

Design of Web-Based Module and Process for Metal Resource Management

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ABSTRACT

Existing improvement measures for resource management are merely concentrating on the document automation only. In addition, such improvements rarely benefit metal millwork management. Following the trend of constructing high rise and multi-complex buildings, the importance of resource management from the aspect of construction project management is being emphasized. Metal work resources are critical most of construction projects, it became a target for special management. Therefore, the study has determined work process of metal work resource management, for the metal millwork is one of the most important construction materials most of construction projects, and proposed a web based module for improving the management task.

Keywords: Metal Resource Management, Construction Resource Management

1. INTRODUCTION

Presently, domestic construction companies are in the progress of building a web-based information system and the government is promoting the development of the CALS(Continuous Acquisition & Life-cycle Support) system. Various concepts such as SCM(Supply Chain Management), implemented on other industries have been applied in the construction industry, creating innovations in the construction processes management. Various construction companies, in an effort to acquire a competitive edge, are shaping the industry to become technology-centered to actively respond to the demands of promoting effective construction and material supply management. However, material planning does not adequately consider methods for improving delivery and transportation of metal resources from and to the site. Most of cases, automated systems built for material management have concentrated on existing material management systems only.

Presently, there is no uniform process for managing metal resources. Also, there is no system that can automatically conduct unit conversion required during processing raw materials. Therefore, most of the processes rely on manual documentation and computer oriented systems for managing metal resources have not been well developed.

In construction project management, ideologies and tasks

related to resource supply are more significant than the integrated resources management in the working level, which combines the construction resources purchasing management and stock management. Furthermore, such ideologies and tasks are considered crucial for achieving terms, pricing, quality, and the goal of the project. Following the recent trend in the construction field favoring construction of high rise buildings and multi-complex facilities and as type and specification of construction supplies are becoming more complex, timely delivery and management of construction materials are becoming a critical issue in the construction field[1].

Therefore, by basing on the recognition of the importance of metal resource management(RM) in construction project management, the study wants to examine methods that can be implemented to efficiently manage resources. Furthermore, the method for effectively improving metal RM, which takes the largest weighting of material expenditures of a construction project while influencing the project most directly, shall be proposed from the perspective of the ordering company and the researcher shall integrate processes involved in the management into one web based process and develop a module for metal RM.

2. RELATED WORK

2.1 Consideration

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2.1.1 Attributes of Metal Resource management in Construction Projects

Following characteristics of internal and external site conditions and difficulties in making an accurate calculation for material usage, construction material management, unlike general material management adopted by the manufacturing industry, show following differences. Such differences can be noted more clearly in metal RM.

- 1) Long-term planning is difficult following an uncertainty of winning the bid.
- 2) Difficult to perform standard management following variable factors.
- 3) Difficult to set standard and specification.
- 4) Dedicated material purchasing and redemption is difficult.
- 5) Disadvantageous in integrated purchasing and delivery as sites are scattered all over the region.

2.1.2 Methodology of Process Improvement

From the perspective of management, task process can be said to be a set of activities that accepts more than one input to deliver valuable results to customers. In this relation, the construction industry is a type of industry where all tasks are based on processes. Therefore, competitiveness of the construction industry in the future shall be derived from adequate management and improvement of such processes. Thus, existing processes must be understood clearly and researches dedicated on processes used by the construction industry must be conducted as well[2].

Generally, in order to improve a process, clear understanding and accurate problem recognition innate in the existing process must be conducted first. Also, during the procedure of process reengineering, technical and organizational solutions have to be suggested so that such solutions can be implemented on the process[3]. However, in the case of metal RM, there is no clear documentation requirement that has been set and such management is done per task basis.

Therefore the study wants to develop a more efficient metal RM process by analyzing information related to metal RM.

2.2 Research Extent and Method

Depending on the status of the site, metal millwork can be in the form of purchase material, provided material and subcontracted materials[4]. In this study, such characteristics of metal resources have been considered for analyzing management tasks then the researcher has designed web based process and module. Detailed research methodologies are as follows.

