

A Study on Work Continuity Analysis in Manpower Management for Rebar Work during Construction

Seo, Jong-min¹ and Kim, Sun-kuk²

1 Graduate Student, Kyunghee University, Kyunggi-do, KOREA , jongmin_seo@yahoo.com

2 Professor, Kyunghee University, Kyunggi-do, KOREA, kimsuk@khu.ac.kr

ABSTRACT

Amid the latest trend in architecture and civil engineering projects characterized by erecting larger, and taller, buildings, a host of issues have surfaced, addressing the current industry practice of inefficient manpower management and, in particular, the urgent need to ensure efficient work flow based on necessary materials, crews and equipment coordinated with timeliness and precision. And relevant investigations have revealed substantial waste in core elements due to inefficient manpower management. Considering the ever-increasing oil and raw materials costs and sluggish economy, studying factors that influence manpower management and inventing appropriate plans are deemed crucial. The purpose of this study was to analyze one such factor “work continuity,” focusing on rebar work during apartment housing construction projects. Results of the study suggest that precision labor placement at the most compatible assignments will likely help establish efficient work flow.

Keywords: Just-in-time (JIT) production, manpower management, lean construction, continuity, resource optimization

1. INTRODUCTION

1.1 Research Background and Purpose

As with the ever-increasing favor of larger and taller buildings in the recent construction industry, amount of resources mobilized, such as labor, materials, equipment, etc. necessary to implement projects, has been skyrocketing as well. Mega-scale projects, in particular, involve vast sites, armies of subcontractors, and diverse human resources, whose success will ultimately depend on whether or not their project manager can place crews to “the perfectly fitting” assignments and job sites according to the construction schedule and manage them efficiently. Nevertheless, in reality, there is a stark contrast between such logical conclusion and day-to-day

practice, one of which being inefficient and under-planned manpower management.

Mismanaged labor generates waste factors, which contribute to nose-diving productivity and soaring costs. When combined with the latest misfortunes in the ailing global economy and its repercussions in construction, the waste factors raise serious issues associated with affecting elements in manpower management and appropriate alternatives. This study aimed to analyze one such element “work continuity,” as related to manpower management, and had its scope limited to rebar work during apartment building construction. Review of literature included: Lee Tae-sik (2002), which studied some of the factors that induce lowered productivity at construction sites; Kim Tae-wan (2003), who investigated the effects of work suspension on on-site productivity and on productivity

achievement rate; Park Ju-hyeon (2003) examined analysis of correlation between productivity-lowering factors and mobilized manpower; and Thomas (2006) study looked into basic principles of work management. The quoted research projects all addressed appropriate manpower management plans, though they offer little to no insight into work continuity analysis in the management of manpower. The results of this study suggest positive expectation effects by assigning right crews to right places and establishing efficient work flow.

1.2 Research Scope and Method

This study investigated the work continuity analysis in manpower management and particularly the productivity of rebar work, one of the manpower management-affecting factors, and the subsequent work continuity.

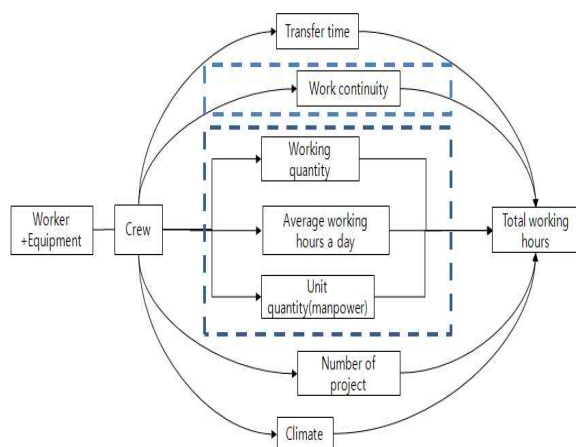


Figure 1. Scope of Study

Research method included, first, review of previous literature to investigate manpower planning and to build concepts. Based on the findings from the review, the present authors examined crews, preparation time, actual work, clean-up time, work quantity, and unit quantity (manpower) as related to rebar work at each of the construction sites run by Korean builders, to help identify productivity during rebar work. For rebar

processing, the present authors investigated sites operated by three constructors and 15 on-site processing sessions. And for rebar assembly, the authors visited four sites and 15 assembly sessions. Due to the vastness of the study question, the researchers focused on apartment buildings only. Another method adopted by this study was to analyze factors that affect work continuity. For the analysis, related literature was reviewed and construction engineers were consulted, and then based on the information obtained, site investigation was conducted to analyze work continuity.

