Global Journal of researches in engineering
General engineering
Volume 11 Issue 7 Version 1.0 December 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Integrated Rfid Model for Optimal Selection of Drilling Projects

By Maki K. Rashid
University Muscat, Sultanate of Oman

Abstract - This work presents a model resolving data shortage problems when facing investment decisions in selecting drilling projects based on availability of equipments and drilling facilities. This is accomplished by enabling an environment for automatic information exchange using the technology of Radio Frequency Identification (RFID) integrated with assessments for projects net profit values. Incorporating the information technology tools facilitates the components selection and improves information retrieval efficiency for such missions especially during projects evaluation and drilling operation phase. Also, a fuzzy model is presented and convoyed with an optimization technique to take into consideration the risk of possible variation in oil prices and production cost. All these components are integrated by using information system design tools.

Keywords : Fuzzy Logic, Intelligent Systems,RFID,Project Management

GJRE- J Classification : FOR Code: 091304

INTEGRATED RFID MODEL FOR OPTIMAL SELECTION OF DRILLING PROJECTS

Strictly as per the compliance and regulations of:

Integrated Rfid Model for Optimal Selection of Drilling Projects

Maki K. Rashid

Abstract - This work presents a model resolving data shortage problems when facing investment decisions in selecting drilling projects based on availability of equipments and drilling facilities. This is accomplished by enabling an environment for automatic information exchange using the technology of Radio Frequency Identification (RFID) integrated with assessments for projects net profit values. Incorporating the information technology tools facilitates the components selection and improves information retrieval efficiency for such missions especially during projects evaluation and drilling operation phase. Also, a fuzzy model is presented and convoyed with an optimization technique to take into consideration the risk of possible variation in oil prices and production cost. All these components are integrated by using information system design tools.

Key Words : Fuzzy Logic, Intelligent Systems,RFID, Project Management

I. Introduction

The industrial obligation of Oil & Gas organizations to oil supply market produced highly competitive companies with a growing trend towards more renovation successively to attain higher output and easier entrance to worldwide marketplaces. One of the elements in adding more value to a company is by accomplishing faster than others. It is the essence of the innovation process, and, important for many business leaders in today's industries. Appreciating the added value that technology can carry to an organization is fundamental to justify financial investment and ultimately the successful adoption of any emerging technology. Without innovation a company will soon get hit by its competitors. The innovation in Oil & Gas is often linked with process improvements.

In the current business environment, process improvements are often supported by technology or IT-infrastructure [1]. To be innovative one does not need to invent a new technology but can use existing technology by various profitable ways. As new technologies are constantly being developed, this provides opportunities for companies to increase efficiency of their processes.

In this work innovative know-how like Radio Frequency Identification (RFID) technology is utilized in the selection of drilling projects set based on equipments availability to maximize net profit value. Such methodology is based on assigning resources only to those alternatives within a given constraint that ensure greater outcomes.

The implementation of Radio Frequency Identification (RFID) in project selection requires techniques for integrating data that relate field requirements to the concept of tracing and pursuing the available drilling string components and other facilities to optimize the selection process of drilling projects. Drilling expenditure includes all costs that are associated with drilling and equipping a well, including surface equipments. This work discusses methods for deploying tactics using RFID technology by deploying a systematic integration of drilling cost with project selection process and field drilling activities. The work proposes an optimization technique for selecting oil well drilling projects integrated with RFID technology by linking available drilling equipments to the assigned geologically detected locations to maximize economic value and assure equipments records for assessment during drilling operations.

II. Rfid And Information Assembly

One of the key elements of project management is the reliable gathering of information. Radio frequency identification (RFID) technique covers the remote gathering of information stored on a tag using wireless communications [2]. Such information is arranged in a database for future communication in a network system. In general the RFID system comprises responder (tag), transmitter and antenna or coil. The incorporation of a computer memory chip on the tag posses a limited information storage capacity depending on available memory size. The identification device that combines the transmitter and coil is named reader. The information is read by generating an electromagnetic wave having the capability of reading information seized on a tag fastened to a device or equipment or might have a writing talent of such information. Decentralized information is the key target of the RFID tools by making the data obtainable wherever the device or equipment exist using data handling software as shown in Fig.1. In the implementation of the RFID technology the aspects of cost, surrounding medium, codes and standards, RFID system preference, database management, system integration and safety should all be taken into consideration. Even though the data are mostly communicated between data bases but one of the main advantages of RFID is its talent reading through harsh surroundings in a reasonable short time as required in

