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Application of Lean Tools in the Oil Field Safety Management

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ABSTRACT
Current safety management in oil fields is in low efficiency and data from DOE indicated that the injury rate in the oil and gas field was greater than those for all the other U.S. industries. The paperintroduced lean concepts and tools to the safety management in oil fields. In theresearch, a new safety management methodology has been set up. The study also compared the current safety management and the new safety management which was built up by lean concepts. In addition, several lean tools have been modified to make them fit and work better in oil fields.
Keywords: Application of Lean Concepts and Tools, DMAIC, Safety Management, Kanban, 5S, 6S, Process Map, Survey, Evaluation Form, Benchmarking, Record-keeping.

I. INTRODUCTION

By the definition, safety management is the formal, top-down business approach to managing safety risk, which includes a systemic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

Lean is a productivity-improvement methodology which aims at optimizing the customer-value chain. Lean was developed in automotive sector but has transitioned into a variety of industries. Lean tools are everywhere. This research focused onhow to apply the lean tools to modify and to improve the safety management in oil fields.

The safety issue is the big cost problem and one vital management principle. For a variety of industries, the improvement of safety in the workplace is always the first goal. For oil and gas industries, safety has long been considered as the first important obstacle, which contains safety both for personnel and for production equipment. The personnel and equipment, which served in the oil and gas industries, are always under the risk of high pressure, high temperature and strong poisonous. The injuries of the production and drilling equipment may result in the lower productivity and extra cost. Plus, the drilling and production equipment are always at high cost so that keeping these equipment working right at right time is saving money. In the oil and gas industries, safe is the money. The application of lean tools can be one efficient method to safety management in the oil and gas field.

Secondly, according to the data from DOE, there were total 450,000 petroleum-related workers who employed in oil and gas fields. And 823 field workers were killed from 2003 to 2007. DOE also got the conclusion that the injury rate in the oil and gas field was 7 times greater than those for all the other U.S. industries. So it indicates that the current safety management in the oil field is in low efficiency. It's necessary to improve the current safety management to minimize the risks to the petroleum-related workers in oil and gas fields.

To summarize, the lean tools can provide a new and reasonable safety management in oil and gas industries. The research aims to study the application of lean tools to improve the safety management system in oil fields.

II. LITERATURE REVIEW

The main objective of the research is to apply the lean concepts and tools to the safety management in oilfields. Before considering and studying the application of lean techniques to safety management, the knowledge about concepts and elements of the safety management should be prioritized as the first. Safety is a biggest issue for almost every manufacturing and operations system. The employer has the

responsibility of providing a workplace getting avoided of any recognized harms to the personnel. According to the previous study, a successful safety management plan and system must rest on a solid foundation of management commitment and support. Based on the study of Joel N. Tietjens, there is a difference between commitment and support. The commitment is to assign and assure some specific application and method. On the other hand, the support is to provide resources, which can be equal to uphold, advocate, and champion. By his management experience, Joel set several criteria to build a reasonable and applicable safety management plan. Firstly, the safety management must thoughtfully and thoroughly develop a safety and health policy that can be understood, believed and "sets the tone for action". Secondly, the safety system must assign responsibility with authority and hold accountable personnel for implementing the plan. Joel also suggested that the record-keeping system should be considered. Records can be used for loss/trend analysis and it also can serve as support during legal or other evidentiary proceedings. A reasonable safety management system should determine what records should be retained and for what period time. These could be the guidelines to build up a new safety management system with lean concepts and tools.

