CHAPTER III
METHODOLOGY

3.1 Materials

3.1.1 Equipment

This research use a computer laptop model: Intel(R) Core(TM) i3-370M at CPU 2.4 GHz, RAM: 4 GB and 64-bit operating system to analyze torque and drag in three-dimensional well trajectory.

3.1.2 Software

The well description data were input to the developed software by the graphic user interface (GUI). The GUI is an engineering tool enabling the user to correct input data, as well as being an analysis tool for the output data from the software processing via MATLAB R2012a.

3.2 Research Procedures

3.2.1 Initiation Stage

3.2.1.1 Literature Reviews

Torque and drag models and drilling operation in well planning phase were investigated. A numerical method was also studied for analyzing T&D including MATLAB program.

3.2.1.2 T&D and Three-Dimensional Wellbore Equation

The operational modes that were valid on the drilling operation consist of rotating off the bottom (RoffB), rotating on the bottom (RonB), pulling out of the hole (POH), and running in the hole (RIH). A T&D equation can be applied to all types of well profile in 3D wellbore composing of vertical, build, hold (tangential), drop, and horizontal.

3.2.1.3 Numerical Method

A numerical method is one of the solving mathematical methods instead of solving analytically. In this research, the Euler method was applied to solve torque and drag equation in three-dimensional wellbore.

3.2.2 Preparation Stage

Feeding the well descriptions into the developed software and investigating of drilling parameters on torque and drag software were required. The profile of the well in each section, depth in, length (measured depth, MD), build up rate or drop off rate per 100 feet (inclination, Inc), and left or right turn rate per 100 feet (azimuth, Az), from top to bottom were put into the software. In addition, the description of the components of the drillstring from the bottom to the top for each item, the length of drillstring, nominal weight, outer diameter (OD), and inner diameter (ID) including bottom hole assembly (BHA), which were bit diameter, bit weight, and weight on bit (WOB), were also prepared together with a drilling fluid density as well as friction factor.

The bottom hole assembly (BHA) is fed into the software by average unit weight of whole the section (shown in Table A3)

3.2.3 Execution and Control Stage

3.2.3.1 Development of a User-Friendly Torque and Drag Software

The prototype of the software was planned to be a user-friendly via the GUI of MATLAB. The GUI can be designed the proficient way to be friendly to the user who can feed input parameters to the software easily. The designed interface of the software can be separated into input panels and output panels as shown in Figure 3.1. The input panels were fed by users and output panels will express the results from the software in a form of graphs and values. The drillstring information was compiled to be a database for the software. It is in MATLAB code that can be chosen from the input panel on the GUI.

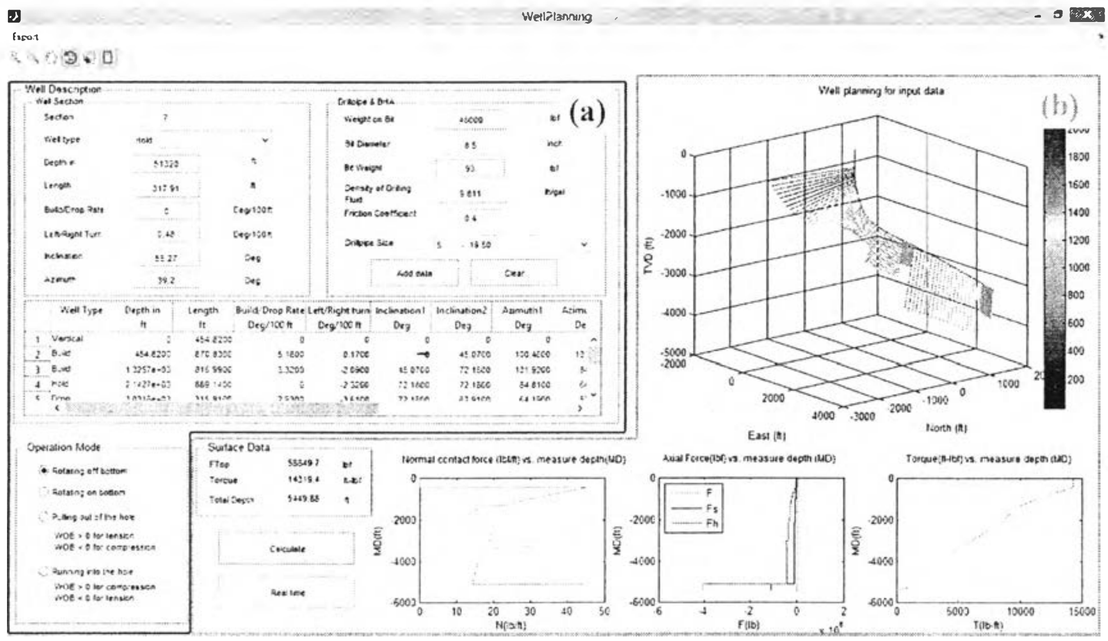

Figure 3.1 User-friendly software consists of (a) input panel and (b) output panel.

The sequences of solving torque and drag equations was managed. The input parameters were fed into the software and collected in the panel of well description. The calculation was systematized beginning with an alpha followed by a step size, measured depth, and well trajectory. These were calculated individually in each of well types. Then, the selection of the operation modes that indicated a behavior of the drillstring in the borehole, the torque and drag was solved by means of the selected well types because the well geometry was affected to the forces acting on the drillstring (Figure 3.2). The outputs of the software were presented in graphical form and the surface data of the axial force, torque, and total depth.