Author : Mechanical and Industrial Engineering Sultan Qaboos University Muscat, Sultanate of Oman E-mail: maki@squ.edu.om

few applications using techniques overcoming wireless communication deficiencies. Over the last years, improvements in RFID technologies, such as increased data storage capabilities, reduced tag prices, and improved robustness of tags, have made RFID-based applications increasingly appealing to a wide range of industries.

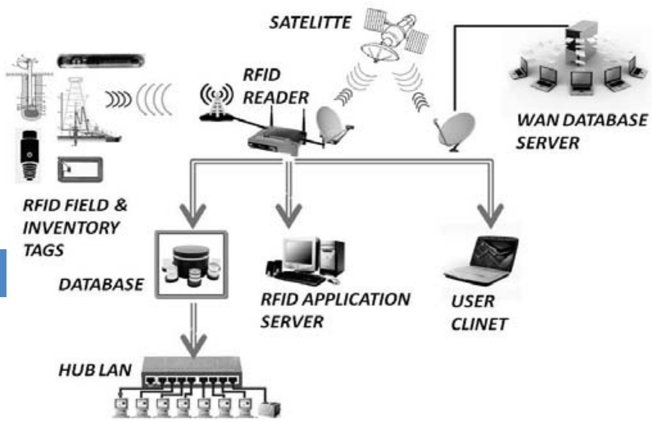

Fig. 1 Integration of the RFID Field and Inventory Tags with Projects Database

The drill string components in oil well drilling are exposed to severe loads and heavy wear under ruthless circumstances. It is well known that considerable costs might be associated with the failure of drill pipe during drilling operations. Therefore, a substantial economic advantage can be gained through predictive and preventive maintenance, maximizing operations efficiency, and, a better logistics strategy. The use of RFID technology with database management will improve efficiency and help to find automatically the most suitable piece of the drill string that is necessary for a specific operation by selecting the right components from racks of similar looking pipes. Using attached or embedded RFID tags allows operators, drilling companies, and drilling equipment leasing companies to map out equipment sites [3] and record environmental and operation severity that experienced as shown in the layout of Fig.1. This is done by keeping an electronic record for previous working environments like how long the tools have been used, including temperature, chemicals, pressure and depth of drilling. Such tracking integrated with codes and standards can help tool users to keep away from disasters, such as a tragic drill string failure or breakage underground, or injuries to drilling workers. Also, this technique generates a database to ensure the availability of the proper drilling components to guarantee the efficient use of these components in drilling projects within the required time frame to maximize profit.

The operation conditions for the tagged drill string components, i.e. drilling pipes, tools and surface equipments, require RFID tags including antenna and perhaps sensors that are designed to withstand the harsh conditions in oil and gas operations environments to allow both onshore and offshore asset tracking during down hole and subsea drilling operations. The RFID tags are needed to meet and exceed extreme acidity, pressures, and, temperatures typical experienced in oil and gas exploration environments in order to generate a reliable track using database management for the drilling components.

RFID tags can also help in achieving high degree of inventory accuracy represented by the degree of consistency between physical and logical inventory. The RFID tag and the automated process for data acquisition should minimize data entry delays and errors, increasing the accuracy and reliability of the information and the ability to plug and play with the existing enterprise resource planning (ERP) systems used by the operators. By using the RFID the human intervention in inventory management can be almost entirely eliminated and accurate levels of inventory are maintained. Furthermore, with RFID it is likely to determine the exact place of the material in the supply chain in real time. Latest advancements in technology have enabled the usage of RFID with tracking devices like GPS to give an accurate pinpoint the location of where inventory is located through the communication with the corresponding databases in the case of masked objects.

