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Making AZADEGAN Oil Field, SMART: Data Model, Weighted KPIs and Management Dashboard

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INTRODUCTION

As global energy demand increases, exploration, development and production of new oil and gas resources have shifted to challenging sites, while laws (especially environmental laws, etc.) are internationally recognized. It is always difficult to find and maintain experienced staff. One of the solutions to overcome these problems is the intelligent oilfield. The intelligent oilfield is, in fact, making use of the advancements in information technology for sharing and analyzing massive data across the field in order to bring people, processes and technologies into the hands of new efficient methods. The path to achieving intelligent oilfields includes a set of steps that, if logically followed, can greatly reduce the value creation time and increase the return on investment. These steps collectively reflect a holistic approach to the field, which replaces the approach of isolated and island-like technologies.

The Islamic Republic of Iran, as one of the paramount oil producing countries, has increasingly lost its prospect of production, especially in the common oilfields with its neighbors, due to years of international sanctions against its oil industry. Therefore, it is necessary for the country to benefit from the most up-to-date industry technologies such as intelligent oilfields in order to offset the losses. The technology, which is widely used by leading oil companies and Iran's neighbors, has not been transferred to Iran by leading companies due to its high competitive advantage. Therefore, the possession of a native model for intelligent oil fields and its application in the oilfields of the country, especially in the common areas, is a critical requirement for the Iranian oil and gas industry.

In this article, we will design a smart exploitation model from the Azadegan oilfield (a common field with Iraq) and ultimately validate it. This intelligent model will include the data model, data warehouse model, key performance indicators of the field, and the importance of each in the strategic, tactical and operational horizons, and ultimately the Azadegan oilfield's management dashboard. The field data model was designed and validated in accordance with the PPDM standard in seven subject areas. In the next step, weighed and validated and by oil and gas experts in three short-term, mid-term and long-term periods, about 40 key performance indicators for decision-making for intelligent utilization from the oilfield introduced.

Then the data warehouse model was designed and validated based on Kimball methodology. According to Azadegan field data warehouse model, based on the actual data of the mentioned field and based on the decision-making indicators, the management dashboard of the field was designed and finally, based on the designed models, the general intelligent production model from Azadegan oilfield was introduced, which could be used to exploit in other oilfields of the country.

In this way, an important step has been taken to overcome some of the theoretical gaps (lack of intelligent oilfield's data model, data warehouse model, and key performance indicators) as well as one of the vital technological shortcomings in the country's oil and gas industry and to reduce its dependence on foreign technology.

METHODOLOGY

In this research, based on the PPDM standard and according to the experts' opinion, the data sources necessary for making Azadegan smart will be determined and based on the ER method, the data model will be designed and validated. The method of the validation is according to Hay's (2003) methodology [1]. The following steps will be taken to design the data model of the Azadegan oil field:

1. Identification of data requirements
2. Design conceptual data model
3. Design logical data model
4. Design physical data model

To identify the KPIs, the related literature has been reviewed, and to weigh the field decision-making indicators, experts weighed the abovementioned indicators in three short-term, short-term, short-term, long-run periods. To design a data warehouse model, we used the Kimball methodology in addition to the KPIs defined in the previous step by following the steps as follows:

1- Select the business process
2- Determine Grain
3- Determining Dimensions
4. Determining Facts

Identification of the above is based on the needs of the business, along with the facts that are obtained by consulting the field's experts. In this research, it is necessary in three positions to validate the results. First, the field's data model, the second, key indicators of field performance and the third, model of data warehouse of Azadegan oilfield. Regarding validation of the field data model, typically two approaches are used. First, the model should be reviewed by the relevant specialists in order to avoid structural defects, in other words, from the perspective of syntax. Second, the model is examined by field experts (here oil and gas specialists) to ensure that what is expressed in the model is relevant to the business needs. Regarding the validation of KPIs for monitoring the field's performance, it has also been carried out through a questionnaire and a survey of experts' opinion. Regarding the validation of the data warehouse model, the first step is to ensure the validity of the data model, which has been carried out in the previous step. Secondly, key performance indicators included in the data warehouse model validated by industry experts [1].

