KIEAE Journal, Vol. 22, No. 4, Aug. 2022, pp.11-19.

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KIEAE Journal

Korea Institute of Ecological Architecture and Environment

116

Policies to Revitalize University Education for Nurturing New BIM Manpower in the Construction Industry

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ABSTRACT

Purpose: This research aims to vitalize the education on building information modeling (BIM) by examining its current status, analyzing and comparing the BIM education level, and suggesting ways to improve the university curriculum for nurturing new BIM manpower in the construction business. **Method:** Institutions that are conducting BIM education at home and abroad were investigated. This study examined the curricula of domestic BIM educational institutions, classified them by level of development (LOD), investigated foreign BIM education cases, and analyzed the level of BIM education in Korean universities comparing it to that in overseas universities. Based on this, a plan was derived to improve the curriculum and raise the level of BIM education. **Result:** As part of the 4th industrial revolution, smart construction technology has been introduced worldwide, and requests for the widespread use and commercialization of BIM technology are increasing, but most existing construction engineers have not learned this technology, Under the current education concept, existing technicians are educated at training institutes for construction technicians, but the conducted education is far from the requirements of the 4th industrial revolution. It was found that universities that provide basic professional skills cannot teach professional knowledge about smart construction technology in preparation for the 4th industrial revolution, including BIM and virtual reality (VR).

KEYWORD

건설정보모델
대학교육
개선방안

Construction Information Model
University Education
Improvement Plan

ACCEPTANCE INFO

Received Jun. 20, 2022
Final revision received Jul. 11, 2022
Accepted Jul. 15, 2022

1. Introduction

1.1. Background and purpose of the study

Recently, with the development of information technology and the increase in demand for large-scale projects according to the 4th industrial revolution, the introduction and use of building information modeling (BIM) is rapidly progressing worldwide[1].

Since BIM was introduced in the Yongin Citizens Sports Park Turnkey Project ordered in 2009, BIM application has been expanding in major domestic public projects, from the mandatory application of BIM by the Public Procurement Service to the Incheon International Airport Corporation's plan to build 100% of the airport infrastructure based on BIM data in 2019[2]. In addition, since the Ministry of Land, Infrastructure, and Transport first announced the roadmap for smart construction technology for innovation in construction productivity and safety enhancement in 2018, BIM has been recognized as an innovative technology with high potential to increase productivity in the construction industry. BIM has been introduced to projects such as the Dongdaemun Design Plaza, Hanam Starfield, and Hyundai Motor Studio and is making technological progress.

Overseas, major advanced countries such as the US, UK, and Singapore are making efforts to promote BIM by setting up BIM standards, operating BIM maturity models, and operating qualifications[3][4].

Education related to BIM is also increasing overseas owing to these efforts to promote it, but it is difficult to say that BIM technology has been universalized in Korea. Therefore, for domestic BIM technology to be expanded to the construction industry as a whole, it is necessary to change the perception of educational institutions about actively introducing BIM technology[5].

Accordingly, the Ministry of Land, Infrastructure, and Transport recently announced the 2030 Building BIM activation roadmap with the goal of establishing a BIM design base by 2025 and fully realizing digital architecture services by 2030. The roadmap cited the phenomenon of design outsourcing to BIM specialists because design practitioners lack BIM execution capability, which is a factor hindering the activation of BIM, and emphasized the importance of new manpower and university

pISSN 2288-968X, eISSN 2288-9698
https://doi.org/10.12813/kieae.2022.22.4.011

education[6]. In addition, as BIM activation is included in the 110 national tasks of the new government1), the awareness of BIM is shifting from the meaning of a simple tool or software to data-based technology for digitalization of the construction industry. BIM is already required in various fields in the building industry market, and the advantages of BIM have already been highly recognized.

Since the introduction of BIM, the importance of BIM education has been constantly mentioned. However, due to lack of understanding of the BIM process, difficulties in learning and using the BIM software for students, and problems in the educational environment of educational institutions, it has not been introduced in the university curriculum[7]. The introduction of BIM and improvement of the curriculum of universities that implement education for the first time are necessary[8].

