Drilling Problems Detection in Basrah Oil Fields Using Smartphones

Abstract

Basrah oil fields contain many unresolved drilling problems, some of which are treated with difficulty, inefficiency, and sometimes leading to a more complex problem. These inefficient problems handling procedures lead to a longer Non-Productive Time (NPT). This lack in efficiency often comes from inadequate preparation, or the slow decision making in the detection of the drilling problems. The main objective of this study is to provide the optimum solutions for the drilling problems in Basrah oil fields on smartphones to achieve credible and quick treatments anywhere on the field.

Tracing of the problems, the gathering process of the field data, and the analysis of the field procedures to treat a problem, all of which were difficulties and challenges faced. Field data deficiency was confronted in many stages.

Throughout this paper, strategies of treatment procedures for the problems that could be encountered while drilling in Basra oil fields are discussed such as Dammam formation's losses, Tanuma's shale instability, Mishrif's special treatments so as not to damage the reservoir, and many others. Discussion of every formation that is drilled from the surface to Mishrif formation will be carried out with the explanation of the problems that was faced in offset wells, in addition to the problems that have a possibility to happen in each formation. The treatments for each problem were based on past field experience and standardized procedures. All of the formations, the problems, and the treatments are constructed in an application called Problems Detector 1.0 (PD) that functions on smartphones that obtains a familiar user interface and can be used anywhere on the field. Two advanced programming techniques are used to construct PD using an Object Oriented Programming language (OOP) that is java, they are the classify algorithm and a well secured database used to enhance the application's capabilities to detect problems and secure the wellbeing of the data that are mounted in PD, respectively.

As a result, a full database of the drilling problems in Basrah oil fields has been constructed. All the problems that could be tackled while drilling with the possibility of their occurrence, the causes of these problems, the indications of the problems on the rig, and the treatment of each problem were all parts of the database set in PD.
Smart phones showed very high efficiency and speed in determining the problems and presenting the solution which can be used on field by the drilling engineer and/or the driller, therefore; the presentation of smartphones to the petroleum industry has proven its importance and value.

Introduction
Drilling problems detection has been mainly reliant on the expertise of the drilling engineer and the driller operating on the rig. The detection of a problem might not always be as straight forward or as plain as it is recorded in handbooks and papers.

On field conditions might somehow overwhelm the drilling crew causing them to a false diagnosis of a certain problem, and false diagnostics might sometimes lead to complication of the problem, and in extreme cases, a very serious problem.

From that standpoint, the idea of this paper was proposed. Data from Basrah oil fields have been gathered, in order to summarize, analyze and reach a conclusion of the occurring problems in this governorate.

The data to execute this study was gathered from a wide range of wells that extends in the southern Iraqi fields. In these wells, multiple problems were encountered and recorded. Some of these problems were registered in the drilling program, and were prepared for in an adequate way, and others tackled the drilling crew by surprise. The second type of problems are the type that are dealt with in this paper, for an efficient problems solving, and an accurate and fast decision making.

Therefore, the Problems Detector 1.0 (PD) was designed for this purpose. The possible problems that are potentially expected due to the presence of; potentially troublesome formations, prematurely expected formations to cause problems, geological heterogeneities, drilling challenges, narrow adequacy window of the drilling parameters, or other surface facilities related malfunctions. In addition to the strategies, analyses and explanations for each formation will be presented with the reasons that led to those concluded results.

The Formations
Each formation will be discussed, individually, and comprehensively while presenting all the supporting evidence that came to sight in confirming the study. The formations are:

Upper and Lower Fars
It consists mainly of limestone and claystone interbedded by few layers of gypsum (impermeable zones). Some sandstone and anhydrite have also been spotted in this formation in various fields with a small amount of hydrocarbons that is present in trapped and fine amounts.

