A Dissertation Report

On

Evaluation of time and motion studies in Construction and Maintenance of surface facilities in Oil India Limited.

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CERTIFICATE

This is to certify that the dissertation report on **"Evaluation of time and motion studies in Construction and Maintenance of surface facilities in Oil India Limited"** submitted to University of Petroleum and Energy Studies Dehradun by Prankush M BujarBaruah in partial fulfilment of requirement of the award of degree of Masters of Business Administration (Oil and Gas) is a bonafide work carried out under my supervision and guidance.

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EXECUTIVE SUMMARY

The primary focus of this research work is reduction in down time in construction and maintenance activities of surface facilities in Oil India Limited by way of time and motion studies. The method employed in time and motion study was drawn from detailed literature review.

Reduction in downtime will help OIL to achieve a competitive advantage as this will directly lead to an increase in the production of oil and natural gas. The study has also identified the problems leading to increase in the downtime. The research seeks to eliminate these problems and with the various identified solutions.

The identified solutions have been applied in a pilot study to see if the identified solutions have led to a reduction in the downtime, subsequently leading to an increase in revenue and profits.

1. INTRODUCTION

1.1 Background of the study.

In recent times we have observed that the energy demands of India have increased multi fold. The demand for oil and gas which is the driving force behind India's economic resurgence is on the rising trend. Domestic production of crude oil and natural gas has not increased to the tune that is expected off, and maximum of country's oil and gas requirement is being meet through imports, which accounts for 80p.c of the requirement. A staggering amount of 109 MMT of crude oil was imported by India in 2014-2015.The Narendra Modi government wants local crude production to rise quickly so that the country's import dependence can be slashed by 10% by 2022, but ageing fields, limited exploration activity and low oil prices are becoming a hurdle.

The primary requirement of crude oil and natural gas in India is being meet by state owned companies, ONGC and Oil India Limited and in the private sector it is by Cains India Limited which is operating in the Rajasthan fields.

As per vision 2022 where 10 p.c. increase in domestic production is required the primary requirement is stepping up of production of crude oil and gas from the brown fields and with the discovery of new fields.

Augmenting the increase in production requires excellent reservoir management for sub surface areas, and also a tremendous increase in efficiency in the surface facilities management. This shall require induction of new technology and also improving the present work practices by way of benchmarking or system improvements.

Oil India Limited a state owned company is primarily operating in the upper Assam sedimentary basins and has been known to maintain a steady level of growth in all its brown fields and also with some new discoveries in the past five years or so. However, with the new environment of globalisation and liberalization in India the state owned companies are expected to be highly competitive to meet the global challenges.

The steady production level of crude oil and natural gas has been possible with good maintenance and construction practices of the surface facilities, coupled with reservoir management. However, there are scope to improve further to increase the efficiency of the process. An increase in efficiency will definitely give OIL a competitive edge, and to realise its organisational objectives.

It is against this background that an analysis of the construction of surface facilities will be taken up to reduce the downtime and subsequently a reduction of cost.

The Oil and Gas Pipeline and Projects Department of OIL is primarily responsible for construction and maintenance of pipelines of all categories right from well flow lines, crude oil dispatch pipelines, gas distribution and injection pipelines to water injection and disposal pipelines. Besides the construction of these pipelines the department also is responsible for installation of indirect bath type heaters, crude oil dispatch and water disposal pumps, emulsion treaters and certain in plant piping works inside the oil collection stations for operational purposes.

The Department has a lot of scope for improvement of efficiency in construction of these surface facilities, reduction of downtime which is the unproductive time, also to have a time and motion study. A **time and motion study** (or **time-motion study**) is a business efficiency technique combining the **Time Study** work of Frederick Winslow Taylor with the **Motion Study** work of Frank and Lillian Gilbert.

The construction of the well flow pipelines is of utmost importance in the creation of surface facilities. 70 p.c of the constructional activities of the Department are concentrated on flow pipelines. Hence this research is concentrated on the time and motion study of the flow pipelines.

