# The Practice of the management by the CIM team on the Construction Site

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**Abstract:**

In this paper, we discuss the necessity for establishing the team of Construction Information Modelling / Management ( hereafter referred to as “CIM” ) on managing design and construction of infrastructure development projects based on our case study of the station peripheral development project, （improvement project of traffic connection in station area), which was implemented for about 4 years since 2007. CIM means BIM for Infrastructure in Japan.

Our laboratory was to provide information to the client of this project as part of research. We adopted the second-tier consultation system to provide the construction information.

The second-tier consultation system consists of advancing consultations by synchronous intensive type where all stakeholders use the model space to discuss at the same place, and obtain consensus, asynchronous distributed type that exchanges information using the Knowledge Oriented Logistic Groupware, so called Kolg.

By the time this project was completed, our laboratory has played a critical role on managing the entire project, including investigating issues which could occur among stakeholders at the site.

In this paper we discussed our own roles in the project and clarify problems solutions, by introducing two remarkable cases where the second-tier consultation system was successfully implemented. As a result, we can confirm the second-tier consultation system contributes to the success of the project. This paper introduced and defined the CIM team for the project management through this case study.

**Keywords:** Model Space, Archives, Management, CIM, CIM Team

## 1. INTRODUCTON

In this paper, we discuss the necessity for establishing the team of Construction Information Modelling / Management ( hereafter referred to as “CIM” ) on managing design and construction through a case of the station peripheral development project, (improvement project of traffic connection in station area), which was implemented for about 4 years since 2007. CIM means BIM for Infrastructure in Japan.

This project contains three-dimensional complexity characterized by the inconvenience of usage between JR station (overhead railway), tramway, and foundation work to support the mentioned infrastructure.

In the project, we faced three major issues; time restriction, design (project planning and scheduling) and management of the project (Figure 1). Firstly, the duration of the Project was limited. The project had to be completed by the end of March 2011 at the time of the opening of the JR Kyushu Shinkansen Super Express. Second, there were several contractors who pursued different projects at the same time on the site at the main road of an urban area. Therefore, careful planning and scheduling of work was critical for the safe and efficient implementation under such constraints. Third, there was an issue in the difference of knowledge level among contractors. The following four different projects were scheduled on the site simultaneously, and it was necessary to coordinate schedules among contractors for smooth implementation of work:

(1) Construction of the station and relocation of the railway viaduct by JR Kyushu Railway Company

(2) Removal and reconstruction of the pedestrian overpass by Kumamoto Prefectural Government

(3) Relocation of the tram stop and alteration of railroad alignment by the Kumamoto Traffic Bureau

(4) Construction of the parking area for bicycles under the viaduct by Kumamoto City.

In this project, it was essential to strengthen transportation location which was a cross point of traffic. Since it was an urban planning project, it was necessary for Prefectural Office to plan, not the city office. Therefore, the prefecture was responsible for the overall management. Meanwhile, at the stage of the overall planning, people who were in charge of ordering other than the prefecture had not been decided, and it was difficult to share various tasks related to the business of each owner in advance. In order to share the problems of complex site, it was important to have understanding of the situation by using 3D CAD. In addition, it was requested to efficiently provide information to related parties who were in distant location such as Tokyo, Osaka, Fukuoka, and Kumamoto.

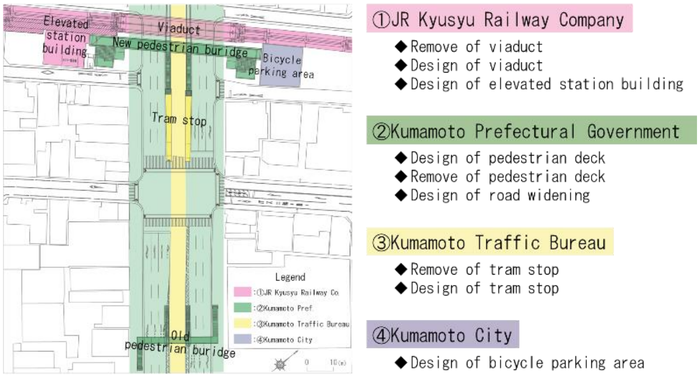



Figure 1. Relationship between project and owner

In our laboratory, we have been conducting research on design and construction support (Tomoshige et al., 2008, Kobayashi et al., 2009, Kobayashi et al., 2008). In order to promote projects efficiently in civil engineering projects and to form consensus with each stakeholder, we are using model space and information sharing system. The two-tier meeting was conducted using Kolg (Knowledge Oriented Logistic Groupware) effectively (Figure 2). Model space is a space which expresses design objects and their surroundings using 3D data (Kobayashi et al., 2010, Kobayashi et al., 2011). Kolg is a SNS (Social Networking Services) tool. It is a system which can keep consultation history and other consideration items (Noma, 2011). The concept of the two-tier consultation system consists of a consensus-building place which is synchronous and consolidated by all stakeholders using the model space, and asynchronous distributed type, Kolg, was deemed appropriate. We proposed utilization of this system in this project because we thought that it could overcome the above three problems, and it could be effective to solve various problems which were concerns that simultaneously occur in different locations.

