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# PLAN VALIDATION IN TVD: A HEALTHCARE CASE STUDY PROJECT IN CALIFORNIA

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## ABSTRACT

Healthcare projects are complex commercial building endeavors, and re-purposing an office building into a healthcare facility within a tight time frame can be especially risky. Conventional management practices are insufficient for the design and delivery of complex capital projects. However, decades of research have demonstrated Target Value Delivery's effectiveness in mitigating risk in complex project design and delivery. While TVD tools are often disseminated through cases that focus on the overall TVD process, there is a need to focus on a less well-known step implemented upstream of design, known as "plan validation." The purpose of this paper is to share how an owner and stakeholder team managed to mitigate risk using plan validation for the adaptive reuse of a complex multi-building healthcare project. The owner engaged general contractors and design partners already experienced in TVD practices. The team collaborated using lean methods such as an IFOA contract, innovated by exploring alternatives early on during interactive big room meetings, developed prefabrication solutions, and implemented takt planning and the Last Planner System of Production Control during the plan validation process. This paper qualitatively documents from stakeholder's comments how lean methods contributed to the owner's ability to confidently proceed with the project.

## KEYWORDS

TVD, plan validation, IFOA, prefabrication, takt planning, set-based design.

## INTRODUCTION

Complex projects carry risks due to significant levels of uncertainty. Traditional project delivery methods such as design bid build have been shown to contribute to cost and time overruns, especially when there are high levels of unknowns (Ibbs 2004). The successful tackling of uncertainties demands deep levels of trust and collaboration from OAEC[5] stakeholder teams.

Lean construction practitioners quickly recognized that real trust could only be established when the legal contract binding project stakeholders aligns with the acknowledged need to approach complex unknown challenges with a relational contract, rather than the more typical, transactional contract. For example, instead of finger-pointing or evading responsibility, stakeholders are rewarded for effective collaboration. The Integrated Form of Agreement (IFOA)—an Integrated Project Delivery (IPD) contract—provides the legal backing to

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5 OAEC stands for Owner, Architect, Engineer, and Contractor, where the Owner is mentioned first to recognize that the primary objective of the team is to fulfill the Owner's Conditions of Satisfaction (CoS) for the project.

incentivize collaborative behavior (Alves and Lichtig 2020). Target Value Delivery, which includes Target Value Design as well as the implementation of the Last Planner™ System of Production Control, was developed to help teams develop flow by identifying constraints early on, so that those constraints could be lifted before each activity is scheduled to proceed (Ballard 2011). TVD tools, such as set-based design and Choosing by Advantages (Arroyo 2020, Rybkowski et al. 2022, Suhr 1999), help teams address complexities and uncertainties before proceeding with a project because they challenge OAEC stakeholders to innovate by brainstorming alternative solutions that resolve challenging problems. Ansah and Sorooshian (2017) argued that lean construction tools help teams identify and remove constraints from sources of external delays, namely those that stem from political, economic, social, technological, legal, and environmental ('PESTLE') concerns. The TVD process includes upfront time in a validation study (Figure 1; Ballard 2008) with key members of the stakeholder team to ensure that a project will proceed only if it makes business sense to do so. Three mottos consistent with lean construction philosophy include: "those who fail to plan, plan to fail," "slow down to speed up," and "plan thoroughly, execute quickly" (Ballard, personal communication 2008).

Dictionaries such as Collins (n.d.) define complexity as parts that are "connected or related to each other in a complicated way." The Oxford Dictionary supports this definition of complexity but also includes the "state of being difficult to understand" (Oxford n.d.). In lean construction, Howell (1999) defined complexity as the number of pieces or activities that can interact." TVD typically includes the full range of activities diagrammed in Figure 1. A number of well-developed decision-making tools, such as Choosing by Advantages (Suhr 1999), mitigate risk that accompanies complexity. Such tools align well with lean philosophy and practices and have been shown to be helpful (Ballard and Tommelein 2012, Bertelsen 2003a, Bertelsen 2003b, Saurin and Rooke 2013, Saurin et al. 2013). While much prior research tends to focus on the formal "design" phase of TVD, this paper contributes to our understanding of TVD processes by providing examples of lean practices implemented and innovations developed during TVD's "plan validation" phase of a complex project. During plan validation, the owner team is still determining if the project should be funded. Ballard (2008) wrote: "If the project is not funded, the companies participating in business plan validation are paid their services and the project is killed. If the project goes forward, target values and constraints are set, then design is launched and steered toward those targets" (p. 7-8).