- 1) Researched theoretical backgrounds for building processes and studied improvement cases dedicated on construction task process improvement.
- 2) Determined existing task processes involved in the metal RM, collected and analyzed documents generated during the course of conducting such tasks and integrated the task and information together.
- 3) Classified information generated in the process of conducting tasks and determined process flows for determining

core tasks required for processing metal RM.

4) The researcher has reviewed various IT technologies that can be applied to core tasks and proposed the development of information system for initial inventory management and transportation process for improving efficiency of metal RM.

Research Methodologies are shown in the Fig. 1.

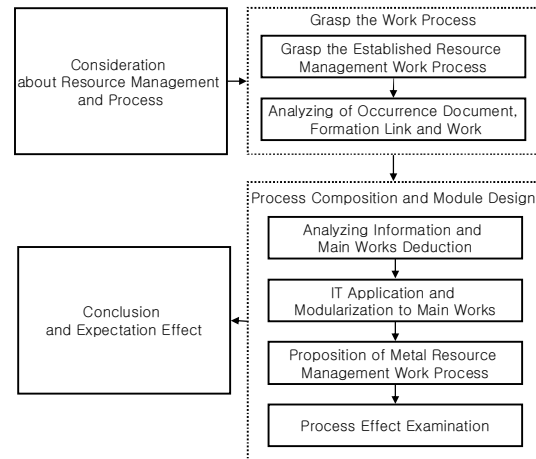


Fig. 1. Research Steps

2.3 Established Resource management Work Process

Material management process at site can be divided largely in to 6: Planning-implementation-review cycle, material planning, purchasing management, inventory management, production management, delivery management and site management. When these processes are applied in the metal RM[5], process shown in the Fig. 2 can be achieved.

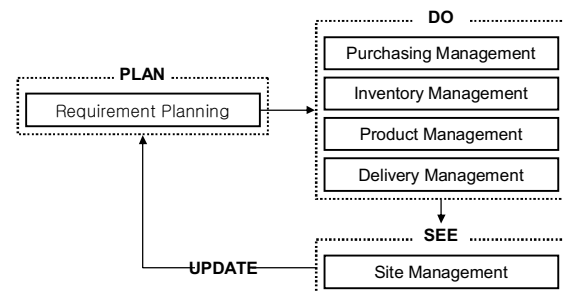


Fig. 2. Roughly Metal Resource Management Steps

Tasks and communications at site get exchanged through unofficial means of communication[6]. Therefore, the study has analyzed and designed framework by basing on document preparation and safe keeping procedures that requires documentation procedures.

3. PROCESS COMPOSITION AND MODULE DESIGN OF METAL RESOURCE MANAGEMENT

3.1 Process Composition

Fig. 3 summarizes types and procedures involved in the web based processing of documents among headquarters, site,

subcontractor and delivery. Input and Output comprising each process had been sourced from various categories shown on the document.

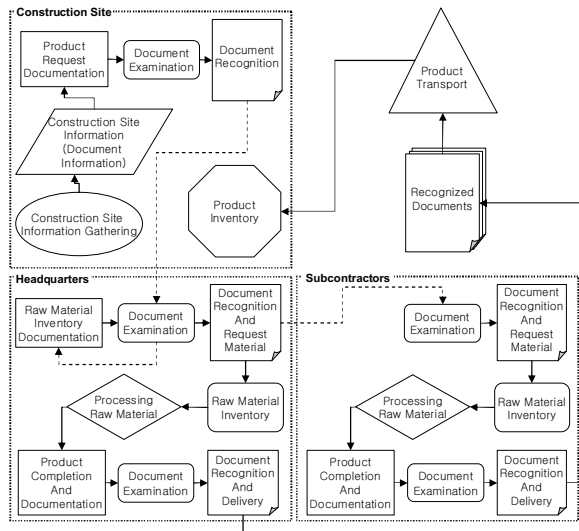


Fig. 3. Data Processing Method

In the metal RM, documents are crucial communication means for processing requests. Since such documents contain certain information required by staff in charge of the management, these documents are very useful in analyzing task and process flows.

The above process flow shows data processing involved in the metal resource request process submitted from the construction site. In reality, documents used at site, headquarters, subcontractors, etc., are not unified. Therefore when the request gets submitted by the site in a document format favored by the site, such format has to be reformatted in to a format favored by headquarters. Furthermore, document sent by headquarters gets sent to various subcontractors and such subcontractors have to reformat or analyze the document format to proceed with metal millwork.

