roof over the lobby & connector/Provide decorative precast pavers	No	closed	-$59,875	Yes	Yes	PLT has agreed to eliminate green roof, need revised estimate for ballast roof	↓	↓	By eliminating green roof and decreasing cost, the value is reduced, however, the roof has the system to accommodate green roof in future
EX107	11/15/12	Norio Tsuchiya	Misc Enclosure	Streamline site access to building	Options for providing required stair at northeast corner of the building	No	closed	-	No	No	This has been moved from the value add log since this stair is required for exiting. Cost to add elevator/stair/vest. $367,530 (closed with EX107.2)			Rejected and Never Happened
EX107.1	01/18/13	Mike Mamer	Enclosure	Streamline egress and future site access to building	Options for providing required stair at northeast corner of the building	No	closed	-	No	No	This has been created to provide options mentioned above in EX107. This pricing for Option #1. Option #2 is - $57,000 (closed with EX107.2)			Rejected and Never Happened
EX107.2	02/13/13	Norio Tsuchiya	Enclosure	Ingress / Egress / Stair	Options to remove stair if project savings can be achieved	No	closed	-$79,000	Yes	Yes	This has been created to provide options without a stair at this location.	↓	—	The egress stair was eliminated and cost was reduced but value didn't change since code requirements for egress have been met by changing design of other stairwells
EX108	12/03/12	Mike Mamer	Canopies	Weather barrier at entrances	Remove 1 bay of main entry canopy to make it 4 bays in lieu of 5	No	closed	-$132,698	Yes	Yes	Base on a 32' Deep Canopy	↓	—	Reducing cost by reducing the canopy by 1 bay; value didn't change since it didn't affect the coverage
EX108	12/03/12	Mike Mamer	Canopies	Weather barrier at entrances	Remove 1 bay of ED walk-in entry canopy to make it 5 bays in lieu of 4.	No	closed	-$124,993	Yes	Yes	Based on a 32' Deep Canpy	↓	—	Reducing cost by reducing the canopy by 1 bay; value didn't change since it didn't affect the coverage
EX109	11/20/12	Norio Tsuchiya	Enclosure	Weather barrier	Window Size/Design Study	Yes	closed	-$31,792	Yes	Yes	Option 2 is approved by PLT	↓	—	Reducing cost by reducing the amount of spandrel glass; value didn't change since it didn't affect the size of window aperture, natural lighting or view to outdoors
EX110	01/09/13	Norio Tsuchiya	Curtain wall	Façade articulation	Deep fin/mullion cap study	No	closed	-$65,000	No	No	Cost savings now can only be achieved through a thinner/shallower mullion as lights will need to be mounted in something. Design has been finalized - verify with UA any deviation from estimated cost			Rejected and Never Happened
EX111	01/09/13	Norio Tsuchiya	Canopies	Weather barrier at entrances	Reduce canopy depth at main entry to single lane coverage (6' reduction to 26')	No	closed	-$68,000	Yes	Yes	This is based on the 4 Bay East Canopy and can be in addition to EX108			Rejected and Never Happened
EX112	11/12/12	Mike Mamer	Enclosure	Enclosed area at penthouse	Review extent of enclosed core area at penthouse	Yes	closed	-$399,199	Yes	Yes	Accepted. MMR has been located at Level 0 and penthouse has been reduced to elevator/stair	↓	—	Reducing cost by reducing penthouse; value didn't change since most of the mechanical systems were moved to level 0
EX113	11/12/12	Mike Mamer	Enclosure	Enclosed area at rooftop stair	Review extent of enclosed area at rooftop stair	No	closed	TBD	No	No	Proposed design an add			Rejected and Never Happened
EX114	11/13/12	Mike Mamer	Canopies	Weather barrier at entrances	Consider prefabrication of exterior canopies	No	closed	TBD	No	No	Not economically viable and will not meet design intent			Rejected and Never Happened
EX115	12/19/12	Ramon Cavazos	Canopies	Provide "warm" material to enhance patient arrival experience	East & West Canopy: Current Soffit Material is wood grain Trespa. Consider plaster	No	closed	-$144,000	Yes	Yes	PLT has approved alternate material but would like to add Trespa as separate value add for each location	↓	↓	Reducing cost by eliminating wood grain Trespa panel and using painted portland cement plaster; value is also reduced by undermining the design aesthetic
EX116	01/09/13	Ramon Cavazos	Enclosure	Access to existing building	Reduce length of connector to existing building at Level 1 short of revolving door	No	closed	-$18,906	Yes	Yes	PLT has approved this A3 but pricing is required	↓	—	Reducing cost by reducing length of connector to existing building at Level 1; value didn't change
EX117	01/09/13	Ramon Cavazos	Enclosure	Access to existing building	Reduce length of public connector to existing building at Level 3	No	Rejected	—	Yes	No	PLT rejected proposed reduction, connector to remain all 3 bays at Centennial. Value of Deduct was $155,000.			Rejected and Never Happened
EX118	01/09/13	Ramon Cavazos	Enclosure	Access to existing building	Reduce overal width of connector to existing building and maintain required 8'-0" clear between columns	No	closed	-$22,000	Yes	Yes	PLT has requested that the Level 1 portion of the connector be mocked up for users before making a decision	↓	—	Reducing cost by reducing overall width of connector to existing building; value didn't change by maintaining required 8'-0" clear between columns
EX119	01/09/13	Ramon Cavazos	Connectors	Provide clean finish at underside of connectors/ bridges	Use plaster soffits in lieu of metal panel at connectors and bridges	No	closed	-$46,540	Yes	Yes	PLT has agreed to revise material, consider EIFS	↓	↓	Reducing cost by eliminating metal panel and using plaster soffits; value is also reduced by undermining the design aesthetic
EX120	01/09/13	Mike Mamer	Building maint.	Provide alternate building maintenance	Consider eliminating davits for building maintenance	No	closed	TBD	No	No	The extent of required davits was issued with the permit package, any deviation from the allowance needs to be confirmed by W/B			Rejected and Never Happened
EX121	01/09/13	Norio Tsuchiya	Enclosure	Remove need for special formwork/Standardize interior spaces	Eliminate "bump out" of curtain wall at patient rooms and move into plane of brick	No	closed	$0	Yes	Yes		↓	—	Reducing cost by eliminating "bump out" of curtain wall at patient rooms; value didn't change because it didn't reduce the size of patient rooms
EX122	01/09/13	Norio Tsuchiya	Misc Enclosure	Façade articulation	Lower "eye brows" over main lobby and elevator lobby so that they are not floating	No	closed	-$55,550	Yes	Yes		↓	—	Reducing cost by lowering "eye brows" over main lobby; value didn't change since it didn't affect the design aesthetic
EX123	01/09/13	Mike Mamer	Roof	Provide optimal roof design	Roof Design Study	Yes	closed	TBD	No	No	Direction from the PLT was to provide modified bit roof at high roof and stairs. Lower roofs to be single ply	—	—	Roof design with no change in cost or value
EX124	01/09/13	Mike Mamer	Masonry	Aesthetic/weather barrier	Replace cast stone coping with prefinished metal	No	closed	-$24,300	Yes	Yes		↓	—	Reducing cost by replacing cast stone coping with prefinished metal; value didn't change because it didn't affect design aesthetic, functionality or maintenance
EX125	01/09/13	Norio Tsuchiya	Misc Enclosure	Façade articulation	Eliminate covered overhang at elevator penthouse	No	closed	-$106,599	Yes	Yes	Revised overhang and west façade per Enclosure Team design.	↓	↓	Reducing cost by eliminating covered overhang at elevator penthouse; value is also reduced by reducing the amount of coverage on roof
EX126	01/09/13	Norio Tsuchiya	Structure/Interiors	Patient experience and Level 1-3 access	Eliminate monumental stair at lobby	No	Rejected	—	Yes	No	PLT has elected to keep the monumental stair in the project. Monumental Stair Allowance was $300,000.			Rejected and Never Happened
EX127	01/09/13	Norio Tsuchiya	Curtain wall	Weather Barrier	Curtain wall reduction strategy	No	Closed	-$57,000	Yes	Yes	Reduce lenth by 24' on the south side, 32' on the north side of the west alcove, reduce one light from the south stair tower. Total 2,293 sf (5.6% reduction in area)	↓	—	Reducing cost by curtain wall reduction strategy; value didn't change because they provided enough openings to capture natural lighting and views
EX128	01/23/13	Ramon Cavazos	Enclosure	Design feature	Move Meditation Room to interior of building and reduce enclosure	No	closed	TBD	No	No	Not feasible, not desired. Design has been approved.			Rejected and Never Happened
EX129	01/23/13	Jake Gaddis	Curtain wall	Façade articulation	Review custom dies to possibly eliminate them	No	closed	TBD	No	No	UA to use their standard system - custom dies will be required for deep fins to hold façade lighting			Rejected and Never Happened
EX130	01/23/13	Jake Gaddis	Curtain wall	CW connection	Review edge of slab embed detail for alternate connection methods	No	closed	TBD	No	No	UA to use standard system - details have been issued with permit package and trade partner package			Rejected and Never Happened
EX131	01/23/13	Jake Gaddis	Curtain wall	CW support	Review curtain wall to reduce amount of steel reinforcement	No	closed	TBD	No	No	UA has had curtain wall engineered - drawings and calculations have optimized the design and have been issued			Rejected and Never Happened

