

EVALUATING PRODUCTIVITY-AFFECTING FACTORS ON FINISHING WORKS IN HIGH-RISE HOUSING CONSTRUCTION

Chi-Joo Lee¹, Jae-Jun Kim², In-Suk Park³, Sang-Hyo Lee⁴ and Yoon-Sun Lee⁵

¹ Master Course, Dept. of Sustainable Architectural Engineering, Hanyang Univ., Seoul, Korea

² Associate Prof., Dept. of Sustainable Architectural Engineering, Hanyang Univ., Seoul, Korea,
(corresponding author). E-mail: jjkim@hanyang.ac.kr

³ Master Course, Dept. of Sustainable Architectural Engineering, Hanyang Univ., Seoul, Korea

⁴ Master Course, Dept. of Sustainable Architectural Engineering, Hanyang Univ., Seoul, Korea

⁵ Research Prof., Sustainable Architecture Professional Education Center, Hanyang Univ., Seoul, Korea

Abstract

Constructing high buildings is a global trend, and skyscrapers for residing are also increasing. But a period of works for finish construction is different depending on a company while a period of works for frame construction of skyscrapers for residing in the country is regular when considering a difference of a method of construction, and the increase of repeated construction for high buildings and number of related process for finish construction are stressing the importance of improving productivity through construction management and plan for works. Because there are many compositive factors affecting productivity other than technical factors, we should intensively study the way of improvement and prevention preferentially through analyzing factors affecting productivity. So in this study, we present important management factors for making systematic strategy and plan for improvement of productivity by finding factors affecting productivity depending on the degree of importance unifying factors affecting productivity of plan factor(internal factor of construction process) and management factor(outer factor of construction process).

Keywords : High Rising Housing,, Frame works, Productivity affecting Factor, AHP

1. Introduction

1.1 Backgrounds and Objectives

Constructing skyscrapers has been a new value added area in construction industry of the country, and the number of skyscrapers for residing in the urban center is expected to increase. When considering each country's state, 47.9% in China is skyscrapers and 920 in Hongkong, 44.7% of that are skyscrapers. In total, the 50% of skyscrapers for residing is been constructing or is going to be constructed. (Jeong chang yeong, 2005) But a period

of works for finish construction is different depending on a company while a period of works for frame construction of skyscrapers for residing in the country is regular by considering a difference of a method of construction. This is mainly because of difference of technology in managing process of each company. The below table 1 is showing comparison between each period of finish construction of skyscrapers for residing in Korea. With referring to progress schedule of representative skyscrapers for residing in Korea, the table was made. And as seen in the table, it shows the period of finish construction changes very differently compared with other kinds of construction.

Table 1. High-Rise Housing Building in finishing works in comparison

Building	Floor (the ground)	Frame works (underground)	Frame works (the ground)	Finishing works	The total time
A	66 floor	2.7 months	13.2 months	13.8 months	37.5 months
B	55 floor	2.5 months	11.3 months	17.7 months	40.3 months
C	69 floor	2.9 months	13.1 months	14.0 months	37.9 months
D	46 floor	1.5 months	13.5 months	21 months	41.5 months
E	36 floor	4 months	11 months	14 months	39 months
F	37 floor	5 months	14.5 months	18.5 months	36 months
G	46 floor	2.7 months	12.5 months	12.5 months	36.5 months
H	69 floor	3.0 months	18.5 months	9.5 months	36.5 months

In this study, we are going to offer basis for improving productivity and analyzing productivity by drawing important management factors depending on the degree of importance of factors affecting finish construction by considering present state of finish construction of skyscrapers for residing.

1.2 Procedure

This study analyzes how the importance in each view changes and how factors affecting productivity are considered in a construction site by applying AHP analysis through questionnaires, interview of specialist and study of the document. This study is processing like the following picture 1.

