Silva, M. A. M., Etges, B. M. B. S., Pereira, M. C. (2022). Using pull planning as a method for the certificate of occupancy process. *Proceedings of the 30th Annual Conference of the International Group for Lean Construction (IGLC30)*, 366–375. doi.org/10.24928/2022/0138

USING PULL PLANNING AS A METHOD FOR THE CERTIFICATE OF OCCUPANCY PROCESS

Matheus Almeida Miranda Silva[1], Bernardo Martim Beck da Silva Etges[2], and Mariana del Carlo Pereira[3]

ABSTRACT

In Brazil, the procedure for obtaining a Certificate of Occupancy is bureaucratic, time-consuming and dependent on decisions that should have been taken in the early execution phases or even during design approval phases. Considering that fit for occupancy legalization is an important milestone in the life cycle of a real estate construction project, this research describes how the Pull Planning approach has been used to ensure that construction planning could reach the whole construction life cycle: since the design phase until customer hand over.

The Pull Planning workshops were part of a larger project considering Lean Construction implementation in a large construction company in Brazil. Nine Pull Planning Workshops were applied when mapping the life cycle of a real estate construction company. This research will describe how the Lean Philosophy was applied and what benefits the Pull Planning workshops brought to the whole project planning perspective in terms of communication, collaboration and decision-making process clearer. A survey was conducted with the workshop participants to understand which benefits were perceived and which improvements could be implemented in the method.

The results are that the Company succeeded in standardizing a new Planning tool that clarifies the whole life cycle of projects. The main benefits that the workshop participants highlighted are: Collaboration and multidisciplinary involvement in the Workshops, Clarity of information, View of the whole project and View of sequence.

KEYWORDS

Lean construction, Pull Planning, Certificate of Occupancy, Collaboration.

[1] Msc. Eng., Lean Civil Engineer at MRV Engenharia, Ribeirão Preto, Brazil, matheus.miranda@mrv.com.br, orcid.org/0000-0003-1158-3064

[2] PhD Candidate, M.Sc. Eng., Founding-Partner at Climb Consulting Group, Federal University of Rio Grande do Sul, Porto Alegre, Brazil, bernardo@climbgroup.com.br, orcid.org/0000-0002-3037-5597

[3] Msc. Eng., Lean Coordinator Engineer at MRV Engenharia, Belo Horizonte, Brazil, mariana.pereira@mrv.com.br, orcid.org/0000-0001-5066-1390

INTRODUCTION

Pull Planning is an important component of the Last Planner System (LPS). It helps define how work will be handed over from one project actor (owners, designers, contractors, suppliers, construction company) to the next (Tsao et al., 2014). It is important to state that that the Last Planner System was initially focused on production control. In other words, it set out to improve the link between "should" and "can", "can" and "will", and "will" and "did". (Ballard and Vaagen, 2017). In 1999, the specification of "should" was introduced into the practice of Last Planner considering the implementation of pull planning and phase-scheduling (Ballard 1999). The next phase for the Last Planner System is the planning of Master Schedules and the strategy for conducting the whole project, which takes into account risks and opportunities that have arisen since its early phases (Ballard and Vaagen, 2017). Pull planning also brings a new perspective about workflow, considering that the collaborative approach may focus on what can be done and not what should be done, given the current situation of the project.

Tvedt (2020) describes how pull planning is used to increase productivity in the design phase. The main goal is to establish a reliable flow in the iterative work performed by designers by bringing them together to engage collaboratively with each other to work out the best possible plan for the design phase and thereby to reduce waste. (Tvedt, 2020). These pull planning workshops should lead to a commitment to the production plan (Freeman and Seppänen, 2014). Tsao et al. (2014) describe pull planning as a process that encourages the actors in the project to collaborate from an early stage on design solutions.