Beyond the basic safety management knowledge, J. L. Watson (1993) stated that management responsibility should extend beyond reacting and correcting safety problems. For an effective safety management with goal of "zero accidents", it requires proactive processes. The safety management can combine with lean concepts perfectly because lean has the belief that there must be a "deliberate path" to follow for continuous improvement. There are tons of lean tools to identify improvement opportunity and sustain the continuous improvement. So lean can match safety management perfectly. Also, Watson suggested that an effective safety management system should be able to address any customer requirements or local safety regulations not covered by established plan. This is also should be a guideline which the term research should consider when building up a new safety management. With the lean concepts, the safety management for the oilfield should have the "Improve" and "Control" steps (or sections) coming from the DMAIC procedures. The "Improve" and "Control" can help to assure and maintain the positive results which are caused by the safety management. For example, similar to the DMAIC, Watson provided a safety management system which can be simplified as ECTR. ECTR is the defined as Eliminate, Control, Train, and Require. Every step in ECTR is guided by the lean concepts. Based on what I learn about lean thinking, there should be step called Monitor and Audits coming after ECTR. The Monitor and Audit step has the same function as the "Control" to make sure that the safety management system is applicable. In addition, the Monitor and Audit step can also meet the requirement we set before which is to meet any customer requirements or local safety regulations not covered by established plan. So the following step is to find more information and data to test the Audit step.

Investigating and developing the safety management with lean techniques in the oilfield should consider the specific dangerous operations which are different from other industries and manufacturing system. For example, Ejike Okoli and Amadi (2014) took the drilling operations as one example to show the importance and the challenges to manage the safety in the oilfield. According to their investigation, the drilling operations have the highest opportunities to cause the recordable injuries to skilled-labor. Similarly to the identification of the waste with lean tools in the process, one safety management method is to identify the risks in the drilling operation before the drilling starts. At this risk analysis step, the tools of VSM and Process Mapping can be applied to identify the opportunity and location of risks. In this procedure, based on what I have learnt, the other little lean tools which can be applied are fishbone diagrams, CE analysis and FMEA. After all the risks and their cause have been identified specifically, we need to re-allocate the training resources and time to make sure the field engineers have the ability to face and get rid of the specific risks at different drilling locations. With these lean tools, the efficiency of the safety management could be increased while the cost of training could be reduced.

Also, in the oilfield operations, safety management could be more complex than other manufacturing and operation system. The components of the oil field system are complex because it should take the management of contractor into consideration. Just like other manufacturing systems which have the contractors or sub-contractors to help the manufacturing procedures, there are also contractors in the oilfield operations based on the scale of the oilfield and oil/gas-companies. Quoting the manger in the Kuwait Oil Company, "We Believe Contractors are our Partners in Business". For many middle and small scale

oil/gas-companies, business partners (contractors) carryout majority of operation activities such as drilling and transportation. For example, Operations in Petroleum Development Oman (PDO) are large and complex with some 22 companies and 3300 contractor staff working in the harsh desert environment of the Sultanate of Oman, which was implied by J. C. R. Careil (1991). Careil also introduced that surface activities, such as production and maintenance operations are primarily carried out by company personnel with some contractor. By contrast, subsurface activities are normally carried out by specialized Drilling or Well Service Companies. The safety management of contractors, according to Kuwait Oil Company, can always be an effective coordination to create a better partnership and to improve the image of the both two companies. The lean concepts and tools can be applied to the contractor safety management. Combined what I have learned in class with what the operations have taken by the Kuwait Oil Company, the lean tools which have been suggested in contractor safety management are 5S, Enhanced Interaction through Weekly Safety Meeting, Standardization of Inspection Checklist, and Site Verification Visits. In the following steps, I plan to find more data to verification and validation these lean tools.

III. METHODOLOGY

The novel procedures, which will be used to study and set an efficiency safety management in oil fields, are divided into four stages and I summarized them as "DREAM" method. The detailed procedures are: 1st stage - Define (D); 2nd stage - Recognize (R); 3rd stage - Evaluate (E); 4th stage - Apply (A);5th stage - Monitor (M).