Therefore in the process flow, all processes are developed by using web based technology so that all data within a document can have the same value for variables. Therefore, these processes are designed in much simpler manner than existing processes while minimizing time wasted in performing tasks.

3.2 Module Design

System modules are developed in web based technology so that compatibility, convenience and promptitude can be experienced. Therefore, the study has summarized various steps comprising the metal RM managed by headquarters and developed a web based module for managing metal resources.

As shown in the Fig. 3, there is a procedure for material delivery and production and another procedure for millwork completion and documentation. During these procedures, measurement units used for measuring a material changes. For example, delivered material gets measured by using measurement units for mass, product under production gets measured by using measurement unit for length and finished product gets measured by using mass. Therefore, complex

measurement procedures presently exist.

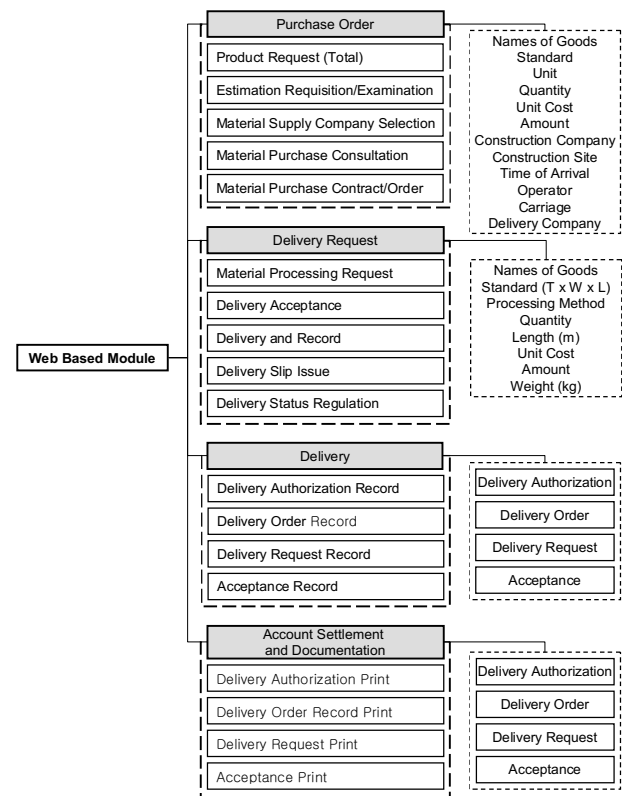


Fig. 4. Web Based Module Method

Fig. 4 shows tasks, documents and contents used in the metal RM. For detailed tasks, they have been segmented furthermore for conducting analysis. However in the study, such segmentation has been done in subcategory level.

In this study, the metal RM is divided in to 4 separate processes and detailed descriptions of these processes are as follows.

1) Purchase Order

By basing on the progress of the construction, the material inventory manager decides adequate time for placing purchasing order and stocking materials. Most of construction companies purchase materials through the purchasing department of headquarters. That is, the purchase order authorized by the site manager gets delivered to headquarters, related department reviews such order, accepts quotations from vendors, selects a vendor then places purchase order.

Material purchasing is composed by three stages: Planning, Purchasing and Stocking. Following characteristics of metal millwork, stocking and production gets conducted simultaneously. Therefore, inventory management is not needed. Therefore, the researcher has integrated planning and purchasing management in to one, 'the purchase order' and simplified steps required for placing purchase order and removed unnecessary factors.

2) Delivery Request

Raw materials purchased through purchase order process get

delivered to the site for production. Purchase order gets issued by headquarters while the delivery request is used to deliver raw material for production. Therefore, the production can be performed at headquarters and subcontracting company. However, problem arises from differences in the specification and the units used during material storing and production.

Generally, material storing gets processed by using the unit mass per material. Here, the T(Thickness) and W(Weight) are used for composing the unit mass. In addition, the length gets added during production task. For instance, when the metal has to be cut, T, W and the symbol L for unit length gets used. Normally, such data are converted manually to be recorded on various documents. However in this study, [i] quantity of finished goods against the weight of raw material and [ii] equation for calculating the weight of finished goods, are used so that such equation can be implemented in the web based module while much faster data conversion can be achieved.

