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Non-Productive Time Reduction during Oil Wells Drilling Operations

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Abstract

Often there is no well drilling without problems. The solution lies in managing and evaluating these problems and developing strategies to manage and scale them. Non-productive time (NPT) is one of the main causes of delayed drilling operations. Many events or possibilities can lead to a halt in drilling operations or a marginal decrease in the advancement of drilling, this is called (NPT). Reducing NPT has an important impact on the total expenditure, time and cost are considered one of the most important success factors in the oil industry. In other words, steps must be taken to investigate and eliminate loss of time, that is, unproductive time in the drilling rig in order to save time and cost and reduce wasted time. The data of six oil wells were approved for the purpose of the study, where it was noted that there are many factors affecting the NPT, which differ from one well to another. Its impact was limited to drilling rig, mud pump and equipment failure. There is also a difference between the planned program and what is actually happening on the ground, due to several reasons, including human errors during the implementation of the drilling program and others due to technical errors, Misuse of equipment, in addition to human errors related to the failure to implement the drilling program.

Keywords: Time, Drilling, Non Productive Time, Integrating risk management.

1. Introduction

The NPT is definite as the time that the drilling process stops in an unintended manner or at what time the drilling penetration rate converts disproportionately low. Some researchers assumed the huge costs in oil and gas exploration projects and worked to find ways to reduce those costs, [1]. Consequently, decreasing the NPT have a duty to progress drilling performance and decrease drilling cost to save time and money. The NPT theory taking place in the 1960s, and since at that time numerous studies and lines arose in an effort to decrease lost time to satisfactory standards [2]. Drilling is tracked according to convergent agendas and delaying

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drilling time results in significant costs. A large part of the drilling days is spent in the construction of the borehole, rig up and down operations for replacing drilling equipment, in addition to preparing the drilling mud all under the framework of the so-called productive time or PT. Whereas a significant fragment of the time is used up on drilling problems, and actions intended to resolve these problems [3]. This is called non-productive time (NPT). Problems that occur during drilling can be avoided from time to time by selecting the appropriate equipment and implementing the drilling program in a literal manner, in addition to a quick and accurate solution to problems if they occur. [4]. Drilling is one of the most important things, composite and expensive operations in oil well industries. Although drilling budgets indicate roughly half of well costs, less than half of the entire drilling time is consumed in real drilling operations and the rest goes as NPT such as drilling operations difficulties, rig drive, equipment failure, drilling fluid circulation [5]. From development managing viewpoint, drilling process should continuously be on agenda and on low-priced. Existence of drilling problems lead to postponement frequently push drilling action overdue the schedule [6]. The incidence of NPT and imperceptible lost time not only reason for undervalued finances but also consequence in postponements of the hydrocarbon production [7]. It was revealed that NPT can be avoided by using and following an optimal drilling program that includes all the drilling process, including equipment and personnel [8]. The method for working with statistical data that organized comparatively fast as associated to manual preparation approaches, in order to estimate the NPT for each well and reduce it as much as possible [9]. The determination of their revision is to guarantee that a balanced budget is going to be attained, by means of forecasting the drilling time predictions as precisely as conceivable. It was noted that the causes of NPT are frequent and most related to drilling equipment for instance a similar NPT incidence can occur in drilling rigs working in proximity to each other, merely since the lesson learned has not been deliberated with the rig team(s) [10]. It should also be taken into account that the drilling stage is one of the most important and costly stages in the oil industry, adopting a suitable drilling fluid is also one of the most important factors in reducing NPT and preferably not harmful to the environment [11]. The drilling performance observing projected in this revision permits the right employment of the composed drilling data in a prearranged way. This study presents an analysis of the drilling time of 6 wells that were drilled in a field in southern Iraq, in order to benefit from its data and to identify the most important reasons that led to NPT. The time taken

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to complete the various activities was analyzed and how this affected the drilling performance. Investigated included actual drilling, casing drop, cement job, fluid loss, logging, drilling equipment repair, stuck pipes, top drive maintenance, and fishing.

2. Methodology

Non-productive time analysis has been shown to have many advantages in many industries. On the other hand, this concept is of great benefit to engineers in many fields, especially in petroleum engineering. To achieve the desired objectives, downtime data composed fromsix different rigs are repeatedly analyzed to find the origin reasons of unproductive time. For the large number of data and its diversity, a statistical program was used to facilitate the analysis and processing. Data were analyzed qualitatively and quantitatively using Excel, the statistical program (SPSS), and the Regression Model. Descriptive statistics were used to display the results tabulated in frequency scatterings, fractions, and diagrams. Regression analysis was used to establish the relationships between the independent variables (rig, pump, drilling fluid, geological challenges, equipment failure, cement and top drive) and non-productive time during drilling.

