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Investigation of construction managers allocation due to changes in laws and regulations and proposals for future developments

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Abstract

This paper intends to analyze the layout and current status of the Construction Manager in the order of time and in accordance with the revision of laws and regulations. The allocation status of Construction Manager (CMr) was analyzed by classifying it into the past Construction Technology Management Act (CTMA) Construction Technology Promotion Act (CTPA), the current CTPA, and the percentage of construction contract and cost plus fee. Recently, the construction industry is necessity of technical personnel who can demonstrate creative solutions based on diverse expertise and sufficient practical experience due to complexity, sophistication, and complexity. In particular, in order to prevent safety accidents and construction defects, competencies of CMr are becoming more and more important. Since Construction management (CM) is defined by laws and regulations, engineers are assigned and service costs are calculated accordingly, it is considered important to analyze related laws and regulations. Therefore, this study analyzes the layout and status of the CMr by the revision of laws and regulations. In the past CTMA, it was confirmed that the current CTPA and the change of the current cost plus fee in the past percentage of construction contract had a great influence on the CMr and showed a more developed situation than in the past. However, there is still a problem in that the level of actual input manpower for each level must be upgraded from the required level regardless of the type of work. As a result, private contract or minority quotation bidding, flexible arrangement, and competency evaluation model are proposed as alternatives.

Keywords: Construction management, Construction manager, Human resource allocation, Service fee, Construction law and regulation

1. Introduction

The construction industry is an industry that produces results through the participation of many people, and has the characteristic of continuously growing and developing during the period of human existence. In particular, in modern times, due to the needs of the construction market for convergence and convergence with element technologies of the 4th industrial revolution and productivity innovation, it is showing professionalism and complexity.[1] Looking at the major participants in the construction project, they can be classified into owners, architects, CMr, and contractors. However, the CMr is responsible for supervising and supervising the construction in accordance with the design drawings within the given budget and construction period, and responding to unexpected situations at the construction site. Among them, CMr has to perform more and more tasks to complete the complex modern architecture, and its role is becoming more and more important.

In particular, safety accidents that occur in construction projects are very fatal, and construction-related defects are continuously occurring, so the role of CMr can play a very important role to prevent such problems.[1] However, until

recently, there have been situations in which the number of manpower to be assigned, which is announced at the time of public notice of CM services, is lower than the legal force required to be assigned to construction work, and there are problems such as the low service cost of CMr. Any damage that may be caused by the input will return as a heavy burden to all participants.

CMr ordered by public sectors must be assigned according to the CTMA [2] and the CTPA [3] enacted in 2014, and the number of CMr manpower is suggested through the 'Deployment of Construction Management Engineers' according to the standards set by Ordinance of the Ministry of Land, Infrastructure and Transport. In addition, the service cost of CMr is determined by the past percentage of construction contract and cost plus fee. As such, the system for CMr is stipulated in various laws and regulations, and CM proceeds through it.

Therefore, this thesis examines the laws and regulations related to CMr that have changed over time to find out what problems have existed from the past to the present and how they have been corrected. The purpose is to suggest a plan. In order to proceed with this study, the current status of CMr will be analyzed through previous studies and literature reviews on laws and regulations that have been conducted since the past. And the current situation is diagnosed through the analysis of the market and manpower for domestic Construction management (CM). And, in order to understand the current status and problems of CMr's manpower allocation, we analyze the cases of placing orders for public works CM services and analyze the current status. This concludes with suggestions for areas and areas to be developed in the future.

2. Literature review

2.1 Related works

Research on CMr has been conducted in a variety of ways, both domestically and internationally. Table 1 below contains representative studies analyzing the capabilities of CMr.

Table 1. Previous studies on CMr

Authors	Title	Main context
Edum and McCaffer (2000) [4]	Developing Project Management Competency: Perspectives from the Construction Industry	Focusing on maintaining the competence of the construction manager, presenting the necessary general knowledge and technical elements
Andrew et al. (2005) [5]	Competency-Based Model for Predicting Construction Project Managers' Performance	Identifying main competencies related to CMr and presenting a logistic regression model for managing manpower in large construction projects
Park (2015) [6]	A Study on Policy Proposal to utilize the Index of Construction Engineer's Competency (ICEC) for Reasonable Construction Management	Policy recommendations through a survey on the level of awareness on CM and the ICEC rating system
Jung (2016) [7]	Improvement of ICEC evaluation system for construction manager using factor analysis	Proposal of effective competency management plan for construction project managers and improvement plan of technology rating system through factor analysis
Im et al. (2018) [8]	A study on the career management for construction engineers through the professional FGI results : focused on the index of construction engineer's competency	Deduction of career management improvement plan suitable for modern construction career environment through focus group interview FGI
Nam BW. Yun SH. (2019) [9]	A Study of Workforce Management of Overseas Construction Site - Focused on the Hand Vascular System and RFID	Investigation of the current status of overseas CMr manpower management and countermeasures
Yun YW. Yun SH (2019) [10]	A Study of Client's Role for Safety Management at Construction Site	Safety management plan and role of CMr in construction site
Yang JK. Hong SW (2020) [11]	CSFs Extraction and AHP Importance Analysis for Construction Technology Services Evaluation in terms of Construction Manager	Critical success factors that can systematically prepare the evaluation from the early stage of the project through in - depth interviews with experts