The statistical population of this research was formed by thinkers, professors, experts and professionals in the upstream/downstream sectors of the oil industry, who engaged to Azadegan oilfield either through research or professional activities. In order to select the statistical society, the available community was used: academicians and professional from one of the subsectors of the Ministry of Petroleum, which is responsible for the Azadegan oilfield were invited to participate in the study. Out of these individuals, 70 people were selected by random sampling method, of which 20 were selected for pre-test and 50 others were selected for the final part of the research. Efforts were made to select the subjects based on the specialized fields related to the research topic. Of the first 20 people, 12 and of the second 50 people 25 individuals responded to the questionnaire.

In this research, the data collection tool is a library method for collecting data related to data standards in the oil industry, an interview on identifying the sources of data needed for intelligence and a questionnaire for weighing data sources of the field. The questionnaire of this research was prepared in a paper copy and sent to the research audience. In the pre-test phase, 20 questionnaires were distributed to assess the reliability of the instrument, 12 of which were completed by the thinkers. In the next step, with a 1-month interval, 50 questionnaires were distributed, 25 of which were completed by the experts.

In order to measure the reliability of the questionnaire, 11 pre-test questionnaires were distributed among the experts, professors and thinkers in the field of oil and gas, and by using SPSS software version -22, the Cronbach's alpha coefficient was 90.9%, which deemed as a good result [2].

DISCUSSION AND RESULTS

As indicated in the research methodology section, the first step in the designing the Azadegan oilfield's data model is to determine the necessary sources of data needed to make the production of the field smart. For this purpose, the necessary data sources were determined by interviewing the relevant experts and consulting with the PPDM general model. Questionnaires were provided to the interviewees and asked them to select the data sources necessary for intelligent utilization of Azadegan oilfield. Data sources were provided based on the PPDM classification and interviewers were asked to provide their answer (yes or no) for evaluating the necessity of each of the data sources for intelligent oilfield.

According to the results of the interview, the minimum data sources required (based on what the PPDM model suggests) can be summarized as follows:

1. General data of Azadegan oilfield
2. Properties of rocks for each reservoir of Azadegan oilfield
3. Fluid data in each reservoir of Azadegan oilfield
4. Data of wells in each reservoir of Azadegan

oilfield

5. History of Production / Injection in each of Azadegan oilfield wells / reservoirs

6. Financial data and contract types in Azadegan oilfield

7. Equipment data in each well of Azadegan oil field

Based on what we mentioned, we concluded that Azadegan's field data model has seven subject areas. Therefore, the field data model is designed based on this seven areas (Figure 1):

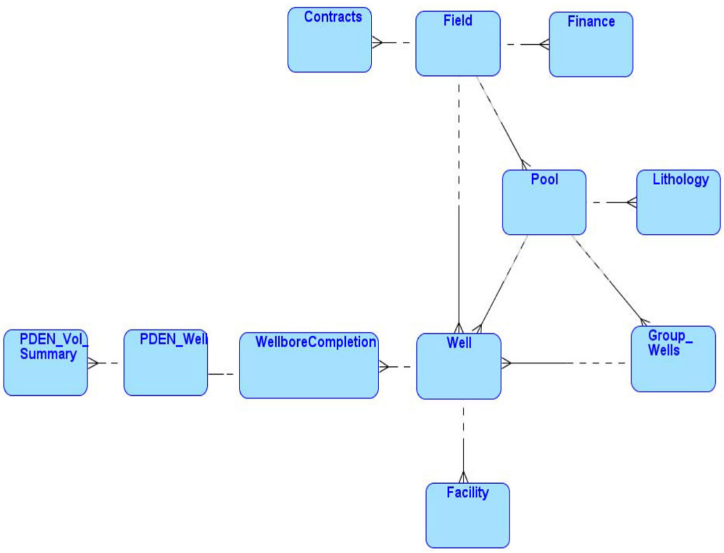

Figure 1: Azadegan's Conceptual Data Model.

In the conceptual model above, each entity covers one of the seven subject areas of interest (previously counted). In the following, the general description of each entity is discussed:

Field: The same as the "oil field" that covers the general data of Azadegan oilfield.

Pool: Data on reservoirs in the Azadegan oil field.

Well: Data on the wells in each reservoir exists in the Azadegan oilfield.

Group Wells: Provides public data for wells groups in each field.

Lithology: Data on rock properties for each reservoir of the Azadegan oilfield.