EX132	01/23/13	Jake Gadda	Curtain wall	Low-E not required on spandrel but maintain appearance with vision	Remove Low-E coating from spandrel glass	No	Rejected	-	Yes	Yes	The PLT agreed to not accept this cost savings and keep low-E coating on spandrel, cost savings associated was $18,000			Rejected and Never Happened
EX133	01/23/13	Jake Gadda	Curtain wall	Back pan not necessary with foil barrier	Use foil-tape vapor barrier in lieu of galvanized steel back pan	Yes	closed	-$66,000	Yes	Yes	Incorporated in 3/22/13 Report out	↓	—	Reducing cost by using foil-tape vapor barrier in lieu of galvanized steel back pan; value didn't change because it didn't affect design aesthetic functionality or maintenance
none	11/19/12	Tom Haginbotham	Curtain wall	Sunshade	Exterior sunshading shading facade elements	No	closed	-$350,000	Yes	Yes	Remove all from budget - not currently shown in model	↓	↓	Reducing cost and value by eliminating exterior sunshading
EX134	02/06/13	Jake Gadda	Curtain wall	Building Enclosure	Curtain wall system decision	No	closed	-	Yes	Yes				Rejected and Never Happened
EX135	02/06/13	Ramon Cavazos	Structure	Reduce steel required for bridge span	Additional columns to support deck bridge mid span	No	closed	TBD	No	No	The bridge was shortened by bringing the southernmost brick wall over - further reducing the span by adding columns would not result in a significant decrease in the steel design			Rejected and Never Happened
EX136	02/06/13	Mike Mamer	Enclosure	Reduce labor for masonry backup	Metal panel system substrate at brick	No	closed	TBD	No	No	See EX144			Rejected and Never Happened
EX137	02/20/13	Norio Tsuchiya	Enclosure/ Elevator	Optimal machine room location and access configuration	Elevator machine room location	No	Closed	-	Yes	No	Potential cost savings of $17,000 but may be a wash	↓	—	Reducing cost by changing the elevator machine room location, value didn't change because it was just a change of location
EX138	02/25/13	Norio Tsuchiya	Architecture Structure MEP Cost	Building Enclosure, Structure, Systems	Remove 1' floor to floor dimension from floors 4, 5, 6 +7 each without affecting the ceiling heights in each floor.	NO	Rejected	-	Yes	No				Rejected and Never Happened
EX139	03/05/13	Mike Mamer	Enclosure	Enclosure	Huddle path forward A3		Closed							Rejected and Never Happened
EX140	04/26/13	Mike Mamer	Architecture Structure MEP Cost	Building Enclosure, Structure, Systems	Interface with Existing Atrium	NO	Closed		No	No		↓	—	Connector design with cost reduction but keeping same value
EX141	04/26/13	Mike Mamer	Architecture Structure Cost	Building Enclosure, Structure,	Waterproofing design and detailing	NO	Closed		No	No				Rejected and Never Happened
EX142	05/16/13	Mike Mamer	Architecture, MEP	Enclosure, Plumbing	Sheet drain Bridge roof in lieu of providing roof drains	NO	Closed		Yes	No	Approx $4,200 savings will be reflected in MEP innovation team estimate	↓	—	Reducing cost by having sheet drain Bridge roof in lieu of providing roof drains, value didn't change because it has no disadvantages
EX143	05/16/13	Mike Mamer	Architecture, MEP, Structure	Building Enclosure, Structure, Systems	Define preferred Connector Separation at Existing Hospital	NO	Closed	$6,265	Yes	No		—	—	Connector design with no change in cost or value
EX144	06/06/13	Mike Mamer	Enclosure	Enclosure	Determine Masonry Cavity Wall Backup System	NO	Closed		yes	No	Would have caused a net add of approximately $55,000 if alternate insulation system was selected			Rejected and Never Happened
EX145	06/10/13	Mike Mamer	Enclosure	Enclosure	Evaluate alternative insulation system for use at field of metal panel wall / area	NO	Closed	$107,230	No	No		↓	—	Reducing cost by using alternative insulation system for use at field of metal panel wall / area, value didn't change because it has no disadvantages
EX146	06/12/13	Mike Mamer	Enclosure	Enclosure	Determine Preferred Helipad Size	Yes	Closed	$9,500	Yes	No		↑	↑	Increasing cost by increasing Helipad Size; value is increased by accommodating bigger helicopters and allowing future flexbibes
							TOTAL =	$ (2,091,517)						

Interior Design Innovation Log (12/17/2014)

A3 #	Date Idea Added	Champion	System	Function	Description	In pull plan?	Status	Estimated Cost Savings	A3 Approved or Closed? Or Design Iteration Accepted?	Reflected in Current Estimate	Comments	COST	VALUE	NOTES
	12/03/12	Andrea Sponsel	Finishes	Privacy Curtains	Delete Privacy Curtains from all ED Exam Rooms and Pre-Op Rooms (dependant upon style of door selected for these rooms)	No	Closed	**-$11,501**	Yes	Yes	Curtains were deleted from Pre-Op, but will not be deleted from ED	↓	—	Reducing cost by deleting curtains from Per-Op; value didn't change since having doors for theses spaces provided optimal privacy.
	12/03/12	Scott Radcliff	MEP	Handwashing Sinks	Remove handwashing sinks from Pre-Op Rooms and replace with code minimum in the corridors	No	Closed	$0	Yes	Yes	Pre Op Rooms have doors, code requires a sink in every room			Rejected and Never Happened
	12/03/12	Andrea Sponsel	Finishes	Handrail System	Remove all handrails (corridors)	No	Closed	$0	Yes	Yes	Need to Do more research 100,000 Allowance in Estimate along with 300,000 Monumental Stair in Enclosure	↓	—	Handrails weren't removed from all corridors and just got removed from the corridors that didn't need. Cost reduced but value didn't change since it didn't affect safety.
	12/03/12	Andrea Sponsel	Millwork	Reception Desk	Define Nurse Station and Reception Station Allowance	No	Closed	??	Yes	Yes	Captured on 12-14-12			Just for Clarification, Not a design innovation
	12/03/12	Andrea Sponsel	Finishes	Painting	Define Elevator Finishes (Do not paint elevator doors and frames)	No	Closed	-$12,000	Rejected	No	To remain brushed stainless to match garage. Stainless is base bid			Rejected and Never Happened
	12/03/12	Andrea Sponsel	Finishes		Define Lobby Finish Allowance	No	Closed	$0	No	No	Captured on 12-14-12			Just for Clarification, Not a design innovation
IN303	12/03/12	Andrea Sponsel	Finishes	Writing Surface	Revise Marker Boards to Marker Board Paint or Marker Board Wallcoverings (Wall Talker)	Yes	Closed	-$27,200	Yes	No	Paint SF Cost is $9.00/SF at 1400 SF Currently - Markerboards are apart of FF&E. Decision to be all wall-hung markerboards, and those will live in construction budget. Need to move money from			Rejected and Never Happened
IN300	12/03/12	Andrea Sponsel	Finishes	Elevator Cab	Use Standard Wall and Ceiling Finishes in Public Elevator Cabs	Yes	Closed	-$30,000	Yes	No	Currently in Estimate Upgraded Finish Allowance at $20,000 per cab for 3 cabs. Design to be plastic laminate with glass accent panel per A3 approval. Otis to revise estimate	↓	↑	Reducing cost while adding value by providing upgraded finishes
	12/04/13	Scott Radcliff	Doors		Change doors in Pre-Op Rooms to 4'-0" doors for remaining (Revised Statement) - 10 Doors Total	No	Closed	-$22,500	Rejected	No	Team recommendation from workshop #8. (1/16/2012)			Rejected and Never Happened
	12/04/13	Scott Radcliff	Doors		Eliminate doors in PACU Rooms (18 Each)	No	Closed	-$95,400	Yes	Yes	Team recommendation from workshop #8.(1/16/2012)	↓	↓	Reducing cost by deleting doors in PACU rooms while reducing value because of higher level of noise for patients
	12/04/13	Scott Radcliff	Doors		Change Telescopic Doors to 4+2 in ED	No	Closed	-$46,800	Rejected	No	Do not pursue			Rejected and Never Happened
	12/04/13	Scott Radcliff	Doors		Replace sliding OR doors with 4+2 (6 Each)	No	Closed	-$75,000	Yes	Yes	Team recommendation from 12/2012 (1/16/2012)	↓	—	Reducing cost; value didn't change since replaced doors maintained the same functionality.
	12/04/13	Scott Radcliff	Doors		Verify Door Hardware	No	Closed	$0	No	No	In Progress with Greg Poe estiamte to be updated 1/30/2012 (1/16/2012)			Just for Clarification, Not a design innovation
IN308	12/03/12	Becky Baumer	Finishes		Reduce Lower Level finishes	No	Pending	-$6,000	No	No	Marge to confirm Hospital standards with Cliff.			Rejected and Never Happened
	12/04/13	Scott Radcliff	Casework		Reduce Casework/Millwork Unit Cost and Verify Quantity	No	Closed	-$772,460	Yes	Yes	Confirm baseline quantity on plans with casework costs. (1/16/2012) Quantity from 2,942 LF @$380 on 12-13-12 to 1382 LF @$250 on 1-10-13			Just for Clarification, Not a design innovation
	12/04/13	Scott Radcliff	Ceilings		Reduce Lineal Feet of Gypsum Furrdown over Upper Casework	No	Closed	$0	Yes	Yes	Confirm baseline quantity on plans with casework costs. (1/16/2012)	—	↑	With no change in cost, value increased because of faster and easier construction and increased future flexibility.
	12/04/13	Scott Radcliff	PTS	Delivery System	Reduce Quantity of Pneumatic Tube Stations From $671,000 to $535,714	No	Closed	-$135,286	Yes	Yes	Refer to E-mails from Becky 1/4 & Scott 1/7 .... Welty to update indicate cost savings over original estiamte (1/16/2013)	↓	—	Reducing cost; value didn't change since there is still one pneumatic tube in each station.
	01/04/13	Scott Radcliff	Walls		Replace Concrete Block with Abuse Resistant Drywall in Lower Level	No	Closed	$0	No	No	Current Estimate Reflects this			Rejected and Never Happened
X	01/04/13	Rachel Saucier			Shell 7th Floor Conference Room @ 944 SF	No	Closed	-$29,618	Rejected	No	Ceilings at $4, Painting at $1, Flooring at 4.5, Walls at100LF			Rejected and Never Happened
X	01/10/12	Rachel Saucier			Shell 7th Floor On-Call, Lockers and Corridor @ 1,905	No	Closed	-$43,678	Rejected	No	Ceilings at $4, Painting at $1, Flooring at 4.5, No Walls, Lockers, Doors			Rejected and Never Happened
X	01/10/12	Rachel Saucier			Shell 7 beds on 7th Floor @2,344	No	Closed	-$121,968	Rejected	No	Ceilings at $4, Painting at $1, Flooring at 4.5, Walls at100LF, Toilet Rooms at 8,000 Each, Doors 4+2 @3500			Rejected and Never Happened

