

Case study of Construction Manager allocation between Construction Technology Promotion Act and Construction Technology Management Act

Seongmi Kang¹, Hunhee Cho², Sangchul Kim^{*3}

¹Executive, Public projects division, ITM Corporation, Seolleung-ro 747, Gangnam-gu, Seoul 06056, Korea

²Professor, School of Civil, Environmental and Architectural Engineering, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul, 02841, Korea

^{*3}Professor, School of Architecture & Design Convergence, Hankyong National University, 327, Jungang-ro, Anseong-si, Gyeonggi-do 17579, Korea

Abstract.

BACKGROUND/OBJECTIVES: This study compared the cases of construction project management services for public works that were ordered based on two Acts.

METHODS/STATISTICAL ANALYSIS: This paper analyzed the limitations and problems of manpower operation based on the previous Construction Technology Management Act and cases based on the Construction Technology Promotion Act, which was completely revised in May 2014.

FINDINGS: In recent years, the demand of technical manpower who can demonstrate creative solution ability based on various expertise and sufficient practical experience is increasing day by day due to the needs of the construction market for convergence with the 4th industrial revolution and productivity innovation. Until recently, when public works construction project management services were announced, the allocated personnel should be placed at a higher level than the actual personnel. Accordingly, the labor cost burden of Construction Management (CM) companies increased due to the decrease in productivity and excessive manpower. And the completion of the project was reduced due to the employment of low-wage personnel. In order to solve this problem, it is necessary to legislate through collecting opinions of various related experts.

IMPROVEMENTS/APPLICATIONS: As a result, although the average cost of construction project management improved by 6.32% compared to the past, it was confirmed that construction managers number did not meet legal standards.

Keywords: Construction management, Construction manager, Human Resource, Resource allocation strategy, Construction Technology Promotion Act, Construction Technology Management Act

1. INTRODUCTION

Recently, the demand of technical manpower who can demonstrate creative solution ability based on various expertise and sufficient practical experience is increasing day by day due to the needs of the construction market for convergence with the 4th industrial revolution and productivity innovation. In particular, compared to the placement criteria, the actual CMr (Construction Manager) is often assigned to a higher level, increasing the burden of holding unnecessary manpower on the CM company. It causes inefficient manpower operation of individual projects and becomes a factor that lowers the productivity of the entire construction industry. In addition, as the Construction Technology Management Act (CTMA) was completely revised to the Construction Technology Promotion Act (CTPA), the division by grade disappeared due to the unification of the technology grade system divided into technical qualifications and educational background and experience [1]. As a result, the allocation of CMr for public works under CTMA increased the labor cost burden of the company as the required manpower was allocated within the range of service costs that did not meet the consideration standard. In addition, the level of completion of the project was lowered due to the deployment of low-wage personnel. For CM missions ordered by public institutions, the necessary manpower is presented through the “arrangement of construction project managers” in accordance with the Ordinance of the Ministry of Land, Infrastructure and Transport [2]. However, since the supply and supply of suitable CMr is not smoothly progressed, it is difficult to efficiently utilize manpower.

This study compared the cases of construction project management services for public works that were ordered based on the previous CTMA and those placed on the basis of CTPA, which was completely revised in May 2014. Through this, the limitations and problems of manpower management in the current system were analyzed.

In this study, in order to understand the status of manpower allocation, we analyze the cases of ordering for construction project management services for public works, and identify problems that arise between the placement criteria in the announcement and the legal placement criteria. In addition, in order to understand manpower operation and manpower status, cases of public building construction project management ordered based on the past 「CTMA」 and public building

construction project management cases ordered based on CTPA, which was completely revised on May 23, 2014. Compare Through this, it analyzes the difference and the current status of the manpower allocation criteria changed from CTMA to CTPA. Research should be conducted as follows;

Through literature review, we analyze the process of change from CTMA to CTPA and the standards for manpower allocation according to institutional changes. Chapter 4 compares the manpower assignment ordered by CTMA and the manpower assignment ordered by CTPA to identify the differences between the legal standards and the manpower assignment in the notice, as well as the limitations and problems of current manpower operation. After that, through practical analysis, the cause of the difference in placement is analyzed, and finally, future research directions are summarized.

2. LITERATURE REVIEW

CMr manages and coordinates the participating entities so that the construction project can be successfully carried out, adjusts the supply and demand of resources, orders and supervises design and construction. Therefore, CMr's competence and management ability have a great influence on the success or failure of a construction project. Accordingly, many studies were conducted that enables efficient management of CMr's capabilities and timely placement of necessary sites. Table 1 below summarizes various studies on CMr.

Edum and McCaffer (2000) presented general knowledge and technical elements essential to the development of project management capabilities, focusing on how project managers can maintain their professional competence in the changing construction environment [3]. Andrew et al. (2005) identified the core competencies related to the role of construction management and developed a logistic regression model for the management of technical manpower in large construction organizations, and through this, tried to predict and evaluate the performance of CMr [4].