Tsao et al., (2014) list some recommendations regarding how best to implement Pull Planning. Some of those were applied in the current implementation, namely:

- Distribute an agenda one week or more in advance to Pull Planning meeting attendees considering all the participants that could collaborate;
- Identify the start and end milestones as well as initial ideas for breaking up the project into modules or phases that support the planning;
- Have project drawings, master plans or details, readily available for referral during the meeting either in paper or electronic format.
- Tsao et al., (2014) suggest that a single pull plan could cover approximately three months of work. The current research aims to cover the whole project life cycle, which can last for up to 20 months. But we followed the recommendation that the workshop take place at least one month if not two months in advance of when work begins;
- Explain to attendees that the meeting will proceed in three phases: (1) the "backward step" which focuses on the main milestone, (2) the "forward step" will check the workflow logic and add any other activities that are required to support the end milestone, and (3) the "tightening step" will strive to manage work in smaller batches and balance work flow to enable the overall duration to be shorter.
- Clarify the agenda for the meeting. Attendees will become less resistant to working backwards because they have been assured that they will be allowed to work forwards during the next part of the meeting.

Understanding the main features identified by Tsao et al., (2014) in how involve an collaborate with construction crew; and considering the characteristics of the Certificate

of Occupancy in Brazil can achieve very complex phases, Pull Planning Workshop could be considered as a Method for better project planning.

Even though the criteria and deadlines for obtaining a Certificate Occupancy (CO) can vary from city to city. In general, the process for doing so is long and bureaucratic, considering different city councils and long flows of analysis and approval in the different public sectors, i.e. water and energy supply, environmental approval, firefighting inspections. The major phases for obtaining the CO are better described on Table 1. These tend to lead to deadlines having to be extended. Moreover, some decisions, if anticipated, can provide greater agility in undertaking activities on the site and in adhering to legalization processes, such as evaluating the possibility of obtaining a certificate that declares fitness for partial occupancy (or by phases of the works). Such an option depends even more on well-executed prior planning to obtain approval from the fire brigade service and city hall for projects and the environmental processes, which are duly organized for this purpose.

In view of the above, the company which is the focus of this study identified that the efficiency obtained in reducing the deadlines for executing works, obtained as a result of a broad project to implement Lean Construction, was not being reflected in the deadline for final delivery to the client. This occurs precisely because the Certificate of Occupancy process does not keep in step with the improvements that the teams on the construction site have started to benefit from the Lean Construction implementation.

Thus, what became a complementary objective of the project mentioned above was to seek to bring together the multiple processes and teams that work and participate in the CO process, in a collaborative way, so as to map the schedule in the initial stages of the project. Doing so ensure greater predictability of the process and of action on deviations in the initial stages of execution of the works, with sufficient time to correct deviations, which in this case tend to take longer to resolve.

It also important do highlight that there is a knowledge gap considering Certificate of Occupancy process and also, how lean tools and methods could be applied to improve this process. Thus, the objective of this research is to understand the benefits of using Lean Construction Tools to define, in a collaborative and efficient manner, the schedule for the entire life cycle of residential projects. Secondary objectives are defined as: (i) identify the characteristics of Pull Planning applicable to operational and indirect processes of the works; (ii) to identify work packages and milestones for the entire cycle of the site works; (iii) to identify how to connect the Certificate Occupancy Process to the production process; and (iv) to identify which benefits were perceived when using Pull Planning as a method for Certificate of Occupancy process. Hence, a tool was developed, based on pull planning, that had the goal to plan and monitor this critical stage for the works and the Company`s strategy as the Certificate Occupancy is a key factor for the final client delivery and also for the construction funding process and has a big impact in the company cash flow.

The current research will be presented as follow: (a) literature Review and in practical cases of the possible planning tools defined by Lean; (b) methodology used and definition of a pilot roadmap for the implementation of Pull Planning to map the Certificate of Occupancy; (c) assessment of the perception of the use of Pull Planning as a tool for sizing the Certificate of Occupancy schedule; and (d) standardization and criteria for the use of the methodology.

METHODOLOGY

The investigation was based on a consultancy project in a construction company in Brazil, named Company A. Considering that the authors of this research are consultants and Company`s A Improvement Group members the methodological approach adopted in this investigation was the Action research (AR) strategy. AR focuses on solving real problems (O'Brien, 1998) and contributing to the development of the organization, the emphasis being on simultaneous action and undertaking research in a collaborative manner (Coghlan, Brannick, 2001). Based on "learning by doing" as a primary aspect of the research process, AR turns the clients involved into researchers in order that they learn better and that they more willingly apply what they have learned (O'Brien, 1998).