1.2 Purpose of the study

The main purpose of the study is to examine all the factors that can lead to an increase in the downtime with subsequent cost overrun in the construction activities of surface facilities like oil and gas pipelines. Against these the researcher shall attempt to reduce the downtime with

a reduction of cost by way of implementing practices which will be evolved out of the study.

The main objective of this paper is to analyse the determinants that will have an effect on the downtime reduction. For this the present practices shall be studied thoroughly.

2. LITERATURE REVIEW

2.1 Introduction to Time and Motion study

A **time and motion study** (or **time-motion study**) is a businessefficiency technique combining the Time Study work of Frederick Winslow Taylor with the Motion Study work of Frank and Lillian Gilbreth . It is a major part of scientific management (Taylorism). After its first introduction, time study developed in the direction of establishing standard times, while motion study evolved into a technique for improving work methods. The two techniques became integrated and refined into a widely accepted method applicable to the improvement and upgrading of work systems. This integrated approach to work system improvement is known as methods engineering and it is applied today to industrial as well as service organizations. Time study is defined as "a work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to allow adequate time for such items as foreign elements, unavoidable or machine delays, rest to overcome fatigue, and personal needs." Taylor liaised with factory managers and from the success of these discussions wrote several papers proposing the use of wage-contingent performance standards based on scientific time study. At its most basic level time studies involved breaking down each job into component parts, timing each part and rearranging the parts into the most efficient method of working. By counting and calculating, Taylor wanted to transform management, which was essentially an oral tradition, into a set of calculated and written techniques.

The time study analysis required to dividing the worker's task into simple basic movements, removing the useless movements, identifying and

timing the quickest motion paths and types and using the time taken to perform these activities as the standard time for completing the tasks.

According to Fred E. Mayers (1992), time study was developed by Frederick W. Taylor in about 1880 which he is the first person to use a stopwatch to study and measure work content with his purpose to define "a fair day's work." He called as Father of Time Study.
Among his study is 'Taylor Shovelling Experiment' which he studied between 400and 600 men that using his own shovel from home to moving material from mountains of coal, coke and iron ore in around two mile-long yards. Taylor identify that there have different size of shovels and he wondered which shovel was the most efficient. Thus, he used a stopwatch and measured everything that workers did. He recorded the data for every working various ways with varied of shovels size, durations to done their work, number of breaks and work hours. The results were fantastic which it reduced time, saving numbers of workers and budgeting for every year.

A **motion study** is a tool used in scientific management where you examine the minimum types and numbers of motions required to perform a work task. Elimination of unnecessary motions from the task increases productivity rather than speeding up the process

Frank and Lillian Gilbrethwasa married couple and were significant contributors to scientific management. They developed motions studies. They called each separate part of a motion a **therblig. Therbligs** are 17 kinds of elemental motions used in the study of motion economy in the workplace. The following are the therbligs:

SNo	Therblig	Symbol	Colour	Definition
1	Grasp	G	Lake red	Begins when hand or body member touches an object for holding. Consists of gaining control of an object. Ends when control is gained
2	Position	P	Blue	Begins when hand or body member causes part to begin

				to line up or located or orient. Consists of hand or body member causing part to line up, orient, or change position. Ends when body member has part lined up.
3	Preposition	 PP	Pale blue	Same as position, except used when line-up is previous to use of part or tool in another place.
4	Use	U U	Purple	Begins when hand or body member actually begins to manipulate tool or control. Consists of applying tool or manipulating control. Ends when hand or body member ceases manipulating tool or control.
5	Assemble	# A	Dark violet	Begins when the hand or body member causes parts to begin to go together. Consists of actual assembly of parts of putting together. Ends when hand or body member has caused parts to go together.
6	Disassemble	 DA	Light violet	Begins when body member causes integral parts to separate. Consists of taking object apart. Ends when body member has caused complete separation
7	Release load	RL	Carmine red	Begins when body member begins to relax control of object. Consists of letting go of an object. Ends when body member has lost contact with object
8	Transport empty	TE	Olive green	Begins when body member begins to move without load. Consists of reaching for something. Ends when body member touches part or stops moving