Table 1. Literature review in CMr

Authors	Titles	Context
Edum and McCaffer (2000)	Developing Project Management Competency: Perspectives from the Construction Industry	Focusing on maintaining the professional competence of the project manager, presenting the necessary general knowledge and technical elements
Andrew et al. (2005)	Competency-Based Model for Predicting Construction Project Managers' Performance	Identifying core competencies related to the role of CMr and presenting a logistic regression model for managing technical manpower in large construction organizations
Majinhyuk (2014)	Plans on supervisors strengthening of ability in accordance with integration of construction supervision and management	Suggested plans to strengthen construction project management capabilities through system integration
Award et al. (2016)	Modeling Project Manager Competency: An Integrated Mathematical Approach	Developing a mathematical model that can reliably evaluate CMr's capabilities
Jeong and Yoo (2017)	Analysis of Factors Affecting Job Competency of Quality Management for a Construction Manager	Analysis of factors affecting CMr's job competency

Majinhyuk (2014) suggested a way to strengthen the competence of supervisors for smooth construction management work through supervision and CM integration. In order to strengthen the competence of the supervisor, the establishment of an informatization system, securing of technology for project management factors, and mandatory CM professional training were suggested, but there is a limitation in that the proposed measures are inadequate to present comprehensive and more detailed improvement measures [5]. Award et al. (2016) developed a data-based mathematical model that can reliably evaluate CMr's capabilities and verified the validity of the model by comparing it with expert evaluation [6].

Seo-young Jeong and Jeong-ho Yoo (2017) conducted a basic study to establish a competency management system segmented for each CMr job, and presented problems by analyzing the current CMr competency evaluation method. Based on this, factors influencing the business management work competency were statistically presented, but there is a limit that it is insufficient to represent the overall capabilities of CMr, as the study is limited to quality management work among CMr's various tasks [7].

3. UNDERSTANDING OF CONSTRUCTION PROJECT

3.1 CAREER DEVELOPMENT PATH

The current career management system for domestic construction engineers is a complete revision of the 「CTPA」, which was revised on May 23, 2014, and introduces the 'Construction Engineer Competency Index', a concrete competency index evaluation method that comprehensively considers education, qualifications, and experience. Levels of Junior, intermediate,

advanced, and special are given by competency. In accordance with the Enforcement decree for the placement of construction management technicians, a construction engineer of an appropriate grade should be employed [8].

(Article 60 (Placement of Construction Project Management Engineers)(1) A construction project management service provider who manages a construction project in the construction phase shall assign construction project management to construction engineers deemed suitable for the scale and type of the relevant construction works and shall place construction engineers responsible for construction project management in accordance with the guidelines prescribed by Ordinance of the Ministry of Land, Infrastructure and Transport, based upon the scale, etc. of construction works. <Amended by Presidential Decree No. 29360, Dec. 11, 2018; Presidential Decree No. 29918, Jun. 25, 2019>)