As mentioned above, various studies have been carried out, and based on this, a study that statistically analyzed factors that affect CM competency and a study that systematically suggested improvement plans for effective competency management and technology rating system of CMr were conducted. However, there is a limitation that studies on the arrangement of CMr according to laws and chronological

order are still insufficient.

2.2 CTMA and CTPA

Since the CTMA was enacted as Act No. 3934 on October 24, 1987, and until April 12, 2010, Act No. 10250, some contents of the CTMA have been revised 26 times in total. Acts related to construction technology and laws that set matters necessary to promote research and development of construction technology, promote related businesses, improve the quality of construction work, and secure safety. Although it was enacted to contribute, it was amended to 'CTPA' by adding the promotion of research and development of construction technology and promotion of related industries in the 'Construction Technology Management' Act, which is a regulatory-oriented law.

CTPA supports entry into overseas construction markets by strengthening the competitiveness of domestic companies as domestic companies are inevitably entering the overseas construction market for construction technology services due to a reduction in the volume of domestic construction market, and through deregulation It was changed and implemented on May 23, 2014 to alleviate the burden on companies.

2.3 Estimation based on CM service fee (CM fee)

The estimation of CM fee for calculating the cost of CM service includes the past 'percentage of construction contract' and the currently applied cost plus fee. The percentage of construction contract follows the CM work guidelines according to Article 75 of the 「CTMA Enforcement Decree」. [12] The cost plus fee is defined in Notice No. 472 of the Ministry of Land, Infrastructure and Transport, and the cost plus fee is based on the calculation of the number of engineers in the CM(based on the calculation of the number of input personnel). It refers to a method in which the cost is calculated by adding up the compensation insurance (deduction) fees, and the number of input personnel is calculated by multiplying the standard number of people for each task by the applied quantity and correction factor, the correction factor, and the difficulty of construction based on the advanced technicians.

2.4 Criteria for calculating the number of CMr

The calculation of the number of CM engineers is defined in Ministry of Land, Infrastructure and Transport Notification No. 2017-414, Standards for Construction Technology Service Fees, etc., and [Annex 2] CM Engineers Arrangement Standards. The basic tasks are divided based on the stage, and correction factors and difficulty are added here.

If we look at only the most important construction stages, we will start the construction, check the construction performance and review the adequacy, review the adequacy of user materials, quality test and performance review, construction plan review, technology review and education, process management, safety management, environmental management, design change management. Inspection, completion inspection, adjustment of the construction interface between contractors, subcontract feasibility review, budget verification and support at the construction stage, and general administrative tasks should be performed.

3. Registration status of CMr

3.1 CM service company registration status

According to the 'Status of Construction Technology Service Companies' announced in 2020 by the National Land, Infrastructure and Transport Statistical Service [13], the number of companies registered in the construction service business by field was 2,226 as of December 31, 2020, and the design and CM service business Companies that do this account for 58.2%, which is far more than the majority of the total.

Table 2. Registration status of CMr

(Unit : number)

	Total	General	CM	Design
Number of companies	2,226 (100%)	560 (25%)	224 (10%)	1,073 (48.2%)

3.2 Status of Registered Engineers of Construction Service Companies

The number of technicians registered in 2,226 service companies is about 50,000, and when classified by grade as shown in Table 3 below, the number of master technicians accounted for 49% of the total. In addition, 19% of advanced-senior technicians, 14% of intermediate technicians, and 18% of junior technicians, it can be seen that the ratio of junior and advanced-senior technicians is at a similar level.

Table 3. Number of registered engineers of construction service companies by grade

	Total	Master	Advanced-senior	Intermediate	Junior
Percentage	100%	49%	19%	14%	18%

In addition, the distribution of manpower by field of project participation of technicians is shown in Table 4 below. The rate of participation in services such as design is 54%, and the rate of participation in CM is 24%, and the proportion of personnel participating in services such as design and project management constitutes 78% of the total. Although private supervision accounts for 4%, due to the nature of private supervision, engineers who are not registered with the association or do not participate in services are sometimes conducted, so the actual number is judged to be higher. Engineers registered as non-participating in other services are

in charge of R&D, field management, PQ work, business management, technology proposal work, planning, etc. can

Table 4. Distribution of manpower by field of business participation

	Total	Design	CM	Private supervisor	Not assigned
Percentage	100%	54%	24%	4%	18%

3.3 Construction Service Performance Report and Confirmation Volume

Looking at the quantity notified to the CM Association by the ordering agency in September 2018 by business field, both the number and amount of cases decreased except for the increase of 27 cases of private supervision. Able to know. As such, the reduction in the number and amount of services indicates a decrease in labor costs relative to the number of input personnel, and is a number that can be guessed as to a decrease in manpower or a decrease in labor costs.

