Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 100 (2015) 622 – 629

Procedia Engineering

www.elsevier.com/locate/procedia

25th DAAAM International Symposium on Intelligent Manufacturing and Automation, DAAAM 2014

Indonesia Coal Trade System: A Knowledge-Based Application Software

Harry T Yani Achsan*, Quintin KD. Barcah

Paramadina University, Jl. Gatot Subroto Kav. 97, Jakarta, 12790, Indonesia

Abstract

Performing coal trading in Indonesia is not simple. Many new comers in coal industry have been fallen down for many reasons. Some coal player collapse by fraudulent and some other fallen down by lack of knowledge in coal trading. To overcome this situation, a solution has proposed. The solution is by developing a web based application software for coal trading named Indonesia Coal Trade System (ICTS).

The method in Software Development Life Cycle of ICTS is Joint Application Design by using prototyping. The software designed using UML and its CASE tools. It is smartphone friendly to support field engineers while in duty, and it will utilize phone's GPS and camera to collect important data.

ICTS is an application that is not only data recording and processing of coal trading, but it also a workflow application developed by experts in coal trading. They transfer their tacit knowledge into software to guide users in coal trading in Indonesia. ICTS will reduce the chance of coal traders from fraudulent and it can lead companies to legal transactions.

Peer-review under responsibility of DAAAM International Vienna

Keywords: information system; workflow; knowledge based system; coal trade; indonesia

1. Introduction

Coal production in Indonesia rises year-by-year [1]. The Indonesian government has decided to replace the main source of national energy from petroleum into coal in 2025 [2]. Since world coal consumption increases and Indonesia coal reserves will last in 83 years if current production rate is to be continued [1], it attracts new players in coal trading.

* Corresponding author. Tel.: +62 21 7918 1188; fax: +62 21 799 3375.
E-mail address: harry.achsan@paramadina.ac.id

Peer-review under responsibility of DAAAM International Vienna
doi:10.1016/j.proeng.2015.01.413

Coal trading in Indonesia is not simple. Even many local traders have been fallen down before passing Break Even Point because of run into fraud [3, 4, 5, 6], trading with illegal coal miners [7, 8, 9], illegal shipments [10, 11], and lack of understanding of government regulations. Many coal importers from foreign countries encounter fraud and illegal trading [3-11]. It could make bad image on Indonesian government especially for coal regulator and tend to decrease Indonesia coal price if these conditions left running continuously.

The root problem of those conditions is lack of knowledge on coal trading in Indonesia. Some new traders do not know how to avoid fraud, how to recognize an illegal miner, how to ensure they have the complete shipping documents, and, basically, how to conduct a legal trading. Traders should follow some right procedures from the beginning to the end of trading. However, it is better to do some important activities before signing purchase contract to miner. Those activities are survey of the coalmine, survey of the hauling, survey of the sociology of the resident, survey the availability of jetty, and survey the behavior of river. Each survey consists of many tasks. For example, when field engineers survey the coalmine, they should take photographs of the camp, the excavators, the trucks, the coal, the stockpile, etc. The photos of the field camp and the excavators could tell whether the coalmine is legal or not. Determining other parameters. They also should gather some necessary documents to ensure that there is no dispute about the mining field and the coal producer. The field engineers have to bring some sacks of coal and send it to a laboratory to determine the quality of the coal. Moreover, the last but not least task in coalmine survey is requesting some trading documents from the miner to be analysed later. These activities are tacit knowledge of experienced field engineers and experts in coal trading.