Initially started as a pure research, we asked the prefecture to provide information. Stakeholders involved in this project agreed that we could use this at no cost.

First of all, it was recognized among the staff in charge of the prefecture that it was effective for problem discovery and examination of solutions at the pedestrian bridge design stage. By the time the project progressed and completed, this laboratory played a role of managing the entire project, including issues that could occur at the stakeholders and on the construction site.

In this paper we discussed our own roles in the project, and clarify problems solutions and stakeholders, by introducing two remarkable cases where second-tier consultation system worked.

As a result, we can confirm that the method leads to the success of the project.

This paper introduced and defined the CIM team for the project management through this case study.

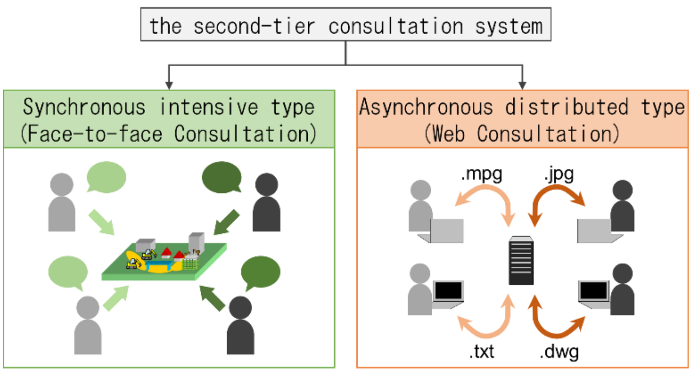



Figure 2. The second-tier consultation system

## 2. Case study and Discussion of the station development project

In this project, initially, multiple owners and contractors of each project had discussions in order to grasp the complicated site situation and to share the further problems, and to provide necessary information (Figure. 3).
Due to the existence of model space at consensus building place, important information was provided which lead participants to come up with improvement proposals for the problems which could not have been found in advance. As the convenience for the stakeholders was recognized, the model space was actively used.
In this laboratory, we could predict that spatial adjustment would emerge. We were facing a challenge to provide and share information efficiently and promptly with stakeholders who were scattered in various places. With this challenge, we introduced the information sharing system, Kolg.
In this chapter, we describe case examples of pedestrian bridge construction projects that were particularly effective in using consensus building places (model space) and signage plans that were highly effective as an example of using information exchange field (Kolg). We described the role and position of this laboratory.

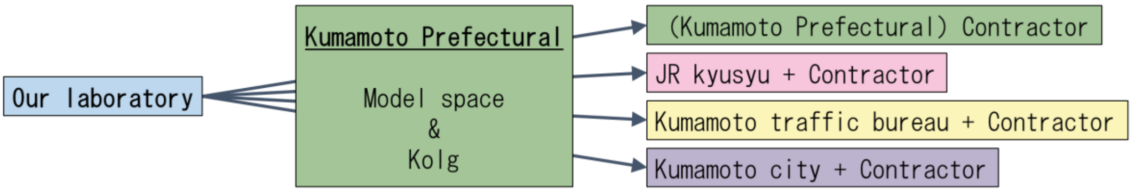



Figure 3. The first project system

### 2.1 Case study and discussion : Construction plan of the pedestrian bridge

(1) Project Stakeholders

a) Kumamoto Prefecture, b) Kumamoto City, c) Kumamoto Public Transportation Bureau, d) JR Kyushu, e) Residents, f) Consultant B, g) Kobayashi Laboratory

(2) Project issues

When constructing a new pedestrian bridge, the construction of the newly built elevated station building and the road widening work were carried out at the same time. The plan was to relocate the train station. The issues in the construction plan were as follows.

- Construction yard was limited, being difficult for securing sufficient area, such as arrangement of heavy equipment
- Adjustment with construction plan other than footbridge was necessary
- Since the construction ban period was one month at year-end and new year, efficient construction planning was necessary for the entire project

(3) Solutions

In this laboratory, information was disseminated by Kolg (Figure. 4). Figure 5 shows the model space that reproduces the entire construction process. On September 8, 2010, it was confirmed that the elevation of the station building was done at the same time with pile foundation construction of the pedestrian bridge.

While displaying the model space in chronological order, overlapping with the yard of the station building occurred (pictured in Figure 6, the red part) and the crawler crane used for the pile foundation construction was being constructed when pile foundation construction of the pedestrian bridge was carried out. It was confirmed that there was a possibility of interfering with the station building (Figure. 6, green part).

As a result of confirming this issue to each stakeholder, it was confirmed that it was a problem that occurred because part of the drawing used for model space creation was not up to date. By grasping the problems before actual construction in this way, except for inconsistencies between the projects, negotiations were made among the owners and the order use of the yards was adjusted.

