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EVALUATION OF NON PRODUCTIVE TIME OF GEOTHERMAL DRILLING OPERATIONS – CASE STUDY IN INDONESIA

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ABSTRACT

Cost overruns can easily manifest during well construction due to unexpected drilling problem issues including lost circulation and stuck pipe. Too often the best drilling practices used to address trouble zones are limited to a few conventional methods with a narrow range of effectiveness. In that purpose, the asset management drilling tools and techniques introduced in this study can be effectively deployed in the analysis of drilling performance. They help to detect new opportunities, quantify and address removable lost time and analyze the major problems in a comprehensively and structured manner. The aim of this paper is to evaluate the Non Productive Time occurred during drilling operation in a geothermal exploration well in Indonesia.

INTRODUCTION

Drilling engineering is divided into several specialties which described in Fig. 1

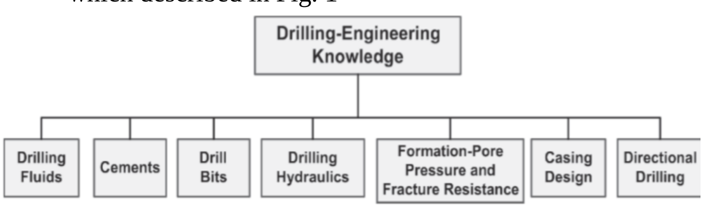

Figure 1: Basic Knowledge of Drilling Engineering (Bourgoyne, 1986)

Each part of the drilling knowledge is connected each other in the flow path of drilling design and operation.

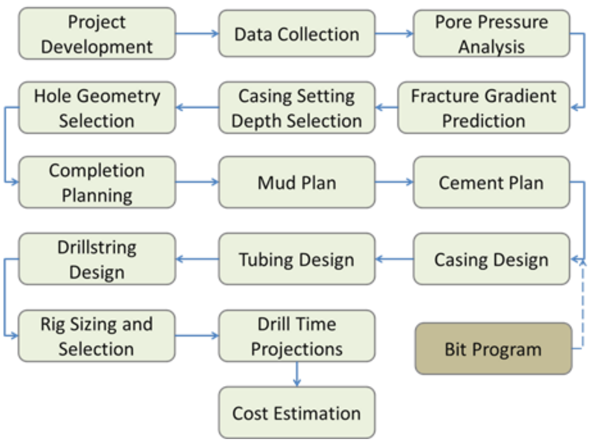

Figure 2: Flow path of drilling design and operation (Adams, 1985)

There are many factors and events that impact the time and cost to drill a well. Factors can be classified as either observable or unobservable (Kaiser, 2007). Measurable factors include the physical characteristics, geology, and drill parameters of the well, while indirect characteristics, such as operator experience and wellbore quality, will be represented by proxy variables. Factors such as well planning and execution, team communication, leadership, and project management skills will also impact drilling performance, but to capture and identify the influence of these variables is often beyond the scope of analysis. There is no way to identify all the relevant characteristics of drilling, but many factors can be identified and in practice it is necessary to identify only the set factors that describe the primary elements of the process.