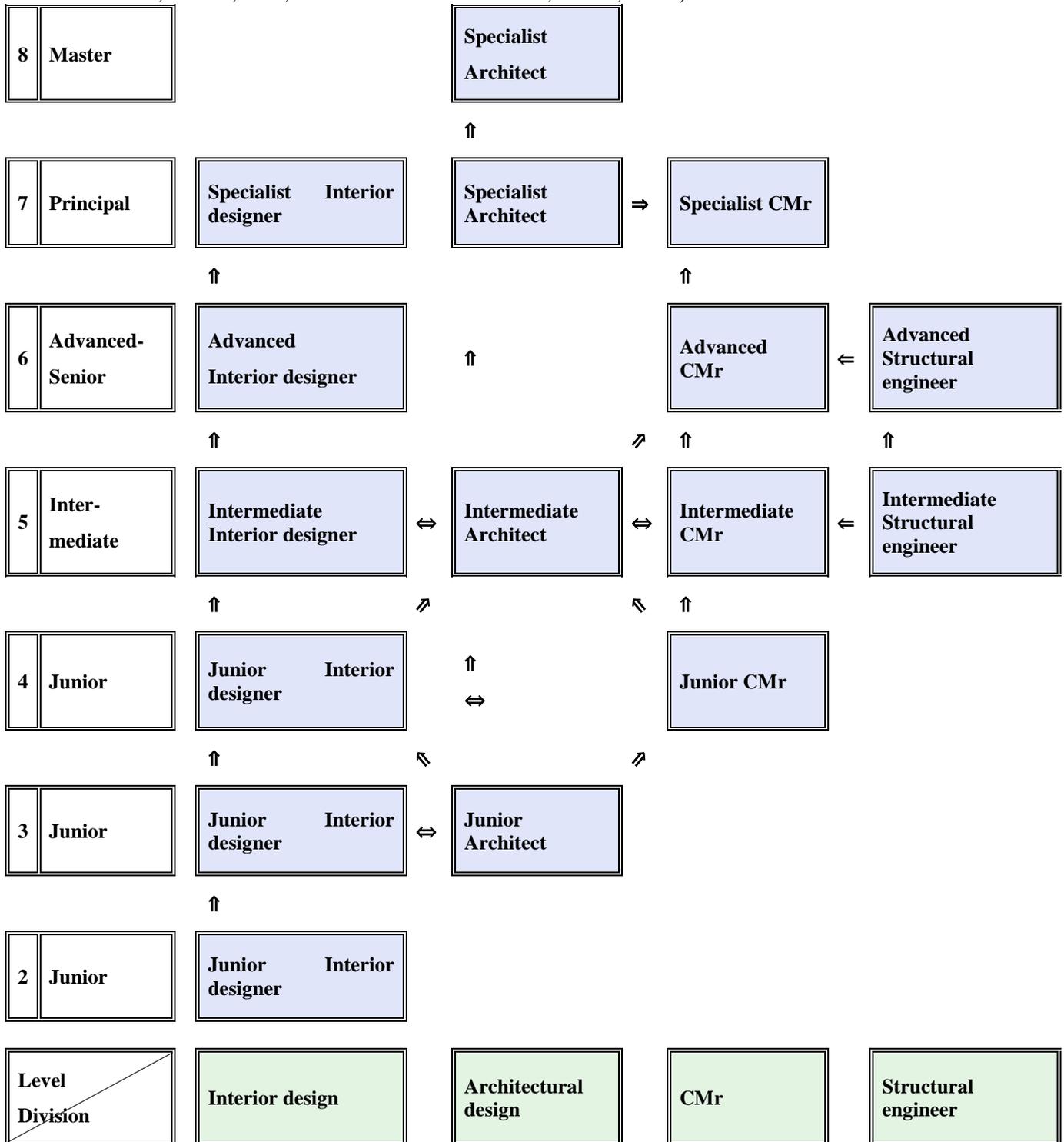


Figure 1. Career development path

3.2 DEFINITION OF CONSTRUCTION MANAGEMENT

The definition of CM can be classified according to seven construction work tasks. As a business that performs CM for design services in accordance with the 「CTPA」, the former design supervision service is defined as CM (design service). If the construction stage, supervisory authority agency or safety management work was performed, it is defined as CM (CM construction stage, supervisory authority agency or safety management). It is defined as CM when performing the task of

describing detailed tasks among planning, feasibility study, analysis, design, procurement, contract, evaluation, or follow-up management tasks.

Table 2. Task and definition of Construction work

Construction work	Definition
13. CM (Design service)	Construction management for design service (formerly design supervision) Article 39(3) to CTPA
14. Supervision (Building Act) [9]	Designated as a construction supervisor to perform construction supervision to Article 25 of Building Act
15. Supervision (Housing Act) [10]	Appointed as a supervisor of the relevant housing construction work to perform supervision to Article 24 of Housing Act
16 CM (CM construction stage, supervisory authority agency or safety management)	<p>5. The term “supervision” means any service of managing construction works, to manage construction works for appropriate execution in conformity with the relevant statutes, standards, design documents, or other related documents, or to give technical guidance with respect to the management of execution, quality, safety, etc.;</p> <p>6. The term “contracting authority” means the State, a local government, or the head of any public corporation or quasi-governmental institution under Article 5 of the Act on the Management of Public Institutions, the head of any local government-invested public corporation or local government public corporation under the Local Public Enterprises Act, or the heads of any institution prescribed by Presidential Decree, each of which is an entity that awards a contract for construction works or construction technology services;</p> <p>to Article 2 of CTPA</p>
17. CM	Business to perform construction project management pursuant to Article 39 (1) of CTPA
18. Supervision	Affiliation of the ordering office or the client to directly supervise construction or design services (including the work of a construction manager)
19. Project management	Indirect management of services such as construction work or design (direct supervisor of supervisor, supervisor's guidance and supervisory authority, etc.)

Supervision (Building Act) is designated as a construction supervisor pursuant to the Construction Act, and supervision (Housing Act) is defined as supervision by designating as a supervisor for the relevant housing construction under the Housing Act. . In addition, the business that belongs to the ordering office or the client and directly supervises services such as construction work or design is defined as supervisor, and the case of indirectly managing services such as construction work or design is defined as project management.

3.3 CTMA AND CTPA

CTMA [11] is a law related to construction technology. It is a law that stipulates matters necessary to promote research and development of construction technology, promote related projects, improve the quality of construction works, and secure safety. The full text consists of Chapter 8, Article 45 and Supplementary Provisions. Chapter 1 General Regulations, Chapter 2 Informationization and Research and Development of Construction Technology, Chapter 3 Construction Technology Services and Management of Construction Works, Chapter 4 Construction Quality Management, etc., Chapter 5 Construction Supervision Association, Chapter 6 It consists of 45 full-text articles and supplementary provisions such as the Association of Construction Engineers, Chapter 7 Supplement, and Chapter 8 Penalty. From the enactment of Act No. 3934 on October 24, 1987 to Act No. 10250 on April 12, 2010, some contents were revised 26 times.