Therefore, this study seeks to find a way to promote the introduction of BIM education by examining the current BIM university education, by comparing the domestic and foreign BIM education levels, and by suggesting an improvement plan for the university curriculum for nurturing new BIM manpower for construction projects.

1.2. Method and scope of the study

In this study, the current status of BIM education at universities was investigated, limited to the design field. To improve and set the level of BIM education, the educational curriculum of institutions that are conducting domestic and overseas BIM education was classified into content and level of development (LOD). Through this, we attempted to find ways to improve the curriculum for nurturing new BIM manpower for construction projects. In addition, by analyzing the support and operation status of major overseas BIM educational institutions, a plan for revitalizing BIM university education in Korea was derived.

2. Literature review on BIM education

2.1. Effect of BIM education

In this study, among domestic and foreign BIM studies, studies related to BIM education and architectural design were investigated (Table 1.).

Yoon Myung-cheol and Ko Seong-ryong (2009) compared architecture, engineering, and construction (AEC) computer-aided design (CAD). tools (AutoCAD) and BIM tools (Revit) and found that Revit can be easily applied as it offers object-oriented architectural expression and basic family (library) use, easy character application, and dimensional application. In addition, Revit has the effect of improving spatial perception by reducing the burden of drawing errors, offering integrated information management, and reducing drawing time. This emphasizes the importance of applying BIM tools in various fields[9].

Table 1. Literature review of building information modeling (BIM) education and design

Author	Title
M.C. Yoon et al. (2009)	A Comparative Study on AEC CAD Educational Methods Applied Building Information Modeling Tools
K.C. Shin et al. (2011)	A Case Study of Architectural Engineering Design Education Using BIM Concept
Y.I. Kim et al. (2012)	The Experiment of Architectural Design Education by means of BIM
J. Benner et al. (2018)	Lessons Learned from a Multi-year Initiative to Integrate Data-Driven Design Using BIM into Undergraduate Architectural Education
S. Kolarić (2019)	The Influence of BIM Education Improvement on Raising BIM Awareness in Croatia and Slovakia
D. Zhao et al. (2021)	Peer Pressure in BIM-Based Collaboration Improves Student Learning

Shin Gyu-cheol (2011) compared and analyzed the results of traditional design education through hand drawing and design education through BIM as an example of architectural engineering design education. It was suggested that BIM education can have a positive effect because it is easy to understand[10].

Kim Yong-il (2012) found out the difference between the current and BIM design processes through a comparative analysis between the traditional and BIM studio design processes and saw the possibility that a faster and more reliable design can be derived. In addition, it would be very helpful to students learning architecture because of the reduction in errors and time during the drawing work given the ease of modifying and changing the design results[11].

For a thesis on BIM education abroad, J. Benner (2018) repeated a series of mass models in Autodesk Revit for 300 students in their 3rd year in a faculty of architectural sciences for 3 years, from the first year of applying BIM to the architectural curriculum. The initial cost, life cycle, and energy performance of the model were analyzed. As a result of examining the students' learning level and perception, it was found that the sophisticated method of BIM can be applied even at the undergraduate level. It was found that a better understanding of the impact of unique shape designs on building performance (especially the effect of glazing and overhangs) increased the reliability of BIM as an interactive design evaluation tool rather than a simple design tool[12].

Sonja Kolarić (2019) analyzed the current BIM training in two civil engineering departments, and after BIM training, students were satisfied with the acquisition of the basic BIM knowledge and BIM techniques commonly used in education. These two faculties need to develop BIM education content, which suggests the importance of connecting BIM education not only with actual companies and projects, but also with the same faculty and other fields[13].

Dong Zhao (2021) compared learning outcomes by using BIM for competition among peers at different levels in the context of collaboration. As a result of analyzing the data of 192 students majoring in architecture in the BIM class, it was found that competition between peers had a positive effect on student learning. This suggested that the impact of peer competition in future AEC projects could be investigated and compared in an educational context[14].

Most of the contents of the domestic literature research are based on BIM education. Compared to the existing 2D-oriented work, when drawing through a BIM work, it is easy to modify and change drawings by 3D visualization The importance of BIM education was mentioned because it has the effect of reducing possible errors and working time.