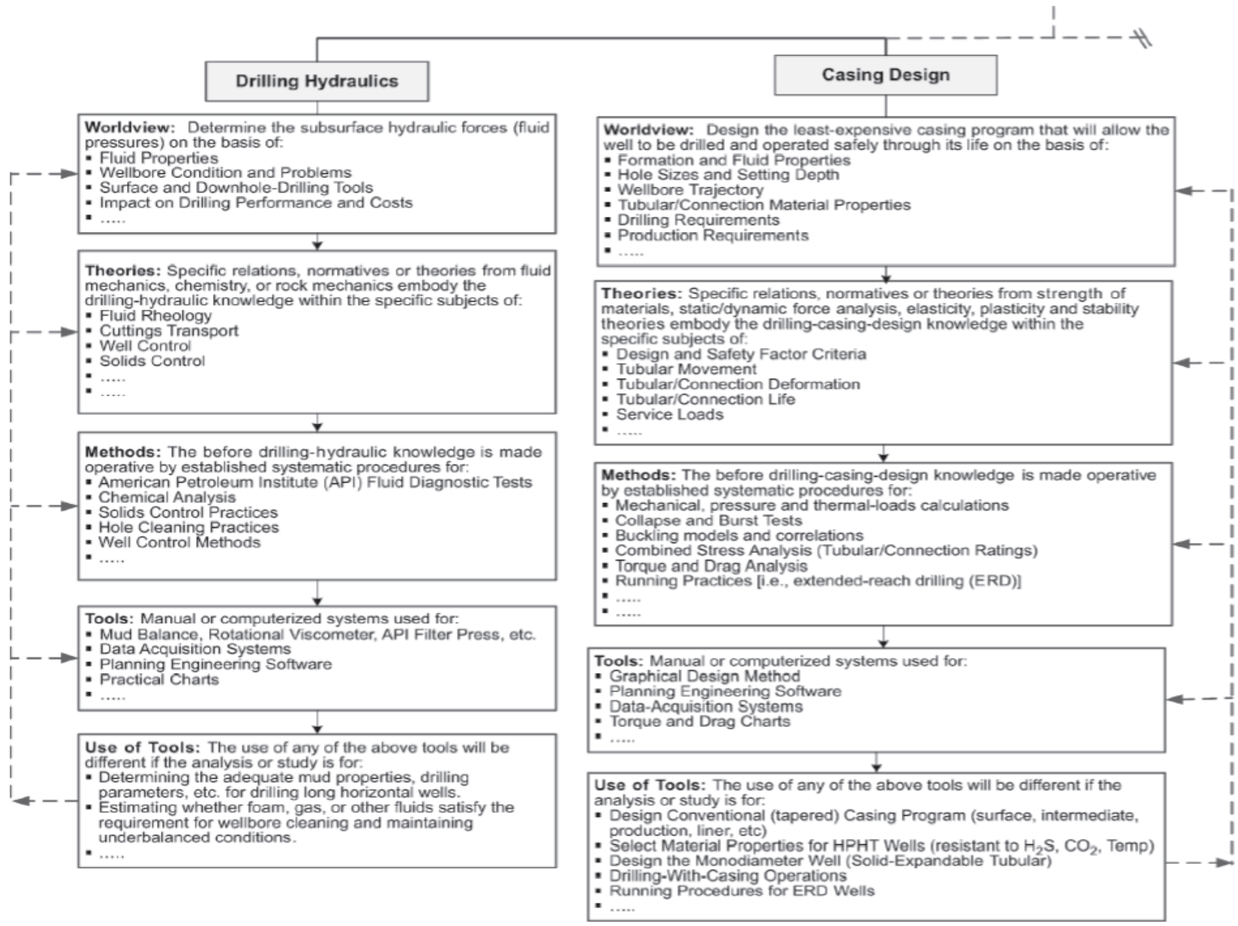

Figure 3: Description of the elements of methodology (Bourgoyne, 1986)

The factors that impact the time and cost to drill a well are (Lagreca, 2008):

Well Characteristics

A wellbore is a 3D tubular structure which can be described in geometric terms with respect to the length, diameter and curvature of the hole trajectory. The drilled interval (DI) is the difference between the total depth (TD) and the spud depth (SD), while the vertical interval (VI) is defined as the difference between the vertical depth (VD) and spud depth.

Well complexity

Complex well arise from a diverse set of factors, including the nature of the geological formation, the depth of the target, the trajectory of the wellbore, the experience of the contractor, and the technology applied. Well complexity is difficult to quantify and frequently ambiguous because practices, opinions, and experiences among drilling contractors vary dramatically.

Site Characteristics.