The "DREAM" method is introduced from the lean concept "DMAIC". The reason that the terms were modified is that the "DMAIC" is for the professional engineers with the background of Lean. For normal petroleum field engineers, it's hard to explain "DMAIC" in details. Secondly, the lean concept of "DMAIC" is a general idea which can be fit most industries. However, we just need to solve the specific problem in one industry. The general concept can fit more industries but it may reduce the efficiency of management when facing specific problems. So it's necessary to narrow down the range of concepts during the introducing procedures to make sure it can solve the specific problems more efficiently. The "DREAM" is composed by several sub-topics under the "DMAIC" which may be applied to the safety management in oil fields specifically. In addition, the terms in "DREAM" are summarized in simple words which can be understood by the field petroleum engineers without any lean background.

1st Stage – Define Stage

Introduced from the Lean concepts of "DMAIC", the very first step to start or evaluate a research is to define objectives, customers and scopes. It should be the same to the safety management system. The safety management in the oil filed may be more complex than other manufacturing and operation systems. Firstly, the components of the personnel in the oil field are complex. The new safety management system should take all kinds of engineers including contractors into consideration. Secondly, the operations in the oil filed may be complex, which includes well logging, drilling, well completion and production. Thirdly, the safety management should take all kinds of oil fields (companies) into consideration. The reason is that there are no two oil fields which can be identical to each other because of different working environments, different policy backgrounds, and different production objectives. So the scope and objectives should be clarified at the very beginning. The Define stage, before other operations / steps in the safety management, can help to identify the customers, the scopes and the objectives, which also can be the first and an important step to prevent and eliminate the waste-caused steps.

2nd Stage – Recognize Stage

After the customer, scope, and objectives have been clarified, the safety management system should start to recognize the potential risks and hazards hiding in specific procedures in the oil field operations which are dependence on the customer requirements and system objectives. For an effective safety management which has a primary goal of "zero accidents", it requires proactive management and processes. So it's necessary to let the decision-maker to get familiar with potential risks and hazards, which makes the Recognize stage as one key step.

Safety issue in the oil field is a highly personnel involvement management. The problems coming from how the personnel and engineers are trained may become one source of potential risks and injuries. Modifying the lean tool of "Survey", we can collect the data to recognize human-caused risks and potential. Based on the procedures in oil fields, a new work sheet was developed as a tool and a

template of "Survey", which is attached in the Appendix-A.

Besides, the potential sources of risks and hazards also contain many other areas. To recognize these sources, the lean tool of Brainstorming and Fishbone diagram can be applied. For the specific customers, who run the only one or two operations in the whole oil field process, the lean tools of VSM and Process Mapping can be applied to identify the location of potential risks.

3rd Stage – Evaluate Stage

After the potential risks and hazards have been identified and recognized, the reasons and causes of these risks and hazards should be investigated. This Evaluate stage step has the similar function to the lean concept of Analyze in "DMAIC".In this step, the lean tools can work quite well to determine the causes of the risks and hazards. Based on functions of lean tools, CE analysis, 5 Whys, and Fishbone diagram can be applied in this step.

Processing the Evaluate stage, it's necessary to judge what level of the safety environment is before applying a new safety management system. I suggested three safety levels to be applied, which are Safety-Sustain level (SS), Safety-Improve level (SI) and Safety-Reconstruct level (SR). Safety-Sustain (SS) level implies that the current working environment is safe enough and the engineers are well-trained. What should we do for the Safety-Sustain (SS) level is to maintain the current safety management and to make it as a "Benchmarking". The benchmarking of SS level can contribute to improve our safety management experience and data base, which can help to modify and to improve other safety management by comparison with "Benchmarking". The Safety-Improve (SI) level may have several areas to be improved but no need to modify the whole system. The reason to set this level is to save money and to consider the benefits of the whole management in oil fields. The last level of Safety-Reconstruct (SR) is the warning to the current safety management which means the risks and hazards may have a high chance to break out. It's necessary to re-build the safety management system with lean tools.

To decide the safety level of the current safety management, the lean tool of "Check-list / Check-sheet" can help. A modified Check-sheet with different scores assigned to different terms can help to classify the current safety management into different levels according to different scores. The modified Check-sheet is shown in the Appendix-B.