III. Optimization Strategy For Projects Selection

The traditional available means for selecting a set of oil well drilling projects to maximize profit are not ingrained computer integrated tools. In this work a database management system enhanced by RFID technology is proposed to help clients to choose the optimum available set of equipments to perform well drilling operations. The implemented optimization model takes into consideration the equipment availability, capacities, and, economic value that satisfies the work goals. This can be achieved by recovering and analyzing the available handy information from database saving considerable amount of time and satisfy the economic gain from the resources. The most favorable blend and sequence of recommending projects to achieve the organization overall targets are primarily initiated by determining the existing available equipments. Drilling equipments are the most valuable and most costly resource in this work. Their accessibility is limited and its allocation is an intricate matter. The problem of assigning equipments of various capacities for different drilling projects is discussed in [4]. The work based on classifying equipments according to their capacities in terms of drilling depth and technological complexity. Cash flow associated with owned or leased equipments are linked to their availability periods of time and hooked up to an economic assess to evaluate the project worth.

The net present value (NPV) is an important indicator used in capital budgeting to analyze the profitability of an investment. Therefore, the net present values (NPV's) of the drilling activities and the associated NPV for the RFID investments for all considered projects are introduced in the objective function as an economic worth indicator for the assigned projects. Accordingly, the objective function can be formulated as:

$$\sum_{k=1}^{C}\sum_{j=1}^{m}\sum_{i=1}^{p}\{npv_{i,j}^{D} + npv_{i,j}^{RFID}\}\in_{i,j,k} \qquad (1)$$

npv^{D} = Net present value of drilling activities.

$npv_{i,j}^{D}$ = Net present value of the RFID implementation.

$npv_{i,j}^{RFID}$ = Net present value of drilling project *i* starting in month *j*

$npv_{i,j}^{RFID}$ = Net present value of the RFID implementation of project *i* starting in month *j*

$\in_{i,j,k}$ = A binary decision variable in the model has a value of (0 or 1), used for assignment consideration of drilling equipment of class *k* for the project *i* starting in month *j* as defined by Glinz and Berumen, 2009. Equipment class *k* involves both the depth at which it may be drilled and its technological complexity.

In this model, optimum values for decision binary variables $\in_{i,j,k}$ are sought, targeting maximum economic value for all possible projects combinations (1→ p), considering different possible mixtures of equipment class assignations (1→ c) for projects having a blend of different month starts (1→ m).

Assuming $q_{i,W}$ is the equipment requirement of project (i) during month (W) and ECA_c is the available equipment of class (c), then, the monthly constraints on equipment of class (c) at month (W) can be written as:

$$\sum_{i}^{\substack{\text{All Projects of}\\ \text{Equipments}\\ \text{Class c}}} q_{i,W}\ \in_{i,1,c} + \sum_{i}^{\substack{\text{All Projects of}\\ \text{Equipments}\\ \text{Class c}}} q_{i,W}\ \in_{i,2,c} + \ \dots + \sum_{i}^{\substack{\text{All Projects of}\\ \text{Equipments}\\ \text{Class c}}} q_{i,W}\ \in_{i,W,c} + \ \leq ECA_c \qquad (2)$$

The other constrains for the multiple choice can be written as:

$$\sum_{k}^{\substack{Equipment\\ of\ class\ c}} \sum_{j=1}^{m} \sum_{i}^{\substack{\text{All Projects of}\\ \text{Equipments}\\ \text{Class c}}} \in_{i,j,k} = \begin{cases}0\\1\end{cases} \qquad (3)$$

IV. Drilling Cost Estimation

The NPV for drilling (npv^{D}) entail drilling cost assessment. Time efficient drilling of an oil well is a matter of expertise and know-how, procedural activities, quality, and, safety restrictions that are all connected to the course of action. Drilling objectives are frequently at discrepancy and depend on interrelated factors that might vary with respect to occasion, place, and personnel. It is a subject of significant market uncertainty. Drilling paces are often controlled by aspects that are not managed competently and lacking data documentation. In many circumstances, the origins of abnormality are multifaceted, occur simultaneously, and being short of effective solutions. Formerly there are diverse methods have been offered to evaluate drilling cost and complexity. Comprehending the drilling process requires isolation of various factors disturbing drilling and to measure their interaction with other factors [5]. There are many factors and events pointing in the direction of time and cost for drilling a well. Factors can be classified as either apparent or not visible. The quantifiable issues incorporate the corporal characteristics, geology, and drill constraints of the well, while the unseen factors, such as operator experience and wellbore quality, can be represented by surrogate variables. Issues such as well planning and execution, group harmonization, leadership, and project management talents will also bang drilling achievement. However, there is no way to identify all the characteristics of drilling that might be important, but many characteristics of the process can be observed, and in practice it is necessary to consider only a set of factors that adequately represent drilling conditions [6].