Following characteristics of metal resources, metal resources are stored by using units such as mm and g and final goods use units such as m and kg.

$$[i] \quad m = w(\text{raw}) \times \frac{L(\text{mm})}{1000}$$

$$[ii] \quad kg = \frac{W(\text{g})}{100} \times T \times 0.9 \times m$$

3) Delivery

Material can be delivered to the site either through direct delivery to subcontractor for site usage or surplus materials from a site gets delivered to other sites. In the delivery task, delivery authorization, delivery order, delivery request and delivery form must be prepared. In the existing work procedure, all documentation had to be prepared manually. However, the module developed by the study automatically fills in the blanks by using value generated from purchasing order stage and delivery stage, reducing work load while increasing accuracy. Furthermore, in the delivery order form, unit price submitted by subcontractors gets automatically erased so that confidentiality of pricing can be uplifted as well.

4) Account Settlement and Documentation

In this stage, payments for all tasks and resources consumed during stock management, delivery, maintenance of delivered goods, etc., are processed. Here, the study will assume that the authentication of material delivery shall be confirmed by the inventory manager. Therefore, the module will automatically return the value for positive delivery to the next procedure for preparing documentation.

Fig. 5 shows development of metal RM process by using IDEF0, the functional modeling method. Flow of the proposed module is as follows.

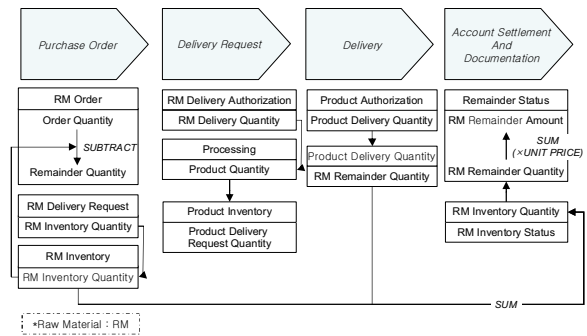


Fig. 5. Progress of Data in Module

The metal RM process links core processes such as resource planning, material request, vendor selection, material testing, material delivery authorization, inventory status, etc., to tasks handled by manager at the headquarters. By doing so, the overall metal RM process can be developed in to module. Detailed procedures of such development are shown in below.

1) In the purchasing order stage, material planning gets reviewed and necessity of such material in the present construction stage gets determined. Also, by basing on the regularly updated progress schedule, purchasing order gets reviewed. Then, material requests gets authorized by using existing procedures and such order gets linked to the online resource purchasing system for selecting the vendor. In this study, headquarters centered purchasing process has been designed so that more efficient purchasing activity can be realized by utilizing surplus inventory list as well

2) In the delivery order and delivery stage, when the material inventory and millwork delivery used for calculating the present status get recognized by the module, the module automatically organizes such data and shows summary of present status. Therefore, more efficient RM and production can be expected.

3) The main procedures of the RM have been determined as planning and status management. Following this assumption, the initiation process of the RM process that is directly related to construction tasks, such as material purchasing, stocking and delivery, had been designed to be smoothly coordinated.

3.3 Module Development

The Metal Resources Management module automatically processes RM tasks ordered by users who accessed the system through the web. When designing the task processing of the RM module, developers have to conduct code designing and process designing. Moreover, this development procedure includes the development of gateway for accessing the database. The prototype of such module has been developed by the researcher.

1) Task processing design

First, for the code designing, the researcher has segmented Input, Modify, Delete and Print class which can be used to generate code so that a separate computation can be done on

each generated code. Codes are segmented into three types as follows.