9	Transport loaded	 TL	Grass green	Begins when body member begins to move with an object. Consists of body member's changing location of an object. Ends when body member carrying object arrives at general destination or movement ceases.
10	Search	 SH	Black	Begins when body member searches for part. Consists of attempting to find an object. Ends when body member has found location of object
11	Select	→ ST	Light gray	Begins when body member touches several objects. Consists of locating an individual object from a group. Ends when body member has located an individual object
12	Hold	 H	Gold ochre	Begins when movement of part of object, which body member has under control, ceases. Consists of holding an object in a fixed position and location. Ends with any movement.
13	Unavoidable delay	 UD	Yellow Ochre	Begins when hand or body member is idle. Consists of a delay for other body member or machine when delay is part of method. Ends when body member begins any work.
14	Avoidable delay	 AD	Lemon yellow	Begins when body member deviates from standard method. Consists of some movement or idleness. Ends when body member returns to standard position
15	Rest for overcoming fatigue	 R	Orange	Begins when body member is idle. Consists of idleness necessary to overcome fatigue from previous work.

				Ends when body member work again.
16	Plan	 PM	Brown	Begins when body members are idle while worker decides on course of action. Consists of determining a course of action. Ends when course of action is determined.
17	Inspect	O I	Burnt ochre	Begins when body member begins to feel or view an object. Consists of determining a quality of an object. Ends when body member has stopped to see an object

Effective	**Ineffective**
Reach	Hold
Move	Rest
Grasp	Position
Release Load	Search
Use	Select
Assemble	Plan
Disassemble	Unavoidable Delay
Pre-Position	Avoidable Delay
	Inspect

According to Ralpha M. Barnes (2001) Frank and Lillian M. Gilbreth are known as the parents of motion study. Gilbreth begin investigation to find the "best way" of performing a given task trough analysing the motions used by his workmen and he easily saw how to make improvements.He also possessed for analysing work motion situationsto enhance their ability for shorter or less fatiguing motions to improve the work environment. The research includedthe elimination of all useless motions and the reduction of those remaining motions. The elimination of this unwantedwaste known as work simplification.According Fred (1992), Elton Mayo started their research known as the humanrelations movement and he discovered that people work better when their attitude is better. He undertook a researchproject to study what factors

affected productivity in the Hawthorneplant. Their studied took place between 1924 and1933.

Motion study is for cost reduction and time study is done for cost control. Thus we can say that motion study is the design and time study is the measurement.

2.2 Techniques of Motion and Time Study

Motion study has the greatest potential for savings. We can by eliminating the task or combining the task with some task. We can rearrange the elements of work to reduce the work content and we can simplify the operation by moving part. Thus, among the techniques for motion study are

(I) Process charts

(ii) Flow diagrams

(iii) Operation charts

(iv) Flow process charts

(v) Multiple activity charts

Gilbreths used flow diagrams to show movement of product around an entire plant because they gave an accurate geographical picture of the entire process. They also develop methods study techniques such as cyclograph, chronocyclo graphs, movie cameras, etc. The techniques of time study start with the last motion technique and it shows the close relationship between motion study and times study. The techniques of time study are:

(i) Stopwatch time study
(ii) Expert opinion standards
(iii) Predetermined time standards
(iv) Work sampling time standards

Frederick W. Taylor used a stopwatch and a clipboard to record the time and findings of his study (Foster, 2003). Motion and Time study technique

can be used widely for variety of research. For example, Ann Hendrich, Marilyn Chow, Boguslaw A. Skierczynski, Zhenqiang Lu (2008) used this techniques to study spend time of nurse at hospital.L. Aharonson Daniel(1996) used time studies in A&E department. While, Jeffrey S. Smith (2003) survey that many production and manufacturing used simulation as alternative way to develop new effective system.