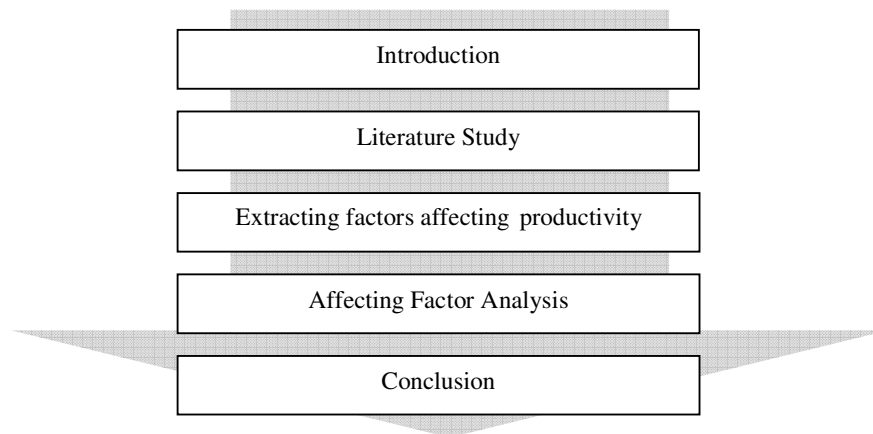


Figure 1. procedure

2. Literature review

2.1 The definition of High-Rise Building

The building higher than 12 stories is classified into the skyscraper in Europe, and the building between 70 stories and 100 stories is classified into the skyscraper in Chicago. Like this, because the standard for the skyscraper is different according to area or the degree of development of technology, it is difficult to define the skyscraper with height or the number of stories. (song du heon, 2002) But when considering the present state of skyscrapers for residing in the country, constructions over 30 stories hardly exist except several big city, such as seoul, busan, daegu, gyeonggi, etc. So this study chose buildings for residing over 30 stories by considering the direction of development and present state of skyscrapers for residing in the country with meeting tendency of construction industry.

2.2 A trend of the productivity study

The study for construction productivity is divided into 2 ways. one is to study about factors affecting productivity and the other is to study about analysis of productivity. The table 2 shows 2 grouping as previously described about preceding productivity study.

Table 2. The existing study in connection with productivity

Classification	An author	The title of document and main contents
The study about factors affecting productivity	Oh, Se-Wook (2006)	The Application of Data Warehouse for Developing Construction Productivity Management System
	Pyo, Young-Min (2005)	The study on the Analysis of Factors Decreasing Construction Labor productivity Using AHP Method
	Kim, Dae-Won (2005)	Evaluation Main Effect Factors in the Duration of Form-work for Tall Building in korea
	Son, Chang-Baek (2004)	An Analysis on the Selection and Application of Productivity Improving Factors in Apartment Building Construction
	Hong, Young-Tak (2004)	Evaluation of Time-Affection Factor in High-Rise Building Construction Using FMEA
	Kim, Yea-Sang (1994)	Analysis of the Factors Influencing Construction Productivity
The study about productivity analysis	Joo, Jin-Kyu (2003)	A Work Model for Engancing the Productivity of Rebar Work
	Koo,Ja-Min(2004)	Construction Delay analysis Method Considering Productivity.
	Son, Jeong-Wook (2004)	A Study on Construction Productivity Measurement Method

3. Extracting factors affecting productivity

Factors affecting productivity of skyscrapers project can be considered as a factor affecting a period of works in each story. Because the whole period of works can be changed by a period of works in each story. The deduction of factors affecting productivity is divided into a plan factor(internal factor of construction process) and management factor(outer

factor of construction process).¹ (hong yeong tak, 2004) The plan factor can be thought as a factor resulted from process of construction, and the management factor can be thought as an external factor of construction process.

