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Effect of Lifecycle Data Sharing for the Maintenance of Steel Bridges

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Abstract: The improvement of the productivity of the public construction is indispensable to keep the international competition power and to maintain the quality of infrastructure by which safe and comfortable life is guaranteed. Generally the sharing of the electronic data has been still limited among relatively small numbers of organizations. So, it is a pressing need to show the effect of the information sharing through the life cycle of infrastructure to enhance the effect of the standardization activities. In this research, the following investigations were carried out for the purpose of presenting the meaning of the standardization activities more concretely: 1) Evaluation of the effect in case that the ideal information sharing is realized in the maintenance stage, 2) Analysis of the issues which obstructs to realize the ideal data sharing, 3) Confirmation of the technologies to realize the ideal data sharing. Sharing of the information produced in the construction of steel bridges was chosen as the example case.

Key words: data sharing, steel bridges, maintenance record

Introduction

The improvement of the productivity of the public construction is indispensable to keep the international competition power and to maintain the quality of infrastructure by which safe and comfortable life is guaranteed. The promotion of IT innovation in the construction industry is very important in the productivity improvement of the public construction. Recently, some important results about the standardization have been obtained to realize the sharing of the construction information produced in the life cycle. But, those results haven't necessarily contributed to the productivity improvement of the public construction. For example, electronic delivery of information produced through design process or construction process has been developing by the acts on standardization conducted by the Ministry of Land, Infrastructure and Transport. But, generally the sharing of the electronic data has been still limited among relatively small numbers of organizations. So, it is a pressing need to show the effect of the information sharing through the life cycle of infrastructure to enhance the effect of the standardization activities. In this research, the following investigations were carried out for the purpose of presenting the meaning of the standardization activities more concretely.1. Evaluation of the effect in case that the ideal information sharing is realized in the maintenance stage.2. Analysis of the issues which obstructs to realize the ideal data sharing.3. Confirmation of the technologies to realize the ideal data sharing. Sharing of the information produced in the construction of steel bridges was chosen as the example case.

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1 Issues on Data Sharing in Bridge-Construction Projects

1.1 Steel bridge construction industry

In this study, paying attention on the establishment of data-management-systems based on the accumulation and management of electronic data, issues to be overcome on the electronic data sharing produced in each process of construction of steel bridges are analyzed.. **Fig.1** and **Fig.2** shows the present image of information sharing in bridge construction projects and the future image of the 3-dimensional information sharing. Following issues should be overcome in order to realize the future image of the data sharing.

(1) Data sharing among investigation, planning and design phases. (Three-dimensional model which has the same precision as general drawings is effective.)
(2) Data sharing between design and fabrication phases. (Effective order method should be introduced.)
(3) Data sharing between fabrication and construction phases. (Usage of advanced Information and Communication Technology and its evolution to the standards is effective)
(4)Data sharing between construction and maintenance phases. (Construction of databases on inspection and repair history is desired to be linked with as-built drawings)

1.2 Electronic delivery

Ministry of Land, Infrastructure, Transport and Tourism (here after called MLIT) has entirely applied electronic delivery for construction and design businesses and proceeding various policy based on the electronic data exchange and sharing.

As the next step of CALS/EC, effective utilization of information produced in preceding phases for maintenance process has been expected. For this purpose, MLIT executed the hearing for practical bridge engineers on information to be accumulated for maintenance of bridges and useful electronic delivery method. The result of the hearing confirmed the following demands of engineers:
(1) Utilization of as-built drawings in the maintenance phase.