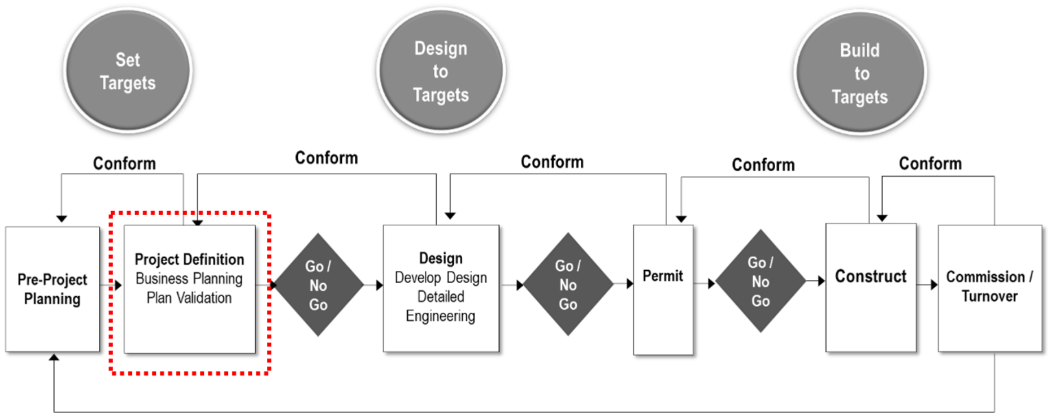


Figure 1: Plan validation is one of the earliest phases of the TVD process (Adapted from Ballard 2008)

## RESEARCH METHOD

To investigate the processes in which the stakeholder team engaged during project validation phase of the project, the authors sought to address the following questions:

- Why did the owner decide to use IFOA/ Lean in this complex project?
- Why did the owner choose this project team?
- How was the validation study carried out?
- What Lean practices were implemented?
- What are some examples of complex problems solved by the team?

The research represents a case study of a single project and is limited in its scope to an investigation of the validation phase of TVD. As such, it followed recommendations from Leedy and Ormrod (2013) for case study research which includes: collecting observations, interviews, and documents, as well as categorizing data, interpreting patterns, synthesizing information, and generalization. Unlike controlled experimentation that begins with a reasoned hypothesis and involves statistical analysis of multiple subjects (e.g. N>=30), for a case study, N=1. Case study research is somewhat akin to grounded theory where researchers begin with observational data and develop a theory that can be proven or disproven through future research. One purpose of this paper was to document and make available one example of a TVD validation study for aU complex project. The validation phase of this project engaged stakeholders in the implementation of multiple lean tools, including an IFOA contract, big room meetings, and exploration of alternatives early on. Stakeholders during the validation phase included the owner, planner/ architect, structural engineer, general contractor, and mechanical trade partner.

Although case study research typically includes both quantitative as well as qualitative analysis, the methods used in this study were primarily qualitative and included:

- Direct observations of big room meetings for the project
- Information provided by the stakeholder team, and
- Transcribed quotations from a recorded presentation delivered by the stakeholder team members at the Lean Construction Institute (LCI) Congress on October 24, 2024, in San Diego, California.

Sutter Health is a not-for-profit healthcare company local to Northern California, founded in 1921 as a response to the 1918 flu pandemic. The organization has been successfully delivering IPD / IFOA projects for nearly two decades.

According to the owner's Senior Project Manager, Sutter Health's new CEO recognized opportunities in their system that needed to be improved, one of which was patient accessibility. After a real estate search, dedicated efforts at business case alignment and market analysis, the owner opted for the underserved area of Santa Clara (Figure 2). Sutter Health decided to purchase and reuse existing buildings from the 1980s. The owner selected a location where the organization needed to expand for future growth and increase patient access. The goal was to heighten accessibility for 150,000 patients by expanding primary care, adding specialty services, and increasing operating and procedural capabilities. The Santa Clara Regional Ambulatory Center (RAC) was part of a strategic decision to invest in a new regional hub. Once completed, the three-building project would offer a spectrum of services, enhancing patient access to primary care, medical treatment, and surgical specialty services.