2. Purpose of the study

We proposed to develop a software that can guide coal traders for their daily activities. It is like an expert system that is accommodate tacit knowledge from experienced field engineers and experts in coal trading. Their tacit knowledge will be translated into rules in the application software. We named the software as Indonesia Coal Trade System (ICTS). ICTS is a web-based application for daily operations that cover many activities of coal trading activities. It will support almost all processes in core business actitivies. Four main processes that covered by ICTS are:

1. Coal mine survey; The purpose of this task is to find new coal miners that have coal reserved and willing to sell their coals to the trader, and to make sure that the coal quality satisfy the trader's client needs.
2. Contract development; Purchase agreement (contract) will be developed if the miner satisfy trader's requirements and they deal with the price and term of payments provided by both parties. The most important requirement that should be completed by miner is legal documents. The miners have to prove that they operate their field in legal manner by providing some documents issued by Indonesian government, i.e. mining license (IUP-OP) and Clean & Clear document.
3. Transportation; This process begins after the coal stockpile loaded into the barge and will be completed just before the barge berthed in the destination port.
4. Unloading; this is a process of unloading coal from the barge into the trucks.

ICTS is not only transactional application but also a workflow application. It means that all transactions has to be signed electronically for internal purposes and should be approved virtually. After virtually approved, the documents can be printed and signed by the authorize employee to be used for further processes. It also supports simple financial transactions to ensure every expenses or invoice to external party are recorded appropriately. In principle, implementing the ICTS will enable coal trading processes be settled electronically (paperless). However, this applications still facilitate users to print out legal documents if it is required.

Therefore, the aim of this study is to develop a software of coal trade system in Indonesia that accommodate tacit knowledge from experienced field engineers and expert in coal trading. The software is not only intended to support transaction processing but also support workflow in coal trading. The purpose of the workflow is to guide users systematically conducting coal trading in Indonesia.

Petrovina is a young local coal trader company that leads by some visioners founders who have adequate experience and valuable tacit knowledge in coal trading. Petrovina has been successfully performing coal trading business since 2012. In the beginning, this company runs the business without proper standard operating procedure while doing so. Thus, the researchers introduced the ideas in implementing the software for supporting their business activities. After, observing all related aspects and business tasks, we finally are able to develop the SOP (Standard Operating Procedure) in writtten format. We, then, develop the ICTS based on this SOP with continue

assistance of Petrovina business founders. By the end 2013, Petrovina has revenue about IDR 30 billlion. In the first semester of 2014, it revenue reached the amount of IDR 55 billion.

3. Related works

There are many studies related to coal trading. Some studies in computer application software related to coal are: coal deposits [12, 13, 14], coal demand [15, 16], coal transportation [16, 17], coal mine monitoring [18], coal worker monitoring [19], coal mine safety [19, 20], coal enterprises [21, 22], workflow [23, 24], etc. Nevertheless, we found no academics paper in the field of coal trading that discussing its whole workflows and transactions. Even though those studies [12-24] are partial, we still use it. We will discuss it one by one.

Studies about coal deposits and coal demand very useful for traders to support them in decision making before signing purchase contract between trader and miner. It can prevent trader from buying a quantity of coal more than coalmine deposits, and to prevent trader from buying too much coal then market demand. Papers about coal transportation also useful in determining coal transport method to maximize transportation rate and efficiency. Coal mine monitoring, coal worker monitoring, and coal mine safety studies useful in risk analysis. We also use papers in the field of coal enterprises in developing the software, because the software's intention is to support coal trader enterprises in running its business processes. In addition, to design the computerized business processes in ICTS we use Unified Modelling Language (UML).

There are some benefit of using UML in designing software, especially to design ICTS. Some benefits of using UML are:

- Object oriented modelling. Since we use object-oriented programming in coding ICTS, it would be less complicated to use object oriented modelling in design phase of ICTS.
- Automatic code generation [25]. Several tools are able to convert diagrams in UML to object oriented database. Although the code produced is not complete, but it will reduce much of coding time.
- Able to generate test cases [26]. UML has many diagrams; two of them are Sequence Diagram and State Chart Diagram. By using those diagrams, we can generate test cases that are suitable for dynamic testing of ICTS.
- Its ability to show a workflow diagram. Activity Diagram in UML is a workflow diagram.
- Its capability to be used as business modelling [27, 28]. We can use UML to model the business of coal trading.
- Support reverse engineering [29, 30]. Since object-oriented database is not mature yet, then we will use MySQL a relational database to manage ICTS's data. Database structures in MySQL can be reversed engineered using certain tool to create Entity Relationship Diagram (ERD). The tool can create Class Diagram based on ERD automatically.