Table 5. Confirmation volume

(Unit: Number, $mil)

	Total	Design	CM	Private supervisor
Number	4,798	3,732	731	335
Cost	19.8	5.6	8.5	5.7

Table 6 below is data classified by contract period for services such as design, construction project management, and private construction supervision. When looking at service types by type, design and other services increased from 9.4 million dollar (593 cases) in 2016 to 2.8 million dollar (1,407 cases) in 2017, but increased to 1.9 million dollar (1,732 cases) in 2017. It can be seen that there is a decrease compared to the amount and number of services for CM also increased significantly from KRW 0.9 million dollar (79 cases) in 2016 to 4.6 million dollar (371 cases) in 2017, similar to the increase/decrease trend of services such as design, but in 2018, 2.9 million dollar (281 cases), it can be seen that the service amount and the number of cases decrease slightly. On the other hand, private construction supervision increased about 7 times from 0.1 million dollar (10 cases) in 2016 to 0.9 million dollar (66 cases) in 2017, and reached 4.6 million dollar (259 cases) in 2018, which is a five-fold increase compared to 2017.

Table 6. Classification by contract period

(Unit: Number, $mil)

	Total(a+b+c)		2018 (a)		2017 (b)		2016 (c)	
	Number	Cost	Number	Cost	Number	Cost	Number	Cost
Total	4,798 (100%)	19.8 (100%)	2,272 (47%)	9.4 (48%)	1,844 (39%)	8.3 (42%)	682 (14%)	2.0 (10%)
Design	3,732	5.6	1,732	1.9	1,407	2.8	593	0.9
CM	731	8.5	281	2.9	371	4.6	79	0.9
Private supervisor	335	5.7	259	4.6	66	0.9	10	0.1

4. Analysis of manpower input for CM services

4.1 Case Analysis Overview

In this section, in order to analyze the current state of manpower input for the CM service, we analyzed the case of placing an order for the CM service for public works. The case analysis was conducted on two companies that participated in the bidding for CM services ordered based on the CTPA.

(1) CM services for public works ordered through the Nara Marketplace of the Public Procurement Service

(2) CM services ordered directly by local governments

(3) CM services for public works excluding the Public Procurement Service (PPS)

First of all, from November 2018 to March 2019, Company A, a domestic CM service company, conducted 44 CM services for public works ordered through the Korea ON-Line E-Procurement system of PPS [14] and 6 CM services ordered directly from local governments. A total of 50 cases were collected, including 50 cases, and Company B collected 50 cases of CM services for public works excluding the Public Procurement Service.

As a result, the status of manpower input for CM services analyzed in this section was used to identify differences and problems between the actual input manpower and manpower

assignment standards through comparative analysis with the manpower assignment criteria analyzed in section 3.3.

4.2 Analysis of the ratio of service cost to construction cost

Table 7 is data analyzing the ratio of service cost to construction cost of CM service for public works ordered directly by local governments from 2015 to 2018. In this case, the average service cost for the construction cost was analyzed to be 7.19%.

Table 7. Analysis of CM by owners

No.	Year	Owners	Construction cost (a) (mil $)	CM fee (b) (mil $)	b/a(%)
1	2015	A	0.137	0.020	14.31
2	2017	A	0.950	0.052	5.43
3	2017	A	1.361	0.057	4.17
4	2017	A	1.418	0.051	3.60
5	2018	A	0.846	0.047	5.56
6	2018	A	2.154	0.064	2.97
7	2018	A	0.676	0.048	7.06
8	2017	B	0.272	0.018	6.78
9	2017	B	1.185	0.063	5.29
10	2015	B	0.867	0.052	5.96
11	2016	B	0.090	0.018	19.59
12	2017	B	1.332	0.076	5.67
13	2017	C	0.147	0.016	10.57
14	2017	C	1.958	0.086	4.41
15	2017	C	0.772	0.047	6.10
16	2018	C	0.396	0.029	7.30
17	2016	D	0.087	0.009	9.85
18	2017	E	0.106	0.009	8.26
19	2017	E	0.126	0.007	5.54
20	2017	F	0.407	0.018	4.31
21	2017	G	0.292	0.017	5.78
22	2017	H	0.172	0.015	8.60
23	2018	I	0.114	0.011	9.39
24	2018	J	0.212	0.009	4.24
25	2018	K	0.373	0.014	3.80
26	2018	I	0.182	0.017	9.28
27	2018	L	0.230	0.016	6.91
28	2018	M	0.131	0.012	9.16
29	2018	N	0.169	0.013	7.66
30	2018	N	0.123	0.011	8.93
31	2018	O	0.236	0.015	6.43
Average			0.565	0.030	7.19