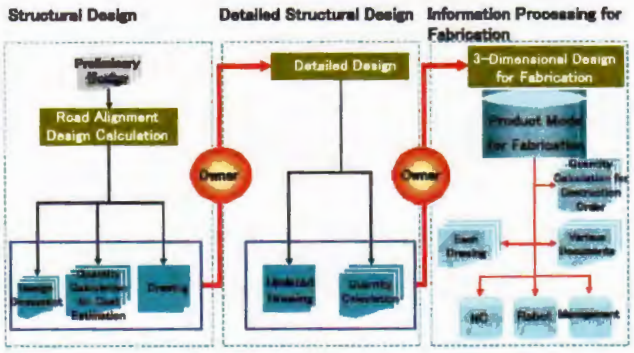

Fig.1 Present image of data sharing in steel bridge construction business[1]

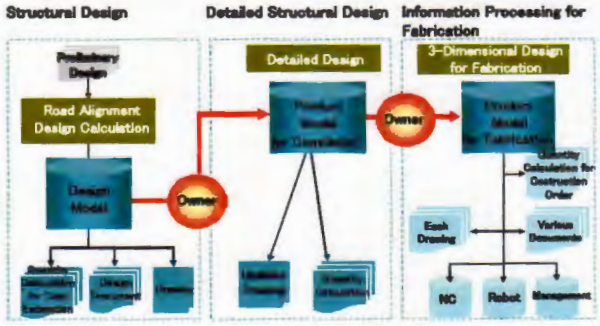

Fig.2 Future image of data sharing in steel bridge construction business[1]

(2) Electronic delivery of the fundamental information on the road facilities produced in each construction project to be used in the maintenance phase.
(3) Appropriate management of electronic data on design and construction.
(4) Electronic delivery of data to be directly input in MICHI-DB prepared by MLIT.
(5) Quick registration of various data into MICHI-DB

1.3 Data management

Road Management Technology Center (hereafter called ROMAN-TECH) has constructed the Road Management Database System (hereafter called MICHI System) to unitary manage the primary data on the road facilities such as bridges, tunnels, pavement and road signs etc.[2]. A set of database is composed of