ICTS will be a knowledge based application software/system. A knowledge-based system (KBS) is a computer program/application that uses at least one and commonly two types of sub-systems: a knowledge based and inference engine [31]. We will accentuate inference engine in developing ICTS, where tacit knowledge of coal trader experts and experienced field engineers are the main source of business rules in ICTS. Inference engine sub-system in KBS presenting rules in IF-THEN constructs [32]. KBS is a domain dependent [33]; therefore, ICTS is a KBS which dependent on knowledge domain of coalmining and coal trading.

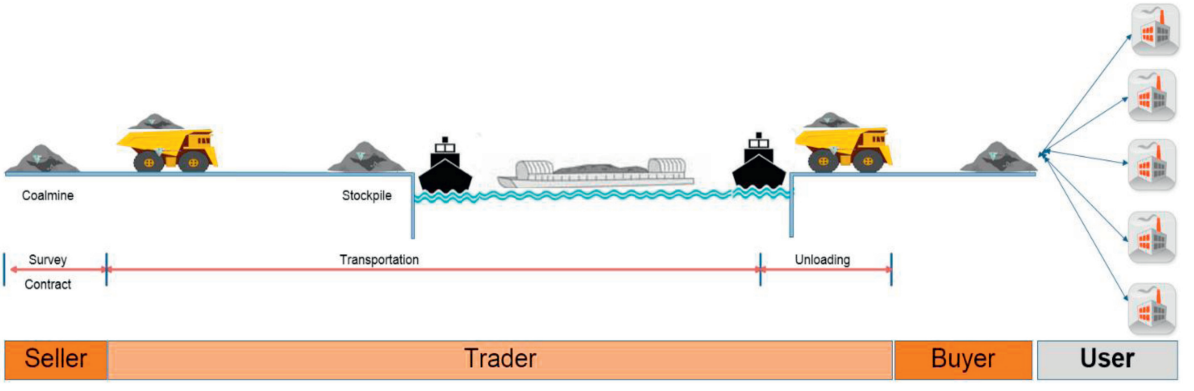

Fig. 1. Scope of ICTS.

4. ICTS Development

The development of ICTS is started from scratch. There was no written SOP at all in Petrovina when ICTS started to be developed. But Petrovina has many experts in coal trading and many experienced field engineers. It also has an expert in the field of information technology especially in the field of e-commerce. Moreover, all of them committed to develop ICTS. These are the most important aspect in the development of ICTS.

4.1. Methods

We use Joint Application Design (JAD) method in designing ICTS which all stakeholders sits together in focused meetings to define their needs and the business rules to be implemented in ICTS. To expedite the processes of development, we use prototyping techniques. Thus, to ease the design process, we utilized CASE tool that is able to support UML and has the ability to create necessary diagrams for development purposes. After, all necessary design documents have already produced, we, then, develop the framework of the application, to ensure all programmers can laid their codes to this framework. The framework itself should has at least: rules in coding, the menus and sub-menus hierarchy, common function/methods that will be used by all programmers, and security and authorization methods. Therefore, we distribute a coding process to several programmers. All programmers are outsourced and hired simultaneously to minimize coding time. We also hope that by using this method Petrovina will not depend on one developer or programmer.