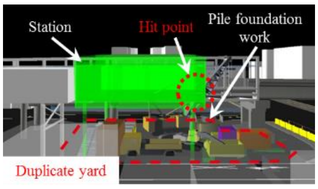
Similarly, in the upper work installation of 2010/12/8 to 2011/2/1 shown in Figure. 5, the installation block is divided into two parts, the left and right parts and the center part (Figure. 7). At this time, the construction planning period was 56 days. In the upper work, the construction of the left and right blocks was done locally (Figure. 8). After completing the installation of the left and right parts, the center part was grounded at the same position. The rear part (Figure 8, green frame part) was a planned place to become a legal plane of a rail track managed by JR

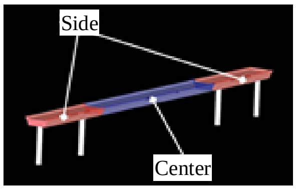
Kyushu and a parking lot of a surrounding residential building. There was interference by temporarily using the site as a space for making the groundwork of the central part. The construction could be carried out at the same time for the left and right bridge blocks at the center and the construction block without the construction prohibition period. Regarding these issues, the prefecture and the JR Kyushu were coordinated, and the consultation was concluded with a corresponding policy with shortening by one-month time.

(4) Discussion

This laboratory first suggested using model space by showing the whole construction at council. This was because it was expected that it would be more effective not only to grasp the individual projects among stakeholders but also to grasp the whole plan as information. This project was the main transportation place in prefecture.

As a result, the author was able to confirm consistency between each structure and solve the problem of yard duplication. In addition, business people other than JR Kyushu in the prefecture and site administrator who were the owners of the pedestrian bridge also provided an opinion during this discussion. This can be said to be an example that all participants had common consciousness of problems regardless of the project standpoint. It was the result of consultation, especially the effect of using the model space was high.



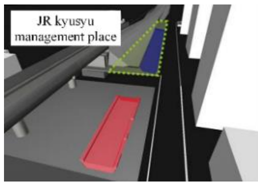
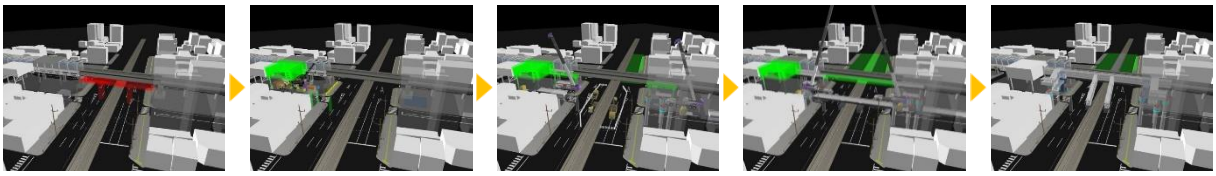




Figure 4. General meeting Figure 6. Construction problems Figure 7. Each parts of superstructure Figure 8. Ground yard



2010/8/20 Remove of viaduct | 2010/9/8 Pile foundation work | 2010/12/8 Construction of Superstructure (Side) | 2011/2/1 Construction of Superstructure (Center) | 2011/4/13 Completion of pedestrian bridge

Figure 5. Construction step of all project

The model space supports spatial grasp in business promotion of civil engineers, which can early detect issues, and can support the execution of the project as planned. In other words, the model space is not limited to modeling for the purpose of "visualization" , as described in this case, a problem solving tool realized by grasping and sharing space together with Kolg. As an example, it can be said that it is a typical case.

In This project, this laboratory was responsible for creating and updating the model space, and as a coordinator between each ordering and receiving, the whole project was supervised through the model space. As a result, we believe that we were able to effectively utilize the model space, and we were able to successfully make inter-project coordination and other concerns that would have an impact on the construction period, leading to strict observance.

### 2.2 Case study and discussion : Design of signs around the station

(1) Project Stakeholders

a) Kumamoto Prefecture, b) Kumamoto City, c) Kumamoto Public Transportation Bureau, d) JR Kyushu, e) Residents, f) Consultant B, g) Kobayashi Laboratory

(2) Project issues

We investigated the flow of users by establishing the station building of JR Kyushu (Figure. 9). Three problems identified by the model space were as follows.

・Impossible to get off the ground unless station users use the newly built footbridge due to elevated railway stations in JR Kyushu

・Station users had difficulty in recognizing the surrounding environment within the station building

・The new pedestrian bridge had six elevator ports in one direction

As the discussions stated below progressed, as a problem solving concerning providing information to users after completion (after start of service), a place where the sign indicating the exit guide was set up and a new task for the design were created.

(3) Solutions

In the first round of talks, we moved the model space and shared the problem part with all the stakeholders. Also, by projecting the model space on the whiteboard as shown in Figure. 10, in addition to the position and size of the signage, the assumed position and viewpoint field to be checked by the user were determined.