CTPA [12] promotes research and development of construction technology to improve the level of construction technology, and based on this, promotes related industries to ensure that construction works are properly implemented, and improves the quality of construction works and secures safety for public welfare. It aims to contribute to the promotion of national economy and the development of the national economy. As domestic companies are forced to enter the overseas construction market due to the reduction of the domestic construction market volume, etc., the competitiveness of domestic companies is strengthened to support entry into the overseas construction market, and the burden of the company through deregulation. On May 23, 2014, CTMA was completely revised and changed to CTPA to alleviate the problem.

4. ANALYSIS OF CMR ALLOCATION STATUS

4.1 OVERVIEW

Until recently, there are many cases in which the number of personnel actually assigned by CM service companies is assigned to a higher level than the criteria for the assignment of public construction CM services at the time of public announcement. Therefore, the labor cost burden of the company was increased by having excessive manpower as well as a decrease in productivity. In addition, the placement of low-wage personnel has resulted in an impact on the completion of the project. This chapter analyzes the differences and problems in the standards for manpower allocation for CM services due to system changes since the previous CTMA was revised to CTPA. In addition, in order to grasp the manpower operation and status, we compared and analyzed the cases of public office CMs ordered based on the past 「CTMA」 and the public office CM cases ordered based on 「CTPA」. Through this, we tried to analyze the differences and problems of the manpower allocation criteria changed from “CTMA” to “CTPA”.

4.2 PUBLIC SECTOR CM SERVICE STATUS

4.2.1. PUBLIC PROCUREMENT SERVICE (PPS) TECHNICAL SERVICE QUALIFICATION SCREENING DETAILED CRITERIA

The purpose of PPS is to establish detailed standards for qualification system to be applied to technical service contracts executed by local governments in accordance with the detailed standards for technical service qualification screening. The detailed evaluation criteria for technical service qualification screening are the same as for technical services that perform pre-qualification (P.Q) in accordance with technology related laws. Service name, service type, service outline, contract number, contract date, contract period, service scale, performance ratio and performance in the technical service performance certificate for performance management and technician experience verification when evaluating public construction technology service project performance capability It is required to describe in detail the details of the performance of such services.

4.2.2. PPS ANNOUNCEMENT CM SERVICE STATUS

The CM service cases announced by PPS are classified into three as shown in Table 3. 1) 2011 and 2012 announced in the past CTMA standards, 2) 2014 and 2015 announced in a mixture of CTMA and CTPA standards, and 3) 2016 and 2017 announced in the CTPA standards. And the total construction cost, service period, service cost, and average number of salaries were compared.

Table 3. PPS announcement CM Service (Unit: \$Mill)

Announcement year	Average construction cost	Service period (Month)	Service price			Average(M/M)
			Announcement price	Contract price	Ratio	
2011-2012	76.93	28.20	2.99	2.25	75.14	207.90
2014-2015	104.41	37.30	4.60	3.37	73.33	354.63
2016-2017	47.36	26.02	3.21	1.79	55.75	211.96
Average	76.23	30.51	3.60	2.47	68.07	258.16

4.2.3. CRITERIA FOR MANPOWER ALLOCATION FOR CM SERVICE

In principle, the total CMr is calculated by the following. ① The total number of personnel input is calculated and summed up by calculating the number of personnel input for each task at the stage corresponding to the scope of the CM service among the common, pre-design, basic design, detailed design, purchase and procurement stages, construction stages, and post-construction stages. ② The number of personnel input for each task is calculated using the criteria for calculating the number of personnel input for each field, and the number of personnel input is based on advanced technicians. ③ The calculation method is calculated by multiplying the standard number of personnel for each job by the applied quantity, correction factor, and construction difficulty, and the number of personnel input for each job is rounded to the second decimal place. ④ The period of one month among the applied quantity units is based on 22 days.