The Joint Association Survey (JAS) and, the Mechanical Risk Index (MRI) are accepted techniques used for drilling cost and complexity assessments that founded in 1954 and 1980 respectively. The JAS estimates drilling cost using survey data and quadratic regression models constructed from four descriptor variables (API 2002). The risk index of MRI utilizes six principal variables and fourteen qualitative pointers to differentiate wellbore complexity [7]. MRI is not of our concern in this work and the drilling cost (*Y*) [6] is:

$$\ln Y = \alpha_0 + \sum_{i=1}^{5}\alpha_i X_i + \sum_{i<j}\alpha_{ij} X_i X_j \qquad (4)$$

Where Y = total well cost, X_1 = TD = total depth (ft), X_2 = TD^2 = total depth squared (ft^2), X_3 = WT = well type, X_4 = WC = well class, and X_5 = DIR= well direction. The X_1 and X_2 variables are numeric, while the X_3, X_4 and X_5 variables are categorical, defined in terms of indicator variables (e.g., X_4 = WC = {0,exploratory well; 1, development well}). The coefficient α_i(i = 0,1,…,5) and α_{ij} (i, j =1,…,5, i < j) are evaluated for each geographic region and only statistically significant variables are maintained in the final model.

V. Fuzzy Model As Risk Factor

The Fuzzy concept is intrinsic in many problems of knowledge interpretation, and multifaceted assessment processes often cope with universal concepts and linguistic expressions, which are normally vague in nature. In this work the fuzzy relation that links NPV for drilling project (npv^D) to market oil prices and oil production cost is launched by set up a modifier or multiplier to NPV which can be considered as a risk factor [8]. An NPV multiplier is introduced in fuzzy model as a function of two variables. First is the normalized oil prices (NOP) characterized by present oil market price divided by average oil price. Second is the normalized oil production cost (NPC) which stands for oil well production cost divided by the average oil production cost. Average and history of oil prices is discussed in [9 & 10]. Models for the average production costs that correspond to the addition of all engineering costs related to the discovery, development, and production from oil field divided by the amount of oil that is anticipated to be picked up from the field over its life span as provided by [11]. Algorithm based on fuzzy modeling is utilized to extract rules that relate the NPV modifier as output to the inputs represented by the normalized oil prices and the normalized oil production cost. For inputs five linguistic values are used, namely L="Low", M/L="Medium to low", M="Medium", M/H="Medium to High" and H="High". For output the five linguistic values are: R="Reduce", RL="Reduce Little", Mid="Middle", El="Enlarge Little", E="Enlarge". The algorithm considers each input and output variables to be equally divided by symmetric membership functions of triangular type, and the algorithm uses the t-norm max to select the degree to which two fuzzy sets match. The output of each fuzzy inference system is derived using the standard Zadeh–Mamdani's min–max gravity reasoning method [12]. The rules in the fuzzy model have the following form:

$$R^{(i)}: \text{IF } x_1 \text{ is } A_1^{(i)} \text{and } x_2 \text{ is } A_2^{(i)} \ldots \text{ and } x_m \text{ is } A_m^{(i)} \text{ THEN } z \text{ is } B^{(i)} \qquad (5)$$

Where, $R^{(i)}$ is the ith rule, x_j are the antecedent variables, and z is the consequent variable. For the inputs, x_j will be the normalized oil prices (NOP) and, the normalized oil production cost (NPC) obtained from the price and cost models respectively, and z will be the NPV modifier. Symbols $A_j^{(i)}$ represent the fuzzy sets, and, $B^{(i)}$ are the rules conclusion of the fuzzy system. The inference operation and the defuzzification formula of the fuzzy algorithm are described in various literatures, [12] and [13]. A number of calculations and fine-tuning are pursued using previous data to obtain the final membership functions and the rule-base for the NPV modifier as given in table 1and Fig.2.