3. Regression Model

Equation (1) shows the most important factors that were used to find NPT.

$$NPT = \alpha + \beta 1EF + \beta 2\ C + \beta 3B + \beta 4TD + \beta 5C + \beta 6WC + \beta 7DF + \beta 8DM + \varepsilon \qquad (1)$$

Where: α and β are constants, ε represents an error term.

NPT = Non Productive Time

EF = Equipment Failure

C = Cement

B = Bit

TD = Top Drive

C = Casing

WC = Well Completion

DF = Drilling Fluid

DM = Decision Making

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Each well is drilled using a specific platform and equipment from different origins, in addition to the multiplicity of companies that drill those wells, all of which leads to some differences between the NPT values from one well to another. The developed statistical program was used to calculate the total NPT hours for each drilling rig for each process and then divide it by the total operating time using the equation2.

$$P = NPT / \text{Normal Operation Time} \quad (2)$$

where P: frequency of occurrence (probability) of an NPT.
Equation 3 was used to apply drilling time data for different activities.

$$T_i = (D_{rd} / D_{ad}) * t_i \quad (3)$$

Where:
D_{rd}: Drilled reference depth, D_{ad}: Actual drilled depth Ti= The planned number of working days for the first section, and ti = the actual number of days spent in the first section.
On the other hand, well problems are related to each other by evaluating well problems using the equation 4 of percentages of unproductive time.

$$WP_{NPT\text{-}Cont.\text{-}i} = [\sum_{R-1}^{R} NPT\ cont - i\_sp] / \sum_{R-1}^{R} NPT\ cont - i - ROP + 1] + \sum_{R-1}^{R} NPT\ cont - i\_Fn] + \sum_{R-1}^{R} NPT\ cont - i\_WS] + \sum_{R-1}^{R} NPT\ cont - i\_DF] + \sum_{R-1}^{R} NPT\ cont - i - EFn] * 100\% \quad (4)$$

Where: $WP_{NPT\text{-}Cont.\text{-}i}$ is the well problems nonproductive time percentages.

4. Results And Discussions

Knowing and anticipating problems before they occur reduces NPT to some extent. Oil and gas companies lose a lot of money because of NPT. On the other hand, risk and time management helps to make the NPT less than expected, it also makes use of well logs previously drilled (listen and learn). Six wells in southern Iraq were studied in detail in terms of the reasons that led to the occurrence of NPT as in Table (1). Figure (1) shows the time failure rate for five wells, and it is clear that equipment failure has NPT about 14% and then its repair had the largest share of the NPT by about 20%. This means that there is an urgent need for new quality

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equipment with high durability in normal and directed drilling. In other words, addressing Giant companies to supply wells with drilling equipment that has a high tolerance for well conditions

Figure (2) illustrates the accumulative Productive Time (PT) vs accumulative NPT Chart of five wells, about 11%, which is not a small percentage. This is due to many reasons, including a defect in the selection of equipment, as well as human errors, which include not implementing the program correctly. Reducing the need for chemicals and high-cost drilling fluids by reducing costs by relying on the integration of services in the field of drilling and preparing wells for production, and in the event that only the cost of renting the drilling tower is taken, there is a loss of about 135,000 dollars, except for the rent of the rest of the equipment and the cost of the crew.

Figure (3) shows the proposal time vs. NPT for five well, the most unsuccessful was well No. 3 with 20% NPT, while the best was well No. 4, where it was observed that there was a match between the planned time and what was implemented on the ground, meaning it can be considered as a typical well, where it gave 0 NPT. Drilling is validated whether well objectives were achieved in a time frame earlier than when intentional drilling was done without collaborating care.Drilling costs will mostly be reduced only if the drilling time is less than the intended program.

Figure (4) shows how the planned time matches the actual drilling time for well No. 4. And vice versa for well No. 6, where we notice a significant difference between the planned program and what has been implemented on the ground, as shown in Figure (5).

Figure (6) shows that the percentage of NPT is about 34%, it is considered a significant proportion and is very costly in terms of time and money, and most of this is due to poor selection of drilling rigs, and that most of them were used to drill previous wells. The most common drilling problems comprise pipe sticking, missing rotation, hole skew, pipe failure, well instability, mud contamination, formation damage, hole clean-up, H_2S bearing formation and shallow gas, and equipment and personnel problems as illustrated in Figure (7).

Based on Equation 2, the annual NPT (Includes well reclamation operations or work over operation) in all operations for the six wells is found, as in Fig.8, the largest percentage was for Well No. 6 and the lowest for Well No. 4.

Figure (9) shows the actual workdays for actual drilled depths including six wells. The problem of each well is illustrated in Figure (10). This does not mean that there are no other problems in

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each well, but the goal is to highlight the problem that had the largest proportion of the NPT. The problem of each well in terms of percentage of 6 wells is shown in Figure (11), depending on Equation 4.

Finally, Figure (12) shows the operation break down for the six wells, it's clear that the instruments repaired followed by the bad selection of bits gave the upper most NPT. Finally, the results show that the NPT for wells 1 and 2 was about 17%, for well 3 was 19%, for well 4 was 0%, for well 5 was about 6% and for well 6 was 41%.