Figure 2: Sutter Health Santa Clara Campus

The intent of the project was to meet, or exceed, Sutter Health's *Conditions of Satisfaction*, which included: (1) design a new medical specialty, (2) maximize "speed-to-market" strategies and construction methods (e.g., prefabrication, virtual design and construction (VDC), etc.), and (3) adaptively reuse an existing 1982 speculative office building. Critical technical challenges included the profile of a building which had limited structural capacity, and the program itself, which needed to be fit inside a reduced structural base and within existing spaces.

### TEAM SELECTION

There was concern that a traditional design bid build type of project would have increased the project duration significantly because the design would be uninformed by a general contractor. Consequently, while interviewing teams, the Owner's prior experience suggested that an IFOA[6] contract with IPD's collaborative behavior, rapid problem-solving, and lean thinking would be needed to deliver the project within the desired time to market. The Owner selected general contractor DPR Construction and architects HGA because DPR proposed innovative strategies for maximizing multi-trade prefabrication through early adoption of VDC and takt production planning. Both DPR and HGA had prior experience with IFOA contracts and collaborative delivery. DPR Project Executive, Dan Tran, was very familiar with Lean processes, having facilitated collaboration with Owners to complete projects within their desired schedule. During the interview, DPR presented examples of prefabrication ideas from previous projects as potential possibilities for this project, and recommended prefabricated wall panels and multi-trade MEPF racks for Sutter Health's project.

## VALIDATION STUDY

A *Validation Study* is a critical part of implementing Target Value Delivery so that a company's business case can be realistically supported; project targets are set for delivery within the schedule and budget that an owner expects (Ballard 2020). Once the stakeholder team validated the project, the scope, budget, and schedule were aligned using DfMA and Takt (Figure 3).

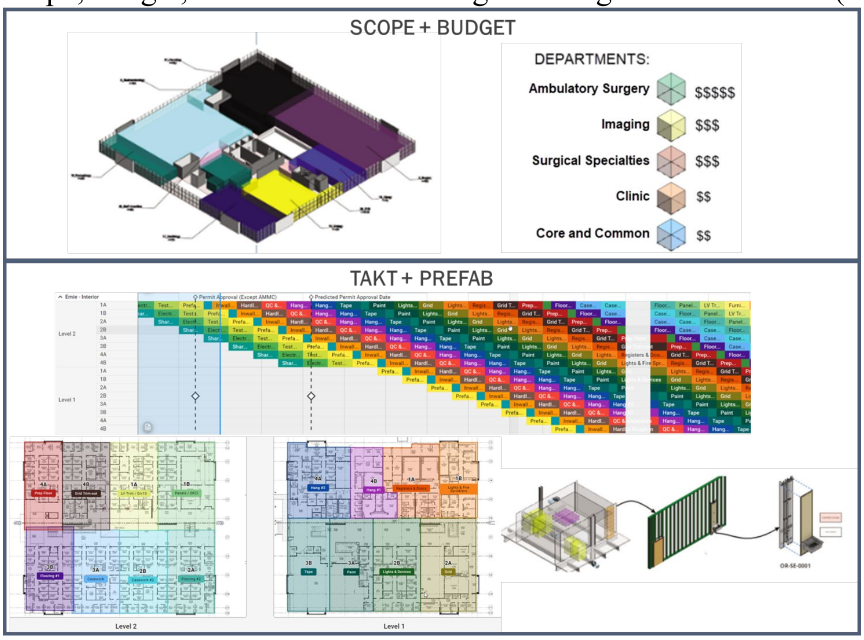


Figure 3: Aligning scope, budget, and plan using prefabrication and takt

[6] An Integrated Form of Agreement (IFOA) represents a relational Integrated Project Delivery (IPD) egal contract that is designed to enhance stakeholder team collaboration. An in-depth description of the IFOA is beyond the scope of this paper, but more information be found by consulting Lichtig (2010).