Table 4. Building type

Simple work	Normal work	Complicated work
- factory	- Apartment house	- Exercise facility
-Warehouse facilities	-Class 1 and 2 neighborhood living facilities	-Culture and assembly facilities

- Automobile related facilities
- Educational research facility Training facilities
- Elderly people facilities
- Business facilities
- Medical facilities
- Facilities related to resource circulation
- Animal and plant related facilities
- Accommodation Sales facilities
- Corrections and military facilities
- Tourist rest facilities
- Tourist rest facilities
- (Only for observation tower)
- Broadcasting and communication facilities
- Transportation facilities
- Power generation facilities
- Cemetery related facilities
- Facilities that do not correspond to other simple or complex building types

4.3 CM SERVICE MANPOWER ALLOCATION STANDARD ANALYSIS

4.3.1 CASE ANALYSIS OVERVIEW

In this section, differences and problems in the criteria for manpower allocation for CM services due to system changes since the previous CTMA was completely revised to CTPA were analyzed. To this end, data on CM services for public works ordered through the KONEPS (Korea ON-line Procurement System [13]) country marketplace operated by PPS were collected. Data are 1) 8 CM services announced based on CTMA (2011-2012) as of 2014, which was completely revised by CTPA 2) 14 CM services announced based on CTPA (2014-2015) 3) Based on the CTPA, 11 publicly announced CM services (2016-2017) were collected, and a total of 43 data were analyzed on Figure 2.

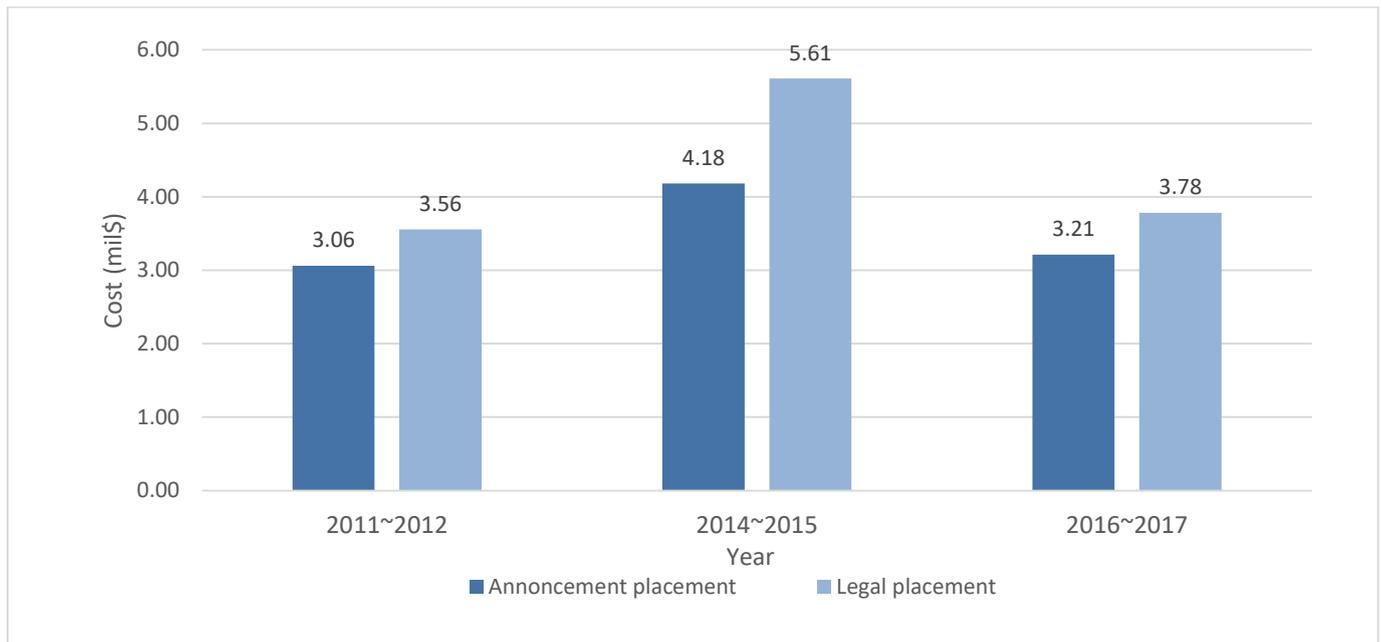


Figure 2. Data overview of case study

4.3.2 CMR ALLOCATION ANALYSIS OF CTMA AND CTPA

During the two years from 2011 to 2012, a total of eight public works were ordered based on CTMA, including the innovation city relocation project. Among the eight public works, six public works with a total construction cost of less than 100 million\$ are composed of 28.87 million\$ to 73.88 million\$. In addition, public works with more than 100 million\$ include EBS Digital Integrated Office Building Construction (115.41 million\$) and Government-funded research institute Sejong City Lease Building Construction (197.85 million\$). However, looking at the cost of the two CM service costs for projects over KRW 100 billion, it was found that the EBS digital integrated office building construction was 4.51 million\$ and the Sejong City lease building construction was 5.69 million\$, which was less than the appropriate service cost based on the announcement

Table 5. Public CM service based on CTMA (2011~2012) (Unit: million\$)

No.	Announcement year	Construction cost	Service period (Month)	Service fee		CMr allocation from Announcement		CMr allocation from Legal	
				Announcement price	Contract price	M/M	Service fee	M/M	Service fee