2.3 Relationship and Utilization of Motion and Time Study

Motion and time study helps management determine how much is produced by workers in a specific period of time, therefore making it easier to predict work schedules and output. Motion and Time Study is a scientific method designed by two different people for the same purpose, to increase productivity and reduce time. The two methods evaluate work and try to find ways to improve processes. Frank B. Gilbreth invented motion study designed to determine the best way to complete a job. Frederick W. Taylor designed Time Study; it measures how long it takes a worker to complete a task. Time and Motion Study has become a necessary tool for businesses to be successful today. Time and Motion Study is very important in production control. Now, Offices, Banks, Department Stores, and Hospitals use Motion and Time Study. Offices use it to measure and simplify work in order to reduce costs

2.4 Literature Review in Brief

Sl. No.	Topic	Author
1	Kinnarps White Paper Beyond Time & Motion: work environments for the 21st Century	Professor Jeremy Myerson
2	Time & MotionStudy Siemens Modular Metering System, Power Mod™ November 2009	John Chiang, PE Senior Engineer Phil Waier, PE Principal Engineer Tim Duggan Senior Project Director Laura Dempsey Senior Peter Nightingale Project Manager

3	Motion and Time Study (1994).	Marvin E. Mundeland David L. Danner
4	Work Measurement and Method Improvement (2001).	Lawrence S. Aft
5	Manufacture and Marketing of Motion Study, 1908	Frank and Lillian Gibreth

3. RESEARCH METHODOLOGY.

Research comprises defining and redefining problems, formulating hypothesis of suggested solution; collecting, organizing and evaluating data; making deductions and reaching conclusions to determine whether they fit the formulating hypothesis.The system of collecting data for research projects is known as research methodology. The data may be collected for either theoretical or practical research.

There are several methods that can be use to achieve research objectives. After the literature review, observation and collecting data is needed. The complete field data collection will be tested before it will be used for data analysis. The problems and non-productive in the work process can be identified based on the data collection and their analysis. Then, the result from the data testing will be determined whether the result can be used or not and if there are any incomplete data, the data collection will be executed again until it fulfils the objective requirement. After all the data and analysis are complete, proposal and opinion will be issued.

3.1Research Design

This research was conducted through field study. Field study as a method of research is made from direct observations towards the live study situations. Researcher collected data by observing and recorded the research subject during the observation.

The nature of the research shall be exploratory, and uses case analysis, where a comprehensive study of one of a few specific situations is dealt

with. This situation is called the case. The design of the research project here is a plan that ties the data to the conclusion that will be drawn. The method is used to find out the differences and similarities so as to find out the answers, and is used to enhance the understanding to undertake further research.

3.2Problem Statement

How to implement time and motion study in pipeline construction for cost reduction and to avoid production losses.

3.3Variables

The variables in this study can be classified into two types, which are independent (time and motion technique) and dependent variable (an impact in the work process for laying of flow lines). The research used time and motion technique to study on improving the work process, thereby reducing the down time and increasing of work process efficiency depending on the time and motion technique.

3.4 Basic Procedure for Research

There are four steps to complete this study. There are given below according to their sequence:

(i) Select: Select the process or job to be studied. Here in our case it's the construction of a 100mm NB well flow line from a producing well to the respective oil collecting station.

(ii) Record: Observe and record all the relevant facts related to the work process.

(iii) Examine: examine each recorded fact critically

(iv) Develop: develop the most efficient work process.

3.5 Data Collection

This research requires to collect data that are related to the time during the working process, the movement ordistance for each process and

the number of jobs that they can be produced in specific time, which was collected based onseveral methods:

(i) Systematic Observation
(ii) Stopwatch Time study
(iii) Standard Operating Procedures.

Data collection is done to determine the data required for building the process design. The data collected can explain how the process operates, when, where and how the activities takes place. The data that was included are

- flow chart for the process
- the detail operation for each process
- production time
- layout
- the motion from one process to another process

3.6 Systematic Observation

Systematic observation means researcher are required to observe the whole work process in the construction of surface facilities, then select and focus on which process or job that is required to be studied. Based on the observation, it is required to record everything that happens in each process from the start to finish.