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Table (1) Break time for each well in details.

Operation Breakdown	Bit	Mud Pump	Top Drive	Equipment Failure	Drilling Fluid	Drilling Equipment	Casing	Instrument Repair	Cement	Completion	Other	Stuck pipe	loses	fishing	Well service
Well 1 hr.	30	60	120	120	120	60	30	180	50	60	55	None	None	1	4.5
Well 2 hr.	30	70	120	120	120	60	30	180	50	60	22	None	2	3	7
Well 3 hr.	30	220	120	120	120	60	30	180	50	60	30	None	0.45	2	4
Well 4 hr.	0	10	0	0	30	0	80	0	0	60	2	None	none	none	1
Well 5 hr.	60	20	40	0	40	10	30	20	50	30	78	None	0.25	2	1
Well 6 hr.	624	144	24	168	72	96	48	96	48	48	122	1	4	3	12

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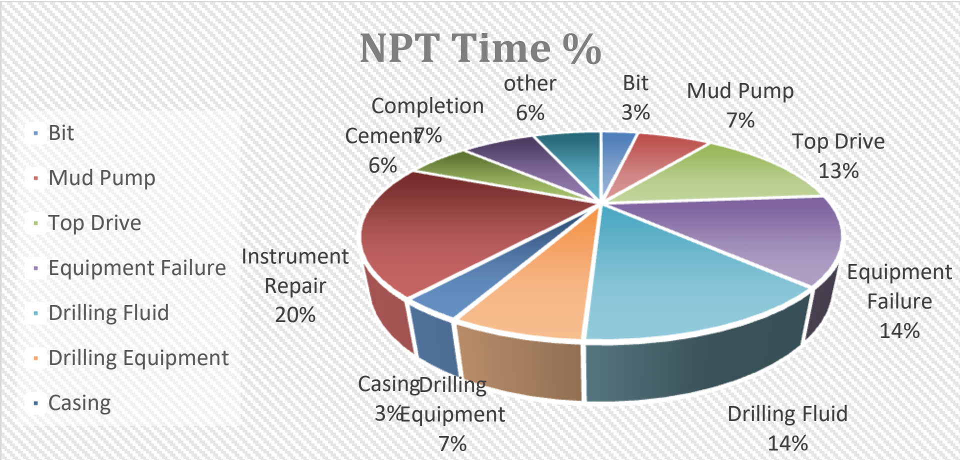

Fig. (1): Time Breakdown Percentage of five wells.

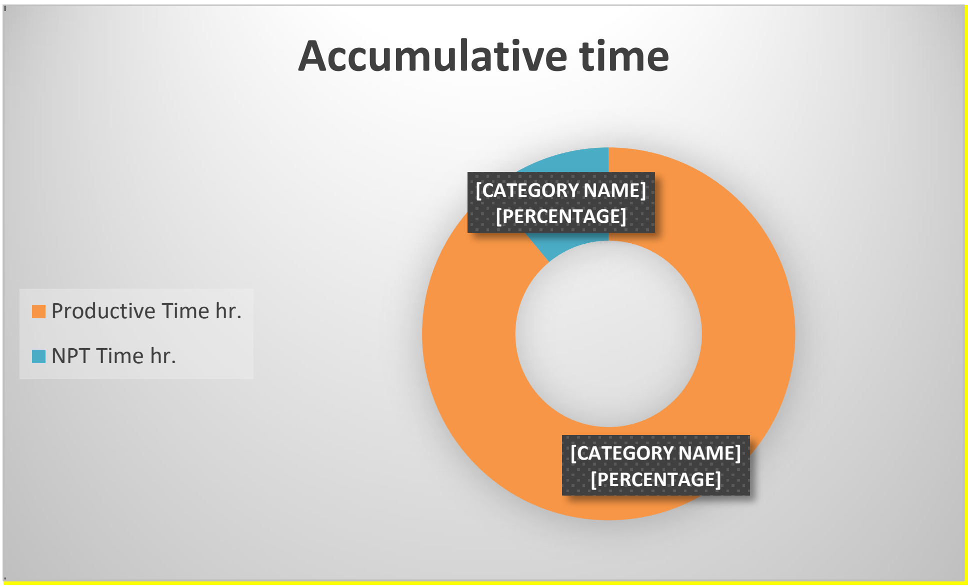

Fig. (2): Accumulative PT vs accumulative NPT Chart of five wells.