3.1 Plan factor (Internal factor of construction process)

We chose the study subject for plan factor by considering importance and the degree of difficulty in finish construction. The analysis of importance and the degree of difficulty is done through questionnaires and interview with assisting company and original building contractor, and the result of this study shows that the analysis result of importance (figure 2) and the degree of difficulty (figure 3) of stud/runner installation and plastering construction of floor is the highest. This is because these are works affecting whole productivity a lot owing to being basis of other processes, and asking high sophistication. The works which can measure improvement of productivity most effectively through improvement of process of work should be the process of construction which is repetitive, whose process is simple, and which has proper quantity for observing for enough time. So we thought stud/runner construction more proper than plastering construction of floor, thus, chose factors affecting construction of the dry light wall as a subject for analyzing.

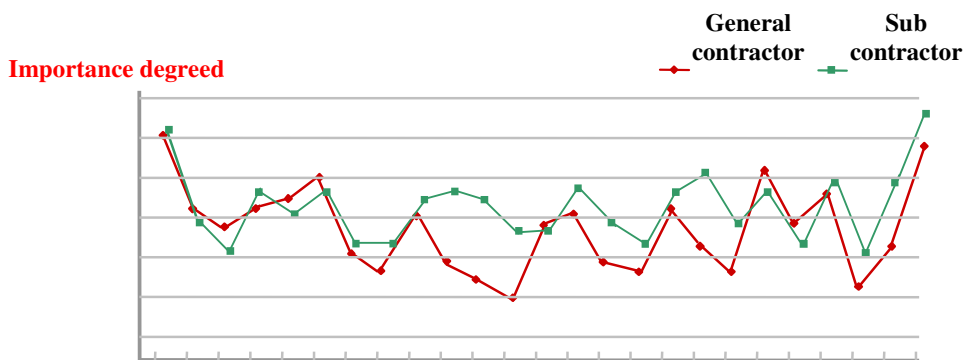


Figure 2. Importance analysis of each finish construction process

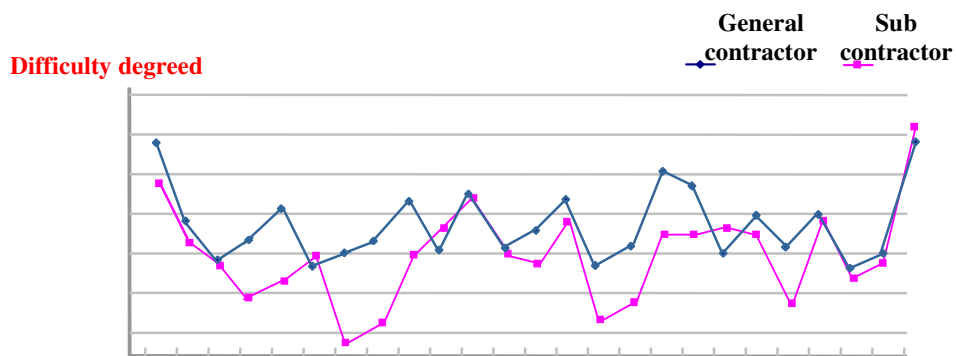


Figure 3. The degree analysis of difficulty of each finish construction process

¹ The plan factor settles a planned period of construction when planning a period of construction for each floor, and the management factor should be managed for following the planned period of construction for each floor.

We drew factors affecting construction of the dry light wall as a subject for analyzing the plan factor with the method in the questionnaires and interviewing with specialists, and that result is presented in table 3 below. This was made by extracting factors through document study, questionnaire after verifying factors through interview, extracting detail factors and affecting factors, and setting up study model after verifying through interview, etc.

Table 3. Plan Factor

Classification	Affecting Factor	Detail Factor
Plan Factor	The cargo-working	Plot planning for a workshop
		Other works and interference
		Procuring yard
	Lifting work	Lifting work plan
		Weather condition
		Security management
	Marking	Vertical and horizontal regulation
		Lifting work and interference
		Interference by early lifting work of material
	Installation	Worker's experience
		Interference of previous and after process
		A lack of transfer route and working place

3.2 Management factor (Outer factor of construction process)

The management factor is also drawn by the procedure in the questionnaires and interviewing with specialists. Especially, to compose proper class for AHP analysis, we composed each class by interviewing with specialists, factors related to human power and supplied sources of that is considered as a detail factor. This is because we thought human power is also one of the supplied sources. Also we found the idea of specialized design agent is scarce in factors related to design and the number of company having technology is limited, and the importance of that was proposed by interview with specialist, so we drew as the management factor. The management factor extracted by same method with plan factor is like the table 4 after comparing with the preceding study.