1	2011	28.87	27	1.50	1.19	115.42	1.50	113.68	1.42
2	2011	31.45	17	1.51	1.18	101.80	1.51	132.74	1.66
3	2012	73.88	30	2.62	2.02	195.58	2.88	257.16	3.82
4	2012	115.41	33	4.51	3.30	327.95	4.84	364.15	5.37
5	2012	197.85	33.5	5.69	4.12	408.97	5.69	586.80	7.32
6	2012	67.38	32	2.61	2.06	193.93	2.61	281.60	3.51
7	2012	46.18	31	3.11	2.29	188.26	3.11	210.63	2.63
8	2012	54.42	22	2.35	1.79	131.25	2.35	219.63	2.74
Average		76.93	28.1875	2.99	2.25	207.90	3.06	270.80	3.56

As shown in Table 6, a total of 14 public works were ordered based on CTPA over the two years from 2014 to 2015. The scale of construction costs for nine projects with a total construction cost of less than 100 million\$ varies, and public works exceeding 400 million\$ include Heavy Ion Accelerator Facility Construction (475.1 million\$). The average CM service cost was 4.60 million\$, which was also found to be less than the appropriate service cost.

Table 6. Public CM service based on CTPA (2014~2015) (Unit: million\$)

No.	Announcement year	Construction cost	Service period (Month)	Service fee		CMr allocation from Announcement		CMr allocation from Legal	
				Announcement price	Contract price	M/M	Service fee	M/M	Service fee
1	2014	178.95	36	5.95	4.37	515.61	5.41	605.57	8.72
2	2014	154.12	39	5.75	4.11	421.57	5.23	575.16	7.87
3	2014	23.22	29	2.06	1.56	138.8	1.87	163.6	2.35
4	2015	29.82	12	1.36	1.04	93.67	1.24	100.63	1.45
5	2015	148.85	34	4.97	3.52	365.99	4.52	385.1	5.96
6	2015	67.19	33	3.77	2.73	261.34	3.42	373.22	5.42
7	2015	67.24	42	3.73	2.67	277.7	3.39	301.45	4.36
8	2015	19.77	40	4.57	3.28	394.45	4.16	419.22	4.88
9	2015	19.14	38	2.46	1.87	171.95	2.24	179.5	2.55
10	2015	182.64	63	8.74	6.27	736.45	7.95	859.58	10.38
11	2015	18.76	42	2.52	1.90	176.62	2.26	181.12	2.54
12	2015	19.41	20	1.34	1.03	91.3	1.22	141.79	2.00
13	2015	57.47	28	3.00	2.67	206.9	2.73	279.86	3.92
14	2015	475.10	66	14.19	10.20	1,112.51	12.90	1,279.03	16.16
Average		104.41	37.29	4.60	3.37	354.63	4.18	417.49	5.61

In addition, there were 21 public works ordered over the two years from 2016 to 2017, 20 with a total construction cost of less than 100 million\$, and 1 public works with more than 100 million\$. It can be seen that the average CM service cost is 3.21 million\$, which is lower than the appropriate service cost based on the announcement.

Table 7. Public CM service based on (2016~2017) (Unit: million\$)

No.	Announcement year	Construction cost	Service period (Month)	Service fee		CMr allocation from Announcement		CMr allocation from Legal	
				Announcement price	Contract price	M/M	Service fee	M/M	Service fee
1	2016	36.99	17	2.21	1.67	146.09	2.27	149.54	2.26
2	2016	98.18	36	4.58	3.80	295.76	4.58	359.74	5.30
3	2016	100.73	28	4.55	3.33	295.37	4.69	345.61	5.41
4	2016	59.61	28	2.54	2.19	171.76	2.69	202.77	3.23
5	2016	83.30	29	2.51	2.39	173.21	2.63	246.04	3.74
6	2016	51.60	25	2.60	1.99	129.17	2.60	193.25	2.95
7	2016	42.00	23	2.36	1.79	155.08	2.36	181.74	2.69
8	2016	36.98	20	1.82	1.39	132.23	1.82	161.87	2.39
9	2016	48.46	15	2.61	1.76	167.96	2.61	153.87	2.33
10	2016	43.45	15	2.48	1.72	158.88	2.48	148.13	2.25
11	2016	20.22	24	1.65	1.31	105.92	1.65	156.81	2.34
12	2016	47.96	21.5	2.18	1.69	146.73	2.18	195.02	2.92
13	2016	63.44	35	3.56	2.55	247.18	3.56	298.12	4.50
14	2017	12.47	11	1.06	0.87	72.24	1.13	70.01	1.10
15	2017	34.94	39	2.78	2.13	194.68	3.03	191.35	3.12
16	2017	28.64	30	1.25	0.96	79.05	1.27	128.03	2.00
17	2017	34.13	30	1.95	1.51	124.09	1.95	176.26	2.77
18	2017	28.61	24	1.57	1.20	100.04	1.57	158.4	2.44
19	2017	39.45	30	9.91	0.71	643.8	10.57	703.24	9.16
20	2017	31.17	41	10.80	0.77	755.68	11.68	863.68	13.24
21	2017	52.14	25	2.54	1.88	156.3	2.54	207.99	3.33
Average		47.36	26.02	3.21	1.79	211.96	3.33	251.97	3.78