The basic policies to promote consultation were to post images synthesizing signature on viewpoints to Kolg, to receive opinions from stakeholders, and to repeat discussion while identifying issues and solving solutions. The face-to-face consultation was required only when examining the color look of the signature and at the work site.

Figure 11 is a representative example of a change in design plan, and Figure 12 is a history for design proposals consulted in Kolg. The exchange of ideas on the design proposal was conducted mainly by academics and designers living in Kumamoto. Table 1 shows the design policy for each design plan discussed in Kolg and the problems with the policies. The final plan of the signage was printed at actual size, provisionally installed on site, confirmed by all of the people concerned and determined as the final decision.

By using Kolg, the plan A, which was originally planned, was changed for five times, becoming to the case F in about two weeks immediately after the examination of the case A was started. Also, even after deciding on the case F, we fine-tuned notation contents / design etc. and further examined 18 plans until the final decision. In addition, it took about seven months to reach the final plan because the discussion temporarily stagnated across the busy season at the end of the fiscal year. The basic discussion was carried out with Kolg, and the face-to-face consultations were five times, including site meeting.

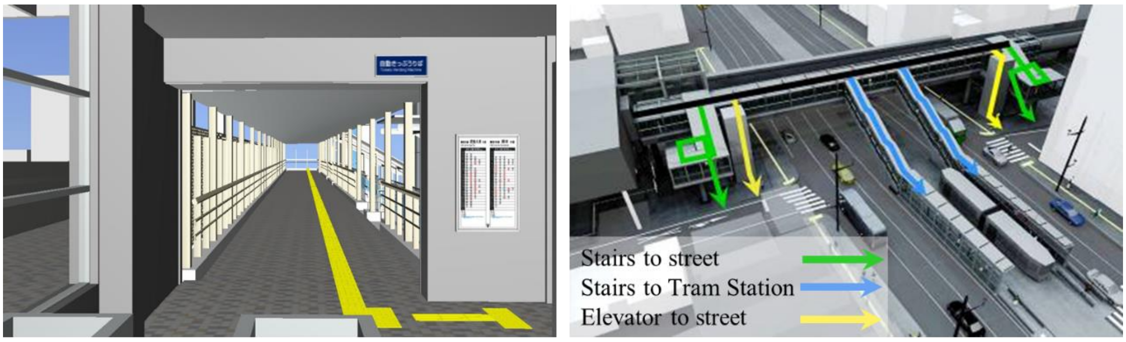



Figure 9. Station exit and Entrance in the newly-established pedestrian bridge

Figure 10. Design discussion by model space


Figure 11. Design change list


Figure.12 Kolg : Conference tree

Table 1. Each design plans

| | Design policy | Design problem |
|---|---|---|
| Case A | Notation with numbers and pictures | Rejection : Similar to the JR sign |
| Case B | Notation with pictogram, four lamguages by universal design | Rejection : Many infomations |
| Case C | Notation with elevation of pedestrian duck | Rejection : Hard to understand |
| Case D | Notation with plane of pedestrian duck | |
| Case E | Notation with only tourist spot | Rejection : Hard to understand |
| Case F | Notation with matching the direction of the user and the direction of the pedestrian bridge | Partially accept : The user can understand the position, but change the design. |
| ... | ... | ... |
| Case F-8 | Notation with the exit of the pedestrian bridge is marked in three colors | Partially accept : The background of the sign design plan is dark. |
| ... | ... | ... |
| Case F-17 Final Plan | Coloring the background of the design plan white, and pedestrian deck drawing by a one-point perspective drawing. | |

(4) Discussion

In this case, although we had a busy season until the final draft, we reviewed 23 plans and a period of seven months from the start of the first round of talks. Meanwhile, we met five times, including final confirmation on site. It is noteworthy here that the designer residing in Kumamoto actively participated in the discussion at Kolg, reflecting opinions not only during ordering but also between users during the signing plan, and opinions on the user's perspective. In general, organizing the committee requires labor to create time and materials, but in this case participation as one party in Kolg, it can be integrated as opinion of the user, and the plan could be brushed up. As a result, we were able to realize the signage plan that everyone were accepted in a limited time.

Figure 13 is a graphical representation of the consultation process. The vertical axis shows the transition (times) of the design plan, and the horizontal axis shows the examination period (day). The point at which the design plan was presented at Kolg is indicated by a blue circle and a solid black line. On the other hand, black dashed line assumes a case where Kolg is not used, present a design plan at a place where stakeholders meet together, examine the revised draft up to the next time and present it once again as a peach circle. Comparing the two, it is assumed that the final plan of the signature will be F-17 if you use Kolg, E if you assume only face-to-face consultation, and there is a big difference in notation content and design quality.

Meanwhile, as concerns that stakeholders can freely express opinions, there are concerns that discussion diverges. If such a case can be seen on the Kolg or there is a tendency, as a countermeasure, as shown in Figureureure.14, this laboratory will organize the discussion and modify the direction of consultation.