3.7 Stopwatch Time Study

Stopwatch time study is the work measurement to determine the baseline for future improvement. It is also used to analyse a specific process by qualified workers in an effort to find the most efficient ways in terms of time. Moreover, this method measures the time necessary for a work process to be completed using the best ways. Also stopwatch technique is suitable for this research because it can develop accurate data. This allows the element times to be entered directly on the time study sheet.

3.8 Process Chart

Process chart is used to show facts as handling, inspection, operations, storage and delays that occur in the work process, where it was happened when the process moves from one process to another process until it finished. Each fact can be represented by symbols, where it is used to describe the process steps

3.9 Data Analysis

After all data is collected, the next step is analysing the data thoroughly for each work process. Analysing databased on systematic observation and the process chart, which recorded all the relevant facts about the work process. Examine each recorded fact critically and in this process we can detect which part are non-productive and take a long time in the work process.

4. DATA ANALYSIS AND INTERPRETRATION

4.1 Work Process for construction of a 100 mm NB well flow pipeline.

Based on systematic observation, we know that there are five main work processes in the construction of flow pipelines. Each work process included minor process. The process started with the issue of materials i.e. pipes and pipe fittings, transportation of materials to the construction site, construction of the pipeline, testing of the pipeline, and commissioning of the pipeline.

4.2 Work Process Operations

Each of the work has several sub work process. The process of issue of material has two sub process, the process of transportation of material to site has two sub process, construction of the pipeline has five sub process, testing of the pipeline has two sub process and commissioning has one process only.

4.3 Production Time

For the purpose of study, the researcher had taken observations from two flow pipelines one was for well HYB in the Makum area and the other was for well DGY in Balimara area. Both the flow pipelines were of 1 km in length. These two pipelines were chosen as the external conditions were relatively free of encumbrance, in the form of land issues and environmental clearance issues.So the only way of varying the output is through the better work efficiency methods. The standard crew that was available for the construction of such flow line has one supervisor.One fitter, two welders, 5 helpers. The purpose here is to study the required time right from start to finish to accomplish the job.The time data was taken and recorded in the process charts. This recorded data is required for future improvement. Based on the data it was observed that the flow pipeline was completed in 9 days with an average work of 10 hours a day in both the cases of HYB and 13 days in DGY.

For a one kilometre pipeline this time is pretty huge as the well is ready for production. This delay is directly adding up to the production loss. Also a flow line can be constructed only once its proven that the well is producing fluid. OIL management is of the opinion that the work of laying a 1 km flow pipeline should not take more than 4 days.

The following observations/ motion studies were seen in the different process:

First the issue of materials. The pipe storage yards are all scattered in and around 1 km periphery of the main office. The concerned Departmental Engineer prepares the material requisition and hands it over to the supervisor and the supervisor than takes it to the store in charge who prepares the gate pass in which is lined up in a Queue. There is a considerable amount of movement of the supervisor in getting all the paper works done. Once the paper work is over the security personnel goes to the yard and physical loading than starts. It has been observed that the whole process of getting the paper work is 3 hours. A number of ineffective therbligs are involved major one being avoidable delay.

The next process is that of transportation of material to the site. The sub process includes loading of material transportation of material to the site and unloading. Time measurement for both the locations of HYB and DGY were taken. As per the standard operating procedure loading of pipes in the trailer is to be done by cranes and the maximum capacity is

110 joints of pipes per trailer of 20 tons capacity. Loading of 110 joints had taken 2 hours, transportation to site had an average speed of 15 kms/hr, hence for location HYB which is 40 kms from the storage site it took 2.5 hours and for location DYB which is 30 kms from loading site time required is 2 hours. Next part is the unloading process which takes place in the form of stringing along the pipe track which is covered in the next process. Hence the total time for this process for location HYB works out to be 4.5 hours and for location DYB it is 4 hours. There are two sub process in this process of transportation.