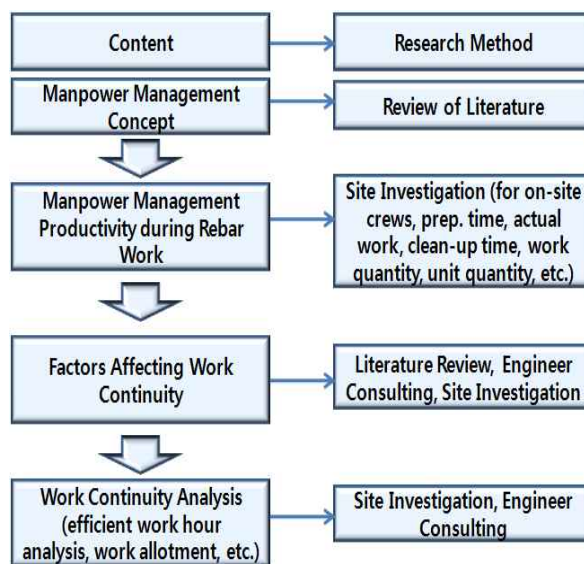


Figure 2. Research Method and Procedure

2. THEORETICAL CONSIDERATION

2.1 Review of Research Trend

Review of both local and international manpower management literature included studies by Park Ju-hyeon et al. (2003) and Chang Wan-bok et al. (2003), which suggested a relationship between manpower management and work productivity. Kim Tae-wan et al. (2003) and Jung Hee-seok et al. (2002), on the other hand, analyzed productivity-influencing factors. Among the offshore research projects reviewed, studies by Hegazy et al. (2004) and Elhakeem et al. (2005) examined manpower planning while

Thomas et al. (2006) performed research on work management. Unfortunately, there were very few articles on analysis of work continuity in manpower management planning.

2.2 Concept of Manpower Management

Manpower management of multi-projects work was developed based on work distribution by Hegazy (2004). Organizing the team with the workers and concrete pump car, appropriate working hours were calculated based on analysis of the productivity of the multi-projects.

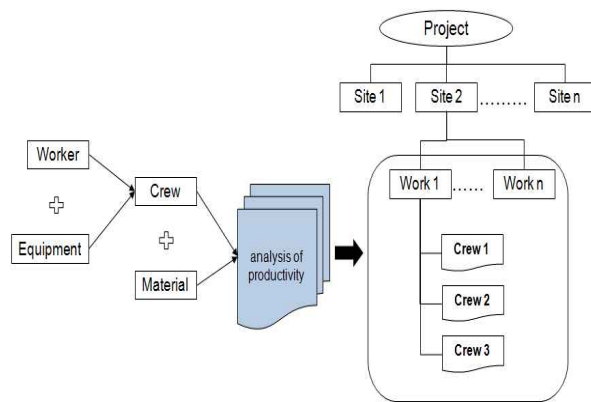


Figure 3. Manpower Management Flow

Total working hours are obtained by multiplying the working quantity by average working hours a day and manpower/unit quantity.

Total working hours = required manpower for unit quantity × quantity of rebar × daily working hours -----(1)

Unit – required manpower for unit quantity: MDY(man·day)/ton, total working hours: MHR(man·hour), quantity of rebar: ton, daily working hours: hours/day

3. ANALYSIS OF THE PRODUCTIVITY OF REBAR WORK

When pouring concrete in Korea, a huge waste of manpower has been often resulted from the manpower allocation based on experimental practice or overestimate. This

study thus was intended to evaluate the productivity for rebar work. Rebar work was evaluated based on site fabrication and erection. In case of rebar fabrication, survey was conducted at 3 different construction sites over 15 occasions, and for rebar erection, it was carried out at 4 different sites over 15 occasions. The survey was carried out at apartment building construction sites. When it comes to rebar work, examination was carried out for retaining wall, floor and basement foundation.

Included in the examination are manpower, time for preparatory work, actual work, finish work, working hours and unit quantity (manpower), and the examination on a team base was carried out for concrete work. The team was categorized into RC worker and common worker as it's a general practice in Korea.