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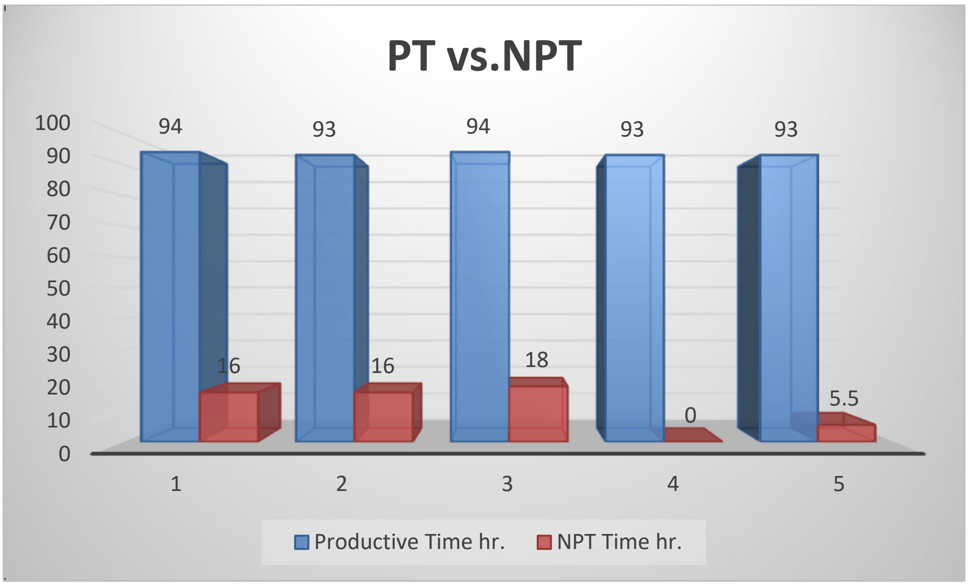

Fig. (3): Plane time vs. NPT for five well

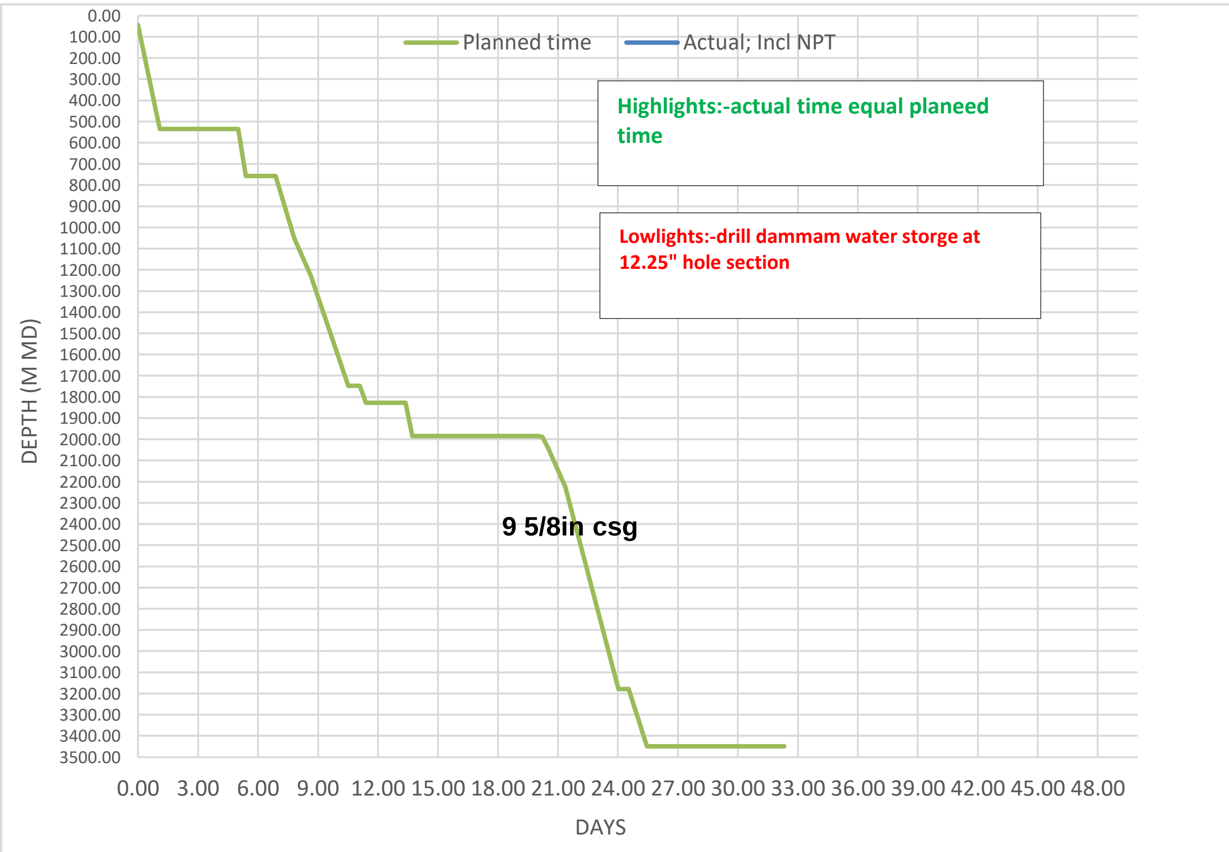

Fig. (4): Depth vs. Time (planned and actual) for well 4.