The expected problems in this formation that have been faced before are the following:

1. Tight hole during connection, due to the rock composition of this formation, the claystone or shale will be pressurized, causing the hole to collapse due to clay or shale movement hence causing the problems in this formation.
2. Tight hole during trip out and reaming during Running in Hole (RIH), caused for the same reason above.
3. Bit balling which is faced due to the presence of the claystone which has a tendency to adhere to the bit causing this problem.
4. Slow ROP will be encountered in case the bit balling problem wasn't treated adequately and optimally.
5. Gas cut mud has been recorded in this formation, so it should be kept in mind if encountered, due to the hydrocarbons earlier mentioned in the formation.
If the bit balling problem have occurred, pull the string out to a zone that does not contain swell-able shale, and spotting anti-balling materials around the bit needs to be performed, drill collar and stabilizers should be put in balance method (in tension). Waiting for half an hour with reciprocating to the string to avoid any tight holes is advised. Starting the circulation with high flow rate, and high RPM, to clean the bit will be the first action. Afterwards, drilling mode should be resumed, if the same problem happens as well, then the procedure above should be repeated. If the problem was not solved, then pull the string out to surface.

In case tight hole problem has been faced, the string should be worked on until the problem is solved.

**Dammam Formation**

It is a formation that consists primarily of dolomite and limestone that contains many fractures. The top of the layer (about 6 feet) consists of limestone, afterwards the formation is mainly dolomite.

Mud loss is highly likely to happen here, due to the vuggy structure of the dolomite, and at the bottom of the formation total mud loss is probable.

Tight hole problem has been encountered in this formation in some cases, due to the improper hole sweeping that was performed by the drilling crew in addition to the presence of limestone which is a big contributor to the tight hole problem.

The following procedure should be taken to pass this formation safely:

1. High torque and string hang, those will be the first signs of the thief zone. A few seconds later and a signal is supposed to be received that losses are encountered.
2. Switching the pumps to water, and keeping the drilling process like that must be acted on. Controlling the ROP at (65 ft/hr max), to avoid loading the annulus with cuttings. The cuttings will go inside the fracture. Also there should be a limitation in flow rate to avoid getting shortage in water.
3. At the end of the second joint of the stand, 60 barrels of high viscosity pill should be pumped (pumping high viscosity LCM pills during drilling Dammam and Hartha formations instead of normal high viscosity pills will be helpful in hole cleaning and curing losses as well) which will prevent the hole packoff. As when a connection is started, the viscous mud should reach the shaker and the hole should be clean.
4. After reaching the bottom of Dammam, the hole should be swept with high viscosity mud with a circulation for two bottoms up.
5. Pull the string to top of Dammam, and monitor for any tight spots, ream up and down if noticed.
6. If the hole is clean, and no over pull is encountered, run in hole to bottom again and LCM should be spotted from the circulating sub (120 lb/bbl concentration is fair), twice the lost zone volume minimum needs to be pumped.
7. After spotting LCM, pull the string to surface and get ready to cement the section. The string while connecting/tripping out/in front of the thief zone, mustn't be stopped. It must be kept under rotation to minimize the risk of differential sticking.
8. At casing shoe, stopping for a flow check is required, afterwards, pull out of hole without filling the well to check the mud level on the drillpipe, from that mud level estimation of the formation pore pressure is obtainable, which will help in calculating the position of cement stinger later.
9. The cement compressive strength should not be more than (1000 Psi) after 24 hrs. As the compressive strength of Dammam is within this limit.
10. Run in hole with cement stinger and drill pipe, and stopping four stands above the losses zone.
11. Pumping volume of the cement batch mixer, and displacing it with the volume of drillpipe – 3 stands (under balance status should be reserved during this operation). The cement will slightly drop from the drillpipe while pulling out of hole, this procedure will be repeated for many times till the losses are sealed. Pull the drillpipe to casing shoe or to surface.
It should be mentioned that the use of LCM in the mud, when losses are more than (95 bbl/hr), will provide little to no benefit.

**Umm-Er-Radhuma Formation**

It consists of mainly two types of rocks; dolomite with streaks of anhydrite and some dolomitic limestone (and shale in some fields).

The problems faced in this formation are:

1. Due to the presence of the dolomite in the top, so some seepages (low rate of losses which is less than 10 bbl/hr) are probable to be happening. In the case of drilling any dolomitic formation, losses are expected due to the vuggy structure of the formation.
2. Differential sticking is probable due to the high permeability of this formation, especially when running in the casing.
3. Tight hole due to thick mud cake is also caused by the permeable beds of dolomite at the top of the formation.
4. Tight hole due to swelling is caused because of the argillaceous beds at the bottom of the formation that are expected to swell.