4th Stage – Apply Stage

The Apply stage is the application and implements stage. This is stage is based on the data collection and data analysis from the previous stages. Compared to the lean concepts of "DMAIC", the Apply stage is similar to the Improve step which focuses on the potential solution and builds up a best solution. The application of lean concepts and lean tools cannot be that easy in the oil field because of the complexity of the oil and gas industry. The modified lean tools in the new and efficient safety management system should be considered.

The first lean tool is 5S. Actually, 5S is the basic lean tool in the manufacturing system, and also the first step to set the lean concept. To make it better match the situation in the oil field management, there is another "S" should be considered, which is "Standardized". The "standardized" is very important in the oil field. The oil filed management always consisted by many different teams and companies, including sub-contractors. So if there is not being standardized in the management, safety rules, communications, and even dangerous signs, the hazards and risks may have a higher chance to breakout. So the 6S, the last step of which should be "Standardized", can help to improve the efficiency safety management and to increase the safety to the different personnel from different teams and companies.

The second tool which should be modified is Kanban tool. Usually, Kanban is visual control tool to make a warning or to work as a reminder. However, the Kanban tool can work as a record-keeping tool in the oil field. The procedures in oil fields usually divided into several parts including drilling, logging, well completion, and production. So the potential safety risks may come from the previous procedures. For example, the well logging engineers may be under a high damaging risk if the drilling personnel didn't fix the drilling platform or rig. How to avoid this? The records of responsibility may decrease the cause of potential risks from the previous step. And the personnel name, title, and job finished time can be shown on the Kanban system. Even for the last procedure Production, the safety supervisor or management can easy to find which team and which engineers finish this job with a clear Kanban system. So the Kanban system posting the responsibility can be applied as a new lean tool to improve the safety management in the oil field.

5th Stage – Monitor Stage

Introduced from the lean concept, the last stage Monitor Stage in the safety management system is similar to the "Control" step in DMAIC. The objective of this stage is to sustain the improvement, which fits the lean concept of continuous improvement. The monitor stage plans to apply the lean tools to make sure the improvement has been established and worked well in oil fields. To achieve this objective, the modified survey tool in the Appendix can be applied again. The results from the evaluation can be compared with the ones from the old safety management system.

Also, in the monitor stage, the new safety management system, which has been improved compared with the old one, can be summarized and added into our database as one benchmarking for the later safety management improvement in another oil field.

IV. DISCUSSION

The current safety management in the most industries contains Safety Policy, Safety Risk Management, Safety Assurance,and Safety Promotion. In this research, the modified safety management "DREAM" is composed by Define, Recognize, Evaluate, Apply,and Monitor.The comparisons between the current safety management and the new safety management are listed as below.

Firstly, the current safety management cares more about safety management while ignores the "personality" of the oil field. In lean words, the current safety management has missed the importance of "VOC".The modified safety management – DREAM – has "Define" stage to define the customers and summarize the VOC considering the differences between different situations in various oil fields. So "DREAM" has the ability to design a more specific safety management to meet the customers' requirements. In addition,"DREAM" has the higher probability to solve a more "realistic" safety issue for different situations.

Secondly, the current safety management has fewer tools to identify the potential risks and hazards so the most current safety management cares about history data. However, "DREAM" introduced lean tools to identify and evaluate the potential risks. For this comparison, several lean tools are applied in "DREAM" to increase the probability to find more potential risks hiding in procedures, which can reduce the injury rate.

Thirdly, the current safety management usually uses check-list and survey to evaluate if the safety management works. However, "DREAM" uses the modified check-list with scores and survey scores to check the safety management. For this difference, the current check-list is really big which contains too many questions. However, it's hard for decision maker to get a direct judgment without quantitative data supports. "DREAM" simplified the safety check-list to eliminate the terms which are not related to the oil field.