Rebar work includes the time for preparatory work, actual work, and finish work. Working hours were checked by activity to calculate the total working hours. In the foreign study on rebar work productivity analysis (Hegazy 2004), it was divided by total working hours as indicated in Formula 2 to estimate the data in ton/MHR for rebar.

required manpower for unit quantity (ton/MHR) = quantity of rebar(ton) / total working hours(MHR) -----(2)

However, unlike foreign cases, unit quantity in Korea is usually set in man·day/ton. unit quantity is calculated in such a way of dividing the total working hours by working hours multiplied by working hours a day. Working hours a day was limited to 8 hours and the calculation was based on 1ton.

required manpower for unit quantity (MDY(man·day)/ton) = total working hours / quantity of rebar × daily working hours ----- (3)

Unit – required manpower for unit quantity: MDY(man·day)/ton, total working hours:

MHR(man·hour), quantity of concrete: ton,
daily working hours: hours/day

Rebar work includes site fabrication and site erection, and Table 1 indicates the productivity analysis of rebar fabrication by site in manpower/unit quantity. The examination for analysis was carried out at the site of Builder N, D and T over 15 occasions.

Builder (Site)	Manpower	required manpower for unit quantity (MDY(man·day)/ton)
Builder N	Rebar workers	0.686
	common workers	0.204
Builder D	Rebar workers	0.585
	common workers	0.219
Builder T	Rebar workers	0.134
	common workers	0.038

Table 1. Analysis of Rebar Fabrication Productivity by Site

In Table 2, rebar fabrication of entire builders was indicated on average by categorizing it into rebar worker and general worker. As average manpower/unit quantity, rebar worker was found to be 0.582 manpower, while general worker was 0.203 manpower.

Type of Structure	Worker	required manpower for unit quantity (MDY(man·day)/ton)
Apartment building	Rebar workers	0.582
	common workers	0.203

Table 2. Analysis of Rebar Fabrication Productivity by Category (Average)

Rebar erection after fabrication was examined at 4 different sites over 15 occasions as shown in Table 3. For fabrication, rebar worker was found to be 0.640 manpower and general worker 0.157 manpower at Builder N and 0.975 and 0.275, respectively at Builder D.

Builder (Site)	Manpower	required manpower for unit quantity (MDY(man·day)/ton)
Builder N	Rebar workers	0.640
	common workers	0.157
Builder D	Rebar workers	0.975
	common workers	0.275
Builder T	Rebar workers	0.717
	common workers	0.359
Builder S	Rebar workers	0.605
	common workers	0.202

Table 3. Analysis of Rebar Fabrication Productivity by Site

According to estimating the rebar fabrication productivity in Table 3 on average, rebar worker was found to be 0.844 manpower and general worker 0.244 manpower.

Type of Structure	Manpower	required manpower for unit quantity (MDY(man·day)/ton)
Apartment building	Rebar workers	0.844
	common workers	0.244

Table 4. Analysis of Rebar Fabrication Productivity by Activity (Mean Value)

4. ANALYSIS OF WORK CONTINUITY

4.1 Factors that Influence Work Continuity

Work continuity in construction sites exercises significant influence on productivity. To identify specific factors that affect the continuity, the present authors quoted the factors described in the study by Jung Hui-seok et al. (2002) and sought specializing engineers' consulting. The investigation led to four specific factors as illustrated in Figure 4 below: inefficient work and insufficient instruction; excessive transfer; work delay; and under-planned support work.