The team was responsible for developing innovative solutions given the building's structural and special constraints. The team completed the validation study within twelve weeks, starting from team alignment to a coordinated validation package. One of the project executives commented, "*That is not normal for this level of complexity; in a traditional setting, this could have taken months. The team has indeed pushed the limits of DfMA*[7] *and Lean ideas*."

### Uncovering complexities

A number of complexities revealed themselves as the project progressed. These included:

- *Scope uncertainty:* The team was tasked with adapting a 325,000 SF project comprising three separate and existing buildings of 100,000 SF, 140,000 SF, and 85,000 SF, respectively, where the latter was currently on hold.
- *Adaptive reuse challenges*: The project scope required incorporating an ambulatory surgery suite into a vintage 1982 office building where existing columns were on a 24' x 24' grid, which is not ideal for clinic flow.
- *Information gaps:* The team discovered elements in the existing buildings for which there was no available documentation, requiring laser scanning of the building.
- *Planning challenges*: The vertical conveyance system needed to be expanded from a single elevator to one that could accommodate the number of patients who would need to access an outpatient surgery center, a primary care center, and specialty clinics.
- *Building limitation challenges:* The adapted design needed to avoid disrupting areas of shear walls and drag ties ("no fly zones") that provided seismic resistance for the building (Figure 4).
- *Structural strength challenges*: The team had to create an innovative way to suspend the prefabricated racks they had developed that would *not* rely on the wooden roof structure, as the roof did not have the structural strength to support them (Figure 5).
- *Noise and vibration concerns:* The design needed to work around floor systems with deep open web joists (3 ft. deep trusses) and a thin concrete slab deck (e.g., 1.5 inches and 2.5 inches in thickness) that created vibration issues which needed to be addressed.

During the validation phase, the team recognized it had to be open about identifying constraints and determining whether or not those constraints could realistically be lifted. For example, Figure 4 depicts the type of "tug and pull" the design team faced. According to the architectural planner presentation: "*The yellow represents where the existing circulation is. As you can see, it was blocking a lot of prime real estate for exam rooms. The red is where the design team wanted the circulation to go. And, of course, when we pulled in …[the structural engineer], he was like, no, it cannot go. There is a 'no-fly zone.' So, as you can see, it's quite a large space where we cannot put the stairs.*"

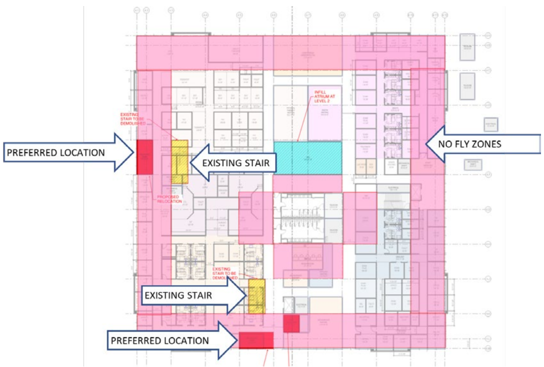


Figure 4: Building limitations challenges, as stair placement.

[7] Design for Manufacturing and Assembly

Adaptively reusing existing buildings with multiple constraints and limitations can cause even the most innovative teams to question whether it might be easier to simply demolish and rebuild. However, a primary tenet of lean—to reduce waste and add value—appeared to heighten the team's determination to fulfil the original plan. For example, a comment by the structural engineer during the presentation sums up some of the significant constraints faced by the team—but also exemplifies the team's tenacious commitment: *"At some point, we thought about asking the owner, would you consider a new building? No, no, no, no. There's, there's a strategy here. So, we just had to find it, right? We had, we had to dust off those things and really work together as one team."* In fact, the decision to adopt lean's collaborative approach between stakeholders during validation helped facilitate the innovation process.


Figure 5: Structural Constraint Challenges

## SOLVING COMPLEX PROBLEMS FAST

To deal with complexity and uncertainty, the team engaged several lean strategies, such as takt, standardization, one-piece flow, visual communication, and collaborative buy-in at multiple levels.