4.2. Standard Operating Procedure

SOP of all processes in the scope of ICTS as in **Pogreška! Izvor reference nije pronađen.** is developed in pre-design phase because it is required as the references in the development of business rules in the application. There are four main business tasks that are depicted in SOP documents, which are Survey, Contract, Transportation, and Unloading processes. Each of this tasks can be shortly explain as follows,

- Survey
  Survey is a primary task before a trader make any purchasing contract to a coal seller/miner. This is the beginning of all processes. The purposes of survey is to make sure that: the seller has coal quality as required by trader's customers, the miner is legal, the mine and the coal produced are legal, seller has good track records, the road from coalmine to jetty is under control of seller, seller has contract with the nearest jetty, the river is capable to be entered by barge any time, etc.
- Contract
  Purchasing contract is an agreement between seller and trader in selling/buying coal. It consists of some detail requirements, such as: coal quality and quantity, coal price, term of payment, etc. Contract can be created if the survey confirmed all necessary aspects, technical and legal, are adequate. Petrovina (PTV) surveyor has to recommend a certain location to be followed up to the next task which are price and term-of-payment negotiation. If the result of this negotiation can satisfy both parties, then the purchase contract can be signed.
- Transportation
  SOP about transportation consists of: checking traveling documents, applying insurance, monitoring coal shipping, loading coal into barge, checking quality of coal on the barge, checking coal weight, paying to seller, and transporting the coal to customer's port.
- Unloading
  Unloading is process of moving coal from barge onto truck. The SOP includes: ordering to unload the coal, checking the coal weight on the barge upon arrival, checking coal weight on every truck, monitoring truck movement, invoicing, etc.