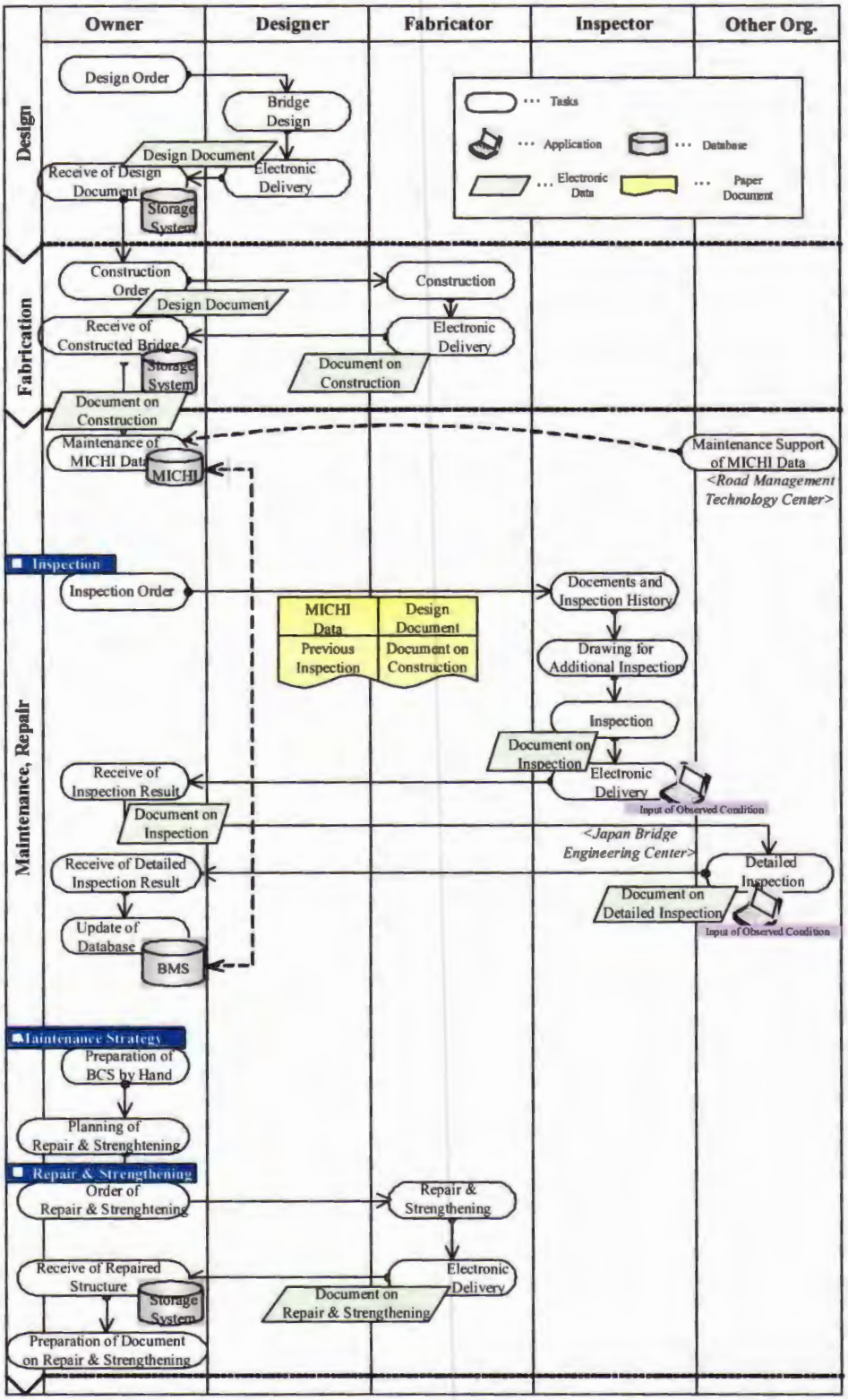

Fig.3 Present business flow of steel bridge construction

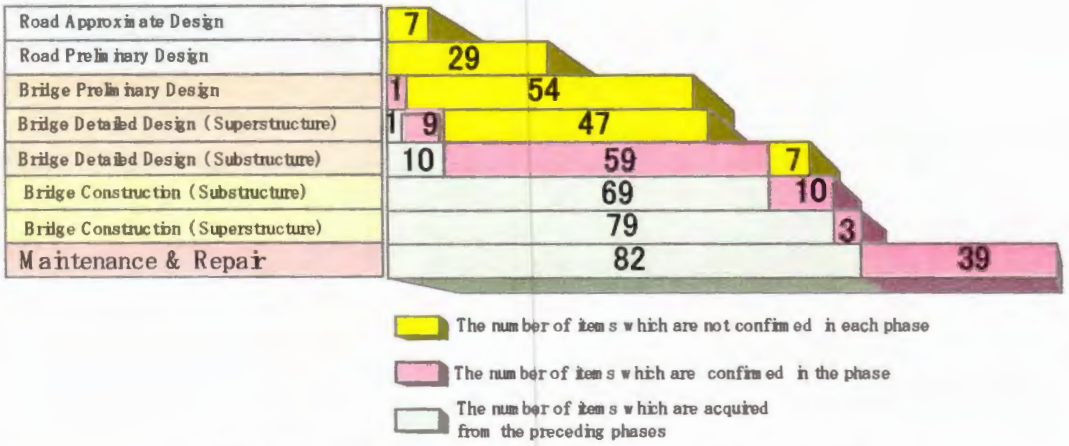

Fig.4 Project phase each information is produced and determined

primary data and numerical data, documents, drawings, photographs on inspection and repair, and is administrated based on the web system.

Japan Bridge Engineering Center (hereafter called JBEC) constructed the database system for the management and maintenance of road bridges. The database system of JBEC is effectively linked with the MICHI System.

General issues on the management of the information on the maintenance and repair, and data coordination from each preceding process to the maintenance and repair process are summarized as follows:

(1) Data produced on preceding processes has not been utilized effectively yet.
(2) Although a large amount of data on the maintenance of bridges exists, it can not been unitary browsed.
(3) It takes lots of time to obtain useful information in the case of disaster.
(4) Information closely connected with inspection results can not be confirmed quickly.
(5) Since documents and drawings on design and construction, inspection results, repair and strengthening history are not correlated, preparation of bridge management databases requires lots of time.
(6) Correction of information for sophisticated analysis of information such as assets management leads to various troublesome tasks.
(7) Since private sectors are not allowed to access the bridge management system, we can not expect useful proposals from construction companies or consultant companies.
(8) It takes lots of time to prepare paper documents on repair and strengthening, because various kinds of documents are to be referred.