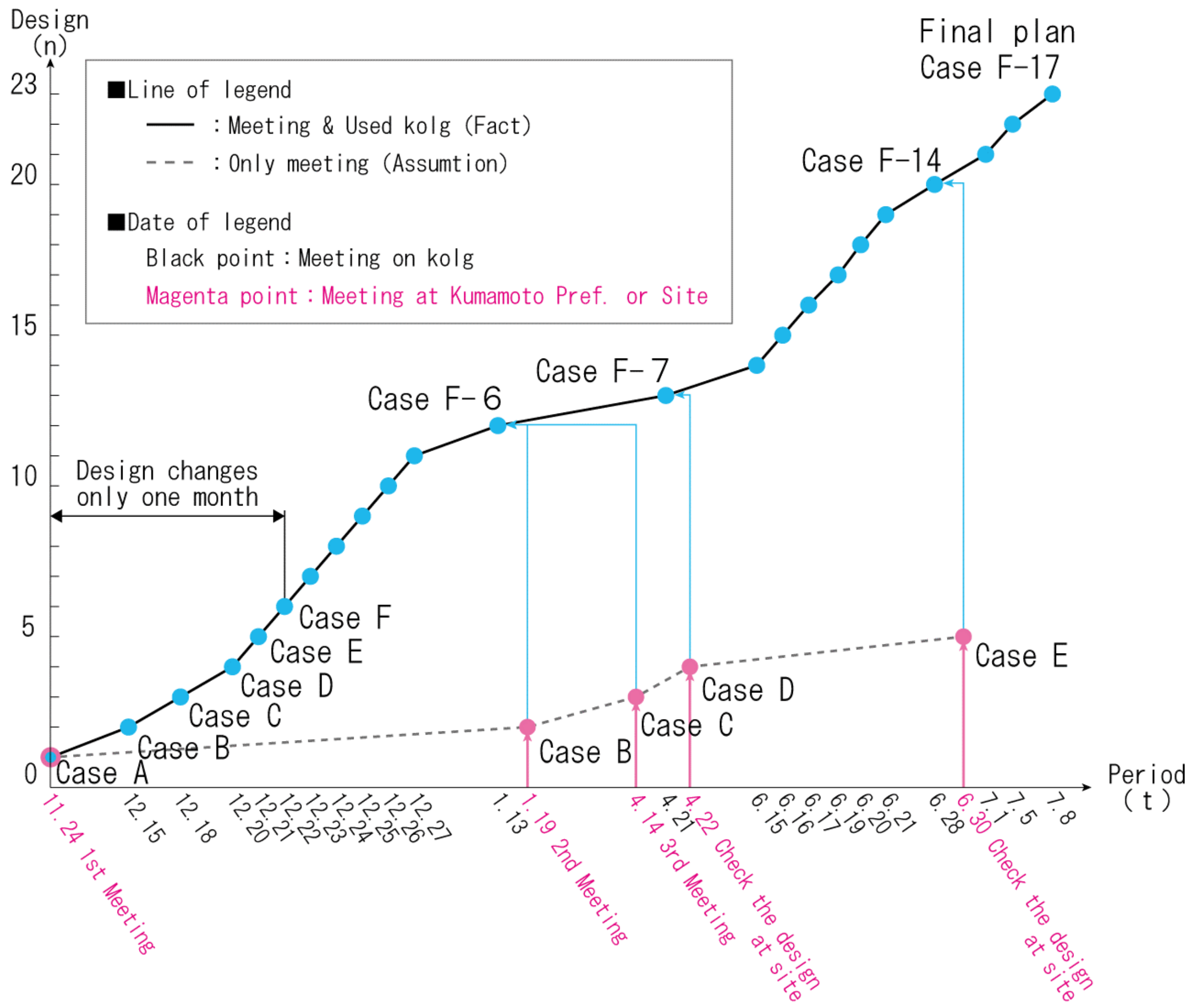



Figure 13. Discussion of sign design


Figure 14. Gives directions to member by Kolg

### 2.3 Role and Standpoint of Kobayashi Laboratory

Regarding to the consensus-building-place, the model space was updated by this laboratory according to the work progress. For problems to be confirmed, discussions were made from the model space using still images, moving images, and models themselves. This information was shared in Kolg. In this way, it was confirmed that the effect of using the model space was particularly high, for example, in the case of requiring tasks of each project or consistency and coordination among projects in the plan.

On the other hand, in the case that the adjustment among projects is almost completed, and solution of a specific problem is required, it is better to share the problem with Kolg than the model space, consolidate opinions, and brush up the solution. It was confirmed that the effect was high. Through Kolg, it is possible to confirm the current discussion about what discussion is being done by tracing the bulletin board, who will be in charge of, and what is the problem clearly. It can be utilized without losing time. As a result, in the case of the signage plan, it was possible to discuss 23 plans among the stakeholders within 7 months, creating a proposal that everyone could be accepted, deepening the discussion and design proposal.