### Starting with Takt as a strategy from the superintendent's perspective

It became apparent that the short fuse for completion of the project would require efficient and unencumbered flows. Stakeholders started developing a takt plan from the beginning of the validation study, even before the design was completed. Takt is still not commonly used in the industry, but the superintendent's prior experience with takt gave him confidence that it would greatly streamline the construction process. In a presentation at the LCI Congress on October 24, 2024, the superintendent commented: "*When we develop a takt plan, we achieve balance, flow, and the entire team's movement at the same cadence…When looking at the takt plan, pulling in the entire team…all within the big room, that's where we started to truly develop what it would take to meet these production plan requirements*."

### Leveraging Prefabrication and VDC in Design

The tight timing led the team to consider prefabrication during validation discussions. They knew they would have little time later to correct potential errors made during design. They identified Virtual Design and Construction (VDC) as standardized way to communicate and share information. VDC enabled the team to align scope, schedule, and budget. The team used a process called 'smart blocking and stacking' facilitated by laser scanning the existing buildings; in a virtual model, geometric blocks represented functional spaces that could be rearranged. The stakeholder team investigated multiple alternatives using early exploration of design alternatives. Keeping constructability and prefabrication in mind, the design manager explained:

"[We would] *start playing with the blocking stack and say, what happens if the ambulatory surgery center is over there on the ground floor? What happens if the clinic is on the 3rd floor? And so, we started to experiment. The architects were really nimble and worked with us, reacting in real-time. …[The structural engineer]…made real-time decisions based on some of these implications."*

**Leveraging the Designer's expertise, early user engagement, and standardization**

From the architectural planner's perspective: "It really makes a difference that Sutter was committed to making the planning schedule work…We had to reduce a month-by-month user meeting iteration into a two-week cadence. It would not have been possible without our stakeholders helping us make these user engagement meetings effective."

Also, the project moved toward standardization. For example, the planner stated: *"Sutter had about 40% of their rooms within our program templated…So we used those as the basis of design for our non-templated rooms to create rules of thumb that could be used throughout the space"* (Figure 6).

In addition, the team found that the lean principle of "just-in-time" or "one-piece-flow" would facilitate the design process. According to the planner, "*We established a few methods to incrementally release information to our design partners as we were doing the programming and the planning user meeting*."

Lean recognizes that visual management can also significantly enhance productivity. To this end, the team used several means of visual communication to share design progress in a weekly basis during the big room meetings. As the planner explained, *"We release information through heat maps to show which users had accepted and signed off on the program, which areas were still in flex. And then the red zones were areas where we anticipated significant redesign."*

Successful implementation of lean has been shown to require support ("buy-in") at all levels of management. The planner stated that for the team to reach this stage, *"We needed commitment up and down the organization outside the project team. We got that."*

Figure 6: Room-by-room development. Green: templated rooms. Yellow: non-templated.

As the team was obtaining user information from the planning team and the architectural team, the construction team was also making progress on determining how to build and solve the challenges previously mentioned. The team engaged trade partners to provide feedback on the design packages that were released. For example, they consulted early with the drywall team about how they could install prefabricated panels. The team created fabrication-level details for more complex areas that required a deep dive. According to the Design Integration Manager: *"We moved around the building strategically and as a team. All of this during the validation* *phase."* Again, these deeply collaborative practices were assisted because the owner had established a relational contract—the IFOA.

**Collaborating to solve structural challenges while optimizing the whole**

Another tenet of lean is to engage the stakeholder team to "optimize the whole over the parts." The integrated team actively developed repeatable and scalable prefabricated solutions to optimize the whole. The team applied this practice to solve a considerable challenge—constraints posed by installation of the new MEPF system. They wanted a prefabricated multi-trade rack system from the beginning of the project that was also designed to meet a takt production plan. According to the mechanical engineer, *"…We had to figure out how to accelerate the schedule and hang racks from a structure that couldn't support it. We also had to deal with the space constraint. So, we couldn't really build the initially envisioned racks in the space because we didn't have enough interstitial space above the ceiling. So, it took the whole team to work together…I'd give it to…[the structural engineer]. [He] would come back and say, no, that doesn't work. There's too much load. Oh, we got to spread this out. And so, it took the whole team together."*