To treat these problems, the following is advised:

1. If any minor losses are faced, the following steps should be taken:
   a. The mud should be loaded with fine LCM (40 lb/bbl), it will help a lot and stop these losses.
   b. Sweep the hole and circulate enough to clean the hole before any connection is made.
   c. Reduction of the flow rate should be acted upon, if needed. This will reduce the ECD and the jet impact.

2. To treat the differential sticking, while the drill string is downhole, or the casing:
   a. *Drill string*: If the bottom hole assembly is in front of Umm-Er-Radhuma, it is better to pump stuck-free fluids, or acid if needed. Torque and drop string down with jarring down is highly recommended to be the first action, this is if the string is stuck. This action should be repeated even while pumping any mud materials that are manufactured to free stick, those materials will help in destroying the mud cake, and also it has some acid that can react with the formation. Maximum flow rate should be used also.
   b. *Casing*: acid cannot be pumped, to eliminate damaging the floating equipment. So caustic soda pill, or stuck-free fluids should be pumped to the permeable zone. If casing becomes stuck, applying torque and drop casing is recommended, but it will be impossible sometimes if the top drive system can't be screwed in with the casing, so dropping casing very fast especially when the stuck-free is in front of the stuck point is required.

**Tayarat Formation**

Tayarat is composed of bituminous shale at the top of the formation, dolomite, compact limestone and some marl at the bottom. It is not a problematic zone itself. Though it will become the worst formation when the hydrostatic balance is lost, due to the presence of a very active water aquifer. This water has some H$_2$S and the concentration of this H$_2$S is not constant in Iraqi fields.

In case an influx entered, the well killing procedures should be followed to treat it.

**Shiranish Formation**

It consists of argillaceous limestone with some marl at the top of the formation. The problems that might be encountered are:
1. Bit balling may occur due to the presence of argillaceous limestone, leading to slow ROP especially at top of the formation.

2. Tight hole is also expected due to swelling of the Marl at the top of this formation (swelling is coming either from the absorption of water or due to pore pressure). Tight hole will be faced later on during pulling the string out of the hole.

   In case bit balling problem was encountered, the best solution is to pull the string to bottom of Tayarat, spot the anti-ballng material to cover the bit and stabilizers, wait for 15 minutes and rotate in high RPM for a few second then start pumping till the bit is cleaned.

   As for the tight hole problem, increasing the MW by (+/- 0.03 ppg) is advised. Reaming and back reaming is also advised.

   **Hartha Formation**

   It is mainly composed of sequences of dolomite, limestone and some marl at the top. Afterwards limestone and argillaceous limestone are dispersed throughout the rest of the formation.

   It is a disaster if losses happened here due to the fact that as the mud level will drop sharply, leading to the flow of Tayarat formation. The problems that will be dealt with in this formation are:

   1. Mud losses are expected in this formation due to the vugs and pores present in the top of the formation.
   2. Tight hole may occur due to the presence of streaks of marl.

   In case mud losses are encountered:

   1. The hole should be circulated clean and the mud conditioned, the mud weight should be as low as possible without losing the balance.
   2. The rheological properties (YP, and VP) should be at the lowest acceptable limit.
   3. Pull out of hole for short wiper trip to the last point of trip or to casing shoe. This will wash out the mud cake, clean the annulus, and lift all the cuttings, which may make some pack-off in the hole, causing some surge pressure in the section.
   4. When drilling is started again, and after breaking the gel. Top of Hartha needs to be drilled with minimum Parameters that can be provided, till at least the first 25 meters TVD are drilled, and then the hole is circulated clean and pull the string for short wiper trip till top of Hartha, to clean the well from the cuttings.
   5. Run in hole back again and drilling starts again, while increasing the parameters gradually.
   6. If losses are encountered (normally at the top of the formation), the procedure above should be used. Moreover, pumping high viscosity mud for the vertical wells before the end of each joint should be very useful. The viscous mud should leave the bit on time (before connection), so accurate calculations should be taken.
   7. The well must be kept filled, from the annulus, by mud or water (in case shortage in mud is faced) to prevent the well from flowing.
   8. Drilling should be kept uninterrupted, until the losses section is reached, and then the hole should be swept to clean the hole, and pull the string out of the hole for a cement plug. The well should be filled constantly at top of Hartha as well as spotting High concentrations of LCM (120 lb/bbl of coarse LCM is displaced and left in the well).