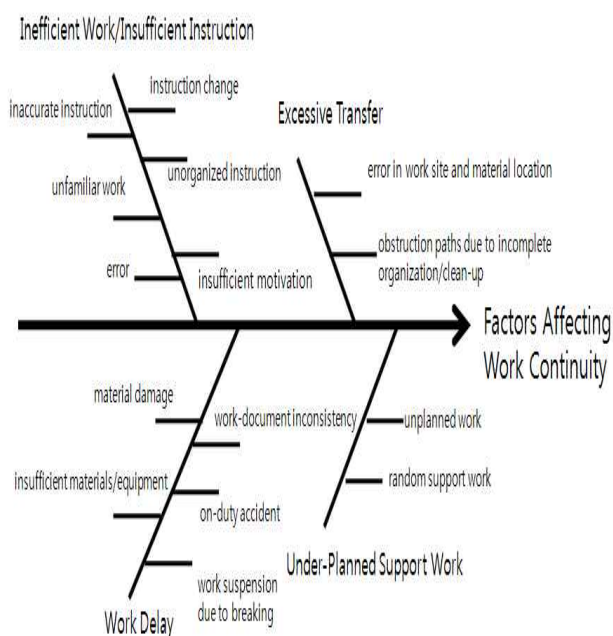


Figure 4. Factors Affecting Work Continuity

The “Inefficient Work/Insufficient Instruction” factor was further identified as inaccurate work instruction, unplanned instruction, operation error, etc. And the “Work Delay” was found to include material damage, inconsistency between documentation and actual work, shortage in materials and equipment, work suspension due to breaking, etc.

4.2 Efficient Work Hour Analysis

To ensure efficient operation in construction sites, as related to manpower management, the management staff must first break down work quantity by time unit. While doing such, manpower and work quantity must be a match. For instance, workers must fiercely concentrate on what they are doing when they are operating on large workload. In addition, proactive analysis must be done to identify concentration level of workers so that, during, say, certain blocks of hours with good concentration, workers should be discouraged to take a break. For this research project, time unit-specific work quantity was examined based on Thomas et al. (2006)'s analysis of workers concentration level by time unit. Scope of the examination was limited to rebar work during apartment building construction, where the work was defined as conventional rebar assembly for floor/ground. The total number of crews involved was 24: 16 rebar operators and eight general workers. The total daily work quantity was 25.1ton.

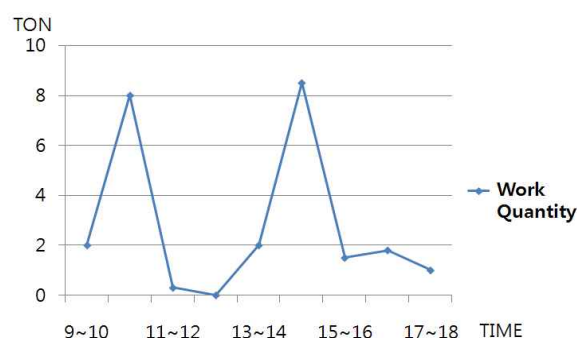


Figure 5. Rebar Work Quantity by Time Unit (Total Quantity: 25.1ton)

Analysis of rebar work quantity by time unit (hour) is illustrated in Figure 5, where an eight-ton work was done between 10 AM to 11 AM and an 8.5ton work, the largest amount, was carried out between 2 PM and 3 PM. The analysis also showed that there was no work conducted between noon and 1 PM, due to the time slot corresponding to lunch break, while from 3 PM to 3:30 PM, workers took their mid-afternoon break to

snack, resulting in a visible drop in the amount of work done.

Considering crews' hours and workload change daily in the majority of construction sites, the present authors also consulted professional construction engineers to supplement the findings from their investigation, which confirmed that the highest level of efficiency was found to operate around 10 AM and 2 PM, respectively. As mentioned earlier, rebar workers take a good number of breaks in addition to the official ones, during which everyone breaks at the same time. As the findings and the consultant feedback suggest, a sure way to get the largest amount of work done is to schedule breaks in such a way that the workers will not break during the two peak-efficiency slots.

4.3 Efficient Labor Allotment

When assigning workers, the crews' characteristics must be taken into consideration to ensure good work continuity. This principle was also found utilized in Hegazy et al.'s 2004 manpower management study, where the researchers considered the work continuity factor before allotting work to the crews.

Figure 6 below is an assignment chart that has incorporated the continuity factor when deploying crews to various sites in multiple-site construction projects, based on the Hegazy study (2004). For example, when a team of crews complete their work in a particular site, they should be transferred to a nearby site to embark on another round of rebar work or to assist in clean-up operations. That way, continuity will be maintained and efficiency be increased. Figure 6 also shows, organizing crews based on work continuity consideration, not on random deployment schedules, saves a considerably larger amount of time.