In foreign countries, research on BIM education has been continuously conducted until recently, and in the design field, additional processes such as energy performance evaluation and collaboration with colleagues are also important.

2.2. BIM education status

To improve the current BIM education, architecture certification and engineering certification were considered. The ultimate goal of the Architecture Accreditation (KAAB) is to improve the quality of architecture education and enhance the understanding of the social role of architecture, thereby contributing to the overall development of related architecture projects and strengthening of national competitiveness[15]. Accreditation of Engineering (ABEEK) encourages the introduction of new and innovative methods in engineering education, and its goal is to promote development and produce the engineering manpower needed by business and society. Both have a common goal: to promote the development of the architecture-related industry by increasing the quality of education. However, as we enter the 4th industrial revolution with the intelligence of the overall industry, there is no specific certification standard for building integrated information modeling, which is one of the major smart technologies and involves aspects such as 3D printing, artificial intelligence (AI), unmanned aerial vehicles, Internet of Things (IoT), and augmented reality (AR)[16]. In addition, it was found that little support is provided to universities in Korea, whereas BIM is mandatory and receiving support abroad. Although there are subjects for the study of smart technologies, there are few convergence education courses on the architecture-related smart technologies specified in the smart construction technology roadmap, such as BIM, drones, robots, IoT, big data, and AI[17]. The problem is that there is a lack of awareness of the necessity of this type of education.

The construction industry clearly needs a curriculum to acquire the 4th industrial revolution technology to realize the "high value-added construction industry" promoted by the government. Nevertheless, most of the university curricula include basic knowledge, construction methods, and technology on traditional construction technology. This means that only basic education of the 4th industrial revolution and smart construction technology is provided, and there is hardly any specialized curriculum that can be applied to architectural practice in the undergraduate course.

2.3. Level of development (LOD)

One of the features emphasized when constructing spatial data through BIM is that collaboration is possible so that projects can be carried out efficiently. However, as the model level required for each project is not the same, a LOD is designated so that

Table 2. BIM level of development (LOD) standards (AIA, 2017)

LOD Level	Description
LOD 100 - Conceptual	The Model Element may be graphically represented in the Model with a symbol or other generic representation. Information related to the Model Element can be derived from other Model Elements. Any information derived from LOD 100 elements must be considered approximate.
LOD 200 - Approximate Geometry	The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Any information derived from LOD 200 elements must be considered approximate.
LOD 300 - Precise Geometry	The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element. The project origin is defined and the element is located accurately with respect to the project origin.
LOD 350 - Precise Geometry with Connections	The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.
LOD 400- Fabrication-ready Geometry	The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.
LOD 500 – Operational/ As-built Models	The Model Element is a field-verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the Model Elements.

efficient design collaboration and consistency of execution are maintained during the project process.

The BIM LOD defines the modeling level step-by-step in the project development stage, and the designer defines the objective contents and characteristics of the BIM model elements according to the detailed use and scope to achieve reliability[15]. The BIM LOD is divided into six levels of development, LOD 100, 200, 300, 350, 400, and 500; the larger the number, the higher is the accuracy of the model level. The LOD is defined according to the information required (Table 2). Countries such as the United States, Taiwan, Hong Kong, and Singapore use the LODs established in the AIA Document E202. Based on similar concepts, Germany uses LOIN and Korea uses BIL[16].

3. Education level setting

3.1. University BIM Education Curriculum

To analyze the current level of BIM education in domestic universities, the top five universities in Korea as of 2021 were selected for analysis.

Universities use the indicators of education (30%), thesis citation (32.5%), research (30%), international outlook (5%), and industry–university cooperation (2.5%) to conduct "THE Ranking," which provides relatively objective university rankings. The architectural design-related curriculum was obtained from the architecture department of each university and classified and analyzed by LOD.

In university 'a', there are subjects that teach how to design using computer programs, such as ① Architecture and Computers, and ② Digital Design Studio. In the education curriculum, only the principles and concepts of CAD and the application of design were mentioned, and there was no mention of using BIM. Thus, it could not be classified by LOD because it does not address the contents of construction information modeling in depth.