	01/10/12	Rachel Saucier			Do not equip or furnish 7 beds on 7th Floor	No	Closed	$0	No	No	Furnish and Equip do not affect interiors estimate			Rejected and Never Happened
X	01/10/12	Rachel Saucier			Shell Milk Lab on 6th Floor	No	Closed	-$16,980	Rejected	No	Ceilings at $4, Painting at $1, Flooring at 4.5, No Walls, 7 Doors			Rejected and Never Happened
IN305	01/04/13	Becky Baumer	Finishes	Flooring	Change Terrazzo Flooring to Terrazzo Tile or Carpet in Lobby	Yes	Pending	-$100,000	No	No	Verify Baseline Terrazzo Costs (1/16/2013)			Rejected and Never Happened
X	01/04/13				Remove Monumental Stair (Reduce Railing and Finishes)	No	Closed	$0	Rejected	No	Per Enclosure			Rejected and Never Happened
X	01/04/13	Scott Radcliff	Specialty	Accessories	Reduce Toilet Accessories Allowance (Define Spec)	No	Clarify	$0	No	No	Need more Detail			Just for Clarification, Not a design innovation
X	01/04/13	Scott Radcliff	Casework/ Finishes		Shell 4 Pre Op and 4 PACU rooms	No	Closed	$0	No	No	Per PLT and E-mail from Doug Dulin (1/3/2013)			Rejected and Never Happened
X	01/04/13	Marge Z	Casework		Eliminate Nurse Servers/Pass Thrus in ED (29 Ea @ $2,175)	No	Closed	-$63,075	Yes	Yes	Accepted	↓	—	Reducing cost; value didn't change because of maintained functionality.
X	01/04/13	Rachel Saucier	Casework		Eliminate Nurse Servers/Pass Thrus in NICU (35 @ 2175)	No	Closed	-$76,125	Yes	Yes	Added to Base 1-14-13	↓	—	Reducing cost; value didn't change because of maintained functionality.
IN400	01/04/13	Scott Radcliff/ Rachel Saucier	Walls		Reduce the number of walls that go full height to deck	No	Closed	ACP to add cost	No	No	Drawing in progress (1/16/2013) (Kale)Wall types that are to be partial ht should be their own wall type, review with KHSS for clarity NICU Bathroom walls not to go to deck			Rejected and Never Happened
IN407	11/23/12	Kale Wisnia/Keith Stillman	Walls/Casework		Optimize Charting Stations for Production	No	Closed		Yes	Yes		↓	↑	Reducing cost while adding value because of better accommodation of frameless windows for enhance patient visibility
IN402.01	11/23/12	Kale Wisnia/Keith Stillman	Walls		Quiet Rock, sound break - reduction in material thickness to achieve STC	No	Pending		No	No	for asymetrical walls (3 layers total) replace two layers of drywall on one side with one layer of QuietRock possibly 1/2". Must be confirmed by acoustition or Design team where it could take the place of standard acoustic design.			Rejected and Never Happened
IN404	01/09/13	Keith Stillman	Walls/Casework		Surface Mounted Backing for Millwork	No	Pending		No	No	Mike to provide ROM of in-wall backing costs 1/18, confirm and review with Reserve			Rejected and Never Happened
IN405	01/09/13	Keith Stillman	Ceilings		Optimize Ceiling and Soffit Design for Production	Yes	Closed	-$60,000	Yes	Yes	Walk thru details and panel max parameters with HKS - KS 1/25	↓	—	Reducing cost; value didn't change because it was just changes in dimension but maintaining same functionality.
IN406	01/09/13	Rob Walter/Keith	Walls		Inc Typ Wall Size to Allow Constructible Tolerances of Pipes Sleeves	No	Pending		No	No	ILPD team not on board. Closed 3/12			Rejected and Never Happened
X	11/23/13	Tim Sample/Keith Stillman/Kale Wisnia	Ceilings		Review and reduction in costly ceiling design. (Yellow vs White ceiling areas - review with interiors team) - simple ~ standard ceiling elevation	Yes	Approved	-$100,000	Yes	Yes	receive RCP design intent drawings - No A3 needed currently - Iterative process to achieve TVD - Then ID areas for further reduction and analyze via A3 if req.	↓	↓	Reducing cost while reducing value because of undermining the design aesthetic.
X	01/07/13	Keith Stillman	Walls & Ceilings		Optimize areas of partial ht walls to run grid continuous	No	Pending		No	No	Closed. Approved reduction of bathroom wall heights by PLT	↓	—	Reducing cost; value didn't change because of maintained functionality and accounting for acoustic in a different way.
X	01/07/13	Kale Wisnia/Keith Stillman	Walls		Standardize height for all partial ht walls	No	Closed		Yes	Yes				Rejected and Never Happened
X	01/07/13	Kale Wisnia/Keith Stillman	Walls		Eliminate low walls and incorp into millwork or furniture pkgs	No	Closed	$0	Yes	Yes	partial height walls to be Gyp.			Rejected and Never Happened
X	01/21/13	Andrea Sponsel			Shell Gift Shop on 3rd Floor	No	Closed		Rejected	Yes	Rejected/Not an option to consider via project leadership			Rejected and Never Happened
	01/21/13	Kale Wisnia/Keith	Walls	Blocking	Metal strapping vs. wood blocking	No	Pending		No	No				Production item; Not a design innovation
IN308	01/21/13	Andrea Sponsel	Finishes	Wall Finish	Primer coat of paint only at Mechanical Rooms	No	Pending		No	No	incorporated into IN308			Rejected and Never Happened
X	01/22/13	Andrea Sponsel	Finishes	Wall Base	Vinyl cove base in lieu of rubber cove base	No	Closed		Rejected	Yes	A3 is complete, but not offering to PLT yet. ILPD team rejected this idea for durability considerations			Rejected and Never Happened
X	01/22/13	Andrea Sponsel	Finishes	Finishes	**Delete all Porcelain Tile in Public Restrooms/Family Toilets – should be revised to Vinyl Tile on 6 & 7**	No	Closed	-$4,589	Yes	Yes	Leadership did not want tile/grout for cleanability	↓	↑	Reducing cost while adding value because of increased cleanability.
X	01/22/13	Andrea Sponsel	Finishes	Finishes	**Delete all Porcelain Tile in Patient Room Restrooms – should be revised to Sheet Vinyl**	No	Closed	-$47,424	Yes	Yes	Leadership did not want tile/grout for cleanability	↓	↑	Reducing cost while adding value because of increased cleanability.
X	01/22/13	Andrea Sponsel	Finishes	Finishes	**Delete Porcelain Tile floors and Ceramic Tile walls in Showers – should be revised to shower unit**	No	Closed	$0	Yes	Yes	Leadership did not want tile/grout for cleanability	—	↑	No changes in cost while adding value because of increased cleanability.
X	01/22/13	Andrea Sponsel	Finishes	Finishes	**Delete Rubber Floor in ORs and Supplies/Meds Sterile Core – should be revised to Sheet Vinyl (note: this is the only space that should have integral cove base)**	No	Closed	-$11,036	Yes	Yes	Design interation	↓	—	Reducing cost, value didn't change because of maintained functionality.
X	01/25/13	Jon White			Move Meditation Space from current location to shell space area	No	Closed		No	No	Note from Interior Design Team. This should be on the Enclosure team's log. Finish out of space would be the same in current location or in another location in the building			Rejected and Never Happened
X	01/25/13	Keith Stillman	Ceilings		Reduce Quantity of soffit in NICU patient rooms	No	Closed	-$75,000	Yes	Yes	Accepted - We will only have a bulkhead at the footwall, 8'-8" ceilings and window detail	↓	—	Reducing cost, value didn't change because it didn't affect patient care.
X	01/25/13	Keith Stillman	Ceilings		Reduce Ceiling NRC ratings in PACU	No	Closed		Yes	No	PACU rooms and PACU core	↓	↓	Reducing cost while reducing value because of reduced acoustical control