Initially, this laboratory started providing information on this project as part of the research, but looking back on the project completion, we played the roles from the support of the overall plan through the model space and Kolg to the construction plan, construction, and landscape study. It can be confirmed that it contributed to almost all stages and facilitate the project smoothly (Figure. 15).

In this way, in a different position from the owners, in order to engage in the business making by full use of the model space and Kolg, to provide information in appropriates from the model space in order to proceed smoothly, the existence of supervising the Kolg in this paper is called the CIM team. In the next chapter, the author will discuss the definition and role of CIM team.

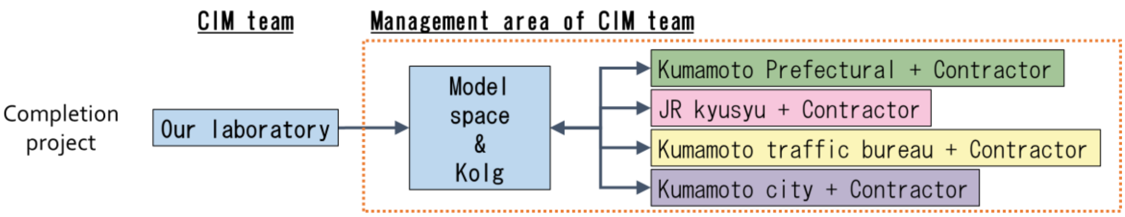



Figure 15. Roles of our laboratory

## 3. Way of Management Team

### 3.1 Definition of CIM Team

This laboratory has played two major roles in this project. The first is management of information such as model space and Kolg. The second was managing and supporting the project as a whole in order to facilitate the project regardless of the owners or the contractor related to the project. In this paper, we define CIM team as a collective term for organizations including people who function like our laboratory.

The CIM team is an organization that manages and supports all events including the owners related to the entire project. In general, the difference with project management is that the CIM team is not limited to assist the owners of construction project. The next section provides details of the two roles that CIM team should have.

### 3.2 Role of CIM Team

(1) Data Management

When building the model space, CIM team manages data creation methods, formats, and update history.

Figure. 16 shows a conceptual diagram of data management by CIM team. In this paper, the person who creates the data of each structure such as bridges and roads arranged in the model space is called CIM modeler.

Also, the person who integrates the created data and makes the person who constructs model space is called a CIM coordinator. In the civil engineering business, there are fears that differences may arise individually in geodetic outcomes handled by the business situation, such as year of acquisition of survey data and past records. CIM coordinator also requires knowledge of the coordinate system for constructing the model space. Furthermore, when asking work to CIM modeler who is the creator of the data, knowledge of data operation and rules making, etc. with the method, data format, software to be used, data exchanging method etc., aiming at ultimate utilization etc. is utmost importance.

(2) Management of the entire project

Particularly among CIM teams, those who proactively advance management and support to facilitate business smoothly are CIM managers.

As shown in Figure. 17, CIM manager actively considers what is necessary to proceed with the project, such as setting up a decision place for overlooking the entire project, making decisions on anticipated issues, and organizing events to solve the problem (e.g. aggregate form consultation).

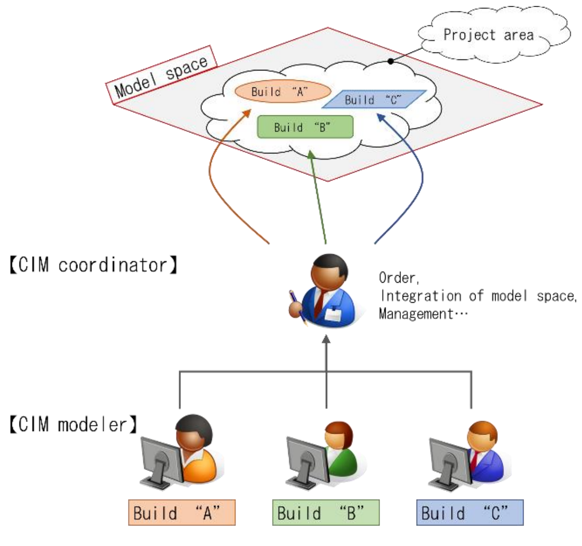



Figure 16. Data management by CIM team

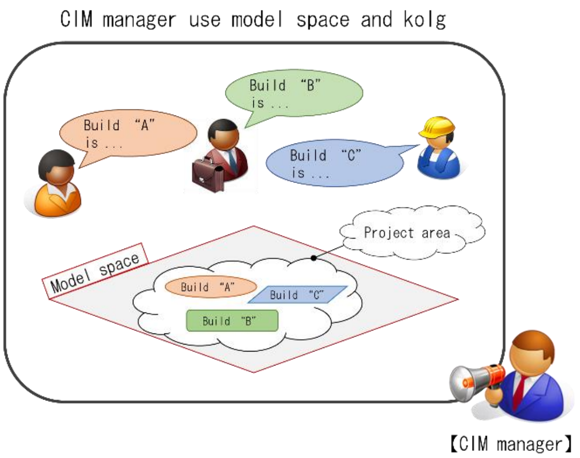



Figure 17. Data management by CIM team

### 3.3 Proposal for Utilization of CIM Team

The use of CIM team is effective when there are specific issues that multiple owners need to fulfill in this project. In that case, it is necessary to decide why CIM team is required, which tasks to prioritize, and the purpose of use among owners with the flow shown in Figure. 18.