In university 'b', BIM-related contents can be learned from the second grade, for over two years, providing the basics of BIM-based digital modeling and BIM design process. Through this process, IT technology and functions can be used to enhance the information management and design process capabilities and to express and apply images of architectural space through computers. In this way, information management and design process capabilities are enhanced, and the image of an architectural space can be expressed through a computer and applied to the design process. Through this, it is understood that modeling and approximate size, shape, location, and orientation can be designed, although not to the extent of defining the exact quantity, size, and shape of each element using BIM. As a result of the analysis, we understand that model elements such as the approximate quantity, size, shape, location, and direction within the model can be graphically represented, and thus the education level can be considered LOD 200.

It was found that the department of architecture at university 'c' teaches basic digital technology in ① Digital Studio I and II, utilizing BIM and Parametric Design in the process of expanding and applying it to architectural design. Through this, we understand that it is possible to learn the contents of the connection between various building systems and to perform approximate modeling. However, there seems to be a limit in the documentation of construction contents because there is no mention of the realization of detailed drawings. It can thus be classified as approximately LOD 300.

University 'd' uses BIM in education activities related to design development and engineering, such as research on wall surfaces and other types of detailed design in engineering education, and in the course ① building system and design integration, in the 5th year of architectural design. By applying BIM in the upper grades, it is expected that modeling including construction-related contents can be performed and documented. However, there is no mention of the contents related to production, assembly, and completion. Therefore, it can be classified as LOD 350.

In university 'e', although mixed with elective subjects, BIM-related subjects are mandatory and are included in a system of advanced and secondary subjects. According to this system, after having basic competencies in theory and practice, students are expected to learn the collaborative method of BIM information for each field, from the initial stage of construction to the final one of completion, and the integrated project management and implementation method according to the integrated project delivery (IPD) concept. This is defined as a clear model and documentation and can be classified as LOD 350 or around it, with details and elements representing the interface

Table 3. Scores for each university

University	Rank	Overall	Teaching	Research	Citations	Cooperation Industry	International Outlook
a	60	69.7	72.4	73.8	68.8	97.8	37.4
b	101	61.7	55.7	60.3	67.8	98.1	55.0
c	167	56.3	48.7	50.1	67.6	96.2	53.4
d	187	54.9	52.2	53.7	54.0	99.5	58.6
e	251–300	48.0–50.5	37.0	41.4	63.9	85.3	63.5

Table 4. LOD of BIM education at domestic universities

University	Curriculum	LOD Level
a	Lack of content on BIM	-
b	Basics of BIM-based digital modeling and BIM design process. Improvement of information management and design skills using IT technology and functions	LOD 200 - Approximate Geometry
c	Basic digital technology and use of BIM and Parametric Design in the process of expanding and applying the technology to architectural design	
d	Use of BIM in design development and engineering, such as in wall studies and other detailed designs	
e	Foundations of BIM, collaboration method of BIM information for each field from the initial stage of construction to the final one of completion, and integrated project management and implementation method according to integrated project delivery (IPD).	LOD 350 - Precise Geometry with Connections

of building elements with various building systems and other elements.

As a result of examining the BIM education curricula of the previously investigated domestic universities, it was found that the level of BIM education related to architectural design at the national universities was significantly lower than the current BIM usage and prospects. Most universities educate at a level below LOD 200, and it is inappropriate to learn BIM-related in-depth contents with an unsystematic curriculum without standards for the level of BIM education. In university 'd', BIM is taught in the highest grade, but it is difficult for students to utilize BIM actively owing to the absence of subjects where they can learn the basic software application abilities of BIM, such as the tools and functions used in BIM software, drawing methods, and the principles of 3D expression, unlike the existing programs in 2D expression.

Currently, domestic construction projects are mainly ordered separating design and construction, and national universities are divided into architecture and architectural engineering, unlike foreign universities. Further, in the departments of architecture, the education curriculum up to 3D modeling is the main focus, but in other majors related to architectural construction, such as those in the departments of architectural engineering, civil and environmental engineering, and architectural social engineering, BIM education covers relatively in-depth contents (4D, 5D) that can be practically used in building construction, such as BIM basic design, the latest concrete engineering and design, and process management.