Contracts: Provides data on contracts and agreements in the Azadegan oilfield.

Financial: Financial data for Azadegan oilfield.

Facility: Provides data on equipment in each well of Azadegan oil field.

PDEN Well: Data on production / injection in each Azadegan Oil Field wells / reservoirs.

PDEN_Vol_Summary: Data on common fluids in each well of Azadegan oil field.

In the conceptual model presented, the relationships of each of the mentioned entities and cardinalities are also indicated. After the conceptual data model was designed for the Azadegan oilfield, the design of the logical model and the physical model began. The main achievement of the present project, after designing the data model, is to determine the key indicators of field's performance and determine the importance of each of which in three short-term (operational), mid-term (tactical) and long-term (strategic) periods. This would help the various levels of managers to make timely and accurate decisions. The achievement of this goal has been carried out through the use of intelligent field technology and has provided all the pre-requisites for decision making in macro and micro levels (ie, strategic and economic areas) through the transmission of real-time information and subsequently the ability to make decisions quickly. For this purpose, by using the relevant literature, the decision indicators are taken into account and then by the survey and weighting by the experts and with the questionnaire tool, the list of final indicators and the weight of each in the short-term, mid-term and long-term decision-making.

After identifying key indicators of the field of intelligent oil field in the relevant literature [3, 4, 5], these indices were combined and, taking into account the commonality between them, the initial set of indicators, approximately 40, was prepared.

In the next step, the above indicators were presented to the oil industry experts for validation. According to the expert survey, the following KPIs were removed from the list:

1- Water saturation map

2- Oil Gravity

In order to determine the importance of each of the indicators, the indicators were provided to oil industry experts, and they were asked to determine, over time and in three intervals, short-term, medium-term and long-term, the importance of each index.

In the short term, the indicators including the type of equipment, the actual production, the amount of pressure in the well, the amount of daily production of water, and the amount of asphaltene, gained the highest weight in the decision making for the field.

In the mid-term, the indicators of 1. gas to oil ratio, 2. Actual production, 3. The amount of daily production of water, 4. The amount of asphaltene and 5- The amount of pressure in the wells, gained the highest weight in the decision-making in the field.

In the long run, the indicators of 1. Gas to oil ratio, 2. Actual production, 3. Daily water production, 4. Asphaltene and 5. Recycling factor, have the highest weight in production decision making for the field.

After identifying the key indicators of intelligent oilfield's performance, in the next step, we used the Kimball method to produce a conceptual model of Azadegan oilfield data warehouse (Figure 2):

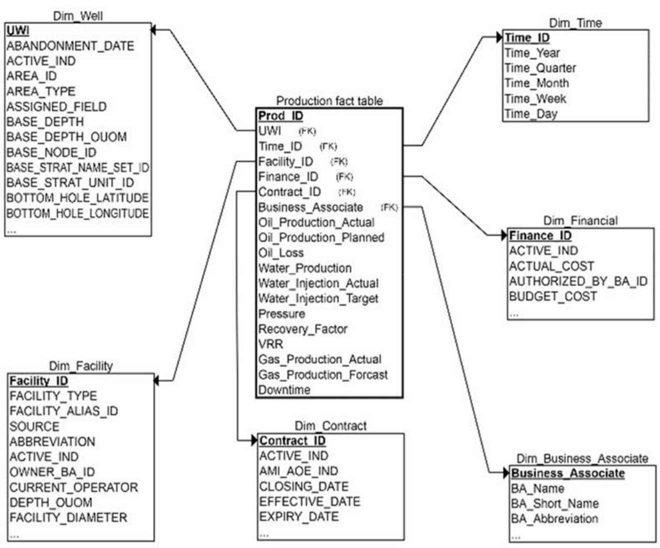

Figure 2: Azadegan Oilfield's Data Warehouse Model.

CONCLUSIONS

One of the most important factors influencing the success of oilfield's intelligence is the correct use of data generated in the field. In this paper, after identifying seven vital data sources in the field, the data model and data warehouse for the Azadegan oilfield, as a case study, were designed and validated. In the next step, about 40 key performance indicators were identified through reviewing relevant literature and expert opinion for intelligent oilfields. By doing so, oilfield managers will be able to convert traditional fields to intelligent ones efficiently and at little cost and benefit from the numerous benefits of this valuable technology.

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