The next process is the construction of flow pipelines. Construction of pipelines has the following sub process as per the standard operating procedures (SOPs). First is the stringing of pipes, along the right of way, next is the swabbing of the pipelines with a pull through tool, the observed timing was 5 mins per pipe, next is alignment of the two joints of pipe using external clamps, this took 10 mins with buffing and grinding and alignment of the bevel ends, with the external clamp than the welding of the pipeline with the root, hot filler and capping joints which was observed to take 25 minutes per joint. The number of joints possible during the whole day with this timing is 20 joints. Hence for 110 joints the time required is 6 days. Trenching job for the two different locations were observed. 20 number of manual labours were used, as most of these pipe tracks are congested. On an average location HYB saw a trench of 200 meters being achieved in a day and for location DYB the trench meterage
covered was 100 meters. The condition of the DYB trench was observed to be difficult compared to HYB since it was narrow along the road and a number of obstructions were created because of traffic movements. Hence for location HYB 1 km trenching job was achieved in 5 days and for DYB it was observed to be 10 days.

The next process is the testing of the pipeline hydraulically. Water filling was done by the drenching pumps available in the oil installations. The line fill of a 100 mm NB (4" NB) flow pipeline is 7.85 KL, per km. As per SOP before pressure testing the entire fluid of water must be air free and the pipeline must be flushed thoroughly with water. For this the drenching pump of 273kl/hr was run for half hour for SOP compliance. Pressure testing was done by a pressure pump. Hydro test pressure of 180 kg/cm2 was developed and holding time of 4 hours was maintained. The total testing was 5 hours. ½ hour setting time was observed in

this.Visual inspection was also done by line walkers the observed time was 2 hours.

The final process of laying the flow line is the commissioning stage. The operation is to hook up the newly laid flow pipeline with the existing facility at one end and to hook up with the well at the other end. Hook up is governed by the SOP. All safety precautions are taken. The observed time during hook up at both the ends was observed to be 4 hours, and the observed time for documentation and handover of the pipeline to the operating section is another 4 hours.

This is the complete process of laying a flow line from a newly producing well to the oil collecting stations in OIL.

The construction of the pipeline is shown in the process flow chart in a flow pattern from the first to the last activity with all the time that the sub process under the various process takes. The primary data recorded is through observation and through stop watch technique.

4.4 Process Flow Chart.

Process	The sub process		Time observed for each of the sub process.
Material Issue			3 hours.
Transportation of material	1	Loading	2 hours for 110 joints.
	2	Travelling time	2.5 hours for HYB 2 hours for DYB
Construction of the flow pipeline	1	Stringing of pipe along the right of way or pipe track	2 minutes per pipe.
	2	Swabbing of the pipeline	5 minutes per joint
	3	Alignment of the pipelines which is buffing grinding and matching the bevel ends with the external	10 minutes per joint

		clamp	
	4	Welding of the pipeline (root, hot, filler and capping)	25 minutes per joint.
	5	Trenching and backfilling process	5 days for HYB and 10 days for DYB.
Testing of the pipeline	1	Hydro testing of the entire pipeline	5 hours
	2	Visual inspection	2 hours.
Commissioning of the pipeline.	1	Hook up with the existing facility	4 hours
	2	Documentation and handover note	4 hours.

From above we can compute the time required for the various process:

Process I: 3 hours.

Process II:4.5 hours for HYB
4 hours for DGY.

Process III: Working for 10 hours a day the total time is 6 days for welding and for trenching it is 5 days for HYB and 10 days for DYB. Thus for HYB process III will require 6 days and for DYB it will require 10 days.

Process IV: Time required is 5 hours.

Process V: Time required 8 hours.

Thus as per the observation flow line for location HYB time requirement was 9 days and for location DYB the time requirement was 13 days.

As per the expert opinion of OIL management the total calculated time for construction of these two flow lines is high and a reduction of this will avoid production loss and with an increase in the profits.