3.2. BIM education curriculum at major domestic and foreign educational institutions

For BIM to be integrated into the university curriculum, it is necessary to investigate the curriculum of current BIM educational institutions and determine the position of the BIM education level through a comparison with foreign institutions. Therefore, the curriculum of four domestic and five overseas BIM educational institutions were compared and analyzed. The local educational institutions, including public and private institutions, were selected improving public welfare through active participation in international activities. Foreign educational institutions in four countries were selected. These institutions provide education certified by the state and organizations aimed at providing and supporting expertise in cooperation with various companies. Given the scope of the survey, the selected curricula included design education, and the subject of education was limited to the general public and students who wanted to receive training by design experts. For the analysis, the main contents of the curriculum of each educational institution were selected and classified.

Domestic BIM educational institutions include a course to practice how to use the concept of BIM. However, in most cases, the contents of education to a certain level are not described. When examining the range of data utilization methods among educational institutions affiliated with public institutions, in institution 'F' it is limited to basic modeling, which corresponds to the basic design stage, and preparation of schedules and drawings. In the case of institutions 'G' and 'H', they attempt to understand and utilize 4D BIM, which corresponds to interference review and process management. Institution 'I' deals with BIM modeling, 4D BIM, and 5D BIM, which corresponds to estimate calculation at the level of approximate information.

In overseas BIM educational institutions, the overall educational goal is to improve the basic or professional knowledge of BIM and problem-solving ability and educate on information exchange. Analyzing the detailed educational content, learning the basics of BIM and how to model using BIM is similar to that of domestic institutions, but in the case of institution 'J' in Singapore, the modeling process is subdivided into building mass, site, and building elements, and the education was focused on the process of sharing work after modeling. In the case of UK institutions ´K' and 'L', the first part corresponds to the concepts and principles, and the following parts correspond to the supply stage of assets based on the international standard ISO 2, project preparation method, process of exchanging and managing project information, and information environment. In institution 'M' in Germany, 3D modeling and data management through BIM, 4D BIM, and BIM in planning, execution and operation are addressed. Institutes 'N' in the United States provide education on the concepts of BIM and ISO 19650, principles of information management function, BIM process

Table 5. Education curricula of BIM educational institutions

Educational Institution		Content	Curriculum									LOD Level
				Training								
			Theory (Intro -duction)	BIM Modeling (3D)	Reflect External Elements	Modeling Assurance	Time (4D)	Cost (5D)	Data Manage -ment	Law	BIM Standard	
Korea	F	Modeling creation, schedule creation	●	●			●		●		●	LOD 200
	G	Drawing design, construction management, construction quality	●	●		●	●					LOD 350
	H	Structural and architectural modeling practice, design coordination, 4D BIM Practice	●	●			●					LOD 300
	I	BIM modeling creation (including structure and equipment), 4D process control, 5D quantity calculation	●	●	●	●	●	●	●			LOD 300
Singapore	J	Modeling of projects and building elements, insertion of external files, creation of E-submission project templates	●	●	●		●		●			LOD 350
England	K	BIM standard information creation according to ISO 19505, information exchange method, contractual requirements	●	●					●	●	●	LOD 350
	L	BIM modeling implementation method and information management	●	●			●		●		●	LOD 300
Germany	M	BIM in model creation, data management, planning, execution, and operations	●	●		●	●		●	●		LOD 500
America	N	ISO 19650 concepts and principles, functions to manage information, key elements of the BIM process, coalition strategy, definition of LOD, roles and responsibilities, etc.	●	●					●	●	●	LOD 400

core elements, SMP, CDE, alliance strategy, LOD definition, information requirement level, roles and responsibilities, etc. (Table 5.).