The company focused on this research, presented as Company A, has been in existence for more than 40 years as a construction and real state company. It is present in more than 160 towns and cities and is the leader in the civil construction market in the residential real estate segment in Brazil and South America. The company has been constantly investing in improving the quality of its products, using the best market practices, while always prioritizing customers' needs. Its focus is operational efficiency, and, corroborating this with market data, which demonstrate the stagnation of the evolution of civil construction productivity in relation to other sectors of the economy. In response to this, it saw an opportunity, supported by the lean philosophy, to foster a change in efficiency within the company.

Considering we have an AR as a methodologic approach, in which testing and improving are characteristics, three pilot cases were conducted in different projects of Company A to reach the first model. After a first reference model of the Pull Planning Workshops, the researchers applied the CO Pull Planning Workshop in more nine projects of Company A in the cities of Ribeirão Preto, Campinas, Goiânia, Porto Alegre, Fortaleza and Belo Horizonte. To address objective of the current research, a questionnaire was conducted with the pull planning workshops participants. The questionnaire was structure on Google forms platform, with 11 questions considering a scale from 1(very low benefit) to 5 (very good benefit).

SCRIPT AND APPLICATION OF PULL PLANNING

The initial strategy for applying the methodology developed was to carry out pilot Pull Planning workshops. In order to facilitate holding these workshops, strategic and key people were summoned to solve problems related to the themes for obtaining the CO. These included: the project engineer, the engineering coordinator, responsible for the legalization process, the installations responsible (electrical and hydraulic networks), and the responsible for planning and for the regional implementation of the lean philosophy. The initial step was to analyze and group by common discipline "work package" all milestones considered as prerequisites for the company to obtain the CO. In summary, a work package is understood to be the set of activities that lead to the conclusion of a common milestone that is a prerequisite for the CO process. After carrying out three events of pilot workshops, the project team arrived at a configuration of work packages as shown in Table 1.

Based on Tsao et al., (2014) the following steps were applied in the three pilot workshops: Definition of Milestones and Project handover: As the beginning of the process, it is necessary, with the engineering and planning team, to define, by analyzing the enterprise's budget, the deadline of the project and, therefore, the date scheduled for handing over the residential project to the final clients.

Definition of work packages: This definition was carried out, while mapping the main services related to the CO and, in general, the packages mentioned above in Table 1 will be the main packages in the mapping, regardless of the town/city in which the works are located. In parallel with these pre-defined packages, the engineering sector must analyze whether there are specific activities for each city/town, state or region in order to include new packages. At this stage, it is understood that, with the evolution of the regional maturity in the execution of the methodology, more packages will be refined and standardized, reaching the point where there is a "catalog" of packages that will be combined according to the needs of the works.

Definition of the milestone dates for each package: Within the long-term planning of the works, the milestone dates are those that will directly influence the flow of the CO and, therefore, must be scored at the beginning of the pull planning process. Earthwork, foundation, structure completion and finishing completion dates are examples of milestones that directly affect the deadline for the works and these must be mapped.

Table 1. Work Packages for the proposed study

Work Packages	Description
Energy	Package with activities mapped for the process by which the concessionaire turns on the energy supply
Water and sewage	Package with activities mapped for the process of turning on the water supply and connecting to the sewage system
Drainage network	Package with activities mapped for the process of connecting to the drainage system
Report on the Inspection by the Fire Brigade Service (AVCB, in Portuguese)	Package with activities mapped for the process of inspection and acceptance of the guidelines for anti-fire installations made by the Fire Brigade Service.
Environment Certificate	Package with activities mapped for the process of inspection and acceptance of the environmental guidelines.
Town Hall Certificate	Package with activities mapped for the process of inspection and acceptance by the Municipal Secretary of Public Works.

Pull Planning: With the aforementioned points raised, with the definitions of the project's delivery date and main milestone activities, the pull planning process is started. This is when all the long-term planning of the construction will be analyzed, including all the work activities to be carried out as well as everything to do with regularizing the documentation so that it is possible to have the CO within the deadline set for the works.

Constraints Analysis: After finalizing the planning with all the mapping of packages, all the constraints, risks and potential new strategies that may contribute to the outcome of the enterprise must be reviewed by the engineering team. That is, all possible impacts that will affect the established planning must be mapped.