X	01/25/13	Kale Wisnia/Keith Stillman	Walls		Remove Shower Enclosure wall and lower counter wall to 6" Above sink counter or below to allow counter material to lap over low wall. See sketch	No	Closed	-$18,492	No	No	Add curtain. Deduct Solid Surface +/- 20,000. Needs to be reviewed with NICU design/planning team - NICU design team does not want to persue this item 			Rejected and Never Happened
X	01/25/13	Kale Wisnia/Keith Stillman	Walls		Change Level 0 rated walls to partial height with rated lid in lieu of full height partition	No	Closed			No	Design iteration			Production item; Not a design innovation
X	02/13/13	Keith Stillman	Ceilings		Alternative wood look ceiling tiles for the Main Lobby	Yes	Closed		Yes	Yes	Keith to give options to Becky and Andrea. Will proceed with Techstyle ceiling selection.	↓	↓	lower quality product
X	02/13/13	Jon White	Glass		Reduce Firelite glass at Pre-Op and PACU and use standard glass and sprinkler system	Yes	Closed		Yes	Yes	Design Interation. Reflected in current estimate. 5-1/2013	↓	—	Reducing cost; value didn't change because of maintained fire system functionality.
X	02/26/13	Scott Radcliff	Doors		Solid wood doors in lieu of Frosted Glass Doors in Pre Op	Yes	Closed	-$850	No	No	ILPD decided to no pursue this cost reduction based on the minimal delta, and user preferences.			Rejected and Never Happened
X	03/07/13	Marge Z	Doors	Hardware Install	Hardware on wood doors to be factory installed	No	Pending				MOVE TO PRODUCTION INNOVATION TEAM: Estimate from Viacon, after door schedule is confirmed			Production item; Not a design innovation
IN308	03/07/13	Becky	Finishes		Sealed Concrete flooring only at Mechanical Rooms	No	Pending				Becky to get "hospital standard" from Cliff			Rejected and Never Happened
IN304	03/07/13	Becky	Finishes		2" corner guard in lieu of 3"	Yes	Closed	-$50,000	Yes	Yes	Estimate changed 5-1-2013. Further verification at end of implementation documents	↓	—	Reducing cost; value didn't change because of maintained level of required protection.
	03/12/13	Mike Everett	Finishes	Corner Guards	Pre-cut/pre-fab corner guards before arriving on site. What is most efficient height	Yes	Pending				Mike to explore factory options			Production item; Not a design innovation
IN304	03/07/13	Becky	Finishes		Most efficient use of wall protection panel dimensions	Yes	Closed	-$50,000	Yes	Yes	52" AFF, Design iteration. Reflected in estimate 5-1-2013	↓	—	Reducing cost; value didn't change because of maintained functionality.
IN324	03/07/13	Jon White	Finishes		Extruded Aluminum sill extension in lieu of solid surface	Yes	Closed	-$8,000	No	Yes	Jon to confirm with United what is carried, details.			Rejected and Never Happened
IN311	03/07/13	Becky/Norio	Finishes		Column Covers alternate material	Yes	Closed	-$33,000	Yes	Yes	PLT approval of A3 for GFRG column covers	↓	↓	Reducing cost while reducing value because of using less durable materials.
X	03/07/13	Becky/Keith	Ceilings		Provide standard 4x4 ACT (white), in lieu of wood-look Techstyle in Lobby	Yes	Closed	-$22,000	Rejected	Yes	Reviewed with PLT 4-30-2013			Rejected and Never Happened
X	03/07/13	Becky/Keith	Ceilings		Reverse lobby ceiling design, Gyp soffits lower than wood look ceilng	Yes	Closed	-$50,000	Yes	Yes	Design iteration	↓	↓	Reducing cost while reducing value because of undermining the design aesthetic.
IN316	03/07/13	Becky	Flooring		Double cut seam on rubber floors where appropriate in lieu of heat weld	Yes	Pending	-$45,000	HOLD	No	Cost savings only applies if Rubber Flooring is on project			Rejected and Never Happened
	03/27/13	Scott R/Mike Everett	Walls		Basement CMU walls extend to 9'-4" AFF with Gyp partitions above.	Yes	Pending		No	No	Team to study cost			Production item; Not a design innovation
IN310	03/07/13	Becky	Walls/Casework		Provide flat gyp wall in lieu of recessed niche shelf in NICU patient room	Yes	Closed	-$23,000	Yes	Yes		↓	↓	Reducing cost while reducing value because of reducing family amenities.
IN304.2	01/21/13	Finishes	Corner Guard		Utilize 7'-2"h Corner Guards in lieu of Full Height	Yes	Closed	-$2,700	Yes	Yes	Reviewed with PLT 4-30-2013	↓	—	Reducing cost; value didn't change because of maintained level of required protection.
IN304.2	04/12/13	Finishes	Wall Protection		Do not provide any trim with sheet wall protection (no top cap, no vertical seam trim)	Yes	Closed	-$3,600	Yes	Yes	Reviewed with PLT 4-30-2013	↓	—	Reducing cost; value didn't change because of maintained functionality.
X	02/26/13	Handrails	Railing		Validate railing numbers	Yes	Pending		No	No	Design information has been provided. Estimate needed			Just for Clarification, Not a design innovation
IN312	02/26/13	Handrails	Railing		Remove child height handrail at stairs and Level 03 balcony railing	Yes	Closed	-$7,000	Yes	Yes	Reviewed with PLT 4-30-2013	↓	—	Reducing cost; value didn't change because of maintained functionality by providing a cleaner design easier for construction.
IN312	03/07/13	Handrails	Railing		Remove all handrails at Level 3 balcony railing. Top cap only.	Yes	Closed	-$19,000	Yes	Yes	Reviewed with PLT 4-30-2013	↓	—	Reducing cost; value didn't change because of maintained functionality by providing a cleaner design easier for construction.
IN315	03/07/13	Finishes	Wall Finish		Epoxy paint on accent wall in toilet rooms in lieu of Altro Whiterock	Yes	Closed	-$27,000	Yes	Yes	Reviewed with PLT 4-30-2013	↓	↑	Reducing cost while adding value because of easier to maintain and repair with a broader choice of colors
IN318	04/12/13	Finishes	Wall Finish		Printed Vinyl Wallcovering in lieu of Glass at elevator lobby graphic glass	Yes	Closed	-$60,000	Yes	Yes	Reviewed with PLT 4-30-2013	↓	↓	Reducing cost while reducing value because glass is more durable and cleaner.
IN318	04/12/13	Finishes	Wall Finish		Printed Vinyl Wallcovering in lieu of Glass at identifier banner behind department desks	Yes	Closed	-$18,000	Yes	Yes	Reviewed with PLT 4-30-2013	↓	↓	Reducing cost while reducing value because glass is more durable and cleaner.
IN302.1	04/12/13	Finishes	WindowCovering		Remove Light Filtering roller shades at all office and staff lounge locations	Yes	Closed		No	No	This issue was resolved in previous A3	↓	—	They kept the shades for office, not the staff lounge. But they can added in future, if needed so reducing cost with no change in value.
IN318	04/12/13	Finishes	Lobby Design Feature		65 linear feet of printed vinyl wallcovering in lieu of 35 linear feet Blue Wall on Level 01	Yes	Closed	-$21,255	Yes	Yes	Reviewed with PLT 4-30-2013			Rejected and Never Happened
IN318	04/12/13	Finishes	Lobby Design Feature		Remove length of blue wall on Level 03	Yes	Closed	-$11,700	Yes	Yes		↓	—	Reducing cost; value didn't change because they just simplified the design.
X	04/12/13	Millwork	Connector Benches		Provide benches as furniture in lieu of millwork	Yes	Closed	-$27,600	Yes	Yes	Reviewed with PLT 4-30-2013	↓	↓	Reducing cost while reducing value because of undermining the design aesthetic.
IN313	04/13/13	Millwork	Nurse Stations		Provide plastic laminate worksurfaces in lieu of solid surface	Yes	Closed	-$39,500	Yes	Yes	Reviewed with PLT 4-30-2013. Nurse station SSF to be listed as a value add item.			Rejected and Never Happened
IN313.1	04/14/13	Millwork	Partial Height wall		Provide plastic laminate top caps on partial height walls in lieu of solid surface	Yes	Closed		No	No	Design team does not want to pursue			Rejected and Never Happened
IN317	04/14/13	Finishes	Flooring		Provide VCT in lieu of Rubber Flooring	Yes	Closed	-$600,000	Rejected	No	Reviewed with PLT 4-30-2013. SHV alternate was accepted			Rejected and Never Happened
IN317	04/14/13	Finishes	Flooring		Provide Linoleum in lieu of Rubber at Patient Treatment Areas	Yes	Closed	-$323,820	Rejected	No	Reviewed with PLT 4-30-2013. SHV alternate was accepted			Rejected and Never Happened

