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POST MEASURING THE LAST PLANNER METRICS IN SHELTER REHABILIATION PROJECTS

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ABSTRACT

The Last Planner System (LPS) implementation showed great results in improving workflow for construction projects. In order to apply LPS, companies must collect key metrics on site; such data include Percent Plan Complete (PPC) for tasks done on site.

In this study, ten shelters from "Self-help" rehabilitation project were monitored. To identify workflow issues and highlight causes of delay PPC was measured for the duration of the project. This study is a personal effort to assess the reliability of workflow in the light of the fact that contractors do not apply the LPS.

The results showed that "Self-Help" delivery method promoted lean behaviour in families who were engaged in the rehabilitation process. They tackled constrains, expedited the work and organized construction activities in sound manner; thus, achieving high PPC. However, families who did not engage in rehabilitation process failed to finish their shelters on time, and achieved a low PPC. Reasons for incomplete weekly tasks were recorded and analysed.

The main goal of this on-going research is to improve workflow of UN projects, highlight causes of delays, and add value to refugees by removing impediments to construction workflow so that projects can be finished sooner and at a lower cost.

KEYWORDS

United Nations, PPC, work flow, self-help, LPS, agile.

INTRODUCTION

The Last Planner System® (LPS) is a production planning tool that is used on construction projects. LPS is better than traditional project management approach as it involves downstream players, focuses on the production system, incorporates learning into all project stakeholder, shifts focus from the end product of activity to the link between activities, and embraces continuous improvement (Ballard, 2000).The LPS is composed of 4 integrated planning elements: Master plan, Phase plan, Look ahead plan, and Weekly work plan (Ballard, 1997).

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The last planner improves productivity when properly implemented (Liu, Ballard and Ibbs, 2011). Its main goal is to reduce workflow variation and pave the way to optimization (Zimhna and Pasquire, 2012). LPS became equivalent to Lean, and it is considered the main tool which makes Lean applicable to construction (Green and May, 2005; Jorgensen and Emmitt, 2008; Rybkowski, 2010). In order to successfully apply LPS, the following actions must be performed: plan in more detail as you get closer to executing the task, create plans with those who will perform the work, eliminate constraints on planned tasks, make reliable promises, and learn from breakdowns (Ballard, Hammond and Nickerson, 2009). LPS primary role is to reduce variability in workflow, thus clearing the way for process optimization, and productivity improvement (Zimhna and Pasquire, 2012).

Figure 1 shows the reduction in project duration when implementing lean on construction projects in different countries.

Country	% of improvement (Duration Reduction)	Used Lean techniques
United States (US)	16%	Last Planner System, Visualization management & First run studies, 5S, and fail safe for quality & safety
Brazil	25%	Last Planner System
Nigeria	31%	Last Planner System, Visualization management & Huddle meetings
United Kingdom (UK)	37%	Just-in-time, collaborative planning, visual management, prefabricated material, Waste elimination, 5S, theory of constraints.
Sweden	79%	Last Planner System, continuous improvement, Value Stream Mapping, Pull approach, reduce batch size, Just-in-time, collaboration, and prefabricated material.

Figure 1 - Effect of implementing lean approach and realized benefits in different countries (Swefie, 2013)

A cornerstone for improving project planning is measuring PPC, identifying reasons of incomplete activities, and finding the root causes (Ballard and Howell, 1994). Measuring PPC allows differentiating between failures to complete plans and failures in plan quality (Ballard and Howell, 1994). According to a survey conducted by lean construction institute for local and international companies, 79% considered PPC as an important indicator of project progress (Hamzeh, 2009). However, focusing on PPC alone can be misleading because projects might have high PPC but are late, it occurs when the activities that were performed are not critical or out of sequence (Hamzeh, 2009). Thus, definition, soundness, and sequence of weekly activities must be considered in the course of evaluating project PPC.