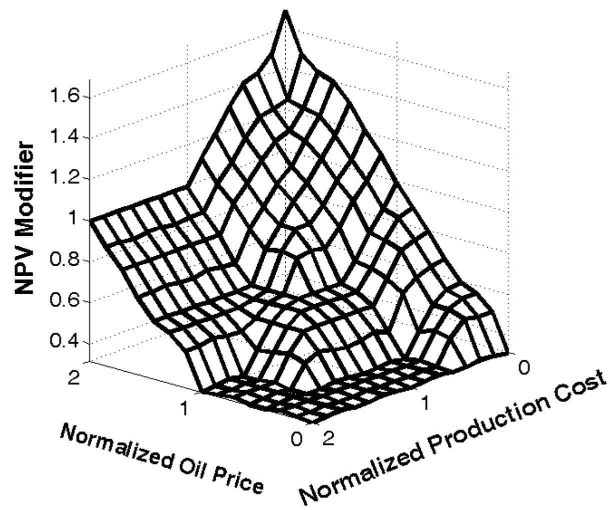

Fig.2 : shows the NPV modifier surface as related to the normalized oil prices and normalized oil production cost.

Table 1: The rule base for (npv^D) modifier

NPC\NOP	H	M/H	M	M/L	L
H	**M**	**RL**	**R**	**R**	**R**
M/H	**M**	**RL**	**R**	**R**	**R**
M	**M**	**RL**	**RL**	**R**	**R**
M/L	**EL**	**M**	**RL**	**R**	**R**
L	**E**	**EL**	**M**	**RL**	**R**

VI. The Net Profit Values For Drilling Project And RFID Implementation

By combining the well deliverability and all other necessary operating expenses the net present value of a well can be assessed [9, 10, 11 and, 14] for (N) number of months with discount rate (i), and

$$\mathbf{npv^{D}} = \mathbf{NPV\ Modifier} * \sum_{t=0}^{N} \frac{(Revenue\ - Operating\ and\ drilling\ expenses\ )}{(1+i)^{t}} \quad (6)$$

The NPV for the RFID implementation requires evaluation for the hardware costs (C_H) including the cost of readers, antennas, host computers, network equipment and tags. Software costs (C_S) include the cost of creation or upgrade of middleware and other applications. Finally service costs (C_V) include the cost of installation, integration of various components, training, support, maintenance, and business process reengineering. On the other hand, RFID benefits are broken down into three parts: cost reduction (CR), minimize inventory inaccuracy (IV), and error prevention (EP) [15]. The cost reduction could be the result from a labor cost reduction, inventory cost reduction, process automation, and efficiency improvements. The sources of the inventory inaccuracy can be from theft, misplacement, obsolescence, transaction errors, and others. Error prevention includes information distortion through equipment availability or allocation for different projects and improper equipment specifications for different drilling tasks causing additional losses. Then, the NPV for RFID implementation is:

$$npv^{RFID} = -(C_H + C_S + C_V) + \sum_{t=0}^{N} \frac{(\mathrm{CR})_t + (\mathrm{IV})_t + (\mathrm{EP})_t}{(1+i)^t} \quad \mathbf{(7)}$$

VII. RFID Management Medium For Projects Selection And Optimization

Maximizing the performance of RFID technology in oilfields requires the use of an intelligent technique integrated with a transportable and fixed wireless communications network that enables a dispersed information system as in Fig.3. Such systems enhance the decision making process by remote selection of oil and gas field data and set a preference to optimize results. In this work ORACLE is used as an information system design tool for data design and correlation as in Fig.4. Oracle is the most common program in database management.

The RFID chips can be prepared and shaped to be attached to various field products. Moving field products into inventory, shifted to different sites, examined, or dispatched, a related RFID as information capturing tool can trace the RFID ID numbers and connect these ID numerals to specific actions executed on that part. The captured information is stored and handled by a set of relational databases. Specifically, four databases are designed for managing the selection process namely drilling project information, cost information, component management, and, field information. These different spots of data storage offer the essential information to force the work progress train to exercise different applications. Updating or retrieving data from database in ORACLE requires interface software to organize the data transaction from database in processing unit. The interface software has identified a set of industry policies and rulings that direct suitable stream of data flow processed by different schemes