   **Sadi Formation**

   This section is composed of mainly limestone of different characteristics. Limestone and argillaceous limestone are the types found in this formation (some marly limestone and chalky limestone have been noticed as well).
Gas cut mud on surface could be noticed during drilling this formation, due to the presence of the hydrocarbons. No problems are encountered in Sadi, if the formation pressure is controlled. Therefore, no special measurements are acquired in this formation.

If Gas cut is encountered, the Poor boy degasser needs to be running to control the well (if the MW is as per the program prescribes). Any increase in mud weight may lead to losses.

**Tanuma Formation**

This section is composed of mainly thick beds of shale and some limestone. Since this formation is composed of shale beds, there are many problems that are potentially dangerous, if not encountered on delicate properties, that can outcome the possible problems of the shale, such as, hole washout, excessive water invasion, the pipe sticking is highly probable in here, and sloughing could be encountered.

To solve the stuck pipe problem:

1. Circulation should be started with very low SPM (if the pressure increased more than 200 Psi, the mud pump must be stopped and the pressure has to be bled off). The hole in the NRV will help in bleeding the pressure from the Annulus also.
2. Torque and Jarring down are recommended, but not over pull. Over pulling will make the stuck much worse.
3. The procedure should be repeated many times.

If any return flow is noticed, the flow rate must be increased gradually. It may take two or three hours till returning back to the drilling flow rate is acquired. Otherwise backing off and sidetracking should be taken.

**Khasib Formation**

Khasib mainly composes of limestone and a few argillaceous limestone interbedded by shale layers.

The only problem that has been encountered here is the differential sticking so leaving the string static is very risky.

Treating the differential sticking in this formation needs to be done according the IWCF regulations.

**Mishrif Formation**

In general, Mishrif is composed of limestone of different characteristics with weak to good oil impregnation, some shale layers at the top, and some interbedded in the middle. Thus, tight holes and stuck pipe problems are expected. In addition to the subnormal pressure due to the production and depletion of the reservoir. This depletion of the reservoir will encounter a low formation pressure, whilst the drilling mud weight must be kept high enough to restrain the fluids in the overlying formations from entering the well, which will cause differential sticking. The potential problems that might be faced are:

1. Records indicate the presence of high pressure shale at the top of the formation. Shale caving and sloughing are expected, as well as tight hole after passing this shale and resuming the drilling inside the formation during the connection and while the pump is switched off, due to the fact that gel strength is not sufficient to hold the shale in place.
2. MA is fractured with oil content, so complete losses might be encountered.
3. The underlying layer also contains fractures but in less severity than the one above, so losses are also expected in this bed in producing fields.

These losses vary in their severity depending on the depletion of the reservoir (e.g. producing fields demonstrate more losses severity). And these losses are very difficult to deal with due to the following reasons:

- As it is in a producing zone, so a kick will be expected.
– As the level of the mud will drop till the hydrostatic pressure will be equal to the Mishrif formation pressure, there are two reservoirs above (Sadi and Khasib) will start flowing.
– Tanuma's high pressure shale will start sloughing due to drop of hydrostatic pressure, so stuck pipe is also expected especially in highly deviated wells; moreover, Mishrif's top high pressure shale should not be forgotten. Mishrif's shale will be very effective when the reservoir is depleted due to the expansion of the shale layers.

4. Cement plugs are not an option in this formation because it will damage the reservoir.
5. The pressure is substantially subnormal in the reservoir due to the production of the field that depleted the formation.
6. Tight hole due to thick mud cake produced from the secondary permeability of the formation.