The present flow of business is shown by **Fig.3**.

2. Analyzing Data Produced in Bridge Construction Projects

2.1 Extraction of information

We extracted the information used in the maintenance phase by analyzing the following materials:

(1) Bridge maintenance record
(2) Documents on Inspection
(3) Documents repair and strengthening works
(4) Items appeared in the design condition table of structural general drawing

2.2 Project phase each information is produced and determined

Project phase the information is produced and determined was identified. Bridge construction projects consists of the following business phases.

- Investigation and planning
- Design
  - Road approximate design A
  - Road approximate design B
  - Road preliminary design A
  - Road preliminary design

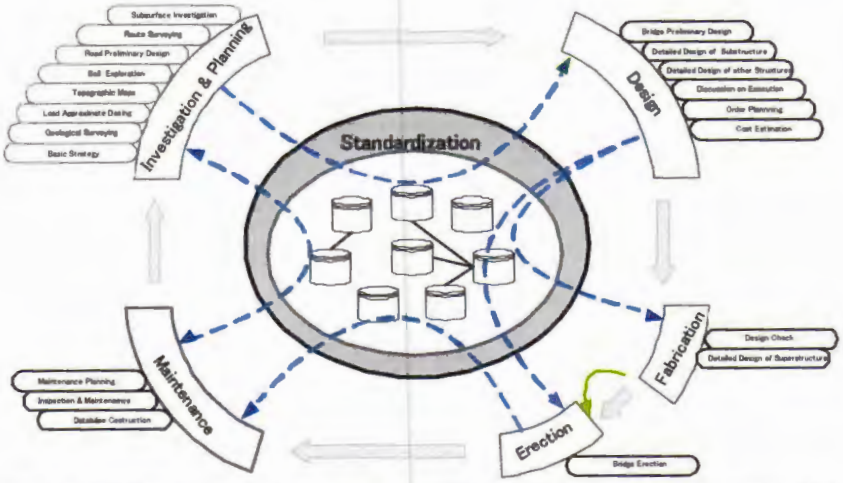

Fig.5 Image of the present data sharing in each business phase of bridge construction

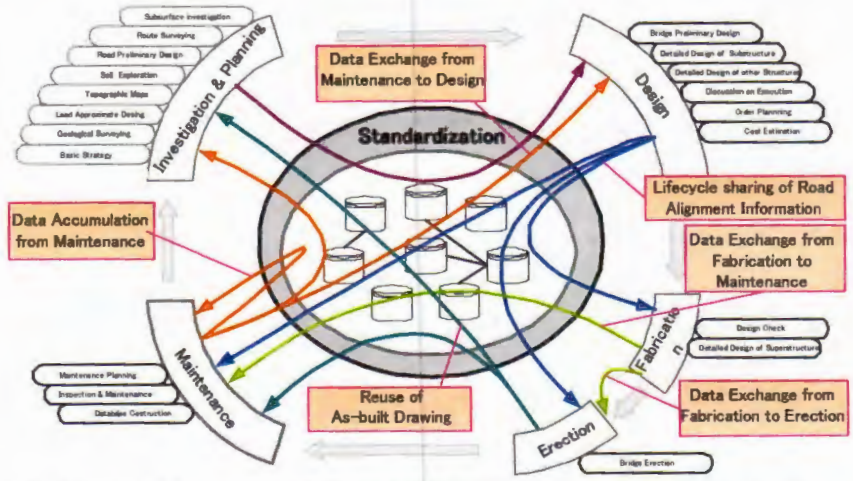

Fig.6 Image of the ideal data sharing in each business phase of bridge construction

- ✧ Bridge preliminary design B
- ✧ Detailed design of bridge superstructure
- ✧ Detailed design of bridge substructure

➢ Fabrication

➢ Erection

➢ Maintenance and management

Fig.4 shows the results of the identification. Yellow parts show the numbers of information items which are not determined in each corresponding phase. Red parts show the numbers of items which are determined in each phase. Blue parts show the numbers of items which are acquired from preceding phases.