Although there are many reports written about UN funded projects, yet there are no case studies related to project performance or LPS implementation. United Nations funded construction projects are considered one of the hardest projects for implementing LPS. This is due to the fact that the UN system follows very systematic rigid policies that rarely seek change. Typically, the UN performs project evaluation through temporary consultants, but none of their work is published. Unfortunately,

these evaluation reports are archived and not shared with other organizations. Therefore, making any possible improvement to the project becomes a difficult task. This is the case with UN funded shelter rehabilitation project in Lebanon.

SHELTER REHABILITATION PROJECT

According to the latest field survey by United Nations Relief Works Agency (UNRWA) in Lebanon there are 4,127 shelters inside Palestinian refugee camps that require rehabilitation (UNRWA, 2011). These camps as shown in figure 2 are known for their tight alleyways, unorganized urban planning, and lack of proper infrastructure.

Figure 2 - Camp infrastructure, tight alleyways

Rehabilitation projects inside the camps are one of the biggest challenges facing UNRWA. In a traditional contractual approach, shelter unit cost is high due to refugee camps harsh conditions.

Upon the request of some families to perform the construction work themselves, a new approach was implemented called Self-Help. In Self-Help, the families act as owners and contractors during rehabilitation. Self-help methodology proved to be a better and cheaper alternative to the old contractual approach saving approximately 50% in cost (SDC, 2010; Eljazzar, Beydoun and Hamzeh, 2013). This approach was implemented previously by Norwegian Refugee Council NRC in Balkans, and western Georgia. The cost savings ranged from 20% to 40 % (NRC, 2010).This approach encourages families to take responsibility, learn new trades, and manage the development of their own shelter (SDC, 2010).

In order to standardize the rehabilitation project, UNRWA created a set of guidelines that dictate the level of intervention, number of rooms, cost, and duration of work for each shelter. For example, a family composed of three to four members will be entitled to rehabilitation of two rooms in addition to the kitchen and the toilet. Therefore, the number of rooms included in rehabilitation is a function of family members. Moreover, the cost for each shelter is divided into instalments; each instalment will be paid upon fulfilling a set of activities. Payment order will be sent upon the approval of UNRWA's site engineers supervising the shelter. This allows the family to collect the payment after six to twelve working days. UNRWA rehabilitation works can be divided as follows:

- **Minor repair**: includes minor repair works, such as paint, minor electrical and plumbing works.

- **Major repair**: includes block work, plaster, paint, Tiling, major plumbing and electrical works.
- **Partial reconstruction**: includes concrete works , in addition to block work ,plaster, paint ,Tiling, plumbing , major plumbing and electrical works
- **Reconstruction**: rebuilding the whole shelter completely.

To assess the shelter rehabilitation project a sample of ten houses will be monitored, PPC will be measured, and the causes of delay will be recorded. The on-going research aims to pave the way for implementing LPS in UN environment.

METHODOLOGY

This study analyses data collected from a sample of ten shelters undergoing rehabilitation over a period of four weeks. Two weekly visits were conducted for each shelter: one at the beginning of the week to record the planned tasks, and one at the end of the week to record the delivered tasks along with causes of delay. In this project Percent Plan Complete (PPC) wasn't used by UNRWA or families it was running in the background. After looking at the project and visiting the sites, PPC was the only metric to measure the weekly performance of the projects. To ensure that PPC reflected the facts on the ground, activity overloading and under-loading was monitored, as well as the sequence of activities. In this sample, such incidents did not occur.

The shelters under study were chosen from two different refugee camps located in Beirut. In order to establish a comparison benchmark, the houses were chosen based on rehabilitation type while taking into consideration the number of rooms and the total area. Three factors were considered in the study, the width of the paths connecting the shelter with main access roads, the location of nearby construction sites, and continuous supervision by family members. Finally, some interviews with field engineers were performed in order to check the soundness and the sequence of performed tasks.