IN317	04/14/13	Finishes	Flooring		Provide SHV in lieu of Rubber at Patient Treatment Areas	Yes	Closed	-$190,000	Yes	Yes	Reviewed with PLT 4-30-2013. SHV alternate was accepted	↓	—	Reducing cost; value didn't change because of same look, functionality, durability and maintenance.
IN318	04/14/13	Finishes	Wall Finish		Provide Spectrim Ven4ma wall panels in lieu of millwork plastic laminate panels in public elevator lobby walls and ceilings	Yes	Closed	-$31,600	Yes	Yes	Reviewed with PLT 4-30-2013	↓	—	Reducing cost; value didn't change because of same look and functionality but easier construction.
IN321	04/12/13	Finishes	Lobby Design Feature		Provide alternate material to 3Form Chroma	Yes	Closed	-$17,600	Yes	Yes	Reviewed with PLT 4-30-2013	↓	—	Reducing cost; value didn't change because of same look, functionality but less expensive.
IN321	04/12/13	Finishes	Lobby Design Feature		Provide alternate light fixture in lieu of ceiling ring	Yes	Closed	-$22,500	Rejected	No	Reviewed with PLT 4-30-2013			Rejected and Never Happened
IN321	04/12/13	Finishes	Lobby Design Feature		Remove ceiling fixture on Level 01 and 03	Yes	Closed	-$24,840	Rejected	No	Reviewed with PLT 4/30/13			Rejected and Never Happened
IN321	04/12/13	Finishes	Lobby Design Feature		Remove ceiling fixture on Level 06 and 07	Yes	Closed	-$16,560	Yes	Yes	Reviewed with PLT 4/30/13	↓	↓	Reducing cost while reducing value because of undermining the design aesthetic.
IN322	04/12/13	Finishes	ASC Design Feature		Eliminate circle wall at ASC waiting	Yes	Closed	-$11,200	Rejected	No	Reviewed with PLT 4/30/13			Rejected and Never Happened
IN322	04/12/13	Finishes	ASC Design Feature		Revise material of circle wall at ASC waiting	Yes	Closed	-$3,000	Rejected	No	Carpet in circles in lieu of SSF			Rejected and Never Happened
IN322	04/12/13	Finishes	ASC Design Feature		Revise wall design to glass divider wall	yes	Closed	-$6,000	Rejected	No	Reviewed with PLT 4/30/13			Rejected and Never Happened
IN314	04/12/13	Millwork	NICU cubicle cabinets		Remove both cabinets from NICU patient room	Yes	Closed	-$37,000	Yes	Yes	Reviewed with PLT 4/30/13	↓	↓	Reducing cost while reducing value because of undermining the design aesthetic and reducing amenities.
	04/30/13	Finishes	Flooring		Flooring, base, and stair treads at Lobby/Monumental Stair	Yes	Pending							Just for Clarification, Not a design innovation
X	04/30/13	Ceilings	Patient Rooms		Reduce gyp in NICU patient rooms	No	Closed		No	No	Design iteration			Just for Clarification, Not a design innovation
X	04/30/13	Millwork	Accent material		Backlit desk circles at reception desks	No	Closed		No	No	Design iteration. Design team will identify quantity			Just for Clarification, Not a design innovation
IN313.1	04/30/13	Millwork	Solid Surface Fabrications		HM frames in lieu of solid surface and channel at NICU nurse alcoves	Yes	Closed	-$35,930	Yes	Yes		↓	↓	Reducing cost while reducing value because of undermining the design aesthetic.
X	04/30/13	Ceiling	Connector		Simplify ceiling design in Connector	No	Closed	-$5,000	No	No	Design iteration			Just for Clarification, Not a design innovation
X	04/30/13	Ceiling	Connector		Simplify ceilnig design in Bridge connector to Parking Garage	No	Closed	-$3,300	No	No	Design iteration			Just for Clarification, Not a design innovation
IN408	05/31/13	Walls	Life Safety/Glazing		Roller Shutters at Pre-Op entry	Yes	Closed		Rejected	No				Rejected and Never Happened
IN408	05/31/13	Walls	Life Safety/Glazing		Roller Shutter in lieu of Deluge System at ASC Waiting Glazing	Yes	Closed		Rejected	No				Rejected and Never Happened
							TOTAL =	-3849586.5						

APPENDIX I

SURVEY QUESTIONNAIRE

Survey Questions	Type of Question	Response Rate
1. Which of the following stakeholders do you represent?	Nominal Category	100% 47 responses
2. Approximately, how long have you been working in your respective field?	Ordinal Category	100% 47 responses
3. Specifically, what is your role in the Akron Children's Hospital project and what are your responsibilities as they relate to the project delivery process?	Qualitative	98% 46 responses
4. Is the Akron Children's Hospital project the first contractual Lean-IPD project in which you have participated?	Yes/No	100% 47 responses
5. Have you worked on a non-Lean-IPD project before (e.g. Design-Bid-Build, Lump Sum or Competitive Sealed Proposal)?	Yes/No	100% 47 responses
6. To which team do you belong on the Akron Children's Hospital project?	Nominal Category	98% 46 responses
7. How often do you attend Team Week meetings?	Nominal Category	100% 47 responses
8. In your experience, how long do each of the following meetings usually take?	Ordinal Category	67% 32 responses
9. List all the barriers you faced in a traditional non-Lean-IPD project (Please skip if you have not worked on a non-Lean-IPD project before).	Qualitative	70% 33 responses
10. List all the barriers that you faced in the Akron Children's hospital project.	Qualitative	78% 37 responses
11. On a scale of 1-5, please rate the Value that you think the following exercises add to the overall project? (1= low and 5= high; N/A = if you did not participate in the exercise)	Five Point Likert Scale	80% 38 responses
12. Please tell us in your own words, what Value means to you?	Qualitative	85% 40 responses
13. In your opinion, how much influence did the following stakeholders have in the decision making process?	Five Point Likert Scale	89% 42 responses
14. Would you agree/ disagree with the statement, "Lean-IPD process for project delivery is better than non-Lean-IPD processes" for the following?	Five Point Likert Scale	89% 42 responses
15. What are some specific things you learned by working on the Akron Children's Hospital project that you did not learn when working with less collaborative delivery methods (e.g. Design-Bid-Build)?	Qualitative	81% 38 responses
16a. Are you aware if your organization quantifies or measures success on a project?	Yes/No	89% 42 responses
16b. If 'Yes', how does your organization currently quantify or measure success?	Qualitative	68% 32 responses

17. In your opinion, what are additional metrics that could be collected by your organization in order to measure success and evaluate the project and overall process?	Qualitative	66% 31 responses
18a. What do you think were the best parts of working on the Akron Children's Hospital project? (+)	Qualitative	87% 41 responses
18b. What do you think could be improved if a delivery process similar to the Akron Children's Hospital project were to be implemented in the future? (Δ)	Qualitative	83% 39 responses
19. What are some of the strategies that you used in the Akron project that were the most valuable and you would consider using in future projects.	Qualitative	83% 39 responses
20. If you have worked on other Lean-IPD projects before, how similar is the Akron Children's Hospital project compared to your experience with those projects?	Three Point Likert Scale Qualitative	36% 17 responses

Part I - Information sheet

The Value Analysis of Lean Processes in Design and Integrated project Delivery/ The Akron Children's Hospital project: A case study in benefit/ cost analysis of lean-IPD project

You are invited to take part in a research study being conducted by Dr. Upali Nanda: Executive Director of CADRE (Center for Advanced Design Research and Evaluation), and Director of Research, HKS Inc., and Dr. Zofia Rybkowski, Asst. Professor at Texas A&M University. It is funded by the Academy of Architecture for Health Foundation. The information in this form is provided to help you decide whether or not to take part. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have.

Why Is This Study Being Done?
The purpose of this study is to find the benefit/ cost metrics tracked by key stakeholders of Akron Children's Hospital.

Why Am I Being Asked To Be In This Study?
You are being asked to be in this study because you represent one of the seven key stakeholders of Akron Children's Hospital.

How Many People Will Be Asked To Be In This Study?
70 people (participants) will be invited to participate in this study online. Overall, a total of 70 people will be invited via email.

What Are the Alternatives to being in this study?
The alternative to being in the study is not to participate.