From this figure we concluded that information items of 67% used in the maintenance phase is determined in preceding phases such as design, fabrication and erection. This result confirms that the mechanism to effectively utilize the information produced in preceding phases must contribute to the efficient maintenance and management of bridge structures.

3 Desired Data Sharing Scheme

Fig.5 shows the schematic image of the present data sharing in each business phase of bridge construction. Various databases are decentralized and can be shared

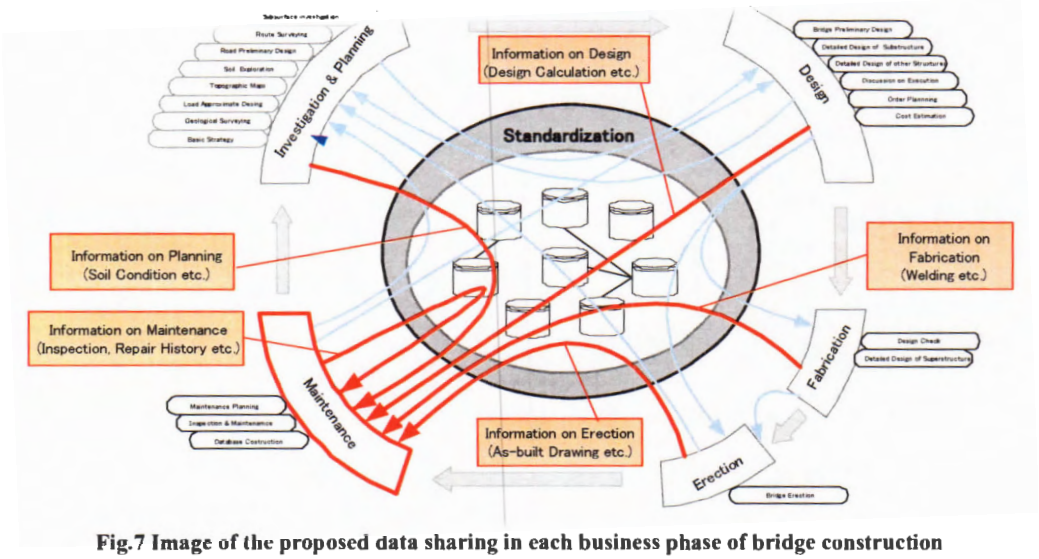

Fig.7 Image of the proposed data sharing in each business phase of bridge construction

among each process. Data exchange has been realized between consecutive two phases by the policy of electronic delivery. But any data exchange among not-consecutive phases such as design and erection, or planning and maintenance has not been established yet. This leads to the limited effect of the data sharing.

Fig.6 shows the image of the future data sharing in each business phase of bridge construction. Data exchanges among not-consecutive phases such as design and erection, or planning and maintenance are to be realized. This leads to the ideal situation of data sharing from the viewpoint of efficient usage of information. But this situation has not been actually established yet because of the existence of lots of issues to be overcome.

Fig.7 shows the image of realization of data acquirement for the purpose of efficient maintenance of bridges because the most important task for the public sectors must be the maintenance of structures constructed from the viewpoint of assets management. In addition, this policy can persuade private sectors to carry out electronic delivery for the distinct purpose of maintenance.

4 Improvement of Business Flow

Existing data management systems which are now administrated by ROMAN-TECH and JBIC can be utilized for the efficient unitary management of maintenance information. **Fig.8** shows the business flow which can be realized by using these data management systems and the policy proposed in this study.

Expected effects are summarized as follows:

(1) Effective usage of information produced in the preceding phases
(2) Unitary management of information produced in each phase
(3) Quick understanding of the situation brought by various disasters
(4) Unitary browsing of inspection histories
(5) Automatic update of the Bridge Maintenance Record System
(6) Sophisticated planning of repair and strengthening
(7) Access permission for private sectors

5 Concluding Remarks

Conclusion obtained in this study is summarized as follows:

(1) General issues on the management of the information on the maintenance and repair, and data coordination from each preceding process to the maintenance and repair process were summarized.
(2) The present business flow was analyzed and issues to overcome were discussed.
(3) Images of data sharing among business processes such as planning, design, fabrication, and maintenance were schematically showed for the present state, future ideal state and realistic stage.