First, when setting up CIM team, discussion of the utilization purpose and definitions are neceassary. As an example of the purpose of use, conditions of this project were severe. In addition, the definition items consist of the range in which the model space is constructed, the coordinate system to be handled, and the operation rule of Kolg, and so in. Next, it is an action for the establishment of a CIM team that can satisfy the set conditions. Ideally, CIM team has personnel equivalent to CIM modeler, CIM coordinator, and CIM manager, but it is not necessarily required to have at least three persons, and the team is organized according to the purpose of use. It is important to organize so that it functions according to usage. Finally, when the organized CIM team is ready for the required model space, Kolg, and when all the stakeholders started an asynchronously distributed environment, CIM team will begin to function.

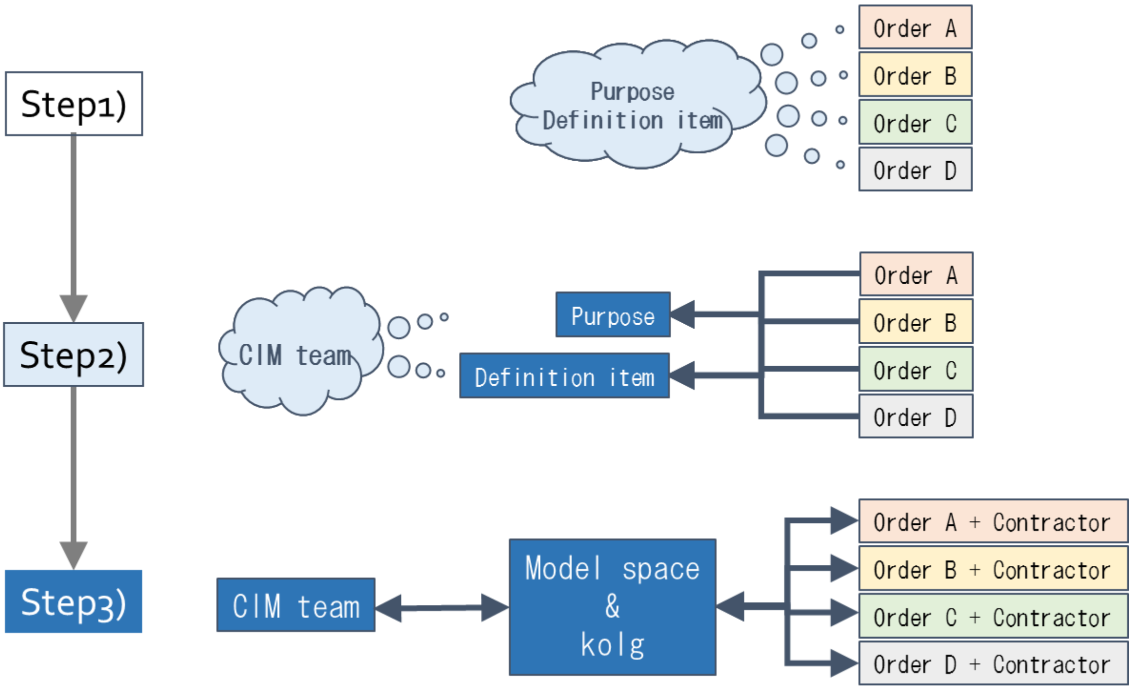



Figure 18. Steps of establishing CIM team

## 4. Consideration on Team Operation of CIM

Civil engineering works take a very long time from planning, design, construction, and subsequent maintenance and management. Even for the owner the counterpart changes from, the contractor to the construction consultant at the design stage and the construction company at the construction stage, and the person in charge is changed.

Meanwhile, the owner is sometimes out of business in charge due to personnel change, and continuous engagement is often difficult. Therefore, the next person in charge will be forced to grasp the whole project from the large amount of materials and drawings etc. when handed over.

CIM team exists to alleviate the load on stakeholders owing to the omission of information transmission due to business progress and changes in person in charge, and utilize the model space to reproduce the shape of the target structure constructed by CIM team as "tool". In the meantime, it is important that "human resources" exists as a person in charge who visualizes and organizes the "history" of consultation at Kolg conducted between the parties concerned, and inherits them at each stage. CIM team consists of these three elements.

If this is a medical team's example, "human resources" is a doctor, "tools" are medical equipment such as MRI imaging equipment, and "history" is a dedicated chart for each person (Figure. 19).