SHELTER DESCRIPTION

In order to establish a comparison criterion, the characteristics of several shelters were recorded. These characteristics are presented in Table 1. Shelters (SHs) entitled for major repair were chosen to be composed of two rooms, a kitchen, and a bathroom. The SHs areas range from 43m2 to 58 m2.In SH 1 and 10 the families hired a contractor to carry out rehabilitation works, while others hired different tradesmen. In SH 1, 9, and 10 the families did not participate nor supervise the rehabilitation works while the rest did. Only in SH 4 the family supervised but didn't participate in the rehabilitation works. SH 1 and 3 suffered from difficulty in entering material due to congestion from nearby construction sites; while SH 4, 6and 7 suffered from tight alleyways that connect them to main access roads.

Table 1 - Shelter Detailed Information

Shelter	Area(m2)	Paths to main road tight	Nearby construction sites	Rehabilitation approach	Regular supervision	Participation in Rehab. works
SH 1	43	×		Contractor	No	No
SH 2	44.5			Diff. tradesmen	Yes	Yes
SH 3	48.3	×		Diff. tradesmen	Yes	Yes
SH 4	55.5		×	Diff. tradesmen	Yes	No
SH 5	48.7			Diff. tradesmen	Yes	Yes
SH 6	52		×	Diff. tradesmen	Yes	Yes
SH 7	58		×	Diff. tradesmen	Yes	Yes
SH 8	51			Diff. tradesmen	Yes	Yes
SH 9	45.8			Diff tradesmen	No	No
SH 10	53.8			Contractor	No	No

RESULTS

During the project duration, several parameters were recorded; the average PPC, the status of work, and the reasons for any incomplete activities. Table 2 below shows the average PPC, and the status of each shelter at the end of the project duration. SH 1, 9, and 10 had an average PPC between 42% and 50%, and they were delayed. SH 2, 3, 4, 5, 6, 7, and 8 had an average PPC between 80% and 86%; and they were completed.

Table 2- Shelter average PPC and status

Shelter	Avg.PPC	Status
SH 1	42	Delayed
SH 2	80	Completed
SH 3	83	Completed
SH 4	80	Completed
SH 5	84	Completed
SH 6	83	Completed
SH 7	82	Completed
SH 8	86	Completed
SH 9	42	Delayed
SH 10	50	Delayed

The reasons for incomplete weekly activities within these projects can be divided into two categories; reasons that are within family/contractor control and those that are not within their control. Reasons such as manpower, rework, inaccurate duration estimate, prerequisite work not ready, litigation and lack of know how are within family/contractor control. Others reasons such as funds and unexpected site

conditions are not under family/contractor control. Figure 3 shows that the major contributors for incomplete weekly task are funds (delay in payments), unexpected site conditions, manpower, and rework with percentages varying from 26%, 16%, 15%, and 15% respectively.

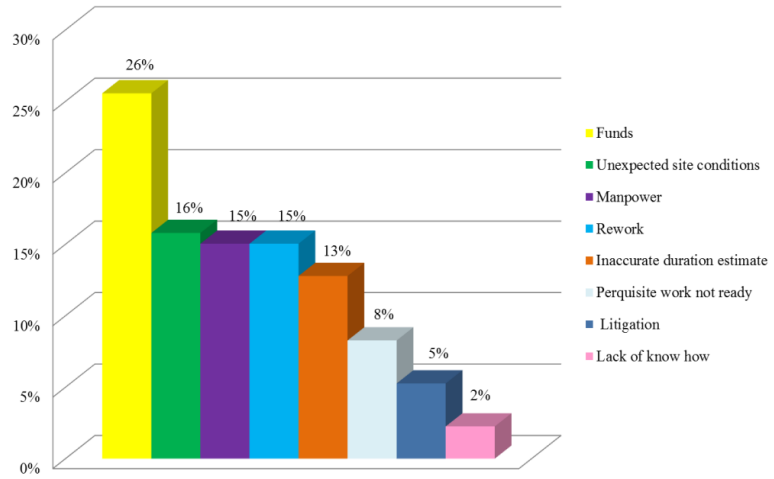

Figure 3: Reasons for Incomplete weekly

DISCUSSION

Figure 4 shows PPC curves for all the shelters during project duration along with the average PPC . It can be clearly seen that SH 2, 3, 4, 5, 6, 7, and 8 that finished on time are above the avergae PPC curve, whereas SH 1, 9, and 10 that were delayed are below the trendline.