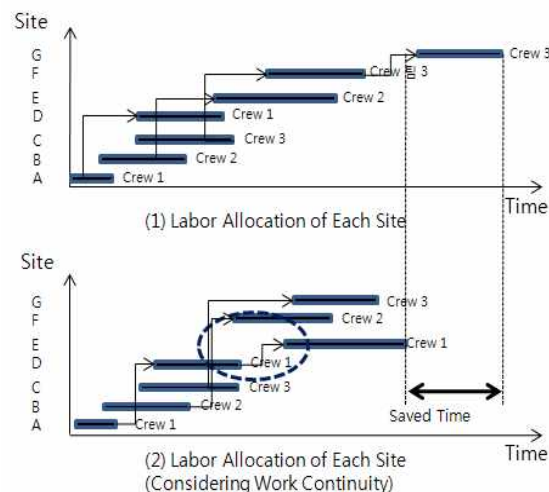


Figure 6. Work Continuity-Based Labor Deployment

5. CONCLUSION

The purpose of this study was to examine work continuity analysis in rebar crew manpower management during apartment housing construction projects. Due to the vast nature of the subject, the present authors focused on work continuity based on productivity, one of many factors that affect workforce. For productivity analysis, site investigation was the research method adopted; for work continuity analysis, site investigation/observation and engineer consulting were utilized. Specifically, rebar processing involved three constructors' building sites and 15 on-site processing sessions. Rebar assembly required four sites and 15 assembly sessions.

According to the results of the productivity analysis, unit quantity (manpower) of the rebar processing operators, on average, was 0.582 (persons) and that of the general workers was 0.203 (persons). In the case of the rebar assembly, unit quantity of the rebar workers was 0.844 while that of the general workers turned out to be 0.244.

Analysis of work continuity, based on the present authors' site investigation and professional constructor consulting, showed that the highest level of work efficiency was observed around 10 AM and around 2 PM

and that efficient labor deployment based on continuity consideration saved a lot more time than random, unorganized deployment programs. The results, however, should be viewed with caution that only one case was analyzed in this study, where relationship between work efficiency and continuity was examined by time unit (specific time of the day). Though this implies that more studies be on the way in the future by capitalizing on larger volumes of data and statistical analysis, what this study has found is believed to generate some expectation effects that will likely help build efficient work flow, based on optimum manpower that is assigned to right places at the right time.

REFERENCES

- [1]Kim Tae-wan, Yu Jeong-ho, Lee Hyeon-su. 2003., Effects of Work Suspension on Site Productivity and Productivity Achievement Rate. Anthology of KICEM Conference Articles, Vol. 4, pp. 311 – 314. Korea.
- [2]Park Ju-hyeon, Kim Dae-yeong, Lee Hak-gi. 2003, A Study on a Correlation between Lean Construction-Associated Productivity-Compromising Factors and Waste Factors. Anthology of KICEM Conference Articles, Vol. 4, Issue 4, pp. 164 – 172. Korea.
- [3]Park Chan-jeong, Park Hong-tae. 2004, A Case Study: Manpower Management using Daily Progress Checking System. Anthology of KICEM Conference Articles, Vol. 5, Issue 1, pp.124 – 132. Korea.
- [4]Won Gyeong-seok, Kim Jae-jun. 2004, Status Analysis and Improvement Plans for Mobilized Manpower Management in Completion Work for Multi-Use High-rises. Anthology of KICEM Conference Articles, Vol. 5, pp. 1 – 4. Korea.
- [5]Chang Wan-bok, Kim Han-su. 2003, A Study on Productivity Analysis Methodology for Office Building Construction Projects based on Work Cycle Analysis. Anthology of AIK Conference Articles, Vol. 23, Issue 2, pp. 619 – 622. Korea.
- [6]Jung Hui-seok, Lee Tae-sik, Park Jong-hyeon. 2002, A Study on Management Responsibilities for Factors that Compromise Productivity. Anthology of KICEM Conference Articles, Vol. 3, pp. 350 – 354. Korea.
- [7]Ahmed Elhakeem, Tarek Hegazy. 2005, Graphical Approach for Manpower Planning in Infrastructure Networks. J. Constr. Engrg. and Mgmt., Vol. 131, Issue 2, pp. 168 – 175. Canada.
- [8]Tarek Hegazy, Ahmed Elhakeem, Emad Elbeltagi. 2004, Distributed Scheduling Model for Infrastructure Networks, J. Constr. Engrg. and Mgmt., Vol. 130, Issue 2, pp. 160 – 167. Canada.
- [9]H. Randolph Thomas, Michael J Horman. 2006, Fundamental Principles of Workforce Management, J. Constr. Engrg. and Mgmt., Vol. 132, Issue 1, pp. 97 – 104. USA.