Action Plan: Having constraints, risks and potential new strategies identified and analyzed, an action plan can be carried out by the team, defining deadlines and responsibilities for dealing with all the impacts raised.

Figure 01 illustrates one of those workshops held with different engineering teams to use the methodology described above. We highlight the collaboration involved during the Pull Planning workshop.

Figure 1. Pull planning meeting for the CO of works in Ribeirão Preto.

ASSESSING THE USE OF PULL PLANNING FOR CO

This section is dedicated to the presentation of the results obtained by collecting feedback regarding the perception of the benefits and opportunities for improvement related to the use of the Pull Planning methodology for the detailing of the CO schedule. The questionnaire was developed using Google Forms and its main objective was to verify the participants' perception according to the following possible attributes:

- Collaboration and multidisciplinary involvement in the Workshop: the involvement of different areas contributes to a more complete analysis of the process of the enterprise as a whole, from project approvals to final handover to the clients;
- Clarity of Information: Analogously, as mentioned in the previous item, the participants come to understand the operationalization of the processes of all those involved, thus making the mapping of planning and restrictions clearer for everyone;
- Holistic view - ability to identify milestones: Looking at the "back to front" assembly of the planning, what becomes clearer for the participants is the possibility of identifying the necessary milestones throughout the duration of the project;

- Sequence view - ability to visualize the dependence between the stages: As the planning takes place throughout the entire enterprise, and involves the site activities and auxiliary sectors (projects, documentation, supplies, etc.), the vision of interdependence of work packages is evident at the time of assembly, allowing for discussion among participants about interference between activities;

- Vision of rhythm - possibility of identifying "rhythmable" stages: With a view of the "whole" it is possible to see, within the documentary and works processes, those that can be rhythmic, thus maintaining a scheduled delivery plan;
- Possibility of anticipation of deadline: With the analysis of all interferences, and the multidisciplinary participation, the possibilities of gain begin to appear and, thus, the ability to anticipate activities is evident for the entire team;
- Possibility of managing constraints: The management of restrictions is very visible and palpable, since the survey is carried out in a multidisciplinary way with the different sectors alerting to the “locks” existing in each of the processes;
- Possibility of altering indirect and executive processes: Due to the analysis being carried out in a collaborative way, participants have the possibility to see the processes that interfere both directly in the CO (such as project approvals, processes and execution activities of the works), and indirectly (such as contracting a supplier to perform a certain service);
- Help chain - ability to involve leadership in the management of constraints: with the format of the execution of the practice, the employees involved are those who are relevant within the processes and, therefore, when carrying out the analysis with all the leaders involved, the ability to evaluate planning and constraints is made simpler as is and sharing responsibilities;
- Duration of the Workshop - time dedicated to the CO Line: the duration is linked to the time for assembling and discussing the planning processes and restrictions; and;
- Prior knowledge of the teams: this topic is directly linked to what information each employee has in the process of obtaining CO for the enterprise. Therefore, it is necessary that, in order to carry out the practice, everyone has at hand the essential information to fulfill the requirements of the packages.

RESULTS AND DISCUSSION

In the research carried out, each of the aforementioned attributes could be classified by the respondents at the following levels: “Very good”, “Good”, “Indifferent”, “Bad” and “Very bad”. In the total of the nine Pull Planning Workshops, 52 people participated in the events, but only 27 participated in the applied research. When analyzing the results, by questions addressed in the research, the representation in percentage of the answers, is evidenced in Figure 02.

Multidisciplinary collaboration and involvement (89%), Clarity of Information (93%), Ability to Identify Milestones (93%), Sequence Vision and ability to visualize dependence between steps (93%), were topics that highlighted the relevance of the results and made it possible to relevant gains such as:

- With the multidisciplinary involvement, the possibility of optimizing projects was identified so that the approval in the competent Organs could be done more quickly and in stages;
- With the optimization mentioned above and the visualization of the sequencing of the work, the possibility of obtaining a partial CO was seen, which, therefore, would generate an early delivery to the clients;
- With the clearer identification of milestones and information shared, the interdependence between work activities and project approvals became more evident and, as a result, strategies for prior assessment at the time of approval were raised;
- Regarding the sequencing vision, the need to comply with both administrative and operational milestones was evident to the teams, as well as the impact of one milestone on the others and generated a learning effect for future projects.