As shown in Figure 3 and Table 8 below, the service cost and m/M ratio change to the public announcement and statutory standards increased by about 13% at the time of announcement compared to the legal standard between 2011 and 2012, and the average number of salaries was about 7.4. % Increased. It can be seen that this change is difficult to judge only with the standard
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revised from CTMA to CTPA, but it has increased somewhat. Nevertheless, it is an important fact that it still does not meet the legal standards.

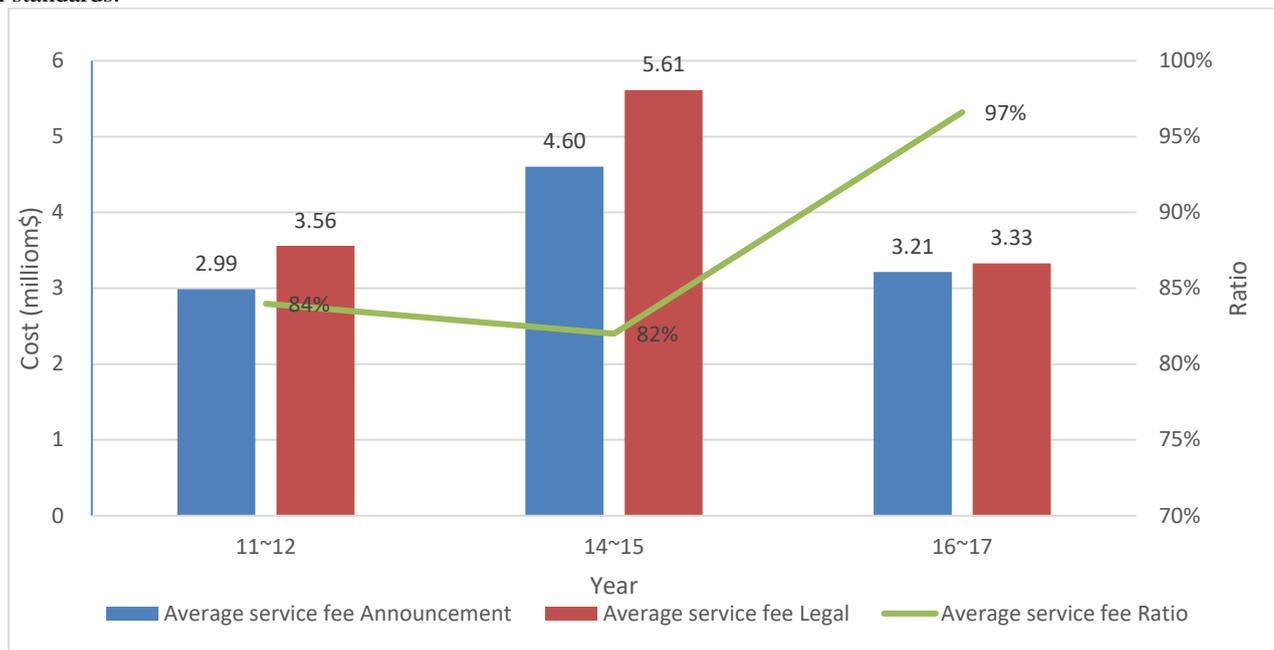


Figure 3. Average service fee of case study

Table 8. Comparison of average service cost and M/M according to the announcement year

Announcement year	Average service fee (million \$)			Average M/M		
	Announcement	Legal	Ratio	Announcement	Legal	Ratio
11~12	2.99	3.56	84%	18.90	24.62	77%
14~15	4.60	5.61	82%	32.24	37.95	85%
16~17	3.21	3.33	97%	19.27	22.91	84%

5. DISCUSSION

As the analysis in Chapter 4, as the law was revised from CTMA to CTPA, the result was that the service cost improved from 5% to 10-20% compared to the existing construction cost. Nevertheless, it was analyzed that the cost of service and service has not yet reached the legal standard of service cost. The contents reviewed from the practical level are as follows.

In the past, if the cost of the service was determined based on the CTMA standard, the cost of the service is calculated in accordance with the standards notified by the Ministry of Land, Infrastructure and Transport when the construction cost is confirmed after the design is completed. Moreover, in the CM consideration standard, the mandatory allocation standard for electricity, firefighting and communication construction sectors is legally determined [14,15,16], so a 100% budget must be allocated for this part. Eventually, the result of reducing the service cost of the construction work came to appear. When analyzing the CM services ordered by several local governments, there are often cases in which the ratio of architectural work to construction cost is very low and the ratio of electric work is high[17]. Therefore, it is judged that the architectural sector also needs to introduce compulsory allocation standards for proper service cost calculation.