Table 8 shows the service cost and the number of delivered deliveries for public works CM services ordered by the PPS for two years from 2018 to 2019. In the case of the case, the ratio of the number of months actually put in to the number of deliveries required was 125%. The reason that 25% of the actual number of delivered months was added is that the number of delivery months is sometimes added through design changes when the construction period is insufficient because it meets the budget after the contract or when there is a need to extend the construction period due to changes in site conditions. However, there are many cases where there is a shortage of auxiliary manpower due to the allocation of manpower according to the insufficient budget.

Table 8 Analysis of CM from PPS

No.	Year	Construction cost (a) (mil $)	CM fee (b) (mil $)	b/a(%)	(Man/Month)			
					Required	Actual	Difference	Difference (%)
1	2019	0.265	0.017	6.56	114.919	129.710	14.791	113%
2	2019	0.130	0.012	9.05	67.779	79.564	11.785	117%

3	2019	0.539	0.027	4.93	165.412	178.714	13.302	108%
4	2019	0.183	0.009	4.69	55.700	59.330	3.630	107%
5	2019	0.253	0.017	6.60	106.038	122.325	16.287	115%
6	2019	0.060	0.007	11.76	43.430	50.895	7.465	117%
7	2019	0.159	0.017	10.93	106.596	133.809	27.213	126%
8	2019	0.060	0.009	14.66	54.797	58.042	3.245	106%
9	2019	0.184	0.009	4.89	59.573	67.695	8.122	114%
10	2019	0.417	0.022	5.25	137.700	156.940	19.240	114%
11	2019	0.132	0.009	6.51	56.700	61.740	5.040	109%
12	2019	0.215	0.009	4.41	56.913	69.407	12.494	122%
13	2019	0.176	0.012	6.54	74.753	86.030	11.277	115%
14	2019	0.196	0.013	6.79	82.964	98.536	15.572	119%
15	2019	0.200	0.013	6.50	83.500	108.430	24.930	130%
16	2019	0.145	0.009	6.19	57.340	61.570	4.230	107%
17	2019	0.062	0.006	8.96	35.595	39.227	3.632	110%
18	2019	0.178	0.009	4.92	57.020	62.380	5.360	109%
19	2019	0.195	0.016	7.98	99.500	130.000	30.500	131%
20	2019	0.198	0.012	5.97	76.008	97.213	21.205	128%
21	2019	0.396	0.027	6.83	185.860	194.508	8.647	105%
22	2019	0.195	0.010	4.98	63.310	68.310	5.000	108%
23	2019	0.320	0.021	6.67	133.100	165.900	32.800	125%
24	2019	0.225	0.012	5.50	78.559	87.618	9.059	112%
25	2019	0.157	0.008	5.36	56.550	66.610	10.060	118%
26	2018	0.090	0.004	4.97	27.650	29.980	2.330	108%
27	2018	0.144	0.009	5.92	57.070	68.470	11.400	120%
28	2018	0.089	0.007	8.29	61.003	81.123	20.120	133%
29	2018	0.259	0.010	3.94	67.620	75.590	7.970	112%
30	2018	0.105	0.016	15.75	91.728	126.914	35.186	138%
31	2018	0.249	0.014	5.65	91.545	110.067	18.522	120%
32	2018	0.147	0.013	8.89	85.500	106.100	20.600	124%
33	2018	0.166	0.010	5.80	63.820	71.450	7.630	112%
34	2018	0.212	0.009	4.24	57.700	77.214	19.514	134%
35	2108	0.105	0.007	6.32	41.460	50.580	9.120	122%
36	2018	0.151	0.010	6.32	62.900	70.530	7.630	112%
37	2018	0.159	0.014	8.72	89.587	111.058	21.471	124%
38	2018	0.213	0.011	5.37	74.010	96.584	22.574	131%
39	2018	0.112	0.014	12.12	87.700	109.600	21.900	125%
40	2108	0.223	0.018	8.26	114.570	117.280	2.710	102%
41	2018	0.155	0.013	8.42	84.300	118.700	34.400	141%
42	2018	0.136	0.011	8.12	74.200	91.800	17.600	124%
43	2018	0.064	0.006	9.59	39.088	45.602	6.514	117%
44	2018	0.110	0.012	11.39	79.030	98.820	19.790	125%
45	2018	0.108	0.010	9.38	64.812	80.085	15.273	124%