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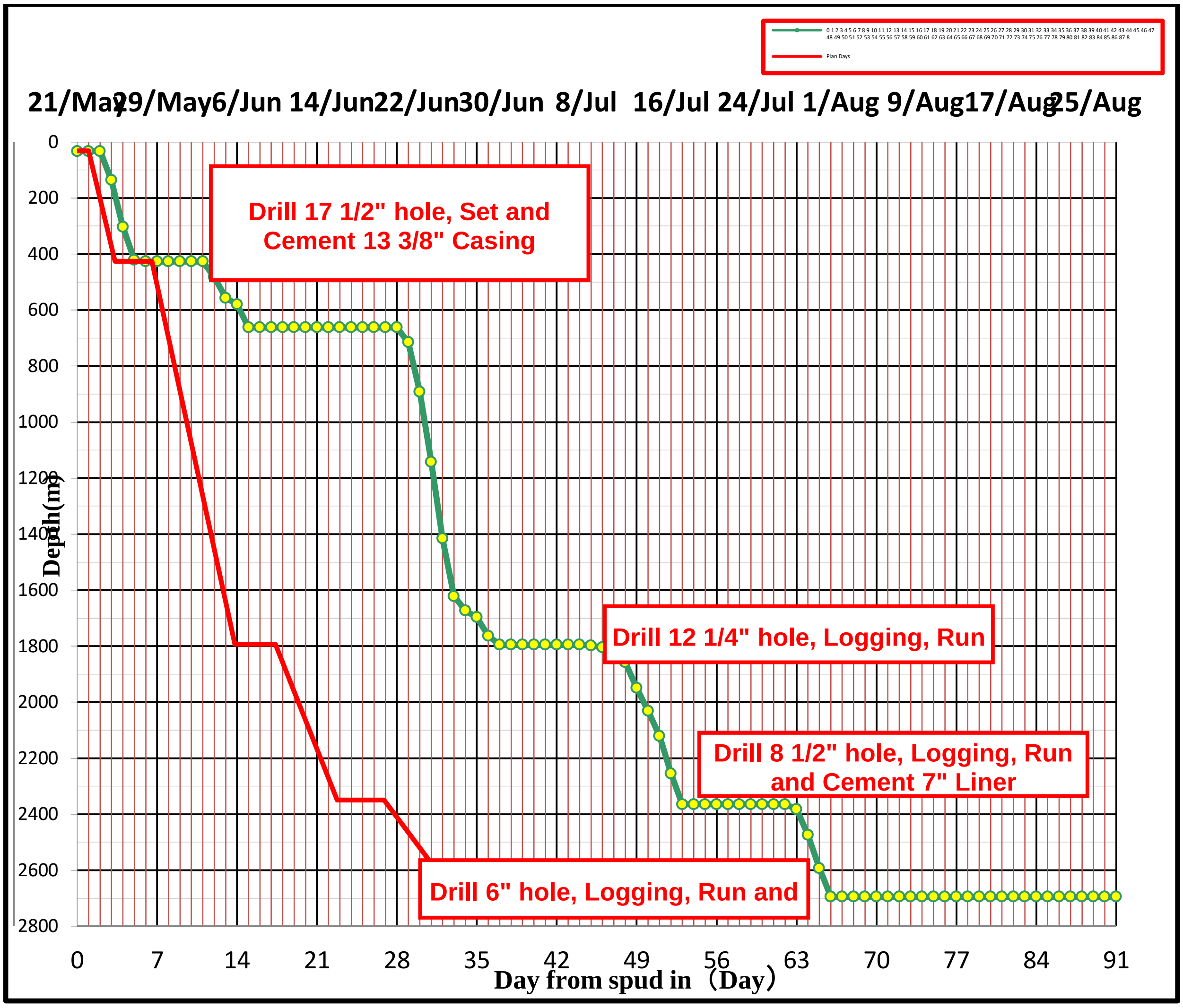