In addition, the current safety management ends in the "improvement" stage while "DREAM" introduced the "Monitor" step from the lean concept "Control".With the "Monitor" step, "DREAM" has the ability to prove and to sustain the improvement of safety management.

V. CASE STUDY

1st Stage – Define Stage

In the case study, the new safety management system is developed for the oil field in the Woodford Shale. The component of the field engineers mainly contains well logger, drilling team, well completion engineers, and production engineers. The objective is defined as to set up a new and efficiency safety management system for these service companies in the oil field. Our safety management should consider all the field engineers from different parts and companies. The general VOCs from the oil field are to follow the "personality" of the studied area and wells and, in addition, to minimize the safety hazards.

2nd Stage – Recognize Stage

To recognize the potential risks and hazards hiding in the Woodford Shale, the lean tool of Process Map can be applied. The potential risks and hazards can be identified and summarized in Table 1.Most possible potential risks and hazards in the processes of Drilling, Completion, Logging, and Production in the Woodford Shale have been identified.

Table-1. The potential risks identified in the Woodford shale.

Potential Risk	Identified in the Operations	The Types of Engineers
Vehicle Collisions	Transportations	Driller
	Preloading	Driller
	Cement	Completion Engineer
Struck-By/ Caught-In/ Caught-Between	Test, Clean, Install	Driller
	Logging	Well Logger
	Cement	Completion Engineer
	Production	Completion Engineer
Explosions and Fires	Check Flow, FIT test	Driller
	Drilling	Driller
	Production	Production Engineers
	Hydraulic Fracture	Production Engineers
	Production	Production Engineers
	Potable water	Driller
Falls	Preloading	Driller
	Drilling	Driller
	Production	Production Engineers
Confined Spaces	Drilling	Driller
	Cement	Completion Engineer
	Production	Production Engineers
Ergonomic Hazards	Preloading	Driller
	Install	Driller
	Drilling	Driller
	Cement	Completion Engineer
	Logging	Well Logger
	Hydraulic Fracture	Production Engineers
High Pressure Lines and Equipment	Hydraulic Fracture	Production Engineers
	Cement	Completion Engineer
	Production	Production Engineers
Machine Hazards	Preloading	Driller
	Drilling	Driller
	Hydraulic Fracture	Production Engineers
	Logging	Well Logger

Safety issue in the oil field is a highly personnel involvement management. Modifying the lean tool of "Survey", we can collect the data to recognize human-caused risks and potential. In this study, a new worksheet was developed as a tool and a template of "Survey", which is attached in the Appendix-A. In this research, a student, who used to be a field engineer working in the similar oil field as the Woodford Shale, was invented to test the evaluation sheet of the safety training status. His safety training score was 110 which was at the level of "normal-trained-in-safety". Normally, we can trust how the engineers were trained about safety issues at this level; however, we need to take the following steps to minimize potential risks.

3rd Stage – Evaluate Stage

After the potential risks and hazards have been identified and recognized, the reasons and causes of these risks and hazards should be investigated.

The first step is to judge what level of the safety environment is. I suggested three safety levels to be applied, which are Safety-Sustain level (SS), Safety-Improve level (SI) and Safety-Reconstruct level (SR). To decide the safety level of the current safety management, the lean tool of "Check-list / Check-sheet" can help. A modified Check-sheet with different scores assigned to different terms can help to classify the current safety management into different levels according to different scores. Because of limited conditions, it's hard to apply the worksheet in this research; however, for our studied area, there are no accidents-injuries reports or hazards reports according to the literature survey. So it's assumed that the current safety management in the Woodford is at least Safety-Improve (SI) level, which means that we can almost trust the current safety management in the Woodford with adjustments and improvements to several areas.

In second step, the lean tools, such as CE analysis, 5 Whys, and Fishbone diagram, can help to analyze the potential risks and hazards which the field engineers may be caught with. The following table (Table-2) was developed to show the results of CE analysis to identify the causes (similar to the input) of different potential risks (similar to output) at different operations in the Woodford Shale.