46	2018	0.134	0.009	6.87	56.590	66.360	9.770	117%
47	2018	0.316	0.013	4.05	78.590	86.660	8.070	110%
48	2018	0.185	0.008	4.27	50.679	65.766	15.087	130%
49	2018	0.152	0.015	9.79	77.438	111.780	34.342	144%
50	2018	0.220	0.019	8.76	126.020	145.993	19.973	116%
Average		0.185	0.012	7.29	78.285	92.972	14.688	118.96%

Also, as shown in Table 9 below, out of the total 81 CM services for public works, the services ordered by the PPS accounted for the largest share with 50 cases, followed by the Seoul Housing and Urban Corporation (SH) in 7 cases and the Korea Land and Housing Corporation (LH) in 7 cases. In these 5 cases, 4 cases were ordered by the Gyeonggi-do Housing Corporation (GH) and 15 cases were ordered by local and local governments.

Table 9. Comparison of average service cost compared to average construction cost by ordering organization

	PPS (50)	GH (4)	SH (7)	LH (5)	Etc. (15)	Total (81)
Average CM fee (a, mil $)	0.012	0.044	0.048	0.045	0.013	0.019
Average construction cost (b, mil $)	0.185	0.818	1.077	0.749	0.197	0.330
a /b ratio	6.64%	5.44%	4.48%	6.03%	6.46%	6.32%

When analyzed by ordering agency, the average construction cost of SH was the highest at 1.077 million dollar, followed by Gyeonggi-do Construction Corporation (0.818 million dollar), LH (0.749 million dollar), others (0.197 million dollar), and Public Procurement Service (0.185 million dollar). The average service cost was also highest for SH with 0.048 million dollar, followed by LH (0.045 million dollar), GH (0.044 million dollar), Others (0.013 million dollar), and PPS (0.012 million dollar).

On the other hand, although SH's average service cost and average construction cost are the highest compared to other agencies, the ratio of average service cost to average construction cost is rather 4.48%, which is the lowest among all ordering agencies. This is a characteristic of the LH, SH business, which receives a lot of orders for public housing, and it is judged that the service cost for the construction cost is relatively low because the simple construction type and the larger area make the calculation of the number of people less than that of the general building.

In addition, the ratio of the average service cost to the average construction cost by each ordering organization seems to be set at the level of 5-10%, but in some cases in Table 10, it can be seen that the service cost is set at the level of 10-20% of the construction cost.

Table 10. Example of average service cost compared to average construction cost

Projects	Owner	Construction cost (a) (mil $)	CM fee (b) (mil $)	b/a(%)
A	LH	0.090	0.018	19.59%
B	SH	0.137	0.020	14.31%
C	GH	0.147	0.016	10.57%

In the past CTMA standards, the CM service cost was calculated using the construction cost rate method, but after the full revision to the CTPA in May 2014, the calculation method was changed to the cost plus fee (Ministry of Land, Infrastructure and Transport Notice No. 472) enacted on June 30, 2015. It is presumed to have been changed.

Another feature of the cost plus fee is that it can be calculated by adding or excluding tasks depending on the characteristics of the construction and the conditions of the ordering agency. Since the service cost is calculated using the cost plus fee that calculates the direct cost as described above, it can be seen that the ratio of the service cost to the construction cost is partially improving compared to the previous CTMA standard.

As shown in Figure 1 below, there are 30 services in which the ratio of service cost to construction cost is 7.5% or more, accounting for about 37% of the total service. Among the factors for improving service cost, not only cost plus fee, but also when planning an additional budget, the changed standards are actively reflected or, with the help of a CM service company, the service cost budget is set so that it does not run out, and it is efficiently operated within the overall budget. On the other hand, there are also frequent occurrences of local governments who procrastinate without planning an additional budget and place an order according to the insufficient budget as the start and completion date of construction is approaching.