The team worked to determine how to get all MEPF needs onto racks and hang the racks from the structure. They produced two different solutions because they had two different scenarios. For the structure above, they used a posting panel system, where the DPR's framing group created a structure from which the MEPF could hang (Figure 7). This solution allowed them to hang off the MEPF and transfer the load to the floor below because they couldn't hang it from the roof. While in a traditional project, posts and headers are typically installed just to support the walls, the integrated team was able to use the post and headers to also support MEPF utilities. Co-locating the team during validation facilitated brainstorming methods for prefabrication and speedy installation. According to one project executive, *"The structure would not allow us to go the way we wanted to go. We had to adapt to the structure. We had to come up with very, very specific engineering solutions that would enable multi-trade racks, would enable prefab walls. The post-and-header does all three of those things. It reduces load from the roof so we don't have to hang off a very limited roof structure. We can support MEP systems, and the posts are located strategically to maximize the prefabrication* of walls. *It's pretty powerful, but it only comes together when we're really together in a single spot."*

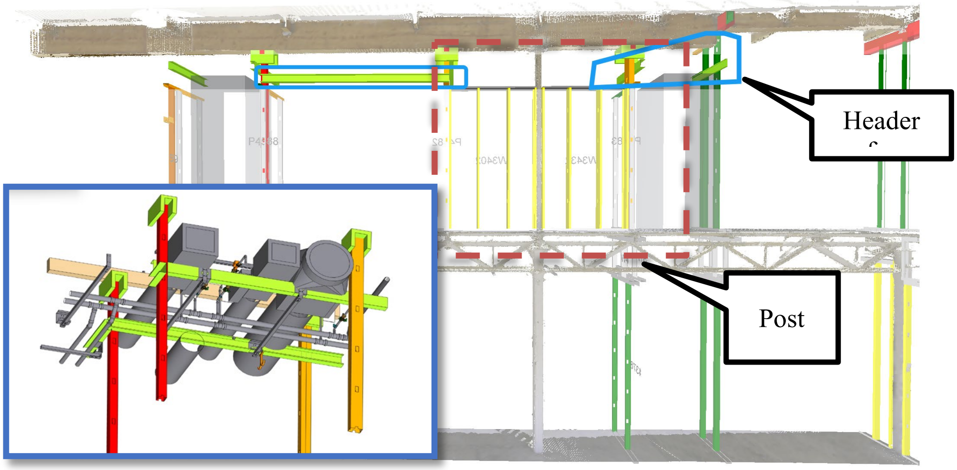


Figure 7: Post and header solution (second floor), represented in VDC (inset)

Following recommended lean practices, organizational management intentionally made specific provisions and established processes that facilitated collaboration. To solve problems, the team of designers, engineers, constructors and modelers co-located and held weekly big room meetings. On the lower floors, the team found they could hang MEPF from a Unistrut™ system, which the team called the dance floor because it was an open space with a different configuration (Figure 8). The Unistrut™ system ceiling attachments also enabled prefabricated interior walls that can be installed using a single point of attachment.

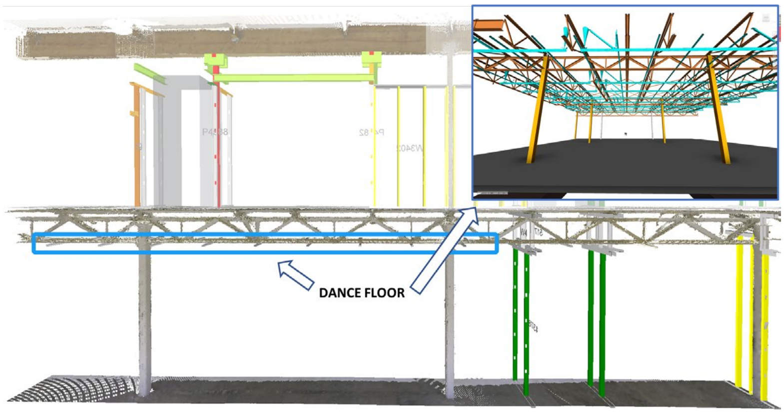


Figure 8: Unistrut "dance floor" solution (first floor)