The BIM education curricula of domestic and foreign educational institutions were comprehensively analyzed and classified by LOD, with the following results. In Korea, education is focused on 3D modeling, design drawings and schedules, process management, and other aspects. According to this educational standard, BIM technology can be handled at a LOD ranging from 200 to 300. In the case of overseas institutions, in addition to basic 3D modeling, the education provided includes the process of reviewing errors, design changes, and information management. The curricula are formed in a way that is possible to manage information using BIM at a LOD ranging from 300 to 500. Thus, BIM technology is not only focused on a few building processes, but is developing and making efforts to cover the entire process of architecture.

3.3. Sub-conclusion

The curricula of universities and educational institutions that provide education on BIM were analyzed based on domestic and foreign literature reviews. The results show that steady efforts, such as setting LODs, are being made overseas to utilize BIM, which is currently recognized for its development potential worldwide. However, in Korea, the specialized curriculum on the 4th industrial revolution and smart construction technology such as BIM is insufficient in the undergraduate course. The current BIM education has been shown to have a positive effect on the ease of drawing and other additional processes compared to the inefficiency of the existing design method.

As a result, the LOD of the BIM education curriculum of educational institutions in Korea is around LOD 200 to 300 in Korea, whereas it is LOD 300 to 500 in the overseas cases.

Therefore, to use this technology in practice through BIM education, it is important to identify the ultimate goal and characteristics of BIM and establish a curriculum.

The first aspect is the composition principle. Currently, architecture education is conducted separately, according to the method of separate ordering of design and construction. This is a situation in which communication between the design, construction, client, and other fields is not optimal, and thus, very often work has to be carried out again at the construction stage, after design. However, BIM is a digital transformation capability within the building industry that allows the construction and design fields to coexist.

Therefore, the use of BIM data from the design process to the construction and maintenance stages should be considered. Rather than focusing on one field, particularly in design education, the curriculum should be conducted to fully understand the use and flow of BIM data after the design stage and collaboration among industries.

The second aspect is the appropriate LOD. Currently, the LOD, which indicates the level of modeling in various countries worldwide, is used to maintain consistency in project development. A high LOD means that you can handle the details, which is also linked to your skills and abilities.

When looking at domestic and foreign educational institutions that are currently conducting BIM education, the level of drawings that can be created without knowing the circumstances of the personnel and materials at the construction site or the surrounding environment is about LOD 350. After that, it is judged that it will be helpful to improve the LOD, based on the understanding of the field situation through sufficient practical training, to LOD 400 or higher. It is necessary to learn the basic principles of BIM and data utilization in school classes, but it is also required to include the technical abilities of BIM by educating based on the LOD 350 level. In addition, it is necessary to manage data efficiently, so that it can be adapted to practice, and to increase the collaboration ability, including the process of sharing work after modeling.

The third aspect is the curriculum structure. BIM comprises not only modeling but also integrated design, process management, and estimate calculation. The departments of architecture should consider, in addition to the basic contents and design method of BIM, the detailed design drawings and documentation of non-graphic information (4D, 5D BIM) as necessary to deal with the contents required for the construction of a building, such as detailed model production and assembly information.

If domestic and foreign curriculum are analyzed and reflected on, then 1) the basic concepts of BIM technology and how to use programs for existing digital modeling can be included; 2) BIM technology, which allows making schedules and drawings and reviewing errors, can be incorporated into the existing design education methods; and 3) data management and work sharing processes, which are necessary for engineering and maintenance, can be deployed, so that non-graphical elements can also be taught.

4. Improvement plan

4.1. Korea Architecture Accrediting Board (KAAB), Accreditation Board for Engineering Education of Korea (ABEEK) link

The KAAB standards include those required for architecture education; the educational environment standards related to human, material, and information resources and the operating system that includes self-evaluation and curriculum; and the minimum educational content required to complete a practical training after graduation. The KAAB standards are divided into three parts, including the student performance evaluation criteria (SPC)[18].

In addition, there are eight criteria for the engineering accreditation (ABEEK), which comprise the certification criteria by major field added to the criteria for program educational goals and learning outcomes, curriculum, students, faculty, educational environment, and program improvement[19].

Therefore, smart construction technology certification systems, including BIM-related curriculum, BIM-related learning achievements, and BIM-related educational objectives, should be added to the criteria for architecture certification and engineering certification, and education and evaluation with respect to each smart construction technology should be established.