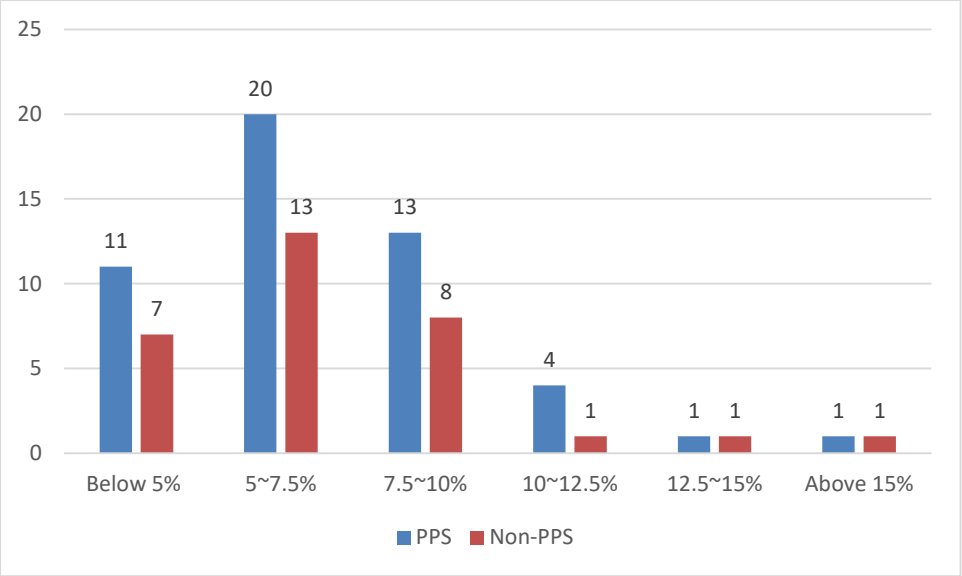

FIgure 1. Distribution of the ratio of service cost to construction cost

As shown in Figure 2 below, it is the public CM service ordered by the PPS that clearly shows a range of less than 100% in the ratio of the service cost to the appropriate service cost. Looking at the graph alone, it seems that the productivity of services ordered by the PPS is much lower than that of services ordered by non-PPS. However, looking at Table 12 'Public CM services ordered by PPS', it is found that the average service cost to the average construction cost is 7.29%, which is about 0.1% higher than the service cost to the construction cost of services ordered by clients other than the PPS, 7.19%. In addition, as there are 13 cases where the ratio of the service cost to the appropriate service cost is 100% or more, it can be seen that the PPS cannot be regarded as lower than non-PPS

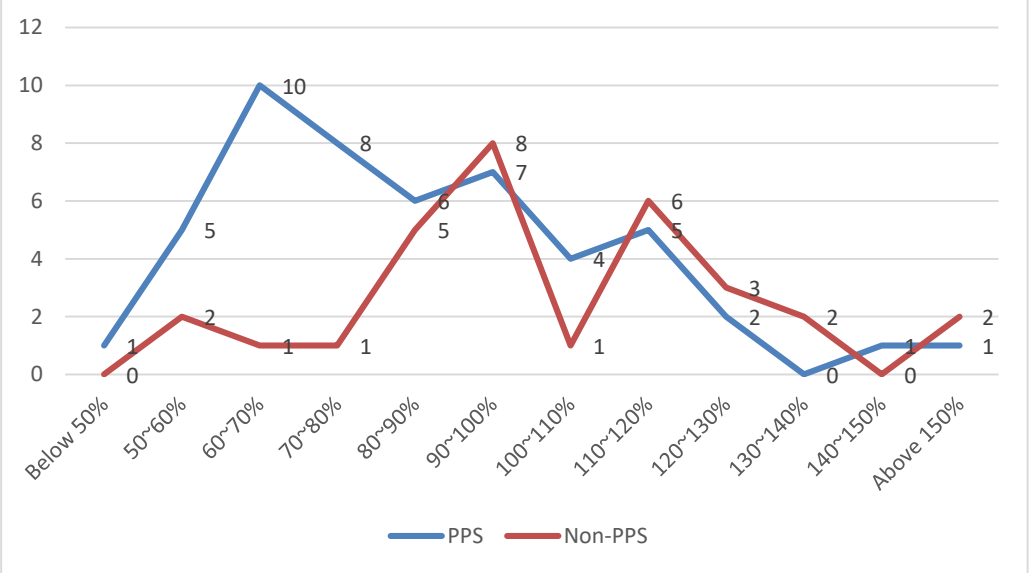

FIgure 2. Analysis of the ratio of service cost to reasonable service cost

Next, the ratio of the service cost to the appropriate service cost of public works ordered by 13 local governments excluding PPS, SH, GH, LH, and the Ministry of National Defense was analyzed (Table 11). 11 sites showed less than 100%. The reason that the service cost is lower than the appropriate service cost is that the service cost is set low as the construction cost rate, which is the past CTMA standard, is still applied when calculating the total project cost.