4.5Data Analysis with Experts and application ofHeuristic Technique

Ex p e r t Opinion is a relatively informal technique which can be used to serve a variety of purposes, and may be used to assist in problem identification, in clarifying the issues relevant to a particular topic, and in the evaluation of process, Individual experts can be consulted, but it is usually better to bring groups of experts together so that a wide range of experience can be drawn on.Depending on the problem to be discussed, an expert opinion session can commonly take approximately half a day to carry out.The results of an expert opinion session are usually a list of perceived problems or reservations regarding the usability of a process, and a list of recommendations for improvement. Involving a number of experts can assist in identifying whether potential problems are likely to exist, as individual expert opinion is not infallible. However, if a number of different experts provide the same feedback it makes it likely that area problem exists. A good rule of thumb is to consult 4-6 experts and see what degree of commonality is present.Heuristic evaluation" refers to the fact that experts commonly make their judgements on the basis of "heuristics" or rules - of-thumb based on their accumulated knowledge, and that often these are implicit rather than having become verbalised. Heuristic evaluation thus requires experts to make judgements on this basis, but does not demand that they make explicit the logic behind their judgements

For early completion a time and motion study was carried out and the data was recorded, An expert opinion based on heuristic technique was done for optimising the process in terms of work flow and manpower requirement and the adoption of new work methods, against the evaluation of the recorded data.

The expert that were drawn in were 5 in numbers who have a wide experience in the construction of surface facilities in the oil and gas industry and particularly in the construction of oil and gas pipelines. The primary data that was recorded along with the standard operating procedures (SPOs), were given along with the primary emphasis of how to reduce the construction time from the present. The main points that had emerged from this technique are as follows:

1. Use of SAP as Oil India is using SAP for material issue. Material issue and preparation of gate pass can be done in SAP system this will reduce the uncalled movement between the concerned Engineer, supervisor and the store keeper. All material planning and issue in the SAP system.
2. Pipes that are stored in the pipe yards are not placed longitudinally or in straight lines racks. Thus when the crane and the trailer are placed there are a lot of uncalled movements between the crane and the trailer to load the pipes and place it in the trailer. Experts have suggested that the crane must be placed in between the trailer and the pipes all three in parallel positions and this will have a very fast effective loading. This technique will reduce a lot of unnecessary movements or therbligs. Also the crane and the trailer can be placed easily and faster in position.
3. External clamps are used in the present process. Experts suggested that in place of external clamps internal pneumatic clamps are to be used. As a thump rule the process of bevel alignment will be reduced to almost half when internal clamps are used.
4. The expert group suggested that two welders be engaged in the process. One welder shall be with the hot and the root pass and the second welder shall follow the first welder with the filler and the capping joint. For this two welding machines shall be required and it will remove the idle time that the welders undergo in the same joint when either the first or the second welder is doing his job. Thus as a thump rule the number of weld joints shall be double as when compared to the traditional method of two welders in the same joint. The suggested current range shall be 130 amps for the root pass, and 160-200 amps for the hot pass, and for the filler and capping it should be again around 180 amps. The expert group suggested that the welding machines should have an output range till 400 amps. One welder with the helper is to be placed in one machine which is going for the filler and capping pass and one fitter one welder three helpers are required for the machine engaged in the root and hot pass, as bevel alignment is required in this operation. This way all uncalled movements shall be reduced to a minimum.
5. The expert group suggested that before the trenching process started the pipeline route should be pegged and then the entire route should undergo trenching. A total of 20 persons were employed for trenching however the group suggested that at least 5 fronts should be made available in a kilometre stretch and a minimum of five persons should be engaged per front. This way uncalled movements

will be reduced and trenching shall be done in much lesser time than is being done presently with the same amount of resources. The whole operation of trenching should be so planned that once welding of the pipeline in parts of 200 meters is over it should be lowered and backfilled completely in all respects.

6. Testing and commissioning process can be started both simultaneously through motion study, an improvement in the work process can be achieved through changes, combining or eliminating some unnecessary processes as per the opinion of the expert group.The moment the hydro testing process starts off the process of de pressurising the hook up points can be started as the operation of de pressurising takes a lot of time. So by the time hydro test of the flow line is completed in 5 hours hook up can proceed immediately and can be completed in the same day, thus by overlapping the two operations effectively one day can be reduced. Also documentation and handover note can be prepared simultaneously.