Primary well characteristics include geographic location, and environmental conditions. The region in which a well is located is important considerations in obtaining local government regulations and permits, port handling and transportation. The maturity of the infrastructure support services as measured, for example, by the knowledge and experience of the operator (as measured, say, by the number of wells drilled in the region in the past 5 years) will also play a role in determining drilling cost.

Operator preference

The operator decides not only where to drill, but also how to drill and the manner in which to execute the drilling operation. Rig selection depends upon technical factors such as the type of well being drilled, environmental criteria, and expected drilling depth.

Equipment selection involves tradeoffs that balance weather risk and the potential cost of delay.

Drilling characteristics

Different types and sizes of bits are used according to the hardness of formations, pressure regime, and drilling plan.

Formation Evaluation

Formation evaluation is critical step, because it is the stage in which information about the presence or absence of geothermal reservoirs is acquired. Time spent coring, logging, reaming, and testing is "flat" time, however, so for all other things equal, if a well requires more extensive formation evaluation, then its drilling performance metrics will not look as favorable if time is not allowed for this activity.

Historically, it is common practice for operators to rely on their well delivery personnel (i.e. foremen, drilling engineers and/or operations superintendents) to work with vendors to investigate and document tool and wellbore-related failures (Hubbard, 2010). In many cases, this type and level of support is appropriate and effective. However, investigations into high-impact Non-Productive Time events involving complex tools and operations typically require more time and effort than well delivery personnel can reasonably dedicate, given that this work has to compete with time necessary for well planning and real-time supervision activities. Without sufficient operator support and influence during failure investigations, tool vendors can (often by necessity) give less focus to failure investigations and risk mitigation efforts. This approach to failure investigations has resulted in fundamental issues (i.e. root causes) ot being identified and/or addressed, which in turn leads to additional tool failures and perpetuation of high levels of NPT and associated trouble cost. Therefore, it is in the best interest of operators and vendors to assign a high priority to failure investigation and risk mitigation work, dedicating the appropriate resources, establishing a fit-for-purpose infrastructure, and allowing the work to be an integral part of the well and tool/service delivery processes. The benefits to the operator are self-evident. The tangible benefits to the supplier come from the ability to demonstrate excellence in service provision to the operator, thereby strengthening the relationship. Through active support and involvement in failure investigations driving down NPT, suppliers are now able to demonstrate that they are competitive from a total cost perspective, including not only the direct cost of goods and services but also the indirect costs associated with NPT.

Technology

The impact of technology on drilling performance is pervasive but difficult to isolate (Kaiser, 2007). Technology may be "enabling" or "enhancing" or both and will normally shift from enabling to enhancing over time. New technology is expensive, but if the technology reduces drilling time or improves the efficiency or safety of the operation and becomes widely adopted, costs decline, and performance efficiencies will improve and become absorbed within process. Many examples of tradeoffs are well-known, but the impact of technology remains notoriously difficult to evaluate, even under carefully controlled field experiments.

Table 1: Procedural aspects in geothermal drilling planning

Before Drilling	While Drilling	After Drilling	Drilling Problems
These should be considered before drilling in geothermal field. 1. Fulfillment of drilling equipments 2. Certification of crew and equipments 3. Administration, permission, and socialization 4. Fulfillment of drilling requirements in area 5. Transportation 6. Equipments and rig transportation, rig preparation 7. Rig skid 8. Orientation of drilling area 9. Drilling program 10. Drilling technology 11. Fire Extinguishers 12. HSE bulletin	These should be considered while drilling in geothermal field. 1. Procedure of milling sidetrack 2. Spud in preparation 3. BHA 4. Slings utilization 5. Formation drilling 6. Monitoring drilling parameter 7. Pull out-in of drillstring 8. Circulation 9. Coring 10. Running conductor casing and liner 11. Running perforated liner 12. Liner adapter 13. Tieback installation 14. Pac-N-Pic Bridge Plug 15. Cementing conductor casing and liner 16. Cementing two stage 17. BOP stack 18. Diverting and evacuation 19. Logging 20. Running caliper log 21. XMRI FWS logging 22. Survey operation (Gyro Survey) 23. Downhole camera Operation 24. Logging GR, Resistivity, PTS	These should be considered after drilling in geothermal field. 1. Drilling reporting system 2. Daily report system 3. Rehabilitation of area 4. Wellhead installation 5. Changing master valve with packer 6. Valve installation 7. Waste management	These problems should be considered in drilling in geothermal field. 1. Lost circulation 2. Aerated mud drilling 3. Blind drilling with salt water 4. Measurement of loss circulation rate 5. Drilling with partial lost circulation 6. H_2S 7. Gas-fluid kick-steam kick 8. Stuck pipe 9. Wellbore stability