Table 11. Analysis of construction project management services for local government and local public corporations

No	Owner	Construction cost (a) (mil $)	CM fee (b) (mil $)	b/a(%)	b/ Appropriate CM fee(%)
1	D	0.087	0.009	9.85	95
2	E	0.106	0.009	8.26	83

3	E	0.126	0.007	5.54	59
4	F	0.407	0.018	4.31	71
5	G	0.292	0.017	5.78	84
6	H	0.172	0.015	8.60	104
7	J	0.212	0.009	4.24	55
8	I	0.182	0.017	9.28	114
9	L	0.230	0.016	6.91	92
10	M	0.131	0.012	9.16	98
11	N	0.169	0.013	7.66	92
12	N	0.123	0.011	8.93	94
13	O	0.236	0.015	6.43	87
Average		0.217	0.019	8.76	87

4.3 Comparison of manpower allocation noticed standards and actual manpower

The difference between the manpower required when announcing the CM service and the manpower actually put in was found to be partially different as shown in Table 12 below. In 9 cases out of 81 cases where actual input was less than the announcement of manpower allocation, the reason is that the number of deliveries of the total input manpower due to design changes or internal budget reductions in the ordering process, which is the demanding organization, during the bidding process after the service announcement was made. It is analyzed that as the contract is signed with reduced manpower input, less manpower is input than the required number of months

Table 12 Ratio of actual number of people input / number of people who have been placed in public notice (81 cases)

		PPS (50 cases)	GH (4)	SH (7)	LH (5)	Etc (15)
Average construction cost (mil $)		0.1849	0.8181	1.0774	0.7493	0.1974
Average CM fee (mil $)		0.0123	0.0445	0.0482	0.0452	0.0128
Man/month	Required	328	189	353	132	132
	Actual	327	190	333	131	131
	Ratio(%)	99.77	100.84	94.29	99.31	99.31
Below 100%		0	1	2	1	5
100%		0	3	2	4	7
Above 100%		50	0	3	0	3

Among the 31 services announced by non-PPS, 9 cases showed less than 100% of the actual number of people per month requested, and 6 cases exceeded 100% (Figure 3). Also, as shown in Figure 4, in the case of CM services for public works ordered by the PPS, there was no case in which the actual number of people input was less than 100% of the number of people requested.

FIgure 3. Ratio of the number of actual employees to the number of requested months

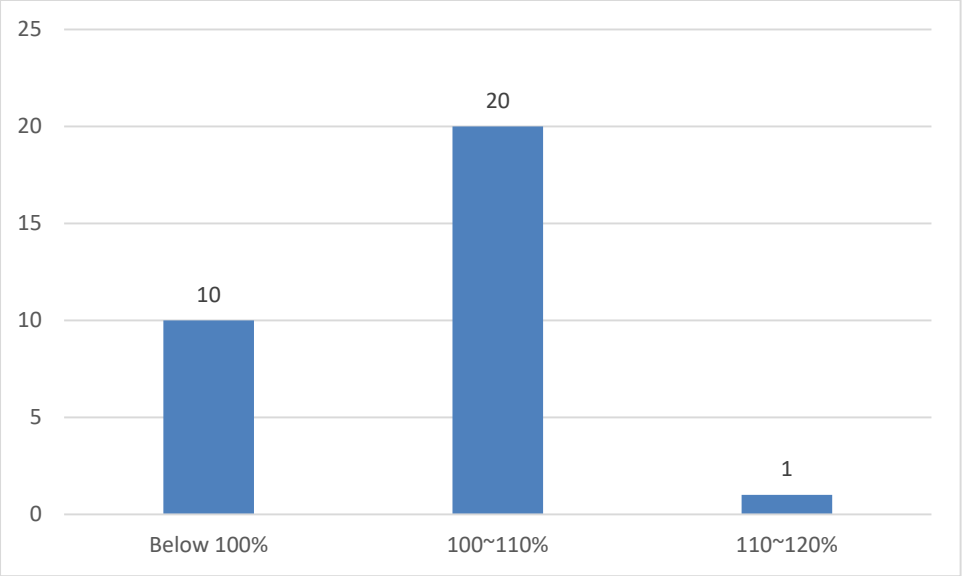

FIgure 4. The ratio of the number of actual employees to the number of months requested by the PPS