This exercise with the experts were completed in 5 hours' time. Using motion studies and with the same resources the whole laying procedure was re designed to complete the job in lesser time, reduction in downtime and to increase the efficiency thus avoiding production losses. Additional resources were not used for this exercise thus keeping the cost factor static with the aim of increasing the revenue and getting higher profits.

4.6Pilot study

The recommendation of the expert committee was put in practice in the construction of one gas artery flow line in Makum area. All the process timings were recorded with the new motion study techniques and improved work methods. Following are the results that was obtained for this 1 km 100 mm NB gas artery flow line.

4.7Process Flow Chart for the 1 km artery gas flow line.

Process	The sub process	Time observed for each of the sub

			process.
Material Issue			2 hours. (using SAP and new motion techniques)
Transportation of material	1	Loading	1 hours for 110 joints. (using the new motion techniques by placing the pipes, cranes and the trailer in parallel position)
	2	Travelling time	2.5 hours till Makum.
Construction of the flow pipeline	1	Stringing of pipe along the right of way or pipe track	2 minutes per pipe.
	2	Swabbing of the pipeline	5 minutes per joint
	3	Alignment of the pipelines which is buffing grinding and matching the bevel ends with the external clamp	5 minutes per joint. (Using the external clamps a new work efficiency method)
	4	Welding of the pipeline (root, hot, filler and capping)	15 minutes per joint. (Reduction of 10 mins as compared to the previous methods)
	5	Trenching and backfilling process	3 days (5 fronts were operated after centre line pegging the pipe track)
Testing of the pipeline	1	Hydro testing of the entire pipeline	5 hours
	2	Visual inspection	2 hours.(carried out simultaneously with the hydrotest process)
Commissioning of the	1	Hook up with the	4 hours (Job started

pipeline.		existing facility	together with the hydrotest process)
	2	Documentation and handover note	4 hours. (carried out simultaneously with the hydrotest process)

From the above time data, the total time required for this construction works out to be
Process I : Time required is 2 hours.
Process II: Time required is 3.5 hours.
Process III: Time required: 4 days to complete the entire welding (30 joints were welded daily with the new method with standard rest of 2.5 hours spread evenly) From the start of the job that is issue of material the welding process has been completed in 3 and a ½ day. Time required is 3 days (with complete back filling of the trenches)
Process III and IV : Time required I day as both had been overlapped.

Hence it can be seen that the construction of the flow line of 1 km in length has been completed in 4 days with the same resources from the previous 9 and 13 days with the application of motion studies to design new work methods and time study to control the time. This reduction in time has a significant bearing on the profitability of the organisation.

5. CONCLUSIONS AND RECOMMENDATIONS

From the discussion of the five process, it can be concluded that the construction of the flow lines can be improved based on the ten sub process that was the cause of the problems. With combination of work process and time measurement and the changes of production methods there was an improvement the current work process, as evident in the pilot study. These modifications are made by eliminating the wasted time and reduction/modifications of the work contents. From the comparison between current and new work process as shown in both the tables, indications are that the best alternative towards this problem is by adapting the time and motion study model. These improvements were successfulto achieve the project goals and objectives, The improvements were in the processes,economy in human effort and the reduction of unnecessary fatigue.

The basic objective of this research was to analyse construction activities of flow lines and to study the time required for these activities including the downtime involved., using time and motion studies.

Hence the researcher can conclude that with the reduction in downtime early completion will be achieved with the same resources. This early completion will save construction cost substantially also there will be an increased revenue as the system can be put in production at an early stage, with an increase in profit.

For future and advanced research, the researcher recommends that this research has to be executed with more details towards all research parameters. The researcher also suggests that the research performed in other industry with a wider scope can calculate the cost of the work process in order to improve it as time is the essence in production process. Also the quality if the product can also be one of the parameters in future research.

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