At this stage, the programmatic error that may occur in the sequences of the calculation was identified, even in the results shown in the GUI (graphs or values of the results). The next stage was to identify intensively on the torque and drag equations compared with actual field data.

3.2.3.2 Verification of the Software by Using Actual Field Data

The software was verified by actual field data obtained from the operator. The actual field data were well profile, definitive survey (shown in

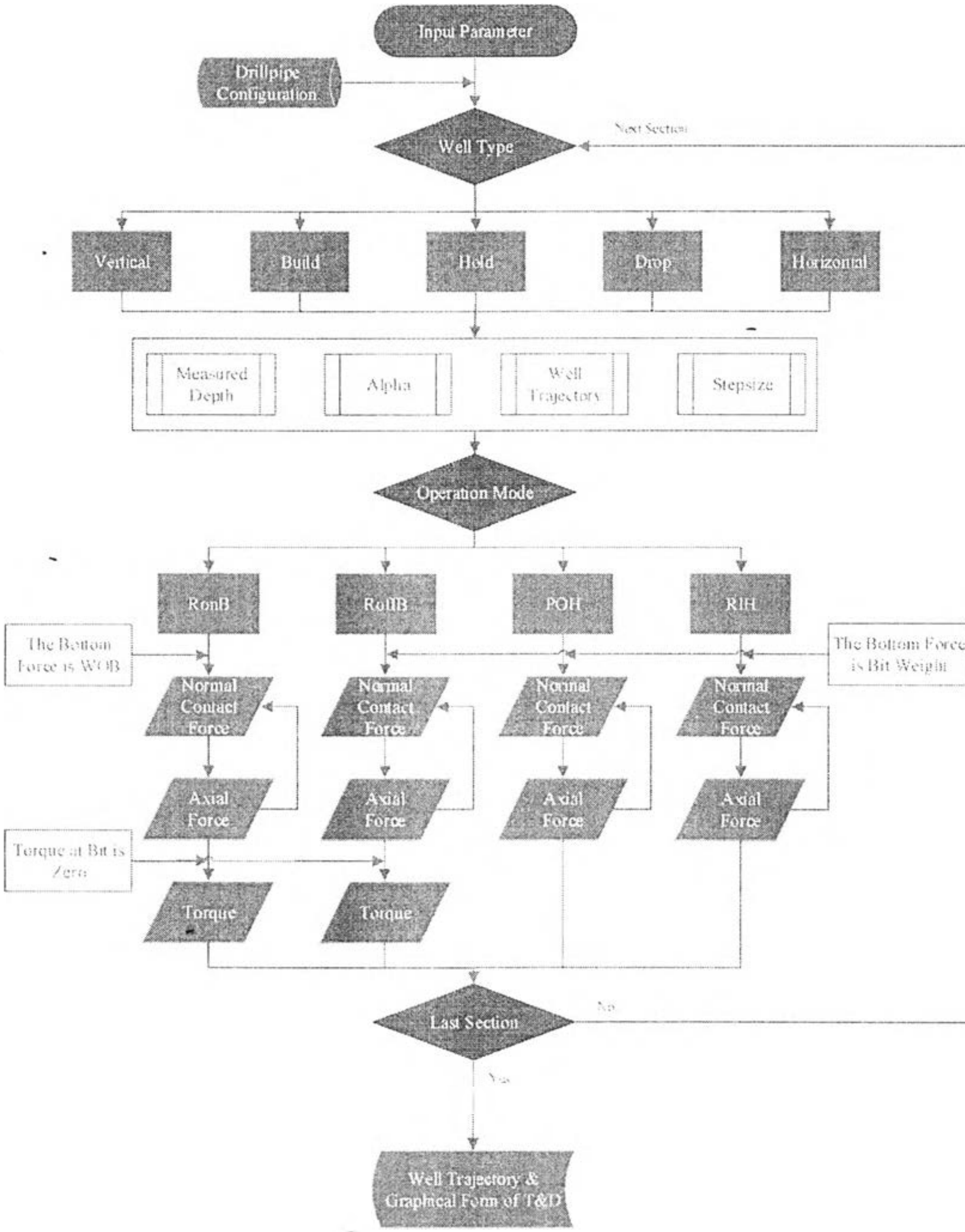

Figure 3.2 Flow chart of the user-friendly software starting from the operation modes followed by the well types, and then the torque and drag calculations.

Table A1), and drilling data, which were MD, TVD, WOB, hook load, torque,drilling fluid density, and BHA. The calculated axial force and torque was compared with the actual field data, and then the results was interpreted and corrected.

The actual field data were in the form of Ascii file type, which was called depth log documented every 0.25 meters only in drilling operation containing the drilling parameters mentioned above. The average of these drilling parameters was required because of the uncertainty of the measurement.

The average hookload was obtained by matching with the survey measured depth above and below that measured depth about 10 meters (shown in Table A2). The average torque was different from the hookload due to the depth log recording both the rotational drilling on bottom (RonB) and sliding operation, which was to drill with a mud motor rotating the bit downhole without rotating the drillstring from the surface, and then torque at the surface of the sliding operation will be zero. The average torque was obtained only in the zone of rotating (shown in Table A2). The average axial force was obtained only in the zone of the sliding operation.

3.2.4 Closing Stage

The software was revised and finalized for planning of the next well. The report was summarized.