In addition, based on the instructors' understanding of digital models (BIM, VR, reverse engineering by 3D scanning, etc.), subject Career Development Roadmap (CDRs) can be reconstructed. A more practical revitalization method could be to apply the "Basic Guidelines for BIM Application of Public Procurement Service Facility Business v2.0" and "Basic Guidelines for BIM in Construction Industry," reorganizing the architectural design process.

4.2. Cooperation with educational institutes for construction technical personnel

Education for construction engineers is conducted at universities, where basic education is provided, and at legal educational institutes for construction technicians. However, it is recognized that the quality of education is poor in various aspects, including the educational process and educational level, which impede scaling the advanced technologies required in BIM, such as process management and material management. Considering that trainees have a high level of satisfaction with manpower education, it is necessary to conduct education in cooperation with technical educational institutions for professional construction manpower and with universities in accordance with the characteristics of the university. Universities providing basic education should cooperate with specialized education and training institutions, such as those providing English language education for overseas construction, construction practice, workshops, and related activities, and focus on the smart technologies of the 4th industrial revolution.

4.3. Provide incentives

Universities should be recognized as institutions that teach basic education and present the future direction for the construction industry. Thus, they should be supported to implement education that can produce smart construction talents. BIM is currently mandatory and supported abroad. However, the support given to universities in Korea is insufficient, and when education on smart technology is provided, it is insufficient. The university philosophy and management, education, faculty, staff, educational facilities, student support, university performance, and social responsibility, are all aspects related to the establishment of a smart technology learning curriculum. A future-oriented evaluation section and an institutional cooperation program can be added to the education area, where each university or department cooperates, allowing the university to conduct education related to smart construction technology. Therefore, incentives should be provided to add a convergence curriculum.

However, there is a possibility that a blind support system may be transformed into a formal act focused on achievement rather than on the purpose of activating education. Therefore, it should be operated so that the generation of BIM manpower nurtured through the improvement of university education becomes the first principle.

5. Conclusion

Owing to the 4th industrial revolution, smart construction technology has been introduced worldwide. As a consequence, requests for the overall use of BIM technology are increasing and commercialization is trending, but most existing construction engineers have not learned smart construction technology. In terms of education, the existing construction technicians have been educated at institutes for construction technicians. However, despite the increase in global demand for smart technology since the beginning of the 4th industrial revolution, the curriculum of universities has hardly changed. Only distant education is being conducted. Universities that offer education on basic professional technology do not provide knowledge about smart construction technology in preparation for the 4th industrial revolution, including BIM, VR, and drones[2].

In this study, a plan to revitalize the university education for nurturing new BIM manpower in the construction industry was presented. The plan includes the following aspects. First, it proposes a method for linking smart construction and BIM in connection with the architecture and architectural engineering certification system. Second, it proposes a method for composing related subjects and conducting education in connection with training institutions for construction personnel. Third, it suggests providing incentives by adding a smart technology-related evaluation section to the university evaluation area. With the plan, it will be possible to revitalize education to acquire leading smart construction technologies.

Through this revitalization plan, students will be able to understand the direction of the future construction industry and think broadly. In addition, it is expected to be helpful in the future construction market by encouraging the active participation of universities through the support of smart construction technology education at the government level. The most important aspect is the active participation of the university. In other words, it is important for universities to strive actively for growth by maximizing changes in the curriculum and incentive systems.

Owing to time constraints, this study could not research all domestic and foreign educational institutions and universities, so it is necessary to investigate further. In addition, the limitations of domestic universities for providing the minimum knowledge necessary in practice should be considered. These limitations include the lack of class hours, ability of instructors, and equipment, along with the position of each institution, including the university and the government. Therefore, sufficient time is necessary to institutionalize the proposed measures.

In the future, it will be necessary to apply BIM-based education to the domestic smart construction field. To this end, it is necessary to improve the certification process and the system of national education laws for architecture and engineering accreditation.

Acknowledgement

This study was carried out as a "BIM Activation Public Capacity Reinforcement Support Study" by the Ministry of Land, Infrastructure, and Transport (Project No. 20210636-001).

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