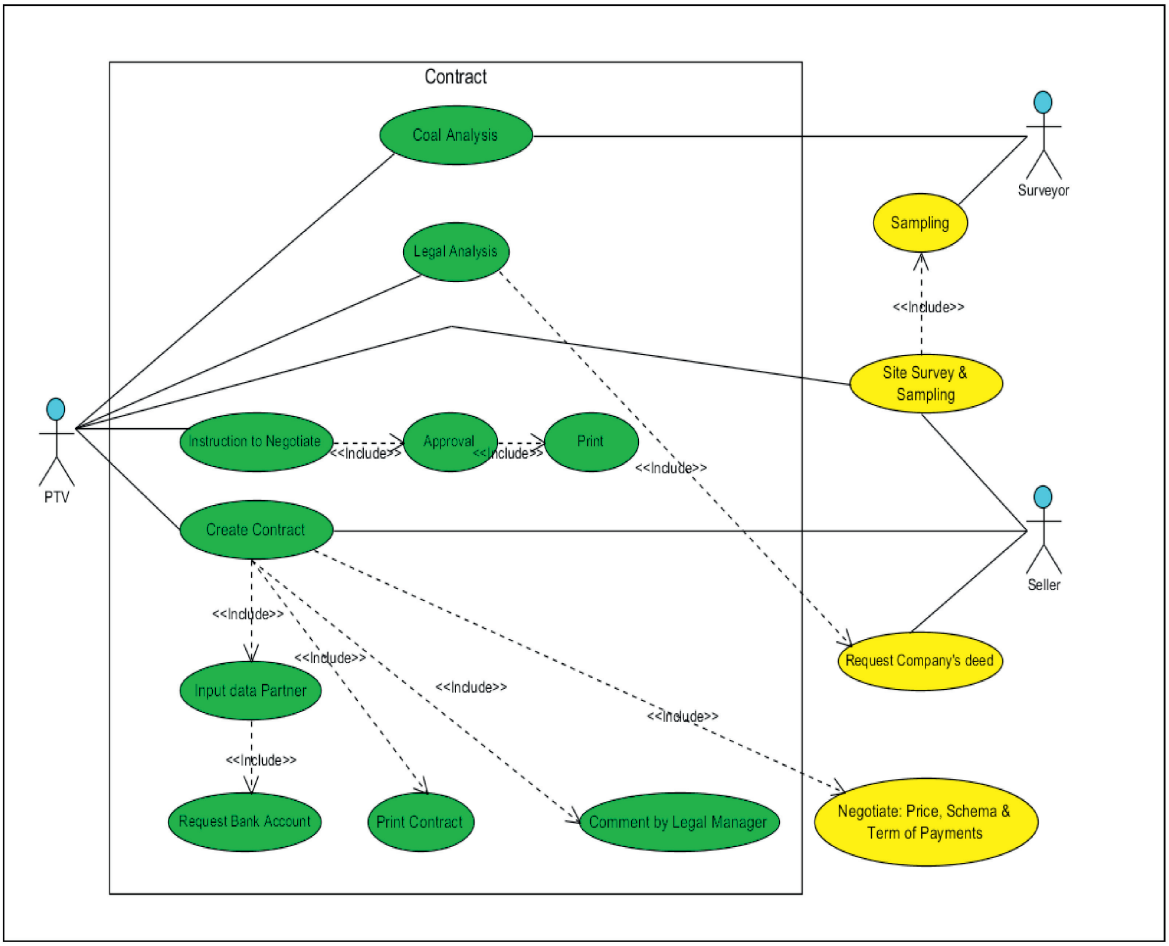

Fig. 2. Use Case diagram for developing Contract.

4.3. UML

We use CASE tool Visual Paradigm in creating UML diagrams. It has many features that software designer needed. Since the limitation of number of pages, we do not show all types of UML diagrams. One type of diagram, Class diagram for example, has about ten figures. Therefore we attach one sample of use case diagram only in **Pogreška! Izvor reference nije pronađen.**.

4.4. Prototyping

The same CASE tool can create prototype of ICTS's forms. These are throw away prototypes, because the prototypes is only a sketch and not created using a programming language. It is a very simple drawing but faster to create than using programming language. Prototypes are tools that can be helpful for communicating the user interface to the users. If user has suggestion then the prototype should be change to fulfill user expectations. It is the fast way to elicit user requirements. A sample of prototype can be seen on **Pogreška! Izvor reference nije pronađen.**.

4.5. ERD

Entity Relationship Diagrams is created automatically using CASE tool. To create ERD in the fastest way is by using feature in the CASE tool reverse engineering. Visual Paradigm can read the database we have created, in our case is in MySQL, and then convert all tables into ERD. There are 35 tables in ICTS's database, and whole of those database will be converted to ERD.

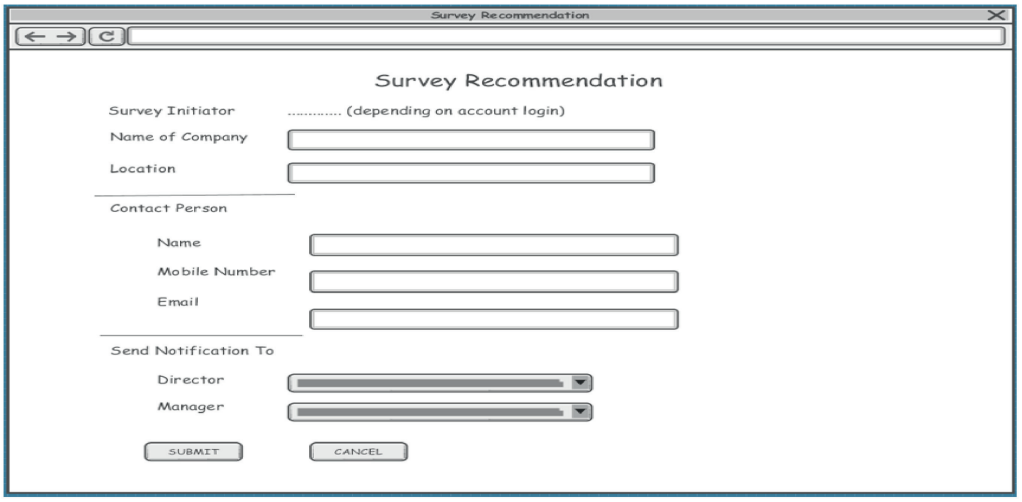

Fig. 3. User interface of Survey Recommendation.

