Abstract

Construction stakeholders always use standard form of contract to regulate their contractual obligations and expectations during contract administration process. They need to refer a vast of contract provisions in the process. It always leads misunderstanding and interpretation errors as most of construction practitioners are without a proper legal background. Hence the research aims to apply data warehouse technology to assist end-users for better and/or right decision making. A conceptual model of data warehouse for contract administration is developed and verified by twelve reputed experts in the construction industry. The results show that the data warehouse modeling is feasible and practical to the construction practitioners. It would render a more effective and proactive approach in contract administration towards dispute resolution or prevention.

Keywords: Contract Administration, Data Warehouse, Construction Industry, Conceptual Model

1. Introduction

Every project is bound to have disagreements due to fragmentation and adversarial in nature construction industry [1], [2]. Contract administration regulates contractual obligations and expectations between the contracting parties. Yet, the contractual conflicts or disputes seem to be inevitable in the industry especially on the issues concerning interpretation and understanding of construction contracts [3], [4]. Application of information technology (IT) could be one of the measures of mitigating conflicts and disputes. In particular, introduction of data warehouse technology in contract administration is rather new in the industry.

Data warehouse technology is very practical for decision making. It is an analytical database that efficiently collects, organizes and stores all relevant data in support of management decision [5], [6]. This approach is practical when dealing with vast of legal information in construction contracts. Yet, there is a great challenge in the research because the textual data from construction contracts is not repetitive and is unstructured [7].

Therefore, generic approach needs to be considered when developing the data warehouse modeling (DWM) for contract administration. It could perform data analysis, reporting, and query tools to help end-users sift through tones of data and extract valuable information from them [8]. Subsequently, the users could use the information for taking proper procedural steps and solutions for the problems that encountered.

The generic source of information is sought in dealing with the contractual issues instead of concentrating on a case by case basis. Thus, it could provide information that is better equipped to make more informed decisions as to contractual issues in contract administration. Furthermore, the research could improve the existing approach on contract administration in terms of retrieving and updating as well as exchanging information. It also encourages a proactive approach in contract administration by examining the problems and react in a quick manner to handle or overcome contractual issues.

2. Data Warehouse

Typically, data warehouse is a system that incorporated information technology for decision making in organization through a database system. It could provide accurate, clean, well-organized, and accessible data for supporting the strategic decisions of organizations [9].
Basically, data warehouse is a database. However, it has functions that differ from those of a general or operational database. The former is designed to respond to analysis questions and make decisions, while the latter is merely to record or store data. The contents of a data warehouse may be a reproduction of a part of some source data or the results of preprocessed queries or both [5]. This approach of data storage provides a useful guide in making decisions.

Decision support system has evolved over the years. Data warehouse is a type of decision support systems. It is a relatively new database discipline. It is an analytical database that efficiently collects, organizes and stores all relevant data in support of decision-making for an organization [5], [6]. In construction, it is to ensure that the end-users could access or retrieve the data for references and decision-making at the appropriate time during the contract administration period.

2.1 Why is data warehouse needed in contract administration?

In general, information on construction contracts is rapidly increasing caused by complexities and contractual requirements of a project. Moreover, judgments and jurisdictions from litigation cases create numerous legal views or positions into the practice of contract administration. Organizations that effectively and efficiently manage this vast amount of data and use this information would definitively be able to make better decisions in contractual circumstances.

In practice, the data required in contract administration are consisted of contract provisions, jurisdictions of legal cases, and literatures. Such data is voluminous and very useful, but end-users are poor in managing and appreciating it. Lack of understanding of the data is a common problem in construction industry since most of the end-users do not possess a legal background [4]. The data warehouse stores summarized information instead of operational data for decision making [10], [11]. It would help to mitigate the problem when the data has been well-developed and organized. It could perform data analysis, reporting, and query tools to help end-users sift through tomes of data and extract valuable information from them [7]. The contractual related information provide proper procedures, precautions and lessons learnt from the past, which the information are extremely useful and important in the perspectives of legal and project administration by construction practitioners. The data warehouse technology motivates the need for a new breed of decision support system in contract administration.

Apart from that, the interface to and from the data warehouse must be able to operate in a batch mode. Operating in an online mode is an appealing option but not very useful in this study [12]. It is because the data warehouse needs to get a full support or sanction from the local authority and professional bodies in order to publish legal information or contract provisions. It is also to prevent the conflict of interest. Hence the data warehouse is developed and used by the end-users within the organization.

2. Model

A good system supplies useful information and data for users to make decisions or references. The DWM consists of two sub-models as to deliver its contents and features as illustrated in Figure 1.
The first model demonstrates how to produce a clarified, organised and reliable source of references regarding the contractual obligations and expectations. It discusses the processes involved in content development. Leading court cases and involvement of local experts are important input in the DWM. Besides, the project characteristics, breakdown of contractual issues, and contract provisions need to be clarified in order to deliver indented messages. The focus of the model is on explaining the sequence and process required.

On the other hand, the second model describes the features required in the DWM. The DWM consists of three main features such as keywords searching, dispute sub-categories (breakdown of issue), and forum for comments or discussion. It is designed in a simple way to ease searching and feedback by users. Eventually, the system is aimed to render a self-examination and proactive approach in contract administration towards dispute resolution or prevention, whereby the clarified references/guidelines are referred and retrieved by end-users.