What Will I Be Asked To Do In This Study?
You will be asked to participate in an online survey about sharing the metrics of benefits/ costs associated with IPD of your organization currently tracked and your participation in this study will last up to half hour.

Are There Any Risks To Me?
This online survey will present no more risks than you would come across in everyday life. One of the risks can be potential discomfort at being asked about the improvement of current state of your company.
Although the researchers have tried to avoid risks, you may feel that some questions/procedures that are asked of you will be stressful or upsetting. You do not have to answer anything you do not want to.

Are There Any Benefits To Me?
No.

Will There Be Any Costs To Me?
Aside from your time, there are no costs for taking part in the study.

Will I Be Paid To Be In This Study?
You will not be paid for being in this study.

contd.

Will Information From This Study Be Kept Private?
The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only Dr. Zofia Rybkowski and Graduate Research Assistant Di Ai will have access to the records. Information about you will be stored in computer files protected with a password. Information about you will be kept confidential to the extent permitted or required by law.

People who have access to your information include the Principal Investigator and research study personnel. Representatives of regulatory agencies such as the Office of Human Research Protections (OHRP) and entities such as the Texas A&M University Human Subjects Protection Program may access your records to make sure the study is being run correctly and that information is collected properly.

The funding agency for this study, Academy of Architecture for Health Foundation, and the institution(s) where study procedures are being performed Texas A&M University may also see your information. However, any information that is sent to them will be coded with a number so that they cannot tell who you are.

Representatives from these entities can see information that has your name on it if they come to the study site to view records. If there are any reports about this study, your name will not be in them.

Who may I Contact for More Information?
You may contact the Principal Investigator, Zofia Rybkowski PhD, to tell her about a concern or complaint about this research at 979-845-4354 or zrybkowski@tamu.com. For questions about your rights as a research participant; or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office at (855) 795-8636 or irb@tamu.edu.

What if I Change My Mind About Participating?
This research is voluntary and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not to be in this study or stop being in the study, there will be no effect on your employment. Any new information discovered about the research will be provided to you. This information could affect your willingness to continue your participation. By participating in the interview(s) or completing the survey(s), you are giving permission for the investigator to use your information for research purposes.

Thank you.

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IRB NUMBER: IRB2013-0889
IRB APPROVAL DATE:04/01/2014
IRB EXPIRATION DATE:03/15/2015

Part II- YOUR BACKGROUND

1. Which of the following stakeholders do you represent?

- ◯ Owner
- ◯ Architect
- ◯ Engineer
- ◯ General Contractor
- ◯ Sub-Contractor
- ◯ Vendor
- ◯ Other (please specify)

2. Approximately, how long have you been working in your respective field?

- ◯ 0-2 years
- ◯ 3-5 years
- ◯ 6-10 years
- ◯ > 10 years

3. Specifically, what is your role in the Akron Children's Hospital project and what are your responsibilities as they relate to the project delivery process?

4. Is the Akron Children's Hospital project the first contractual Lean-IPD project in which you have participated?

- ◯ Yes
- ◯ No
- ◯ Not sure (please explain)

5. Have you worked on a non-Lean-IPD project before (e.g. Design-Bid-Build, Lump Sum or Competitive Sealed Proposal)?

- ○ Yes
- ○ No
- ○ Not sure (please explain)

6. To which team do you belong on the Akron Children's Hospital project?

- ☐ Project Leadership Team
- ☐ Project Innovation Team
- ☐ Project Workshop Team
- ☐ Project Production Team
- ☐ Other (please specify)

7. How often do you attend Team Week meetings?

- ○ I do not attend any Team Week meetings
- ○ Every two weeks
- ○ Once a month
- ○ As required
- ○ Other (please specify)

8. In your experience, how long do each of the following meetings usually take?

	0-1 hour	1-2 hours	2-3 hours	3-4 hours	>4 hours	I do not attend these meetings	N/A
PLT Meetings	○	○	○	○	○	○	○
Recurring Meetings	○	○	○	○	○	○	○
Cluster Group Meetings	○	○	○	○	○	○	○
Other Meetings	○	○	○	○	○	○	○

Please describe other meetings that you feel were very productive. Tell us how long they took.

Part III: Your experience with the Akron Children's Hospital project and Le...

9. List all the barriers you faced in a traditional non-Lean-IPD project (Please skip if you have not worked on a non-Lean-IPD project before).

10. List all the barriers that you faced in the Akron Children's hospital project.

11. On a scale of 1-5, please rate the *Value* that you think the following exercises add to the overall project?
(1= low and 5= high; N/A = if you did not participate in the exercise)

	1	2	3	4	5	N/A
a. Team Week Meetings	○	○	○	○	○	○
Please explain						
b. Target Value Design	○	○	○	○	○	○
Please explain						
c. Full Scale Mock-up	○	○	○	○	○	○
Please explain						
d. Co-location	○	○	○	○	○	○
Please explain						

12. Please tell us in your own words, what *Value* means to you?

13. In your opinion, how much influence did the following stakeholders have in the decision-making process?

	Not Sure	Low	Average	High	Very High
Owner	◯	◯	◯	◯	◯
Architect	◯	◯	◯	◯	◯
Engineer	◯	◯	◯	◯	◯
General Contractor	◯	◯	◯	◯	◯
Sub-Contractors	◯	◯	◯	◯	◯
Vendors	◯	◯	◯	◯	◯

Please Explain

14. Would you agree/ disagree with the statement, "Lean-IPD process for project delivery is better than non-Lean-IPD processes" for the following?

	Strongly Disagree	Disagree	No difference	Agree	Strongly Agree
Overall Schedule	◯	◯	◯	◯	◯
Overall Cost	◯	◯	◯	◯	◯
Overall Quality	◯	◯	◯	◯	◯
Safety during construction	◯	◯	◯	◯	◯
Morale of the stakeholders	◯	◯	◯	◯	◯
Learning of the stakeholders	◯	◯	◯	◯	◯

15. What are some specific things you learned by working on the Akron Children's Hospital project that you did not learn when working with less collaborative delivery methods (e.g. Design-Bid-Build)?

16. a. Are you aware if your organization quantifies or measures success on a project?

◯ Yes

◯ No

b. If 'Yes', how does your organization currently quantify or measure success?

17. In your opinion, what are additional metrics that could be collected by your organization in order to measure success and evaluate the project and overall process?

18. a. What do you think were the *best* parts of working on the Akron Children's Hospital project? (+)

b. What do you think could be *improved* if a delivery process similar to the Akron Children's Hospital project were to be implemented in the future? (Δ)

19. What are some of the strategies that you used in the Akron project that were the most valuable and you would consider using in future projects.

20. If you have worked on other Lean-IPD projects before, how similar is the Akron Children's Hospital project compared to your experience with those projects?

- Very similar
- Somewhat similar
- Not at all similar

Please explain

Thank you so much for sharing your valuable opinions and experience with us.

Thank you so much for sharing your valuable opinions and experience with us. Let us know if you have any additional comments/ questions. We appreciate your time and welcome your input.

APPENDIX J

PLUS/DELTA ANALYSIS FOR ON-SITE FOCUS GROUP

***Individual* brainstorming of top Plusses (+) and Deltas (∆)**
(Source: Individual Post-it® notes)

LEGEND

Owner (O)
Architect (A)
Construction Manager (C)
Trade Partner (T)

Design-Bid-Build

PLUS + (12 total)

Entire Package Complete	A1, C3, T3, T5	4
Familiar with Process	A2, C4	2
Don't have to talk to designer, only worry about own scope	C1, C2	2
Change Orders give more $	T1, T4	2
Benefit A & C more than O	C5	1
Other	T2	1

- **A1** Complete Information/ Single package
- **A2** Familiar with process
- **C1** Don't have to talk to Designers
- **C2** Just worry about you own scope of work
- **C3** Entire Design more complete sooner
- **C4** No education needed most people know this process
- **C5** Benefit the Architects and Contractors more than the Owner
- **T1** Hard Bid
- **T2** Value Engineering allowed
- **T3** Complete Bid Documents
- **T4** Change orders
- **T5** Design Complete

DELTA ∆ (22 total)

Change orders & Redesign	O3, A2, A3, A5, C6	5
Adversarial	O4, A4, C7, T4	4
Silos/ No Teamwork	A1, C1, C8, T2	4
Owner loses money and value	C2, C3	2
Longer Schedule	O1	1
Benevolent Dictatorship	O2	1
Lower Quality	C4	1
RFI's laborious	C5	1
Sub-contractor input not valued	T1	1
Poor planning	T3	1
Sub-contractors assume risk	T5	1

- **O1** Schedule: longer
- **O2** Benevolent Dictatorship
- **O3** Change order for all little changes
- **O4** Combative
- **A1** Silos in decision making
- **A2** Change Orders
- **A3** Re-design and Re-selection late in project/ Frustrating
- **A4** Heightened tension level
- **A5** High risk for re-work
- **C1** Typically don't interface with owner
- **C2** Owner loses both financially and operationally
- **C3** Higher cost
- **C4** Lower quality
- **C5** Submittal RFI is laborious
- **C6** More changes during Construction
- **C7** Very confrontational
- **C8** No input from production team to influence design
- **T1** Input from Sub-contractor not valued
- **T2** lack of teamwork
- **T3** Poor planning
- **T4** Change order battles
- **T5** Assume all risk for estimate