On the other hand, the results that the respondents received with lower indices are linked to attributes of the methodology's operation, which, throughout the process of the rollout of the tool were adjusted:

- Workshop duration (81%) and Help Chain (82%) were items that, over the course of the pilots, were adjusted. The initial duration, for example, was 2 days and, with the development of the practice, it became 1 day, with a more intense and collaborative multidisciplinary work. The help chain, on the other hand, was adjusted with the vision of the need for punctual collaborators who would need to be present during the practice;
- Possibility of Managing Restrictions (78%) was an item for which, initially in the operation, it was not very clear how the feedback of this process would happen. However, during the rollout, a practice of managing restrictions online was developed in order to facilitate management follow-up.

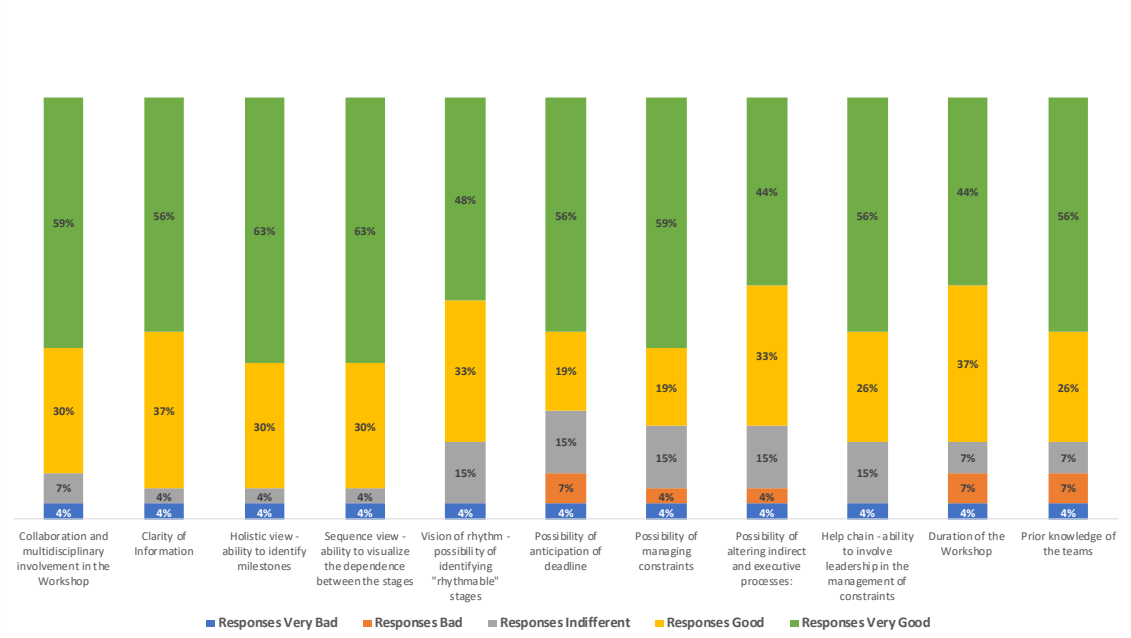

Figure 2. Analysis of the results of the questions applied

Another interesting analysis found that the audience that was most involved in the research carried out was the construction engineer. About 40% of respondents have this function and the average participation of this audience in workshops is 1.45, compared to a general average of 1.7 participations. Of the 27 responses collected, 66% reported that the person responsible for the lean implementation in the region was the one who conducted the workshop. This is normal, since these people were trained in the methodology for applying pilot projects. The audience with the highest participation in the workshops, an average of 4.2, was related to the team that started the implementation of the methodology. Considering the answers of the engineers, the following points are highlighted:

- Rhythm view - possibility of identifying "rhythmable" steps, with 100% of the answers being "very good"; and
- Collaboration - multidisciplinary involvement in the Workshop, also with 100% "very good" responses.