The treating procedures are as follows for each individual problem:

1. Stuck pipe due to swelling: the procedure that have been discussed in Tanuma needs to be followed. Acidizing will help as the formation is Calcium Carbonate.
2. If losses are encountered:
   a. The best option is to continue drilling with the drilling mud till the loss zone is finished.
   b. Pumping of high viscosity mud must be done and pulling the string to casing shoe.
   c. 130 lb/bbl High concentration coarse and medium LCM should be pumped. Using a circulating sub is highly recommended.
   d. The filling of the well must be kept on going while monitoring for losses.
   e. If the losses have been sealed, then circulation by high flow rate at shoe must be established to soft squeeze the rest of the LCM into the formation, and ensure that the losses have stopped.
   f. If not, repetition of this procedure must be continued.

   If Calcium Carbonate cement is available, it should be used.
3. Regarding the filter cake, in case a tight hole was faced and over pulling is confronted, ream up and down for two times to scratch the wall prior to any connection.
4. Regarding the differential sticking:
   a. Circulating and Jarring down with torque up the string must be established. This should be repeated for many times.
   b. If the above solution wasn't successful, then acidizing with tension or compression in the string should be applied.

Finally, if the above solution didn't work as well, then backing off and the side tracking should be followed.

**The Software (Problems Detector v1.0)**

The Problems Detector v1.0 (PD) application is an automated problems detection system that receives data from the engineer, analyzes those data and concludes the encountered problem depending on the input data provided by the driller or drilling engineer. It consists mainly of five parts which are:

1. *The Input parameters:* This part specializes in receiving the information from the user that are being observed on the measuring devices on the rig floor. Six parameters were chosen to be set in this part, which are:
   a. The formation: This input requires the formation being drilled.
b. Return Flow: This parameter represents the percentage of drilling fluid that is returning to the surface.

c. Mud pumps pressure: This input requires the pump pressure of the mud pumps that are working.

d. Torque: This parameter represents the amount of torque being exerted by the drill string.

e. Rate of Penetration (ROP): This parameter represents the speed of the drilling operation.

The five chosen parameters will be the main indicators that help the drilling crew to determine whether there is a problem or not, as well as specifying the type of the problem being faced. Any other indication of a specific problem shall be credited in the third point (additional indications), in which other specifications of the problem will be presented for the user to be guided through the problem and whether it's the problem at hand or not.

Problems Detector v1.0 (PD) requires the driller or drilling engineer to enter the field they are working in, the formation currently being drilled, the changes that have happened to the four parameters, before the problem, and after the problem (e.g. during drilling, the torque suddenly dropped, so the user should specify the condition of the torque to the application which is "decreased"). In this context, PD will base its analysis on the alteration of these values before and after the occurrence of the problem. Therefore, the accuracy of the changes of these parameters and their insertion in addition to the field and formation being drilled must be of maximum accuracy, because any misleading value that is entered might lead to a problem that is not the actual one, which consequently will lead to mistaken problem analysis and detection.

2. The problem: Once the input parameters are specified, an interpretation process will take place. In this interpretation process, PD will start a diagnostic process in the database that was preinstalled.

   There are three possible scenarios that could be encountered, first there is a problem, second the parameters refer to a problem that cannot be happening in this formation, and third the parameters are inaccurate.

   In case the parameters were validated, and the problem was identified, PD will proceed to the next step of solution casting.

   If the parameters weren't validated, PD will signify to the user to re-enter the parameters or the problem could not exist in this formation with the reason.

   And finally if there is no such problem causing the inserted parameters, PD will notify the user to re-enter the parameters.

3. Additional indications: In some cases, the indications of a specific problem are not limited to the deviation of the four parameter that the application requires from the user (in which it increases, decreases or remains stable), but extends to more than that (e.g. over pull, drag, cuttings in the shale shaker … etc.). These other indications are also stated in order to increase the knowledge about the problem and provide additional indicators to determine whether the problem suggested by the application is truly the one that is being face or not.

4. The causes: For additional reassurance, and to comprehend the roots of the problem, and why it happened, the application will provide all the possible scenarios that may have led to the current situation. From which, the drilling engineer will establish the reasons that caused the problem; thereby, avoid making the same mistakes in the future.