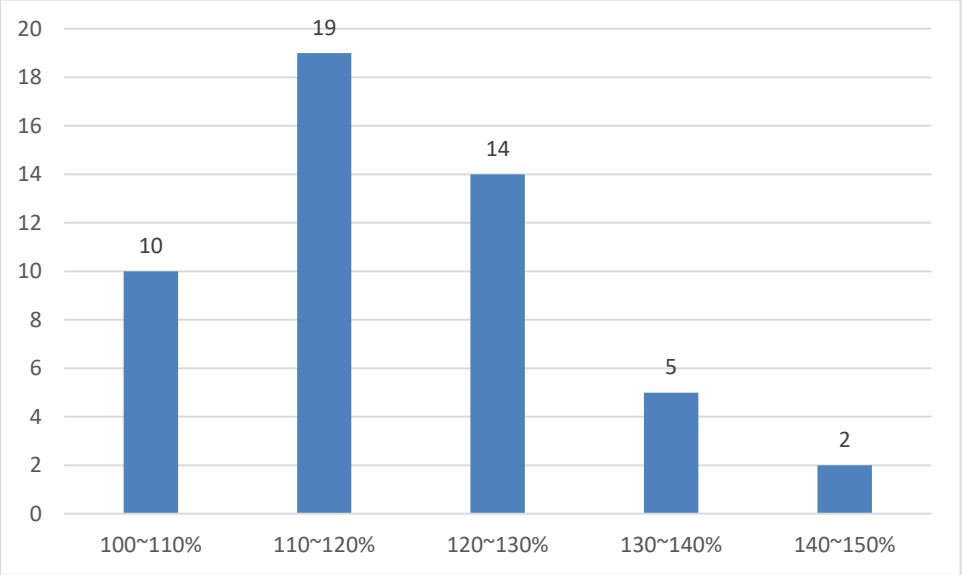

Figure 5 below is the simplest layout table among construction project management service layout tables. There is one technical manpower for each field, and among the five permanent manpower, three are master, one is advanced-senior, and one is intermediate in communication field. This is the situation where master-level personnel occupy the most weight in the sense that they can be used in a variety of ways. Also, except for those who have professional engineer license or are specialized in a specific project, even if the technical grade is master, there is not much difference in labor cost from advanced-senior engineer.

FIgure 5. The example of CMr allocation

Manpower allocation in CM project

☐ A CM project

		Division	Phase	2020 Construction										Summary	Weight	Man/month
			Month	1	2	3	4	5	6	7	8	9	10			
			Grade	1	2	3	4	5	6	7	8	9	10			
CMr	Leader	Architecture	Mater	1	1	1	1	1	1	1	1	1	1	10.0	1.000	10.00
		Architecture	Advanced-senior	1	1	1	1	1	1	1	1	1	1	10.0	0.830	8.30
		Mechanical	Mater		0.20	1	1	1	1	1	1	1		7.2	0.830	6.00
		Electrical	Mater		0.20	1	1	1	1	1	1	1		7.2	1.042	7.50
		ommunicatio	Intermediate			0.5	0.5	0.5	0.5	0.5	0.5	0.5		3.5	0.810	2.80
		Total		2.0	2.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	2.0	37.9		34.60
Headquater support		Architecture	Mater												4 times / month	2.70
		Mechanical	Advanced-senior													1.08
		Electrical	Master													1.08
		ommunicatio	Master													0.70
		Fire-fighting	Advanced-senior												1 time / week	1.30

※ 1. This plan depends on budget and schedule

5. Conclusion

This paper examines how the past and present of CMr, a major participant in the construction project, have been connected and changed with the revision of laws and regulations. The analysis of the past CTMA and current CTPA, the construction cost rate method and cost plus fee was conducted, and based on actual cases, the status of technician placement and changes in service cost were identified. The case analysis was performed on two companies that participated in the bidding for CM services ordered based on the CTPA. was confirmed to be. Among the factors for improvement of service cost, it was analyzed that, when planning an additional budget as well as cost plus fee, the changed standards were actively reflected or the service cost budget was set so that it was not insufficient and managed efficiently within the overall budget.

In addition, the current status of the total number of actual employees was analyzed through the analysis of the number of actual employees for the number of months requested at the time of announcement. As a result of the analysis, it was found that technicians with a higher grade than the required grade were placed regardless of the type of work. Although there is no damage to CM service company if the arrangement according to the grade required by the notice is not harmed, the reason for the placement of the technicians of the higher grades is that they must have high-productivity and efficient technical manpower and be on standby. It is possible to utilize one technical manpower in many ways only if he possesses the technical manpower rating that accounts for the most weight in various public works CM services based on CTPA. It was found that the special workforce accounted for the largest proportion in terms of being able to use it in a variety of ways.

Also, although the manpower allocation table is at the intermediate level, the current standard for PQ is that the perfect score below the intermediate level for job field evaluation is 8 years or more of technical experience. If the technical experience is more than 8 years, the grade is higher than the advanced-senior level. As such, it was found that the arrangement and service cost of CMr, which plays an important role in the construction project, is somewhat unreasonable to fully reflect the current situation.

1. In order to properly calculate the CM service cost, it is necessary to introduce mandatory allocation standards in the construction sector as in the electricity sector. In addition, since the exact construction cost is confirmed after the design is completed, the construction project management service cost also needs to be properly prepared by experts using private contracts or small-scale bidding.
2. For the efficient arrangement of CMr, it is necessary to place an order so that the arrangement for each construction type, except for the mandatory arrangement, can be arranged flexibly to suit the characteristics of the project.
3. Institutional improvement and continuous research of the competency evaluation model that can present the competency index reflecting the job performance ability appropriate to the actual skill level of construction engineers should be supported.

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