Fig. (5): Depth vs. Time (planned and actual) for well 6

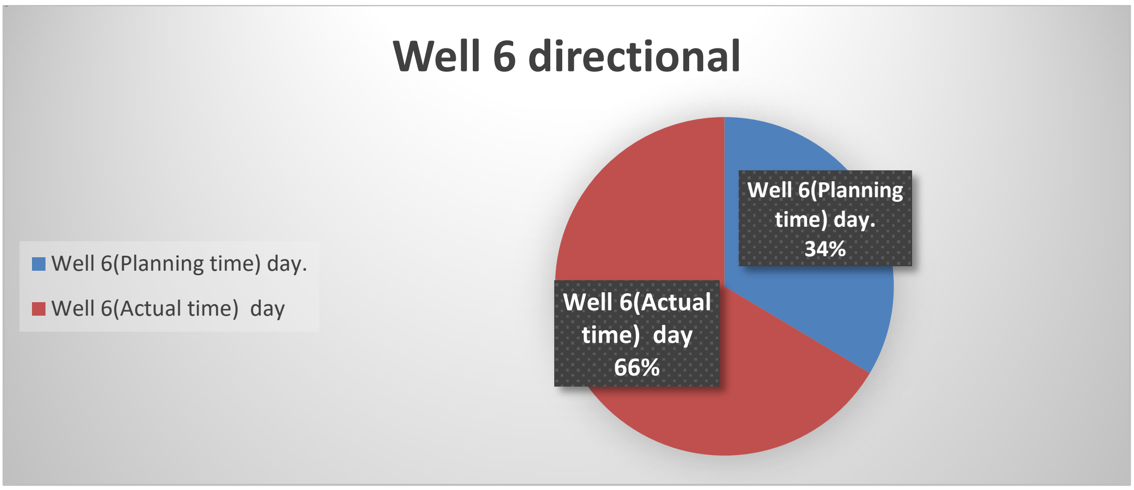

Fig. (6): Accumulative PT vs accumulative NPT Chart of well 6.

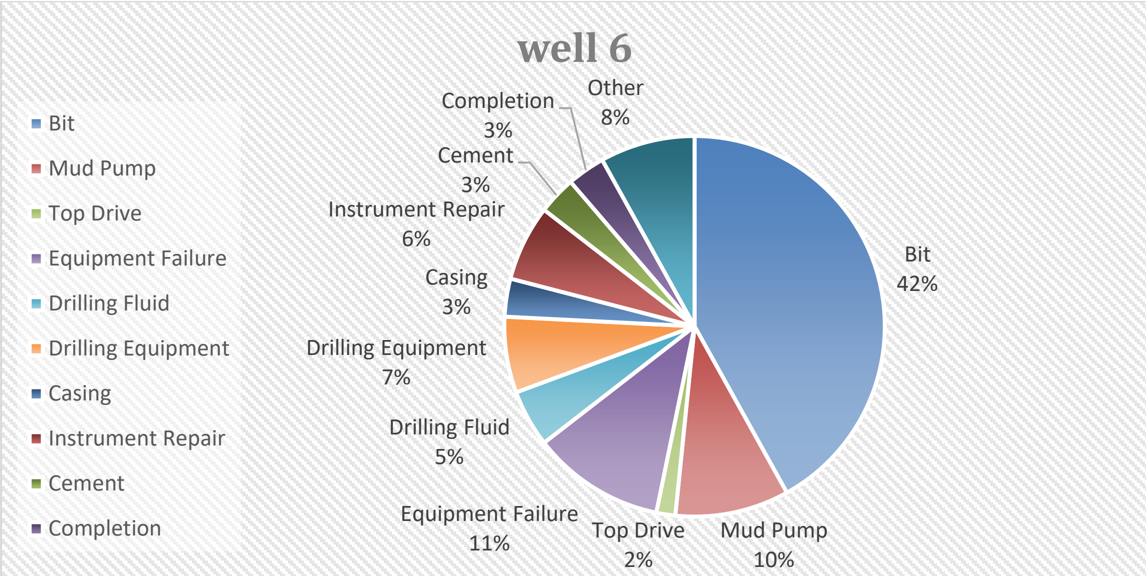

Fig. (7) Time Breakdown Percentage of well 6.

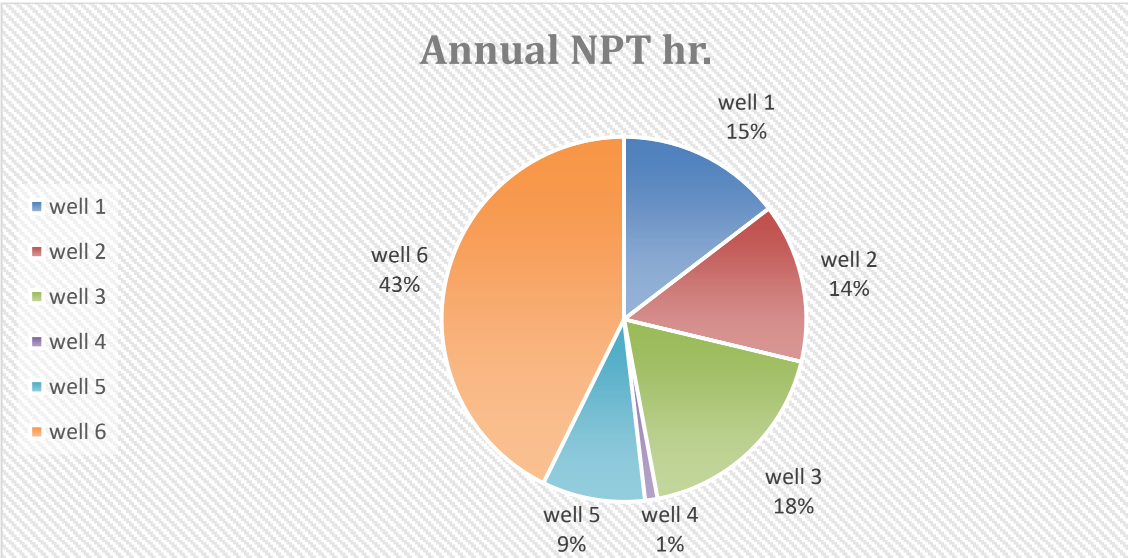

Fig. (8) Probability of the annual NPT in all operations for the six wells.