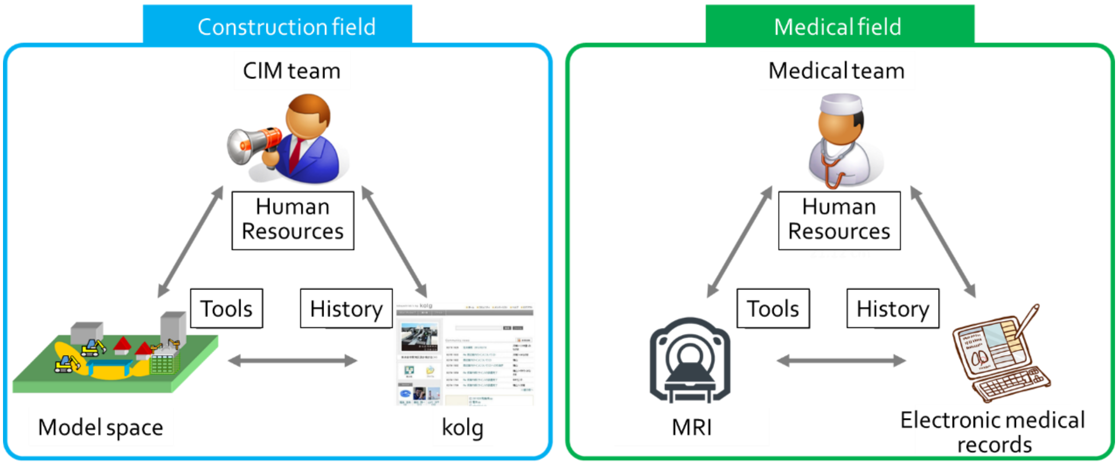



Figure 19 Three elements of construction filed and medical field

### 4.1 Human resources

Human resources are those who can discuss and determine contents from "Tools" and "History", and in some cases can decide on the solutions.

In medical field, a team consisting of specialized functions and roles, such as doctors and nurses, corresponds to examine the condition of a patient using medical equipment and charts. Due to recent technological innovation, medical team can use computer to draw out all the necessary information for consultation, such as medical examination records of the patients.

In construction field, there are multiple stake holders, and it is common for multiple projects to be conducted simultaneously in the same time frame. In order to efficiently execute the projects, CIM team is essential, the same with medical team. Inside CIM team, people who can make visualization and who can manage the project are necessary. There can be many people in one project, and there can be a few people. This is different from the medical team whose numbers are decided base on the condition of the patients.

### 4.2 Tools

Tools are used to express materials necessary for judgment in conducting consultation and examination.

In the medical field, it is a medical device such as a stethoscope or an MRI imaging device necessary for judging patient's health information.

In the construction field, it refers to a model space constructed by making full use of tools for visualization of models, CG, VR, AR etc, and includes not only shape but also given attribute information.

The model space mentioned here redefines "the terrain and structure of digital data at the position defined by the projected coordinate system and the information thereof" based on the concept of the past research. The reason why the geographical coordinate system is not dealt with is because the numerical value used for measuring the distance between the business object and the surrounding environment uses the decimal method such as meters.

### 4.3 History

The history is information which consists of consultation and examination content. They are later archived after the project has ended.

In the medical field, it is equivalent to the medical chart on which information sharing on patients is based on. In recent years, the introduction of electronic medical charts has advanced from the chart of the paper to digital, and it is possible to confirm the "history" conducted by medical personnel, such as instructed by a doctor in charge and treatment by a nurse anytime and anywhere. It seems to contribute more accurate and prompt medical treatment.

In CIM team Kolg is equivalent one as a system and mechanism which inherits all information on business and confirmation of each discussion. Consultations made in the past on Kolg are arranged in chronological order as bulletin boards and are searchable, so if the users of Kolg keep the operation policy, they can fully utilize it as an archive. Also, since it can be used under the Internet environment, it can be used asynchronously, that is, it can be used according to the availability time of the users. However, while each can speak freely, there is also concern in topic divergence which CIM team is required to manage.

## 5. Conclusion

In this paper, as an example where each of the two-tier consultation systems was particularly useful. In this project, we categorized two cases of pedestrian bridge construction plan and signature plan. Then, the authors examined the role that this laboratory played in each case. Based on the results, and in order to succeed in projects which require complicated and multiple constructions to be carried out in parallel, in addition to model space and Kolg, CIM team played very important role in managing the entire business including data.

MLIT has announced CIM introduction guidelines and various standards concerning the operation of CIM in March, 2017, but as mentioned in this thesis, the operation from the viewpoint of managing the business is as yet untouched. In the future, in order to effectively use CIM in actual business, more discussions should be made from the viewpoint of how to configure and operate CIM teams rather than discussing about model definition and its creation method. The author will continue to increase the number of successful cases in the future, to research what is necessary to efficiently manage such projects, and to research the necessity of CIM team for it.

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