The element of project characteristics is designed for both models because different project characteristics would have different effects on the contractual issue. The project characteristics would help the users to refine their search. The list below explains the categories that could be referred in the DWM, such as:

- Project Name
- Project Title
- Location
- Construction Type
- Contract Type
- Procurement Method
- Form of Contract
- Employer/Client
- Architect
- Main Contractor
- Civil and Structural Engineer
- Mechanical and Electrical Engineer
- Quantity Surveyor
- Original Contract Value
- Final Contract Value

Figure 1. Data Warehouse Modeling Development
Overall, the developments of the models need to be carried out in proper manner as to construction practice. Firstly, the project characteristics need to be categorized for the ease of reference, such as project type, contract type, standard form, location, and other related characteristics. The involvement of experts is related to competent persons who have proper legal background and experience to manage the contents for the model. Next, the features of the model needs to be organized into stages, from tendering stage until post-construction stage and breaks down into smaller elements or issues. The smaller elements or issues are the contractual related issues, which the background, problems, solutions and actions used to resolve the issue will be summarized. Subsequently, the information that captured from contract documents or other relevant sources would be stored as a read-only analytical data. The Boolean Search method could be applied for the keyword searching.

Figure 2 below briefly describes the overall architectural framework for the DWM.

Consequently, the models were verified and supported by a mixture of local experts who are specialized in contract administration in the construction industry. It was conducted through two rounds of Delphi process. The experts consist of three lawyers who specialized in construction litigation, three veteran quantity surveyors, three licensed architects and three professional engineers. They are holding a significant position in their respective professional bodies.

3. Discussion
Two models were described based on the data warehousing principle toward contract administration. They were verified and modified through a series of discussions and interviews with the local experts. The first model describes how to build up the content of the DWM, while the second explains how the clarified references/guidelines to be referred by end-users through a system. These models are discussed separately instead of having a single one because to provide a better understanding on the DWM.

The first model requires a detailed study to be carried out towards the standard form that applied in the construction contract administration. Next, it needs to clarify the language structure for better understanding. The re-structuring language use in contracts could refer to Plain English principles. This concept is well accepted for construction projects [4]. Twelve guidelines could be applied to clarify the language structure such as:

1. Shorten the sentence for ease of reading to average 15–20 words [13]
2. Reduce the unnecessary words to keep it as short as possible if more than 20 words in a sentence [3, 13, 14]
3. Use vertical list to break up complicated text [13]
4. Avoid too many cross-references between clauses [14]
5. Use positive style rather than negative style [3, 13]
6. Use everyday words and grammar and only include legal terms where it has to [14]
7. Use the active voice instead of passive voice [3, 13]
8. Use verbs instead of noun phrases [14]
9. Use language of obligation correctly: avoid using “shall”, but still using it to express party’s obligation [14]
10. Eliminate the repetition or redundancy of word [3, 13, 14]
11. Put accurate punctuation in a “long” sentence [13]
12. Use illustrative examples or flow chart in treating procedures as processes [15]

Subsequently, the data warehouse on clarified information need to be developed based on the second model. It is important to ensure that the accurate and useful legal information is always available at the right time in the right format to the right person. The better and more comprehensive features of development tool could be applied for the development of the complete data warehousing, such as Oracle, SQL Server and the like. Nevertheless, it is recommended that to use Microsoft Access for the development of data warehouse system because the software is user-friendly and cheaper. Besides, Microsoft Access is capable to perform and apply the principles of data warehousing into the database system for the proper use and retrieve of legal information in the organisation. The Boolean search tool that built-in from Microsoft Access could further assist the end-users in terms of information retrieval since the language structures are simplified and clearer. As a result, the developed data warehouse system could be shared and used within the organization, so that the information can be retrieved, exchanged and stored in the data warehouse.

Certain limitations need to be considered in order to deliver a complete data warehouse system for contract administration, especially for the culture differences, working environment and legal system of the respective countries. It is because difference cultural dimensions and legal systems, such as codified law or common law system would have different approach of contract administration. The paper presents a conceptual model which limits its practical contribution. Thus it is recommended that pilot projects are undertaken so as to assess and validate the sub-models as well as to identify, if at all, any issue that has not been considered by the researchers. Although the sub-models developed have provided helpful guidelines for future contract drafting, future research on the possible improvement measures on the clauses to be taken into consideration by contract drafters and experts is warranted. Nonetheless, the DWM renders a generic approach towards contract administration, particularly in the aspects of avoiding or resolving contractual issues in an early stage. It would be very useful to serve as a template or reference for further development in construction contract administration.

4. Conclusion

The application of data warehouse technology in contract administration is rather new in the construction industry. The DWM has successfully developed and verified by twelve local experts. The models describe the requirements and features that needed to be incorporated for future information
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System based on data warehousing. This approach could facilitate the process of retrieving, updating, and exchanging of information. It thus provides useful information in better equipping the construction practitioners to make more informed decisions as to the contractual issues in contract administration. Subsequently, it renders a useful reference or proactive approach to the prevention or mitigation in contract administration. It could transform the conventional approach of contract administration that using a bunch of complicated contract documents and contract provisions in the standard form of contract.

In this paper, the DWM provides a very useful and clear methodology for its system development in the construction industry. The DWM concept in contract administration could be incorporated into advanced information system for better information retrieval and application. Ultimately, the complete data warehouse system helps the users to make better decisions regarding contractual circumstances in a construction project at the right time in the right format to the right person along the construction period.

5. References