Table 4. Manatement Factor

Affecting Factor	Detail Factor	Kim, Yea-Sang.	Hong, Young-Tak.	Pyo, Young-Min.	Son, Chang-Baek.
Human power and input material	Supply system for input materials and human power	△		△	●
	Efficient distribution of input materials and human power	△			●
	Manager's quality and ability to manage crisis	△	△		●
Factors related to design management	Design with considering possibility of construction	●			●
	Design in depth	●	△	●	●
	Training specialized design worker				
Factors	Rational process plan	△	△	●	△

related to construction management	Prompt decision making and ordering job	●	●		
	Make up efficient working group	△		●	●
Construction character and outer factors	Working condition on the spot	△		●	●
	Regulation on the spot	△			●
	Generating a strike and a civil appear	●	●		

△ : similar ● : equal

4. Analysis of the Affecting Factor

4.1 Investigation plan

A period of study is 3 weeks from 9.4, 2006 to 9.24, 2006, and a method of study is a questionnaire study through e-mail and direct visit. The subject of this study is that first, original construction contractor is a large enterprise and the site of construction is in a big city larger than megalopolis, second, finish construction in constructing building for residing more than 30 stories is doing in the site of construction, and third, a form of placing an order is a bundle form and a method of wall construction is dry wall. The method of measuring question is composed by pairwise comparison method between each factors having 9 points, and 109 of 120 questionnaires were collected and chosen as the subject of analysis.

4.2 Extracting priority order of Productivity Affecting Factor

In this study, the system formation for setting importance of each factors affection productivity is divided as the plan factor and management factor of 1 class, 2 class and 3 class. We drew the important management factor by prioritizing factors affecting the plan factor and management factor after evaluating importance of result of questionnaire according to 1, 2, 3 class. The plan factor has higher importance than the management factor. When considering detail factors of each factor, the importance of marking and installation of plan factors are high, and the importance of factors related to construction management and installation management of management factors are high. In the result of analyzing importance of 3 class the importance of heavy work place arrangement plan, safety management, vertical and horizontal modulation, intervention of before and after process of plan factors is high, and the importance of quality and ability for crisis management of manager, design considering execution, rapid decision and orders, environment of the site of management factors is high. The table 5 presents total importance and priority unifying the importance drawn from 2 class and 3 class . A vertical and horizontal modulation, intervention by materials, intervention of curing works, intervention of before and after process, worker's experience which are detail factors related to marking and installation of 2 class are in high priority of total affecting factors. A design considering execution, rapid decision and orders, environment of the site of management factors, rational process plan, etc. which are detail factors of 3 class of management factors are in high priority.

Table 5. Total importance and priority of the affecting factor

1 class	Importance	2 class	Importance	3 class	Importance	Total Importance	Priority
---------	------------	---------	------------	---------	------------	------------------	----------