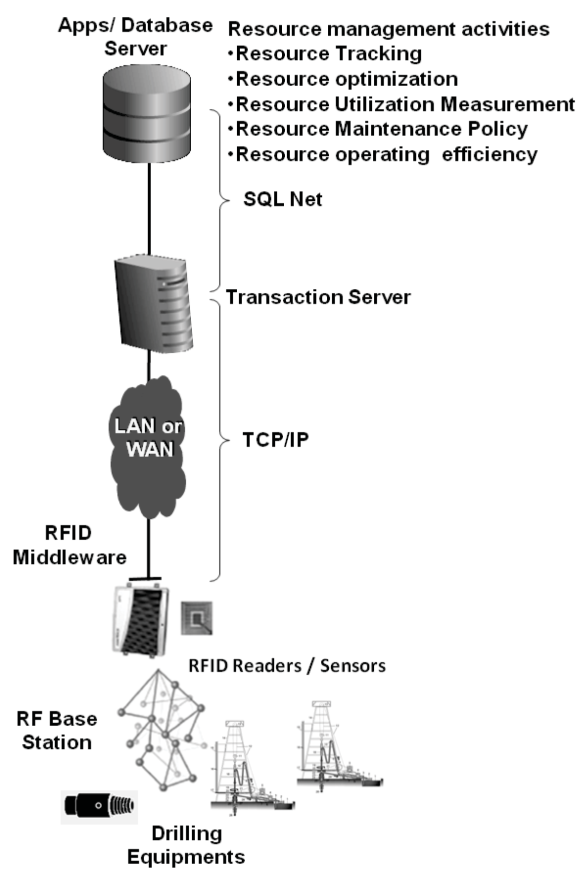

Fig.3 Integration mechanism of RFID with drilling management activities

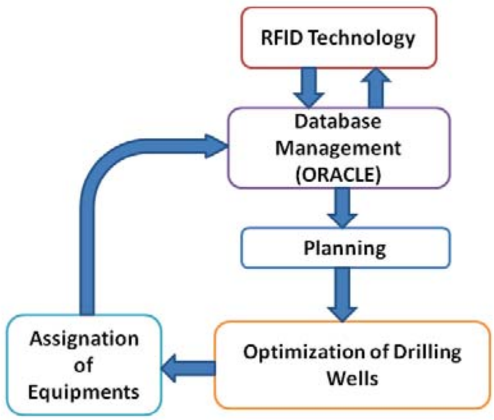

Fig.4 Integration flow chart to the database management activities with RFID

VIII. Decision-Making Calculations

Choosing which drilling projects must be selected from a pool of candidate projects can be a demanding mission. The complexity comes up in addition to the information integration is by restricting the availability of equipments and facilities. Also specifying competing goals of cost minimization and maximizing the net present value of the selected projects. The selection is ended more complex because certain factors, such as costs, and, prices are uncertain. The calculation flow chart for the decision-making process incorporating these parameters is shown in Fig.5. Showing final calculations will not add new concepts or draw general conclusions that can be used in future work. Each set of projects have their own characteristics and have to be investigated independently but the methodology of evaluation remains unchanged as specified in the flowchart of Fig.5.