5. The treatment: After the confirmation of the problem, there is nothing left to do but to treat the problem. So, a set of procedures that should be taken to solve the problem shall be provided. These treatments provided will lay out the general guidelines based on IWCF's recommendations to treat a specific problem and the field experience of the drilling crew in the southern Iraqi fields.

The block diagram of PD has been demonstrated in figure (1) to show the work flow of the program, how it receives the data, analyze it, and come up with a result that is the most likely scenario.
The problems that will be analyzed are the most common problems, which happen in the southern Iraqi fields. The problems are discussed thoroughly in appendix A including their indications, causes, and treatments.

**Programming the Software**

Android Studio (the compiler of Oracle) was used to program the application by the usage of java language, which is an Object Oriented Programming (OOP) language. Android Studio is the official Integrated Development Environment (IDE) for Android app development, based on IntelliJ IDEA. On top of IntelliJ's powerful code editor and developer tools, Android Studio offers even more features that enhance your productivity when building Android apps [1].

**The classify algorithm (forward):** after multiple trials of trying to find the optimum way that extracts the information from the database in the most accurate, and efficient way.

In this partition, the classification algorithm type forward has proven its efficiency in delivering results at the highest speed with the lowest time consumption. Classify algorithm forward method showed exquisite improvements for the coding of this part to be at optimum level of sophistication and efficiency.

**The database:** PD has been supplied with a full database in the form of texts that are installed during the coding of the application. Every down hole problem that could be faced during drilling in Basrah oil
fields is preset in the database along with its indications; which are the parameters that indicate a significant drilling problem, the additional indications; which are any extra indications (besides the previously stated five parameters) that the drilling engineer should look for to emphasize the results, the causes; which are the initial causes that could've caused this problem, and the treatment; which is the procedure that should be taken to treat the encountered problem.

As a security precaution, and to maintain the database of the application from being corrupted, the database is secured by the use of the android studio security features. This security method ensures the safety of the database from external manipulations, and prevents unauthorized changes to the database creating a safe environment for PD to function fully and safely.

Algorithm 1 demonstrates the nature of PD and the way it works for solving the problems that are faced during the drilling operation.

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Algorithm 1: Problems Detector Algorithm