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Fig. (9): Actual workdays for actual drilled depths including six wells.

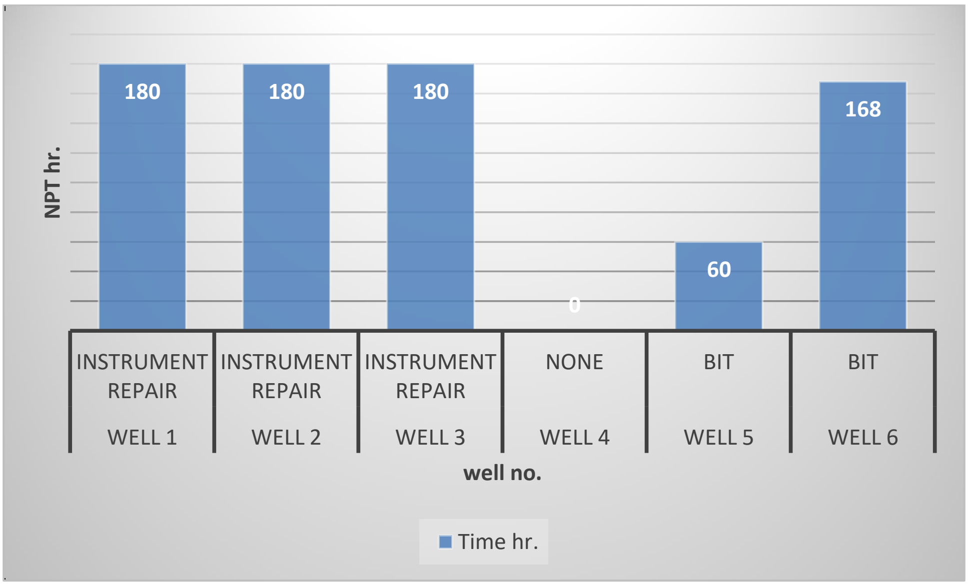

Fig. (10): The well problem in terms of hr. including six wells

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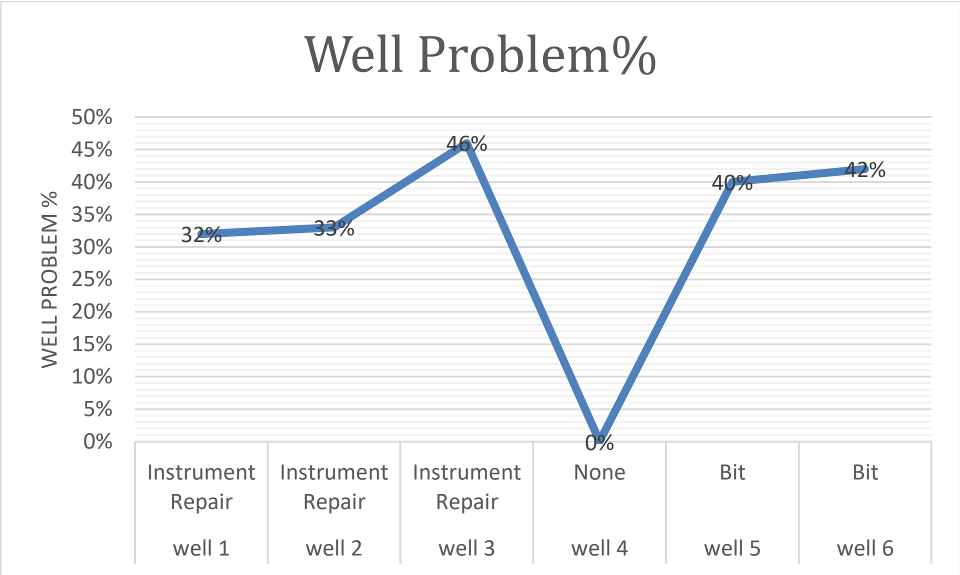

Fig. (11): The well problem in terms of percentage for 6 wells.