The item with the least relevance for this audience was: clarity of information, with 4 responses "very good" and 3 "good". Analyzing the responses of those responsible for implementing lean in the region, what stands out is that they had a less "optimistic" perception than that of the engineers. For this audience, the most relevant factor was the clarity of information, with none of the others being considered important to highlight.

STANDARDIZATION AND ROADMAP OF IMPLEMENTATION

At the end of the nine pilots, the Pull Planning model for CO was standardized in an Implementation Manual and a schedule and Roadmap were defined for expansion to the other construction sites of Company A. In this document, the prerequisites for implementing the tool were defined. These include: (a) the work must be in the initial stages, prior to mobilization, in mobilization or in a phase prior to the start of the structure; (b) the construction site and the engineering team must have previously implemented the set of Lean Construction tools, rituals and training defined by the company; (c) the construction must have a team that is familiar with the CO process in their region; (d) the master plan for must be completed and the legal projects approved.

Finally, the Roadmap for the next year includes all the new projects to be launched by Company A, which totals approximately 100 construction sites that must go through the approach described in this study.

CONCLUSIONS

Considering our main objective to understand the benefits of using Lean Construction Tools to define, in a collaborative and efficient manner, the schedule for the entire life cycle of residential projects, with the results obtained, it is possible to highlight the relevance of using the pull planning methodology to obtain a CO for vertical residential works. It was clear that using the methodology led to a pull planning view with obtaining the milestone dates that were "key points" in the analysis of restrictions and interferences between the processes. Such evaluations took place by means of discussion between the different sectors, evaluating the interdependencies between the execution of the constructions sites, project approvals and inspections and the process of final handover to the clients.

In the same way, the practice made it clear to those involved that the deadlines for the execution of the services are directly linked to the need for approval of stages in the

concessionaires and city halls for the release of the CO. With this, the need to anticipate documental processes was seen, so that approvals could occur respecting the deadlines in a more planned way and making the "link" with the partial deliveries of internal packages of the works, such as the end of a block and the end of activities related to AVCB (the Fire Brigade Report).

The involvement of the entire management body of the enterprise and support areas, made it clear to everyone that the multidisciplinary collaboration at the time of pull planning was of paramount importance for everyone to see the interdependence that exists between the activities of each one. Therefore, this made it perceptible that group work (with the prior information of each package in hand) has become essential for putting the planning together.

Therefore, the promotion of practices such as the pull planning methodology for mapping the CO process of an enterprise, proved to be essential for meeting the deadlines for the construction site and for public bodies, thereby showing that, with its use, it becomes clearer for the entire management of the construction what steps have to be followed for a good fulfillment of the planning of works.

REFERENCES

Ballard, G. (1999). “Can pull techniques be used in design management?” Conf. on Concurrent Engineering in Construction: challenges for the new millennium, CIB - Int. Council for Research and Innov. in Building and Construction, Helsinki, Finland.

Ballard, G. & Vaagen, H. 2017, 'Project Flexibility and Lean Construction' In:, 25th Annual Conference of the International Group for Lean Construction. Heraklion, Greece, 9-12 Jul 2017. pp 589-596

Coghlan, D. and Brannick, T. (2001). Doing action research in your own organization. Sage.

O'Brien, R. (2001). An overview of the methodological approach of action research, in: Roberto Richardson (Ed.), Theory and Practice of Action Research, UFPB, Brazil, 2001, http://www.web.ca/~robrien/papers/arfinal.html, (Accessed 20/1/2022).

Tsao, C. C. Y., Draper, J., and Howell, G. A. (2014). “An Overview, Analysis, and Facilitation Tips for Simulations that Support and Simulate Pull Planning.” Proc. 22nd Ann. Conf. Int. Group for Lean Construction, Oslo, Norway.

Tvedt, I.M. 2020. “Divergent Beliefs about Productivity despite Concurrent Engineering and Pull Planning, a Case Study.” In: Tommelein, I.D. and Daniel, E. (eds.). Proc. 28th Annual Conference of the International Group for Lean Construction (IGLC28), Berkeley, California, USA, doi.org/10.24928/2020/0006, online at iglc.net.

Freeman, C., Seppänen, O. “Social aspects related to LBMS Implementation – a case study”. Proc. 22nd Ann. Conf. Int. Group for Lean Construction, Oslo, Norway.