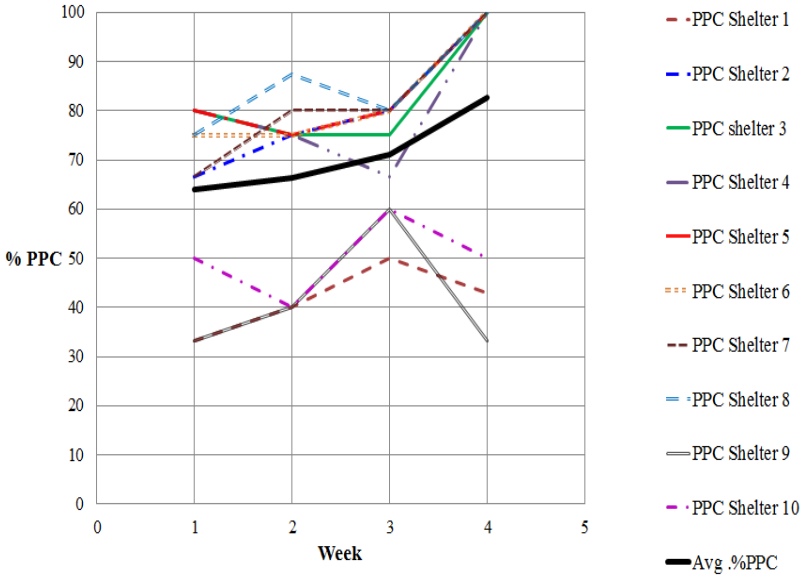

Figure 4: %PPC variation for all shelters

In delayed shelter, the workflow was slow and unorganized. The families in SH 1, 9, and 10 didn't supervise nor participate in activities; this resulted in poor execution of the tasks. In SH 1, and 9 the head of the family is very old; thus the younger members

supervised the work in non-regular manner. Therefore, no one was taking an effective role on organizing work on site. Moreover, the hired contractor tried to keep the number of workers to a minimum to ensure maximum profit. Rework, lack of manpower, inaccurate duration estimates were common reasons for delay in these shelters. In SH 10 the contractor was a relative to the family, they trusted him to perform the tasks; unfortunately, due to lack of follow up the quality of work was poor. The field engineer supervising the shelters refused the performed tasks multiple times, and forced them to redo the work. In summary, the families failed to actively engage and supervise the works.

In completed shelters, the workflow was fast and organized compared to delayed shelters. Some families hired tradesmen, others hired contractors; however , family members performed some rehabilitation activities, such as demolishing, plastering, painting, and transporting construction materials to site. The families managed the site and supervised the works in an agile manner. For example, SH 4, 6, and 7 had difficulty in transporting and handling material due congestion caused by neighbouring construction sites; to overcome this they transported the material at night time. Furthermore, the families continuously improved the activities. For example in SH 6 and 7 the families forced the workers to redo some of the tasks when they noticed poor implementation. In addition, in SH 8, the family noticed that internal plastering team productivity was low; as a result, they changed the team, and they hired another one for external plastering thus ensuring a parallel work flow for external and internal work activities. Moreover, in SH 3, workers had to use staircase to deliver backfill material from main access road to the shelter. After the material was dumped on the side of the main access road, it was filled in small bags that were then transported by workers back and forth on a long staircase. The family noticed that the old delivery method was time consuming, and it caused fatigue among the workers. To deal with the material delivery issue, 12 inch PVC pipe was used. The pipe was placed in a slopped manner spanning from main access road to the shelter as shown in Figure 5.Thus, ensuring a fast delivery method for backfill material.

Figure 5: Backfill material delivery

Finally, in SH 4, 5, and 6 the families prepared the site before the notice to proceed from UNRWA. They cleared the furniture from the house. They evacuated the house and started demolishing works for walls mentioned in contract. Hence, they gained an additional week. In summary, the families showed a great deal of collaboration. They expedited the flow of work through consistent supervision, and continuous improvement. The families showed lean behaviour during work; they tested different scenarios, removed constraints, took the initiative, and implemented the work safely.