Step 1: Begin.
Step 2: Select all the data required.
Step 3: Compare with data in database.
Step 4: If the input parameters are invalid.
        Go to step 2.
Step 5: Else analyze the input data.
Step 6: Determine and output the validity of the problem.
Step 7: If the problem is invalid.
        Go to step 2.
Step 8: Output the problem and its details.
Step 9: End.
```

The input data of the algorithm are:

1. The field.
2. The return flow.
3. The mud pump pressure.
4. The torque.
5. The rate of penetration.

The output data of the algorithm are:

1. The problem's validity.
2. The additional indications.
3. The causes.

- The first step is the beginning of the application.
- The second step will be to select the required data. The required data are the formation that is being drilled, the return flow, the mud pump pressure, the torque, and the ROP.
- The third step is the comparison of the selected data with the database.
- The fourth step is the if statement to check if the selected parameters are valid. If they are invalid, go back to step two and re-select them correctly.
• The fifth step is in case the input data are valid, analyze the selected data.

• The sixth step is the determination of the problem.

• The seventh step is if the problem is invalid, go back to step two and re-check the parameters entered.

• The eighth step will output the problem. The details will contain additional indications, causes, and treatments.

• The ninth step is the end of the algorithm.

**Work Results and Discussion**

Following the steps of the algorithm, PD will present the most probable problem (but not the one being faced necessarily). The error range lies in the accuracy of the human effort to accurately establish the increase/stability/decrease of a specific value to sustain the accuracy of the results and reach the actual problem that is being faced.

Several iterations were performed on a wide range of wells from Basrah oil fields to achieve the optimum set of treatments for the largest amount of drilling problems. The problems varied between formations' troubles and personnel mistakes, all of which was taken into consideration during the construction of the application.

Smartphones have once again proved to us their efficiency in dealing rapidly, delicately and astounding precision with the sets of data that was fed to the application from previously obtained data. **Figure (2)** demonstrates the main window of PD as demonstrated on the smartphone.

![Figure 2—Problems Detector main window.](image)
In table 1, all the downhole problems of Basrah oil fields have been assembled across all the formations included in this study. Inbetween, the probability of each problem has been assigned a level of criticality, depending on this level, it is determined whether the problem is (Highly possible, moderately possible, not possible, and could happen anywhere) with the signs of A, B, C, and D respectively.

![Table 1—Basrah oil fields formations vs downhole problems possibilities.](image)

For example, the probability of a tight hole due to swelling is very high in Upper and Lower Faris, it is moderately probable in Dammam, and it is not possible to occur in Tayarat. Whereas the key seat is probable to happen anywhere because it does not necessarily occur due to subsurface heterogeneities rather than drilling errors in calculations or performance.

For dealing efficiently with the extremely dangerous drilling problems, the field experience and the data gathered from offset wells that indicate the exact procedures on how to treat each problem are analyzed and studied throughout this paper.

The formations with their respective problems are discussed as follows:

1. **Bit balling:**
   
   A. Highly probable: it is highly expected to happen in upper and lower Fars in Basra, as well as in Shiranish formation.
   
   B. Moderately probable: The formations that carry the potential possibility of developing these formations are Dammam, Tayarat, Tanuma, Khasib, and Mishrif in Basra fields due to their
shale or limestone that is close to claystone content which could yield such a problem if not handled accurately.

C. Could happen anywhere: As for the other formations, this problem could occur due to surface malfunctions (such as poor mud properties).

2. Plugged bit nozzle, bit washout, drilling on junk, hole cleaning, under gauge and pipe washout:

A. Could happen anywhere: These are all possible to occur in any formation because they are caused due to drilling crew errors (such as inappropriate drilling parameters).

3. Tight hole due to swelling:

A. Highly probable: It is highly probable in upper and lower Fars, Khasib, and Mishrif.
B. Moderately probable: Dammam, Umm-Er-Radharga, Shiranish, Hartha, and Tanuma has dolomite and shale which has the tendency to swell that could cause the mentioned problem.
C. Not probable: Tayarat, and Sadi cannot produce this problem due to the lack of the causing characteristics in their lithology.

4. Tight hole due to heaving:

A. Highly probable: This problem is highly probable in only upper and lower Fars in which records have shown this problem has occurred in this formation.
B. Moderately probable: It has the potentiality of happening in Hartha and Mishrif due to the streaks of dolomite that can heave.
C. Not probable: As for the rest of the formations in Basrah oil fields this problem does not have the potentiality of happening.

5. Tight hole due to differential sticking:

A. Highly probable: It has been recorded several times in Umm-Er-Radharga, Sadi, Khasib, and Mishrif in Basrah oil fields due to their relatively high permeability.
B. Moderately probable: There is a possibility of its occurrence in Dammam its because of its permeability.
C. Could happen anywhere: As for the rest of the formations the probability of the differential sticking is increased when the mud weight is much higher than the formation pressure.

6. Sloughing:

A. Highly probable: It has a high tendency of occurring in Tanuma and Mishrif formations due to the shale content of these formations.
B. Moderately probable: As for upper and lower Fars, Tayarat, and Khasib formations, there is a possibility of its occurrence in these formations due to the shale layers that could be found in different ranges in these formations.
C. Not probable: As for Dammam, Umm-Er-Radharga, Shiranish, Hartha, and Sadi formations, they do not have the tendency to cause sloughing.

7. Finally, mud loss problem is a widespread problem that could be found in many formations.

A. Highly probable: Dammam, Hartha, Khasib, and Mishrif formations have this problem in a very high probability ranging from seepages to complete losses.
B. Could happen anywhere: As for the rest of the formations, no records show losses occurring in them, but if the mud weight was higher than the fracture pressure, this problem will happen.

Conclusions

An application was programmed for android. Data of Basrah oil fields was used to determine the problems that needs to be encountered in PD. PD was capable of detecting all the problems correctly. The program can
operate in any field that has a close composition to the southern Iraqi fields' composition. A table including all the formations from the surface to Mishrif formation with the downhole problems possibilities to occur has been established.

References