4.6. Workflow

Workflow is flow of events or tasks from one person to another person. For example, a document of Survey Recommendation is being created by Survey Initiator using Survey Recommendation user interface as seen on **Pogreška! Izvor reference nije pronađen.**. Survey Initiator fill up the Survey Recommendation form. Whenever he/she clicked Submit button, the data will sent to ICTS server. The server then send notification emails to a Director and a Manager as typed by the Survey Initiator. As the Director/Manager read the email and then he/she clicked the hyperlink in the email body then it will open ICTS special web page. The web page is Survey Recommendation form, but the user interface is different from figure 3 above. The user interface will reformatted depending the login person. Since the login person is the Director/Manager then the Survey Recommendation form will display some options to be chosen: Accept, Pending, or Decline. If he/she chose Accept, then the system will send notification email to the Survey Initiator. The initiator then fill in some additional data into the form and after he/she clicked the submit button then an assignment letter will be sent automatically via email to a field engineer who has responsibility in the survey.

The field engineer can use the assignment letter as a fund request for financing the survey task. He should bring the assignment letter and cellular phone to the survey location. On arrival at the coalmine, he has to activate the GPS in his cell phone and open the Survey form in ICTS web page. Then he should click the Save button in Geo Location tab to save his current position. His position, thus, will displayed in the map to confirm the survey. He has to take pictures by using his cell phone of some main coalmine facilities: field camp, dozer, stockpile, coal, excavator, and trucks. All the pictures should be uploaded using the appropriate field for each picture in ICTS. He also has to fill up the coal quality data. Miner's legal documents and other required documents should also be uploaded to ICTS server. After fill up all the necessary data then he can click submit button. By clicking submit button, the server will send notification by email to legal person.

The legal person will provide his/her advice in written to the ICTS after observing all legal documents from the surveyor in the field. As soon as the legal person send the result of legal analyzing, the system will send notification email to the Director and Manager. The Director and Manager can read the summary of legal analyzing. They

should make a decision whether to accept or to reject this legal summary for further processes. If one of them accept it, then it will continue to contract processes.

The example above is workflow for Survey. There are many workflows in ICTS. Each of them requires at least one decision making. Every Director/Manager can use data in ICTS to make decision. Not all decisions should be made manually, some decisions are made by the system. ICTS could make a decision based on business rules that has been supplied to the system.

The users of ICTS might do their job easier. They only have to follow the instruction or the user interface. Some instructions that has to be responded will be sent by email, while some others can be read directly on ICTS web pages/forms. In collecting the necessary data, such as photographs from the coal mine, the field engineers who responsible for conducting the survey has clear guideline what building is necessary, or what equipments are important to be captured. For example, the system shows six blank image with six image names to remind user to take picture off, such as displayed names: camp, coal, dozer, excavator, stockpile, and trucks. If user touch the browse button under the Excavator, then the cell phone will activate the camera automatically. User should take picture of excavator. If the picture has been uploaded then it will displayed on the screen. User will know which picture has not been taken yet.

Conclusion and Future Work

KBS as shown in ICTS makes coal trader companies do their business processes on the right track. ICTS can minimize fraud in coal trading, because all business processes should obey the workflow in ICTS and there is no one man show on decision making process. The workflow is in line with Indonesia government regulation, therefore this system is able to prevent the company from doing unintended illegal trading. The system also prevent the trader from illegal shipping by checking the completeness of shipping documents. These documents always be checked before the barges start to voyage, because these documents are parts of requirements documents for invoice payment.

Petrovina has less depending on its most experienced employees in analyzing reliable coal miner or coal qualities. If any experience employee left the company, it will not disrupt business processes. It happened because any user can run KBS by following the workflow and read its instruction. KBS is easy to use, it changes the user interface depends on logged in user as describe in section 4.6.

Implementing Knowledge-Based application software such as ICTS will make business processes can be done easier. It is achieved by applying inference engine that use business rules supplied by experts in coal trading. Inference engine is a simple way to formalized tacit knowledge. Knowledge-based system has two sub-systems, but ICTS implement one sub-system only. Researchers are encouraged to implement knowledge base sub-system. By using it, we can even predict coal price using data collected by ICTS. It will enable us to estimate coal needed by buyer at any time and forecast customer demand.