P L A N F A C T O R	0.521	The cargo-working	0.182	Plot planning for a workshop	0.363	0.034	18		
				Other works and interference	0.305	0.029	21		
				Procuring yard	0.332	0.031	20		
		Lifting work	0.227	Lifting work plan	0.342	0.040	12		
				Weather condition	0.269	0.032	19		
				Security management	0.389	0.046	11		
		Marking	0.307	Vertical and horizontal regulation	0.357	0.057	2		
				Lifting work and interference	0.315	0.050	8		
				Interference by early lifting work of material	0.328	0.052	5		
		Installation	0.284	Worker's experience	0.346	0.051	7		
				Interference of previous and after process	0.398	0.059	1		
				A lack of transfer route and working place	0.256	0.038	15		
		M A N A G E M E N T F A C T O R	0.479	Human power and input material and resources	0.209	Supply system for input materials and human power supply system	0.254	0.025	23
						Efficient distribution of input materials and human power	0.286	0.029	22
						Manager's quality and ability to manage crisis	0.46	0.046	10
Factors related to design management	0.273			Design with considering possibility of construction	0.426	0.056	3		
				Design in depth	0.296	0.039	13		
				Training specialized design worker	0.278	0.036	17		
Factors related to construction management	0.287			Rational process plan	0.338	0.046	9		
				Prompt decision making and ordering job	0.387	0.053	4		
				Make up efficient working group	0.275	0.038	14		
Construction character and outer factors	0.231			Working condition on the spot	0.463	0.051	6		
				Regulation on the spot	0.331	0.037	16		
				Generating a strike and a civil appear	0.206	0.023	24		

5. Conclusion

The importance of plan factor is higher than that of management factor according to AHP analysis. Especially, intervention of before and after process of plan factors, vertical and horizontal modulation, etc. which are detail factors related to marking and installation of 2 class of plan factors are in high priority. To improve construction productivity having different features from manufacturing industry, we should do systematic productivity analysis by establishing measurement, and before that, manage and study important factors which help potential improvement and has high importance of factors affecting

productivity. This study found priority according to importance by unifying plan factors and management factors of factors affecting finish construction of skyscrapers for residing. This improves understanding for factors affecting productivity and offers factors affecting productivity which should be managed practically, so it is thought that this can help construction company's systematic management. Because the purpose of this study is to draw total affecting factors unifying plan factors and management factors, the analysis in detail for each measured factor is insufficient. Thus, a study trying to find causation between plan factors and management factors will be needed. And finding the way of improvement will be needed through practical productivity analysis after finding factors which are deterioration factors and have potential improvement power by analyzing specific analysis for each factor.

6. Acknowledgment

This work was supported by the SRC/ERC program of MOST/KOSEF (R11-2005-056-03001)

References

- [1] **Yea-Sang Kim(1994)**, “Analysis of the Factors Influencing Construction Productivity”., Journal of the Architectural Institute of Korea., v10. n10, 267-273.
- [2] **Jeung-Ik Bae and Byung-Uk An and Sang-Min Kim.(2004)**, “A study on the Post Occupancy Evaluation of Super High-Rise Apartment”., Journal of the Architectural Institute of Korea., v20. n9, 127-134.
- [3] **Chang-Baek Son and Duck-Chan Lee.(2004)**, “An Analysis on the Selection and Application of Productivity Improving Factors in Apartment Building Construction”., Journal of the Architectural Institute of Korea., v21. n4, 133-140.
- [4] **Se-Wook Oh and Myoung-Ho Kim and Young-suk Kim.(2006)**, “The Application of Data Warehouse for Developing Construction Productivity Management System”., Journal of the Korea Institute of Construction Engineering and Management., v7.n2, 127-137.
- [5] **Won-Jo Jung and Il-Han Yu and Kyung-Rai Kim and Dong-Woo Shin.(2005)**, “Analysis of the Weights of Performance Measurement Index according to the Size of Construction Companies”., Journal of the Architectural Institute of Korea., v21. n8. 121-128.
- [6] **Chang-Yong Jeong and Sung-Kyu Kim and Boo-Seong Kang and Jin-Wook Kim.(2005)**, “A Comparative Study on ghe Developing Trends and Charateristics of High-Rise Housing at World Wide Cities”., Journal of the Architectural Institute of Korea., v21.n12, 193-200.

- [7] **Young-Tak Hong and Jung-Ho Yu and Gyeong-Ho Lim and Hyun-Soo Lee.(2004)**,
“Evaluation of Time-Affection Factors in High-Rise Building Construction Using
FMEA”., Journal of the Architectural Institute of Korea., v20.n.10, 183-192.