LEAN-IPD

PLUS + (25 total)		
Early involvement of stakeholders	A5, C3, C6, C7, T2	5
Coolaborative	O1, C2, T4, T8	4
Team proactive/ Common Goals	A1, T7	2
Accurate estimating	A3, A4	2
Pull Schedule systematic process	T3, T10	2
Clean and organized work space and job site	T5, T6	2
Faster	O2	1
Cheaper	O3	1
Efficient delivery of information	A2	1
More integrated with Owner	C1	1
Owner gets what they need	C4	1
Innovative	C5	1
Reliable commitments	T1	1
Pre-qualified contractors	T9	1

O1 Collaborative
O2 Time: Quicker Construction
O3 Cost: Cheaper
A1 Team driven value
A2 Delivering information just in time
A3 Greater cost transparent
A4 Real time cost
A5 Early sub-involvement
C1 More interface with owner
C2 Collaborative
C3 Production Team influence on design
C4 Owner gets what they truly need
C5 New idea
C6 Construction has design input
C7 Early knowledge and understandings of the project
T1 Reliable commitments
T2 Valued input from trade partner
T3 Pull Schedule
T4 Collaborative communication
T5 Clean Job site
T6 Organization
T7 Teamwork: all driving for the same goal
T8 Communication between trades improves team effect
T9 Pre-qualified trade contractors
T10 Pull plan systematic building process

DELTA Δ (9 total)		
Complex Process	A1, C1	2
Difficult to implement Lean Culture	A2, C2	2
Resources-Heavy	O1	1
Edges of stakeholder's responsibility not always clear	C3	1
Many meetings	T1	1
Incomplete Design	T2	1
Need key people involved from beginning	T3	1

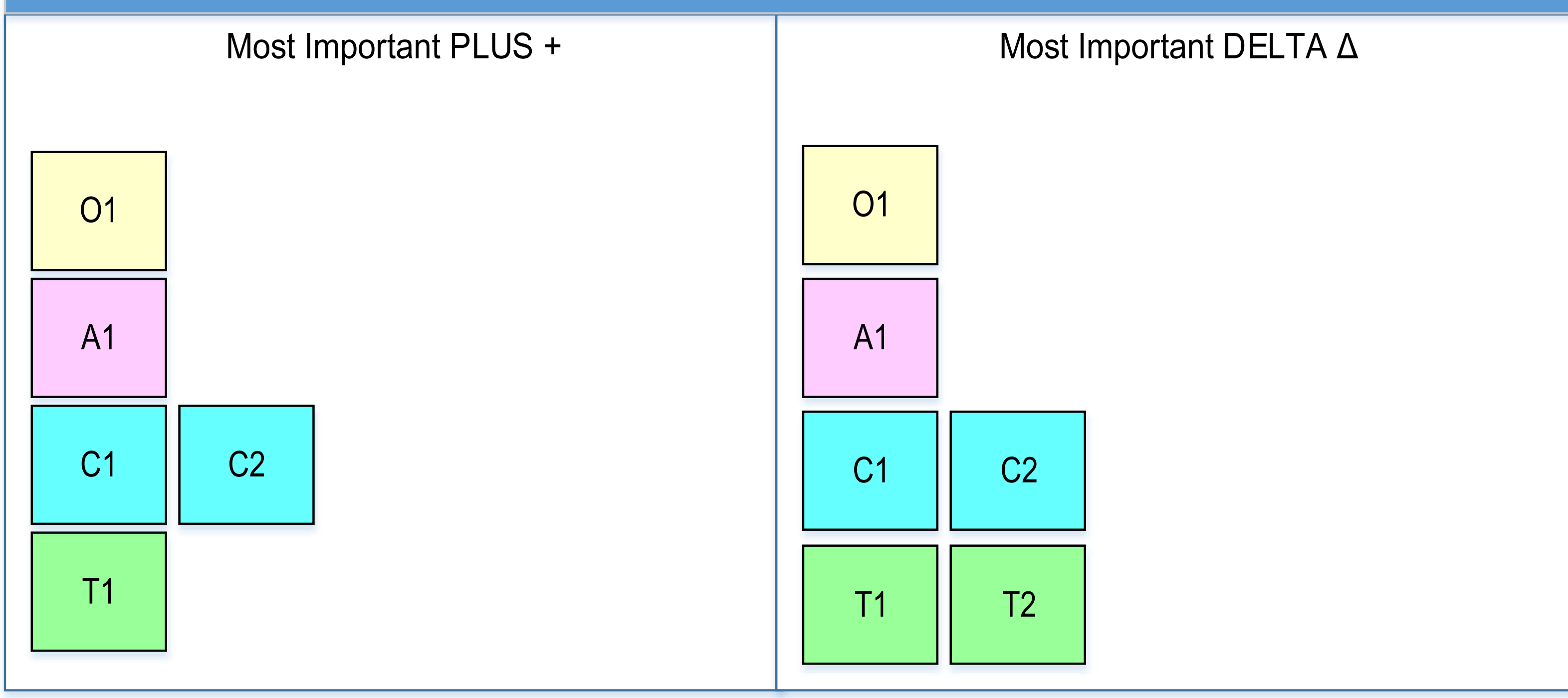
O1 Resource heavy
A1 Multi package
A2 Falling back to traditional mindset
C1 Multiple design package all burdensome
C2 Sometimes difficult to get Trade partners to "buy in" to process
C3 Communication lines sometimes are blurry
T1 Meetings
T2 Design not complete
T3 Key people should be involved from day one

PLUS/DELTA ANALYSIS FOR ON-SITE FOCUS GROUP

***Collective/team* brainstorming of top Plusses (+) and Deltas (Δ)**

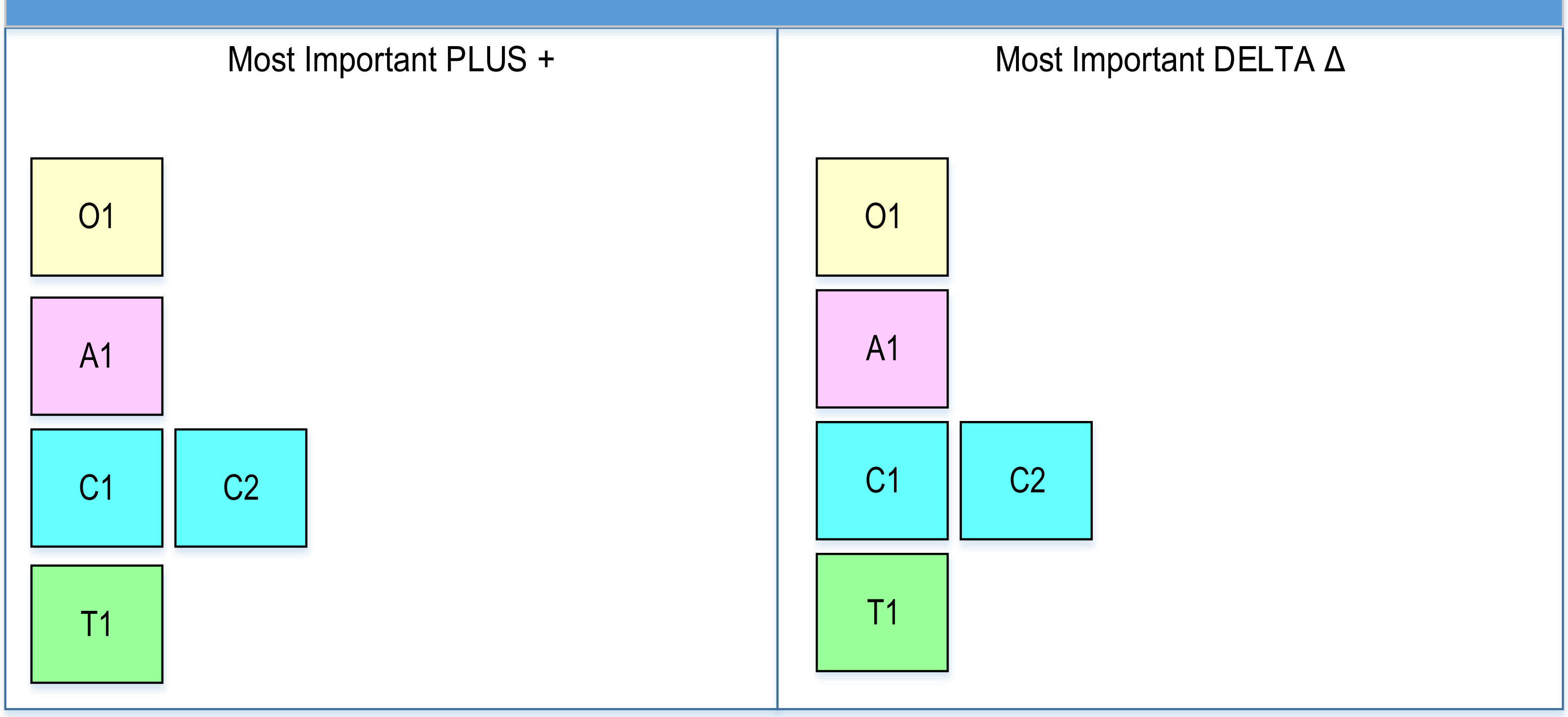
(Source: Team Post-it® notes)