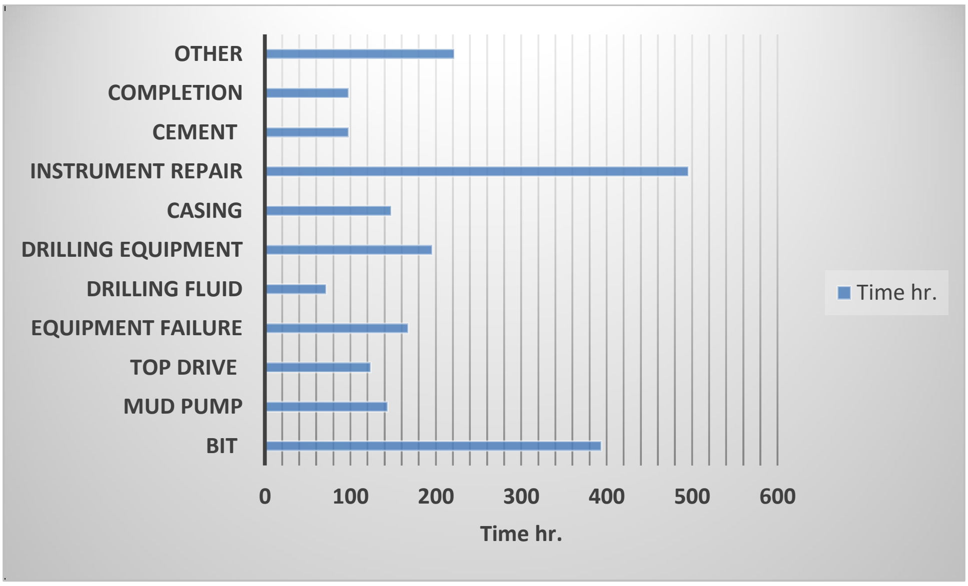

Fig. (12): The operation breakdown for six wells

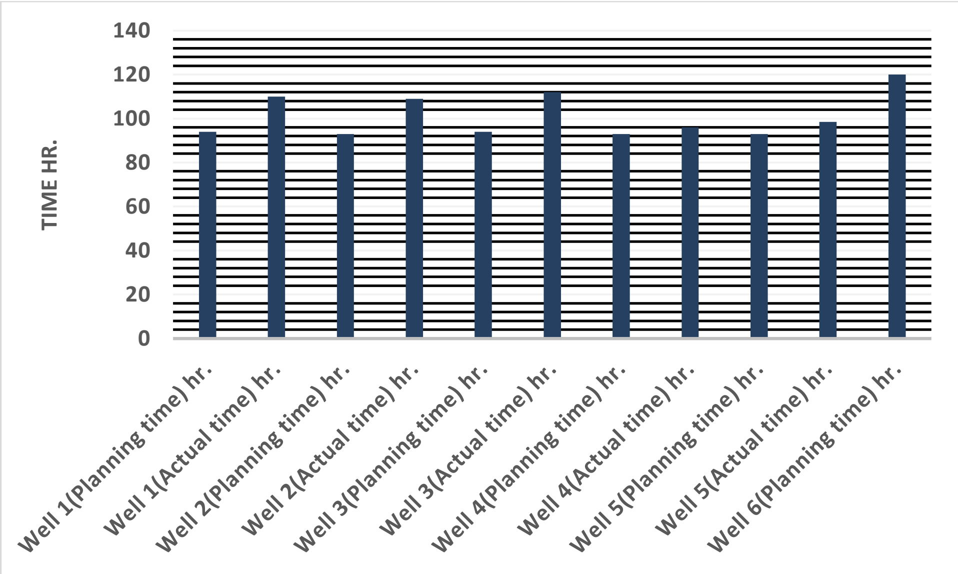

Fig. (13): The planning time vs. actual time for six wells

5. Conclusions

The main objective of this research is to find out the root causes of NPT and then find appropriate solutions to reduce NPT and as below:

1- Excavation problems must be taken into consideration during the planning process in order to minimize wasted time. The case study proved that there was a huge waste of time that occurred due to improper planning in addition to the use of bad and inappropriate equipment.
2- The planning program for drilling procedures can be derived based on drilling experience and equipment performance while drilling previous wells. In addition, attention to planning detailed procedures during each process and activity, and this can control the risk of wasting time during all stages of drilling.
3- Time consumed on actions for instance tripping for bit and BHA alteration and correspondingly reaming due to a pointed formation may be significantly reduced by using excellence bits' types. The consequences of this study exposed huge amount of NPT related with drilling operations for six well in south of Iraq.
4- It exhibited that the typical total NPT is 44%, while only56% of the entire drilling period is creative time. In drilling operations, it is possible to reduce the NPT, for example,

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when choosing the appropriate bit and the suitable equipment with high durability, and that will certainly lead us to reduce the NPT and unnecessary costs.

5- In order to have the most efficient time to operate any equipment or machinery, it is necessary to have a deep knowledge behind the causes of equipment failure and this certainly comes from the experience and competence of the company producing that equipment and tools to reduce NPT time to the nethermost level.

6- Depending on the results obtained, it was found that the NPT for wells 1 and 2 was about 17%, for well 3 it was 19%, for well 4 it was 0% and it is considered the lowest among the wells studied, for well 5 it was about 6% and for wells 6 it was 41% It is the largest of the wells that have been studied.

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