[Code 1] Purchase order Code

[Code 2] Delivery related batch Code

[Code 3] Cutting method input Code

Purchasing and delivery order related batch codes are linked to respective databases. In the case of purchasing order, when raw material is desired to be purchased, a new set of codes can be generated/saved into the existing pool. For the delivery related batch code, the quantity of raw material becomes basis for determining the volume of manufactured goods and remaining tasks. In relation to this, the researcher was able to increase the efficiency of the previous work pattern, where the user had to put all unit conversion values manually, by developing an equation for computing them automatically. Furthermore, all data values can be printed out for offline tasks and confidential information such as unit costs and prices had been designed with strict security in mind.

```
<? $Mlength=$quantity*$length/1000 ?>
<? $weight=$width*$thick*0.9*$Mlength/100 ?>

global $Mlength, $weight;

$query = "INSERT INTO tablename
VALUES('$Mlength', '$weight')";

$result = mysql_query($query);
```

The design module is shown in the below Fig. 6.

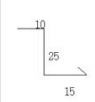
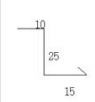
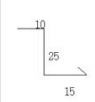
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Fig. 6. Display showing web-based module execution

The cutting method and input code had been developed under the Java platform. Since it is not possible to display

numerous ways of cutting in text, the researcher developed a web-based drawing module where users can simply draw cutting methods. By developing such module, the researcher was able to eliminate the inconvenience in existing work pattern where all data are inputted manually or uploaded by using different software.

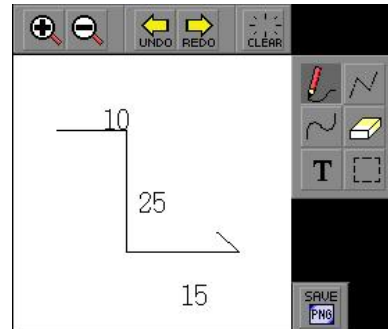


Fig. 7. Drawing module developed under the Java platform

2) Gateway Development

The gateway program used in the research allows data to be inputted and outputted through APM and MySQL. The gateway has been designed to integrate with the drawing module developed under the Java platform by using msjvax86.

3.4 Effects by Module Design of a Proposal

The study has analyzed information generated from conducting tasks, determined work flow and determined critical tasks among them. Then, the researcher has designed a module for metal work RM. Benefits expected by implementing module designed by the study are as follows.

1) Simplification of RM Tasks: By designing processes by centering on critical tasks, unnecessary tasks during evaluation, multiple document preparation, etc., had been greatly reduced, simplifying the overall work process.

2) Raising efficiency through Headquarters Centered Management System: While maintaining rights given to site managers for metal RM, increase the role of the Headquarters. Through this, the Headquarters where the status of production and delivery of metal millwork can be determined more conveniently than the site can efficiently manage the metal resources.

3) IT Centered System: The researcher has eliminated factors reducing efficiency of work process and developed web based management module for improving work efficiency.

4) Improving Management Function: To improve the existing document centered and supply centered RM system, the researcher has integrated resource planning and manufacturing process in to one in web based system and added inventory management function as well.

4. CONCLUSION AND FURTHER STUDY

This study has determined work process of metal work RM, the metal millwork is one of the most important construction materials most of construction projects, and proposed web based module for improving such management task.

To be specific, the study has analyzed documents and information generated during metal work RM tasks, suggested a new task process based on the major tasks involved in the construction works and designed a module by basing on them. That is, the study has systematically classified information generated during the course of task handling and distinguished critical tasks among them by determining the work flow. Then the researcher has removed unnecessary tasks, integrated overlapping tasks and designed web based modules. By basing on such modules, the researcher was able to propose a more efficient construction work procedure. Integration and simplification of such tasks are directly related to expenditures and improving the quality of construction tasks. Depending on the area, such tasks can lead to reduction in miscellaneous costs, highlighting the significance of the study.

The objective of the study was designing a module for metal work RM. Therefore there are a lot places where personal decisions of the researcher had influenced logics behind the actualization of process, problem selection, problem solving, etc. Thus, the researcher had implemented opinions of subcontractors whom are usually dispatched to handle construction sites. Despite of such efforts made by the researcher, it is very difficult to flexibly handle all factors comprising the construction tasks. Therefore, such difficulties have to be overcome by analyzing problems present on site.

In the future, a research dedicated on implementation of module designed by the study at site shall be conducted. Furthermore, as many of management tasks in the construction industry are interlinked and information sharing among these tasks are crucial, researches dedicated for improving efficiency of construction tasks and work flow are critical in the future.

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