Design-Bid-Build



Most Important PLUS +	Most Important DELTA Δ
O1 Know fixed cost	**O1** Change order for all small things
A1 Known scope & design	**A1** Silos in decision making
C1 No education needed most people know this process	**C1** Customer pays more for less
C2 Changer orders produce additional revenue	**C2** Owner loses out
T1 Completed design	**T1** Lack of Team work
	T2 Poor planning

LEAN-IPD



Most Important PLUS +	Most Important DELTA Δ
O1 Real time estimating	**O1** Resources intensive
A1 Collaboration	**A1** Design is always evolving
C1 Higher profit margins	**C1** Falling back to traditional mindset
C2 Owner gets more for less	**C2** Need more education and training
T1 Trade partner input	**T1** Design falling behind

Collective/team **brainstorming on Explicit versus Implicit metrics currently used**

(Source: Team Post-it® notes)

EXPLICIT METRICS		
Cost	A2, A3, A4, A6, A7, A9, A10, C2, T1, T4	10
Time	O1, A3, A5, A8, T2	5
Customer Satisfaction	C1, T5	2
Quality Design	A1	1
Morale	C3	1
Quality	T3	1
Worker Employment	T6	1

O1 Get it done
A1 Post occupancy reviews
A2 Job profit multiplier
A3 Projections VS Actual
A4 Productivity
A5 Schedule time to produce work
A6 Profitable
A7 Under budget
A8 On time
A9 E/O change orders
A10 Staffing hour projections
C1 Satisfied customer
C2 Profitability
C3 Labor relation (both in-house and sub-contractors)
T1 On budget
T2 On schedule
T3 Minimum punch list
T4 Profit margin
T5 Retained a customer
T6 Labor goals met

IMPLICIT METRICS

Customer Satisfaction	T1	1
Morale	A2, C4, C5	3
Other	A3, C1, C3	3
Cost	T2, T4	2
Quality Design	A1, C2	2
Time	T3	1

A1 More efficient workflow for long-term client operations

A2 Duplication of efforts (submittals)

A3 Value of REVIT vs ACAD

C1 What is "Done Done" ?

C2 Value beyond cost

C3 Collaboration: Was true collaboration achieved?

C4 Morale: Team members are excited to be involved with the project

C5 Would rest of project team work with us again?

T1 Owner's satisfaction

T2 Elimination of wastes

T3 Saved time

T4 Saved resources

APPENDIX K

PLUS/DELTA ANALYSIS FOR FOCUS GROUP WITH DESIGN TEAM

Page 1		
Plus (+)	Delta (Δ)	Notes
More face time with Contractors, subcontractors and consultants To get to know people better and how they react You are not physically removed Physical interaction Interactive activities Communicate Body language Eye reactions	Technology (connecting others remotely RMS w/o Video)	Comparison in person vs video conferencing In-person was the best Video conferencing was second best option depends on the intents (pregnant team members, good for reports); not good for designing as a team, design interaction, or follow related conversation Challenges - where multiple called and where rooms had no cameras.
Fewer technical glitches (remote conf.) Enhanced remote participation	Local /on site would have removed spur of the moment meetings	
More effective pull planning	Make trips more productive/worthwhile	
Education time may have given better results	Face time spent on education should be more on moving forward	Time wasted on education was because of lack of planning and matching schedules
More opportunities for participation	Plan work better so can leave earlier	
Strong relationships	Start education earlier (collective Lean teaching team)	
Promise of transparency	Catch up new comers Each DME slows process	
Ability to communicate with clients	Actual transparency limited	
	Participation not always “willing/focused”	Human factor; politics; political people; People who are not aligned with the purpose of project
	Growing frustration	

Outcomes ↑	Lean design should be led by architects not g/c. design is more iterative	Traditional concept of leadership should not been thrown out completely; architecture should have control which should gradually transfer to construction; transition in leadership
2 hour check-ins→ 30 min (what did work before and what will work on)	Facilitator should be either Co-led or outsider led. Facilitator should understand the design and construction process (i.e. it is not painting a wall) need more flexibility People can trust them	
Output and reliability ↑ Productivity of team member	Estimating should have been focused/preset at every meeting	
Warehouse/mockup was the best part (but would have put design team w/ them)	If on site/shouldn't be on PLT. Since lean is about doing the work	
	Need power to get rid of bad apple	
	Having co-location in the warehouse in the future	
Client participation	CBA: cumbersome way to make decision. Didn't use much (felt tool used to justify decision rather than to make decision; it take too long to set up and run)	
Incremental decision making	People told LRM was 1 Mo. ago, but it wasn't	
	People need to know cost to make changes in design IPD changes hourly vs. traditional which is lump sum (↓ morale)	
	Being away from home base/friends & families	
	Meeting plan	
	Not sustainable	
Mock-up warehouse		
User buy-in	Drive to mock-up	

Elimination of change orders (surgical space example)	Distance from big rooms Proximity of warehouse	
Timely (reversal of decision)	Comfort; hot and cold temperature (No AC) and smell	
Stakeholder buy-in (lesser) • MEP • Interiors • IT • Medical Equipment	No control	
	No estimator/ no contractors participations	
3 p 7 way	Control limited	
	Limited time on team building	
	Design process had to match process (prior to edu)	

OTHER COMMENTS, REMARKS, etc.:
Over time improvements ↑

- More design prod.
- Check-ins and check-outs Red. Time
- A3 approval time
- TVD innovative ideas

Over time ↓

- Frustration
- Personal strife outweighs project benefits
- Design team influence on construction

Additional comments

- We cannot schedule inspiration
- C.O.S less relevant
    - Changes happen but they are not change orders; it is changing buckets of money
- Time associated with big vs small decision
- Collaboration works best if project is local
- Colocation is very positive but one has to be very careful; because life is important, you cannot discuss personal life at business so you should make everything clear at the beginning
- IPD project can lead to strong relationships; relationships are maintained post project
- Transparency was expected but not reciprocated
- Equal partnerships
- Planning the whole project at the beginning is very helpful

Recommendations:

2 people recommended
1 person did not recommend
1 person recommended but with caveats

- She said she would not tell people “not to do it,” ....

APPENDIX L

Differences in Architects, General Contractors, and Owners' Perceived Influence of Different Groups of Stakeholders in Decision Making Process (Tukey HSD Test Results)

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Q13_1_Owner	Owner	Architect	.500	.225	.087	-.06	1.06
		General Contractor	-.500	.270	.175	-1.17	.17
	Architect	Owner	-.500	.225	.087	-1.06	.06
		General Contractor	-1.000*	.247	.001	-1.62	-.38
	General Contractor	Owner	.500	.270	.175	-.17	1.17
		Architect	1.000*	.247	.001	.38	1.62
Q13_2_Architect	Owner	Architect	.462	.298	.287	-.28	1.21
		General Contractor	-.667	.358	.172	-1.56	.23
	Architect	Owner	-.462	.298	.287	-1.21	.28
		General Contractor	-1.128*	.327	.006	-1.95	-.31
	General Contractor	Owner	.667	.358	.172	-.23	1.56
		Architect	1.128*	.327	.006	.31	1.95
Q13_3_Engineer	Owner	Architect	.240	.294	.696	-.49	.98
		General Contractor	-1.042*	.354	.019	-1.92	-.16
	Architect	Owner	-.240	.294	.696	-.98	.49
		General Contractor	-1.282*	.323	.002	-2.09	-.48
	General Contractor	Owner	1.042*	.354	.019	.16	1.92
		Architect	1.282*	.323	.002	.48	2.09
Q13_4_G_Contractor	Owner	Architect	-.154	.246	.808	-.77	.46
		General Contractor	-.500	.296	.229	-1.24	.24
	Architect	Owner	.154	.246	.808	-.46	.77
		General Contractor	-.346	.270	.419	-1.02	.33
	General Contractor	Owner	.500	.296	.229	-.24	1.24
		Architect	.346	.270	.419	-.33	1.02
Q13_5_S_Contractor	Owner	Architect	.038	.344	.993	-.82	.90
		General Contractor	-.667	.413	.260	-1.70	.37
	Architect	Owner	-.038	.344	.993	-.90	.82
		General Contractor	-.705	.378	.170	-1.65	.24

	General Contractor	Owner	.667	.413	.260	-.37	1.70
		Architect	.705	.378	.170	-.24	1.65
Q13_6_Vendors	Owner	Architect	.135	.409	.942	-.89	1.16
		General Contractor	-.917	.492	.171	-2.15	.31
	Architect	Owner	-.135	.409	.942	-1.16	.89
		General Contractor	-1.051	.450	.069	-2.17	.07
	General Contractor	Owner	.917	.492	.171	-.31	2.15
		Architect	1.051	.450	.069	-.07	2.17