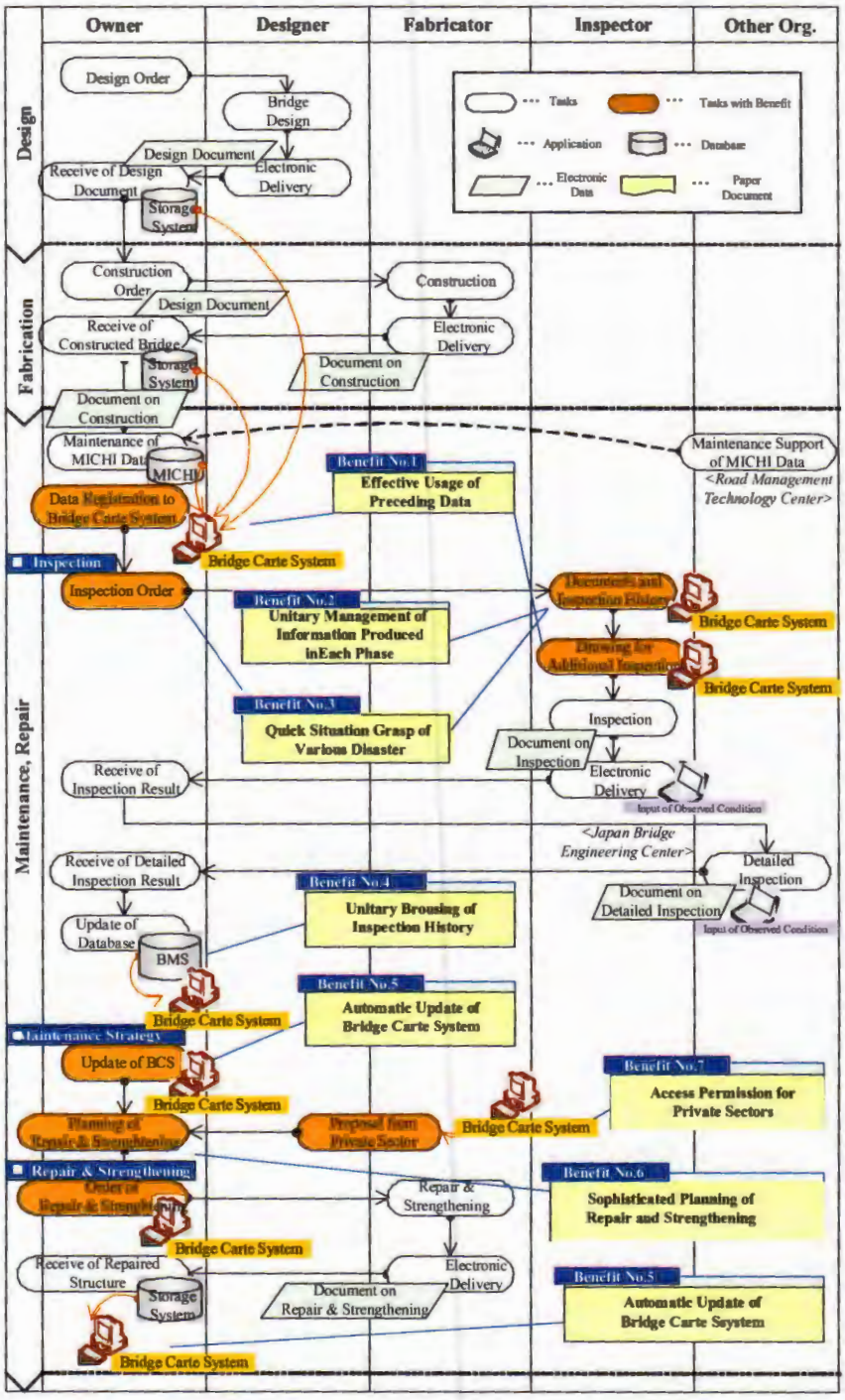

Fig.8 Proposed business flow of steel bridge construction

(4) The desired business flow was presented and its efficiency was summarized.

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