One of the major contributors for incomplete weekly tasks was the delay in receiving funds which caused major disruption for work flow.

Each family in this project was given a scope of work schedule, including the activities that must be completed in weeks and the payments that will be received upon satisfactory completion. Failing to achieve the progress required in the scope of work - can be seen by low PPC scores - resulted in delayed payments request which add up to payments processing duration which ranges from six to twelve weeks. For shelters with high PPC, families were working ahead of schedule achieving more tasks faster. Thus, payment processing duration should be faster to accommodate for both delayed and fast shelters.

Refugee camps are dynamic environments and conditions vary every hour. Unexpected site conditions cannot be handled in planning. However, all families suffered equally from these conditions. Families that were present on site with contractors, managed to remove these conditions and solve them on site compared to other families that solely depended on foreign contractors who do not know the camp. Looking at Table-1, SH 9, and SH 10 didn't suffer from unexpected site conditions, however they were delayed. SH 3 to SH 8 managed to fix these conditions and achieve a higher PPC. In camps electrical and water lines are running together externally in a web form directly on top of the streets as shown in figure 2. During rehabilitation, some alleyways couldn't be accessed due to leakage in water pipes which resulted in electric hazards. According to UNRWA's field engineers and families, many refugees have lost their lives due to lack of proper infrastructure.

In the self-help approach regular supervision is a must. Even though UNRWA's field engineers visit every shelter on daily basis, some families worked at night time when engineers weren't on site. The role of the families is to fill the supervision gap and organize the flow of work in order to help achieving the rehabilitation process. Failing to supervise the works, will result in poor implementation of tasks as seen in SH 1, 9, and 10.

CONCLUSIONS AND FURTHER STUDIES

This study monitored ten shelters in a UN funded rehabilitation project in Palestinian refugee camps applying the self-help approach. PPC and causes for incomplete tasks were measured and analyzed for the projects' duration of 4 weeks. In order to establish a comparison, the houses having similar characteristics such as area, type of repair, and access to main road were chosen. PPC wasn't used by families or UNRWA to do weekly plans; instead it was running in the background.

The results showed that SH 1, 9, and 10 were delayed with average PPC between 42% and 50%. The poor performance was due to lack of regular supervision during project. On the other hand, SH 2, 3, 4,5,6,7, and 8 were completed with average PPC between 80% and 86%. The families took advantage of the rehabilitation process. They were Lean in managing the site, followed up all aspects of work, continuously improved processes, and removed constraints (Hamzeh and El Jazzar, 2015). The main motivator was the fact many families lived in extremely poor conditions for a long time, thus living in a decent and safe shelter is a once in a lifetime opportunity for them. When they were given the chance to repair their shelters through self-help approach, they worked very hard to achieve the best results, hence projecting their attachment to their homes through extreme effort. Still delay in receiving funds, and

unexpected site conditions were the major contributors for incomplete weekly tasks in all shelters with an occurrence rate of 26% and 16 % respectively. Delay in transferring funds is caused by the bank transfer process. Unexpected site conditions are caused by the camps unorganized infrastructure.

This study shows the benefits of Self-Help approach and how it affects families' lives. This process promotes lean behaviour as it engages people in the repair process, driving them to take initiative, and achieve their dreams. Even though this method wasn't designed to be lean, yet for this specific project there was a high correlation between both (Hamzeh and El Jazzar, 2015).This study measures LPS metric, and causes of delay which is the first time in a UN funded project. Project evaluations that was previously done, didn't measure field data such as PPC. The aim is to promote further research in order to implement LPS in UN projects as these projects affect people life's directly. Future research should focus on improving the fund transfer process, and studying more complex interventions such as reconstruction since these interventions hold more challenges along the way. In addition, Self-Help method in the scope of this particular project promoted lean behaviour (Hamzeh and El Jazzar, 2015). However, applying self-help on other types of projects requires further research.

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