**Lessons learned**

When asked by the researchers about lessons learned, the team shared the following practices which they felt offered substantial benefits during plan validation:

- *Early collaboration:* The team felt it unlikely that the results they achieved would have been possible if the project had instead been managed as a typical design bid build job. The team found they needed input from the people who would install the systems, ensuring that their proposed ideas could be built. It took a significant amount of coordination with the whole team to develop confidence in designs created during the validation plan.
- *Project first mentality*: Ironically although the validation study represented an early phase of TVD, including critical stakeholders during big room meetings was more important than worrying about cost. One team member observed: "*Obviously, it had to fit into the budget, but…we didn't have to worry about the money so much. It was just…how do we solve the problem?*"

# DISCUSSION

The primary purpose of this paper is to document and share one example of TVD's plan validation phase for a complex project. The validation phase of the project engaged stakeholders in the implementation of multiple lean tools, such as an IFOA contract, collaborative and interactive big room meetings, and using set-based design to explore alternatives. The stakeholders during validation included the owner, planner/architect, structural engineer, general contractor, and mechanical trade partner.

The quotes from the practitioners' presentation are intended to provide a vivid description of how the team interacted. Documenting lessons learned, collaborative behavior, and sharing evidence of how the team operated is important to understand how to solve complex challenges in this type of project. The need to expand healthcare services is becoming coupled with a desire to reuse existing office buildings which are now vacant since the COVID-19 pandemic. This is especially true in locations of growth and with limited available land, such as California's urban areas.

The team was able to innovate within a short twelve-week time frame during the validation phase of TVD. For example, the team iteratively developed a structurally feasible solution for a shared MEPF system and, at the same time, created a design that allowed for prefabrication and fast installation of walls and MEPF overhead sections. Each stakeholder brought a unique perspective. Continuous communication and transparency of information was a critical part of optimizing the whole over the parts—a core tenet of lean.

It is also important to highlight that the availability of the owner organization, not only in terms of their participation in meetings, but also with respect to their leadership, set the right conditions for the team to succeed. For example, the owners ensured that appropriate incentives were in place with a multi-party agreement. After validation and alignment of scope, budget, and schedule, the team agreed to an estimated maximum price, and the core team managed contingencies. The owner also made an early selection of both the general contractor and designers based on their capabilities, including considering their prior experience implementing lean practices. The owner led the implementation of the Last Planner System of Production Control, modelling collaborative behavior themselves. Finally, the owner's willingness to test and try new methods and ideas for the building motivated the rest of the team to innovate.

# LIMITATIONS / DELIMITATIONS

This research scope is limited to the validation phase of a single case study project in Santa Clara, CA. As such, it is difficult to truly generalize findings. Also, although case study research also may include quantitative as well as qualitative data, to preserve confidentiality, the authors of this paper predominantly focused on qualitative measures. Nevertheless, communications with stakeholders and transcriptions of their meetings, as well as public presentation comments, offer preliminary insights into the functioning of the validation phase of a TVD project. Engaging OAEC stakeholders during this early phase of the process appears to have served as a relatively low-risk way of helping an owner decide about the feasibility of a project under consideration.

# CONCLUSIONS

This paper documents TVD’s plan validation phase for a hospital project in California. As a case study, the paper offers one example of how a stakeholder team addressed challenges which arose from a complex project. The paper shares design and production problems that were solved by using lean practices to mitigate intrinsic project risks. The team implemented an IFOA contract, collaborative big room meetings, VDC, set-based design, one-piece flow of information, and standardization. The paper describes roles and the iterative design solutions that emerged from tackling the project’s challenges. Collaborative teamwork and owner leadership were requirements to promote innovation. This case study contributes to filling a knowledge gap about the validation phase in TVD—a step about which little has been published thus far. As this paper qualitatively documents the validation phase of a case study project in one city and by a single organization, further studies need to be done. Nevertheless, findings from this research suggest that future investigations into the validation phase of TVD implementation would be beneficial.

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