Table 2: Drilling aspects for time and cost evaluation

Drilling Phase	Drilling Activities Analysis
Conductor	Conductor
	Rig moving/skidding
	Spud in preparation
	Drilling-Milling
	Diverter
26”	P/U DP - BHA - RIH - Change mud - DOC - FIT/LOT
	Drilling
	Hole conditioning
	POOH
	Casing 20”
	Cementing, WOC, POOH, Lay down stinger
	Wellhead-BOP
17 1/2”	P/U DP - BHA - RIH - Change mud - DOC - FIT/LOT
	Drilling
	Coring operation
	Hole conditioning
	POOH
	Logging operation
	Casing13 3/8”
	Cementing, WOC, POOH, Lay down stinger
	Well Head - BOP
12 1/4”	P/U DP - BHA - RIH - Change mud - DOC - FIT/LOT
	Drilling
	Coring operation
	Hole conditioning
	POOH
	Logging operation
	Liner 10 3/4 ”
	Well Head – BOP
9 7/8”	P/U DP - BHA - RIH - Change mud - DOC - FIT/LOT
	Drilling
	Coring operation
	Hole conditioning
	POOH
	Logging operation
	Liner 8 5/8”
	Well Head – BOP
Completion	Preparation
	Well clean up
	Christmas tree-wellhead

FIELD CASE 1

Figure 4 shows a case study of exploration drilling time in Field X, Indonesia. The stuck pipe occurrence was major source of lost time. The pack off happened while drilling operation dominantly caused by inappropriate hole cleaning program, drilling equipment, personnel response. Further, fishing operation done to recover the lost parts of drillstring in hole. The stuck pipe and fishing operation to recover the string after stuck are major source of NPT in field X, therefore stuck pipe is explained in more detail in hole problems sub chapter previously.

The engineering aspects also have been analyzed for the likes of hole cleaning, equipments performance, drilling and completion process performance, problems and other events of drilling activities, to make better plan for the subsequent wells.

The primary focus on the drilling activity was the preparation and planning of drilling operation. The remote area issue couple to improper preparation and communication brings forth the access problems to transport the equipments and personnel. Besides, the improper estimation lead to lack of resources while drilling, cause another lost time. The equipments issue, related to availability, conditions and performance bring forth another lost time while drilling and completing the well. Majority of lost time have been analyzed through the procedures planning system. Proper planning and preparation are the main elements to solve the problems. The performance analysis have been incorporated to the procedures planning for the further well drilling operation, therefore the lost time occurrence risk will reduced.

Designing the well, particularly preparation in time, equipments and procedures is critical issue. Drilling and completion operation must be done properly according to the plan. By the proper planning, precise execution, and careful evaluation of drilling, the risk and operation error will be reduced. Minimizing the risk and operation error will reduce the NPT and reducing the NPT will decrease the non-productive cost significantly.