References

[1] Indonesia Investments, “Coal Mining in Indonesia,” 2014. [Online]. Available: http://www.indonesia-investments.com/doing-business/commodities/coal/item236. [Accessed 7 11 2014].

[2] H. L. Azahari, “New and Renewable Energy Policies,” Directorate General New Renewable Energy and Energy Conservation - Ministry of Energy and Mineral Resources Republic of Indonesia, Jakarta, 2012.

[3] J. Riseborough, “Indonesia’s $6 Billion of Coal Mine Thefts Said to Widen,” 5 3 2014. [Online]. Available: http://www.bloomberg.com/news/2014-03-05/illegal-coal-trade-at-indonesian-mine-said-to-widen.html. [Accessed 7 11 2014].

[4] The Hindu, “Inferior coal import scam: CBI registers 2 cases,” 4 1 2014. [Online]. Available: http://www.thehindu.com/news/national/inferior-coal-import-scam-cbi-registers-2-cases/article5538695.ece. [Accessed 7 11 2014].

[5] The Pioneer, “CBI Files Two Cases in Low Quality Coal Supply Scam,” 5 1 2014. [Online]. Available: http://www.dailypioneer.com/sunday-edition/sunday-pioneer/nation/cbi-files-two-cases-in-low-quality-coal-supply-scam.html. [Accessed 7 11 2014].

[6] B. Besalicto, “Govt asked to control coal traders, brokers,” 24 8 2009. [Online]. Available: http://www.thejakartapost.com/news/2009/08/24/govt-asked-control-coal-traders-brokers.html. [Accessed 7 11 2014].

[7] F. Shauketaly, "A Fraud In the Making at Lanka Coal," 19 11 2012. [Online]. Available: http://www.thesundayleader.lk/2012/11/17/a-fraud-in-the-making-at-lanka-coal/. [Accessed 7 11 2014].

[8] A. Sipress, "Indonesia's Illegal Coal Mines Feed China," 25 9 2005. [Online]. Available: http://www.washingtonpost.com/wp-dyn/content/article/2005/09/20/AR2005092001528.html. [Accessed 7 11 2014].

[9] C. Quiambao, "Indonesia plans 14 coal terminals in bid to curb illegal exports," 2 6 2014. [Online]. Available: http://www.platts.com/latest-news/coal/bali/indonesia-plans-14-coal-terminals-in-bid-to-curb-26800188. [Accessed 7 11 2014].

[10] F. Jensen, "Wanted by the taxman: Indonesia's $5 billion of lost coal," Reuters, 1 10 2013. [Online]. Available: http://www.reuters.com/article/2013/10/01/us-indonesia-coal-idUSBRE9901BN20131001. [Accessed 7 11 2014].

[11] R. Cahyafitri, "Govt gets tough on illegal," Jakarta Post, 9 6 2014. [Online]. Available: http://www.thejakartapost.com/news/2014/06/09/govt-gets-tough-illegal-mining-suspends-licenses.html. [Accessed 7 11 2014].

[12] S. Frantiek, "Programming system for rapid evaluation of coal deposits," *Acta Montanistica Slovaca,* vol. 7, no. 3, pp. 181-187, 2002.

[13] K. H. F. S. J. H. Jan Jelínek, "Digital model of South Moravia lignite coalfield," *Acta Montanistica Slovaca,* vol. 13, no. 4, pp. 454-471, 2008.

[14] J. H. F. S. J. J. Kerstin Hoňková, " Interactive program system for application of modern evaluation of coal deposits and their parts under complicated conditions," *Acta Montanistica Slovaca,* vol. 11, no. 1, pp. 50-59, 2006.

[15] L. Qiuhong, "Grey Neural Network Model and its Application in Coal Demand Prediction," *Information Technology Journal,* vol. 12, no. 22, pp. 7050-7055, 2013.