In addition, construction costs are determined only when the design is completed, but CM service costs are often set in accordance with the budget, the preparation of CM service costs must also be made on a private contract or estimate bids by experts [18].

And if we look at manpower allocation chart that can confirm the actual number of employees, it is found that the project management work is not included in the design stage and the construction stage. It means the realistic labor cost can be seen to be lower.

6. CONCLUSION

This study analyzed the problems in the allocation criteria and actual manpower allocation by companies through the current public CM service order execution case. The limitations and problems of manpower management in the current qualification screening system are compared with the case of performing CM for public offices ordered under the previous 「CTMA」 standard with the case of conducting CM at public offices ordered under the 「CTPA」 standard revised on May 23, 2014. As a result of the analysis, it was confirmed that the average service cost to construction cost was 6.32%, which was partially improved from the previous CTMA standard. However, it was also confirmed that even the improved service cost still did not meet the legal standard service cost.

The reason of low service costs was due to lack of budget, legal obligations of electricity, firefighting, and telecommunications works, and it was analyzed that the project management work was not included.

Therefore, in order to place an order for a service applying the legal standard, it will be accompanied by a demand for proactive legalization through related ministries such as Ministry of Economy and Finance and the Ministry of Land, Infrastructure and Transport as well as gathering opinions from various related experts. The results of this study are expected to contribute to the establishment of an efficient manpower allocation system to enhance the competitiveness of the domestic construction industry.

7. ACKNOWLEDGE

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8. REFERENCES

1. Kim HY. Kim YS. Analyzing the Competence of Construction Engineers in Apartment Construction, [Korean journal of construction engineering and management](#) , 19(6), 14-23.
2. National Law Information Center. (2018). Enforcement Rule of the Construction Technology Promotion Act, Retrieved from <https://www.law.go.kr/LSW/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&y=0&x=0#liBgcolor6>
3. Edum FT. McCaffer R. Developing project management competency: perspectives from the construction industry, *International Journal of Project Management*, 18(2), pp.111-124, 2000
4. Andrew RJD. Cheng MI. David RM. Competency-Based Model for Predicting Construction Project Managers' Performance, *Journal of Management in Engineering*, ASCE, pp.2-7, 2005
5. Ma JH. Plans on supervisors strengthening of ability in accordance with integration of construction supervision and management, Pukyong National University, Master degree
6. Award SH. Michael WI. Wafik L. Karim AI. Jeffrey SR. Modeling Project Manager Competency: An Integrated Mathematical Approach, *Journal of Construction Engineering and Management*, ASCE, 2016
7. Jung SY. Yu, JH. Analysis of Factors Affecting Job Competency of Quality Management for a Construction Manager, [Korean journal of construction engineering and management v.18 no.1](#) , 2017, pp.65 - 73
8. National Law Information Center. (2016). Enforcement Decree of the Construction Technology Promotion Act, Retrieved from <https://www.law.go.kr/LSW/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&y=0&x=0>
9. National Law Information Center. (2017). Building Act, Retrieved from <https://www.law.go.kr/LSW/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&y=0&x=0#liBgcolor0>
10. National Law Information Center. (2018). Housing Act, Retrieved from <http://www.law.go.kr/LSW/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&y=0&x=0#liBgcolor31>
11. National Law Information Center. (2016). Construction Technology Management Act, Retrieved from <https://www.law.go.kr/LSW/eng/engLsSc.do?y=0&x=0&menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT#liBgcolor0>
12. National Law Information Center. (2016). Construction Technology Promotion Act, Retrieved from <http://www.law.go.kr/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&x=0&y=0>
13. Korea ON-Line E-Procurement system. Retrieved from <http://www.g2b.go.kr/index.jsp>
14. National Law Information Center. (2016). Electric Technology Management Act, Retrieved from <http://www.law.go.kr/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&x=0&y=0#liBgcolor0>
15. National Law Information Center. (2018). Fire-fighting System Installation Business Act, Retrieved from <http://www.law.go.kr/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&x=0&y=0#liBgcolor0>
16. National Law Information Center. (2018). Enforcement decree of the Information and Communications Construction Business Act, Retrieved from <http://www.law.go.kr/eng/engLsSc.do?menuId=1&query=CONSTRUCTION+TECHNOLOGY+PROMOTION+ACT&x=0&y=0#liBgcolor0>
17. Nam BW. Yun SH. A Study of Workforce Management of Overseas Construction Site - Focused on the Hand Vascular System and RFID, *Journal of Next-generation Convergence Technology Association* v.3 no.4, 2019 pp.150-157
18. Yun YW. Yun SH. A Study of Client's Role for Safety Management at Construction Site, *Journal of Next-generation Convergence Technology Association* v.3 no.1, 2019 pp.29-40