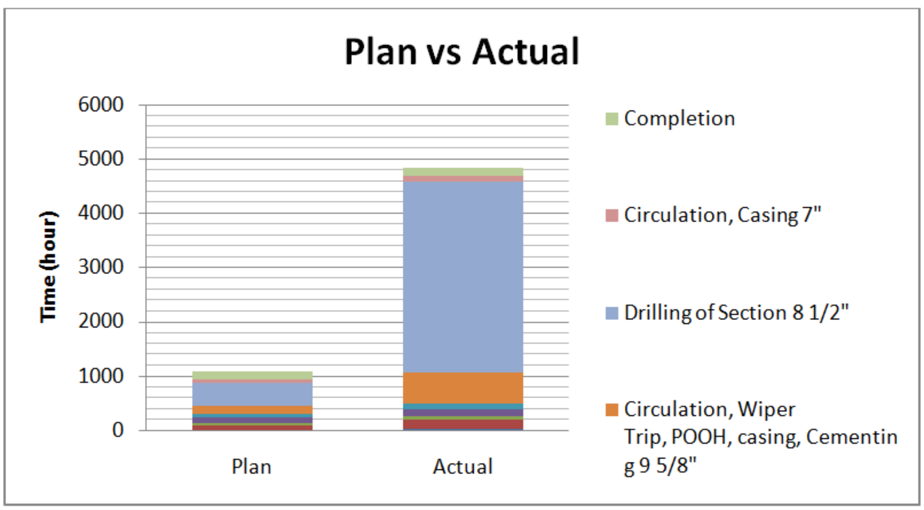

Figure 4: Plan and Actual Drilling Time of Field X

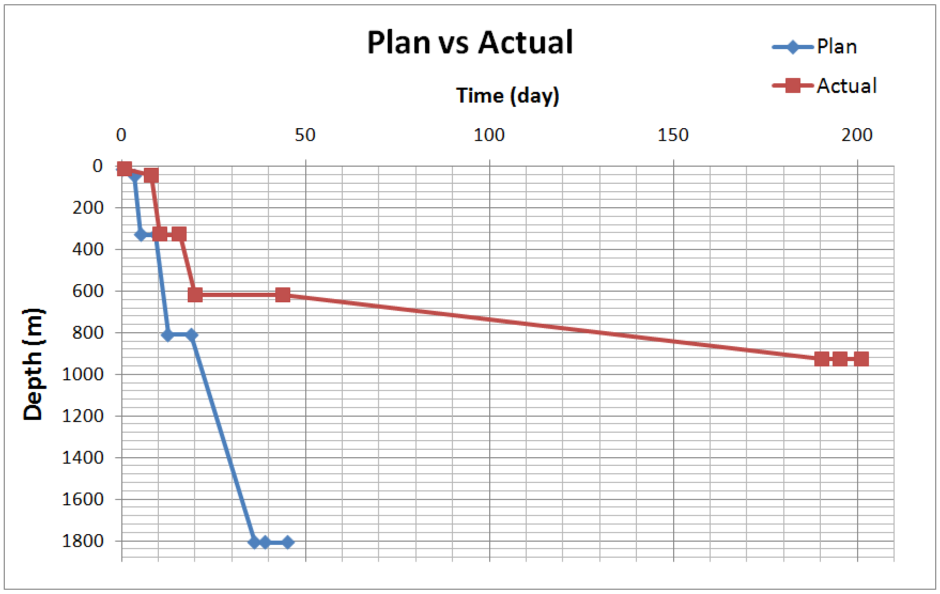

Figure 5: Time vs Depth Graph of Field X

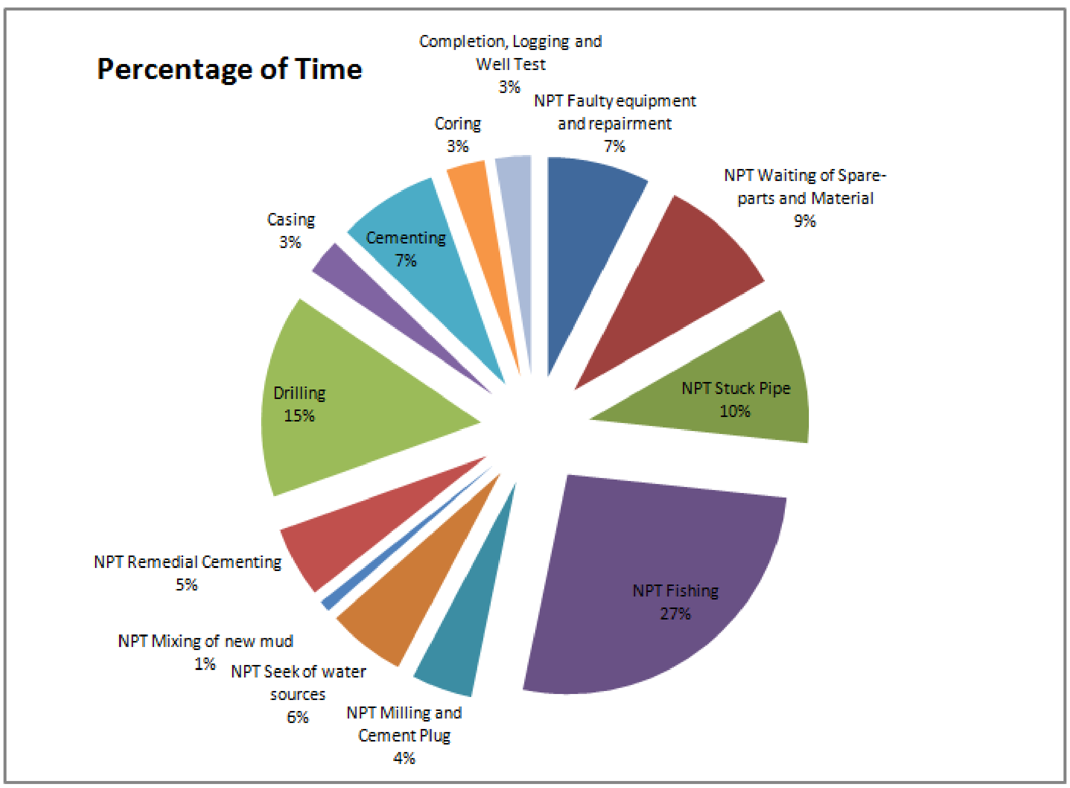

Figure 6: Time Breakdown Percentage of Filed X

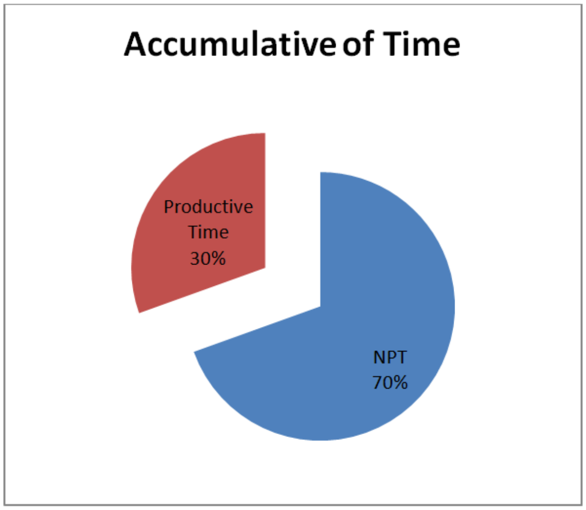

Figure 7: PT vs NPT Chart of Field X

CONCLUSION

The following conclusions can be derived based on the study:

1. The planning of drilling operation is critical phase to push down the technical limit in achieving the perfect well drilling time.
2. The drilling problems must be accounted in planning process to reduce the risk of lost time occurrence. The case study describe that the improper planning could lead to significant lost time.
3. Based on drilling experience and performance in several field, couple to research study of geothermal drilling, the planning program of drilling procedures could be derived. The detail procedures planning explain each of process and activity, therefore the risk of lost time could be pressed down since the beginning of drilling.

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