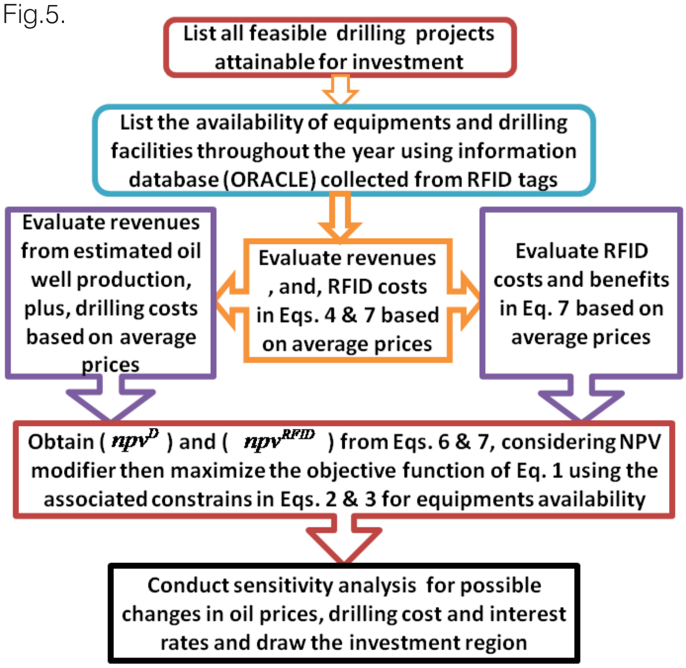

Fig. 5 Flow chart for optimum selection of projects set

IX. Conclusion

By encoding project money assessments and required drilling facilities in an integrated optimization mock-up, a more well-organized distribution of reserves can be accomplished. It is particularly significant under the condition of limited financial resources, facilities, and, insufficient information. Automation reduces the identification and selection time, and decreases manual errors for drilling equipments. The process discussed in this work enables development of an integrated selection process for drilling projects enhanced by the RFID technology. A considerable amount of time for retrieving information is saved since it involves searching and validating from multiple fields and documents. The optimal method of selecting the most profitable oil well drilling projects under limited available resources has been presented using mathematical modeling. Problem formulation lets managers and decision makers to openly include risk elements, such as variations in costs, prices, and, tradeoffs that must be made in funding drilling projects Unification of information system design with operation research and RFID technology in oil well drilling offered opportunities in better resource management activities in term of tracking, optimization, utilization, maintenance, and, operation efficiency.

References Références Referencias

1. O. Okereke, Report on Projects & Project Management in Nigeria, PM World Today – January 2011 (Vol XIII, Issue I) (http://www.pmworldtoday.net) , pp.1-6.
2. H. Chow, K. Choy, W.B. Lee, and, K.C. Lau, Design of a RFID case-based resource management system for warehouse operations, Expert Systems with Applications, 30, 2006, pp. 561–576.
3. C. Swedberg, Drilling Company Taps RFID Benefits, RFID Journal, Chemical News, June 2009, 25, pp. 1-2.
4. I. Glinz, , and, L. Berumen, Optimization Model for an Oil Well Drilling Program: Mexico Case," Oil and Gas Business, Issue 1, 2009, pp. 1-16, (http://www.ogbus.ru/eng/authors/Glinz/Glinz_2.pdf)
5. M. Kaiser, Modeling the time and cost to drill an offshore well, Energy 34, 2009, pp. 1097-1112.
6. M. Kaiser, and, A. Pulsipher, Generalized Functional Models for Drilling Cost Estimation, SPE Drilling & Completion, Volume 22, Number 2, 2007, pp. 67-73.
7. J. Dodson, and, T. Dodson, Drilling efficiency Number Static, Offshore 55(9), 2003, pp. 26-28.
8. A. Idrus, M. Nuruddin, and, M. Rohman, Development of project cost contingency estimation model using risk analysis and fuzzy expert system,

Expert Systems with Applications 38, 2011, pp.1501–1508
9. J. Williams, Oil Price History and Analysis, WTRG Economics, 2009.
10. J. Williams, Crude Oil, Gasoline and Natural Gas Futures Price, WTRG Economics, NYMEX Prices for February 17, 2011.
11. C. Jojarth, The End of Easy Oil: Estimating Average Production Costs for Oil Fields around the World, Center on Democracy, Development, and The Rule of Law-Stanford, Published by Program on Energy and Sustainable Development Working Paper #72, 2008.
12. M.K. Rashid, and, S. Al-Araimi Fuzzy Algorithm and Structural Stiffness in Error Attenuation of Intelligent Toolpost, Journal of Intelligent Manufacturing (JIMS), vol. 16, no. 3, 2005, pp. 277-286.
13. A. Ustundag, M. Kılınç, and, E. Cevikcan, Fuzzy rule based system for the economic analysis of RFID investments, Expert Systems with Applications, Volume 37, Issue 7, 2010, pp.5300-5306
14. H. Cho, Integrated Optimization on Long Horizontal Well Length, SPE Hydrocarbon Economics and Evaluation Symposium, 2-3 April 2001, Dallas, Texas.
15. E. Bottani, and, A. Rizzi, Economical assessment of the impact of RFID technology and EPC system on the Fast Moving Consumer Goods supply chain, International Journal of Production Economics, 112, 2008, pp. 548-569.

This page is intentionally left blank

i