[16] W. B.-S. Liu Hai-Bin, " Management and Control of the Middle Transport Costs of Coal Reserve and Transit Centers Based on IP," *Information Technology Journal,* vol. 12, no. 22, pp. 6751-6755, 2013.

[17] N. A. K. S. V. A. S. Kuttalakkani.M, "Sensor Based Effective Monitoring of Coal Handling System (CHS)," *International Journal of Engineering and Technology,* vol. 5, no. 3, pp. 2432-2435, 2013.

[18] x. han, "Safety Production Monitoring Schemes and Terminal Software Based on TD-SCDMA in Coal Mine," *Modern Applied Science,* vol. 4, no. 2, 2010.

[19] H. L. Y. W. Wang Yang, "A Novel Real-Time Coal Miner Localization and Tracking System Based on Self-Organized Sensor Networks," *EURASIP Journal on Wireless Communications and Networking,* vol. 2010, no. 1, 2010.

[20] Z.-z. W. Cheng-gang Wang, "Design and Implementation of Safety Expert Information Management System of Coal Mine Based on Fault Tree," *Journal of Software,* vol. 5, no. 10, pp. 1114-1120, 2010.

[21] I.-C. Dina, "Management accounting, an important source of information for the decicional process in the coal mining industry," *USV Annals of Economics and Public Administration,* vol. 12, no. 2(16), pp. 184-191, 2012.

[22] Y. D. Huang Hui, "UML-based Requirements Analysis on Risk Pre-control System in Coal Enterprise," *TELKOMNIKA : Indonesian Journal of Electrical Engineering,* vol. 11, no. 7, pp. 4012-4019, 2013.

[23] J. S. F. L. Q. Z. T. C. Jie Zou, "A Visual Management and Monitoring Tool for Cross-organization Emergency Response Workflows," *Information Technology Journal,* vol. 11, no. 10, pp. 1341-1356, 2012.

[24] L. J.-Y. Z. Y.-W. Hou Shao-Jie, "Development of Boreholes Construction Deviation Tracking Software System: BCDTracking," *Information Technology Journal,* vol. 12, no. 19, pp. 4918-4924, 2013.

[25] V. S. M. Harshal D. Gurad, "An Approach to Code Generation from UML Diagrams," *International Journal of Engineering Sciences & Research Technology,* vol. 3, no. 1, pp. 421-423, 2014.

[26] R. S. Gurpreet Singh, "Generation of test cases using UML models," *International Journal of Computers & Technology,* vol. 13, no. 7, pp. 4671-4674, 2014.

[27] D. Ionita, "UML in business administration," *Journal of Knowledge Management, Economics and Information Technology,* vol. 1, no. 1, pp. 57-68, 2010.

[28] W. Y. Hui Du, "A MEASUR and RUP Combined Business Modeling Method," *Journal of Computers,* vol. 6, no. 6, pp. 1086-1093, 2011.

[29] D. V. Dragan Bojic, " A Method for Reverse Engineering of Use Case Realisations in UML," *Ajis: Australasian Journal of Information Systems,* vol. 8, no. 2, 2001.

[30] A. A. Q. Khaled Musa, "Distributed Graphical User Interfaces to Class Diagram: Reverse Engineering Approach using Pattern Recognition," *International Journal of Software Engineering & Applications,* vol. 4, no. 3, pp. 21-28, 2013.

[31] Wikipedia, "Knowledge-based systems," DBpedia, [Online]. Available: http://dbpedia.org/page/Knowledge-based_systems. [Accessed 11 11 2014].

[32] Y. Erdani, "Developing Backward Chaining Algorithm of Inference Engine in Ternary Grid Expert System," *International Journal of Advanced Computer Science and Applications,* vol. 3, no. 9, pp. 241-245, 2012.

[33] C. V. N. Gabriel Burstein, " A Kabbalah System Theory of Ontological and Knowledge Engineering for Knowledge Based Systems," *International Journal of Advanced Research in Artificial Intelligence,* vol. 2, no. 2, pp. 9-14, 2014.