Table-2. Root cause for different risks (Cause and Effects Analysis) in the Woodford Shale.

Risks (Output-Effects)	Reasons (Input-Causes)	Personnel
Vehicle Collisions	Motor Vehicle Safety	D,C
	Work Zone Traffic Safety	D,C
	Work-Related Roadway Crashes	D
Struck-By/ Caught-In/ Caught-Between	Crane, Derrick, and Hoist Safety	D,C,L,P
	Struck-by	D,C,L,P
Explosions and Fires	Well Site Ignition Sources	P
	Hot Work, Fire, and Explosive Hazards	P
	Static Electricity Buildup in Plastic Pipe	D,P
	Flammable and combustible liquids	D,P
	Storage and handling of liquefied petroleum gases	P
Falls	Fall Protection	D,P
	Walking/Working Surfaces	D,P
Confined Spaces	storage tanks	P
	mud pits	P
	sand storage containers	P
Ergonomic Hazards	lifting heavy items	D,P,L
	bending	D,P,L
	reaching overhead	D,P
	pushing and pulling heavy loads	D,C
	working in awkward body postures	D,C
High Pressure Lines and Equipment	compressed gases	P
	high-pressure lines	P
	Internal erosion of lines	C,P
Machine Hazards	rotating wellhead equipment	D,C,P
	struck by or caught between unguarded machines	D,P
Note: D-Drilling, L-Logging, C-Completion, P-Production		

4th Stage – Apply Stage

The Apply stage is the application and implements stage. I modified several lean tools trying to make them work better in the oil field.

The first lean tool is 5S, which was developed into 6S including "Standardized" by considering the different personnel from different teams and companies. The second tool which should be modified is Kanban tool which was developed to show the responsible person who take the charge or finish the specific part. The other operations which can be applied to improve and modify the current safety management in the Woodford Shale are listed in the Table-3.

Table-3. General solution to solve the safety problems in the Woodford Shale.

Risk	Detailed Classified	Lean Tools
Vehicle Collisions	Motor Vehicle Safety	Training, Regular Check
	Work Zone Traffic Safety	Kanban
	Work-Related Roadway Crashes	
Struck-By/ Caught-In/ Caught-Between	Crane, Derrick, and Hoist Safety	Strict-Entrance-Permit
	Struck-by	Training
Explosions and Fires	Well Site Ignition Sources	6S
	Hot Work, Fire, and Explosive Hazards	Strict-Entrance-Permit
	Static Electricity Buildup in Plastic Pipe	Regular Safety Check
	Flammable and combustible liquids	

	Storage and handling of liquefied petroleum gases	Regular Safety Check, Strict-Entrance-Permit
Falls	Fall Protection	Personal-Protection
	Walking/Working Surfaces	Warning System, Personal-Protection-Equipment
Confined Spaces	storage tanks	Warning System, 6S,
	mud pits	
	sand storage containers	
Ergonomic Hazards	lifting heavy items	Kanban, Warning System, Training, Personal-Protection-Equipment,
	bending	
	reaching overhead	
	pushing and pulling heavy loads	
	working in awkward body postures	
High Pressure Lines and Equipment	compressed gases	Strict-Entrance-Permit, 6S
	high-pressure lines	Strict-Entrance-Permit, 6S, Regular Safety Check
	Internal erosion of lines	Regular Safety Check, Kanban
Machine Hazards	rotating wellhead equipment	6S, Personal-Protection-Equipment
	struck by or caught between unguarded machines	Kanban, 6S

In addition, it's necessary to build-up a record-keeping subsystem in the safety management in the Woodford Shale to test the improvement for the future step.

5th Stage – Monitor Stage

The last stage Monitor Stage in the safety management system is similar to the "Control" step in DMAIC. The objective of this stage is to sustain the improvement, which fits the lean concept of continuous improvement. After the new safety management system has been modified for the Woodford Shale, it's necessary to apply the check-list in the Appendix B to re-evaluate the safety management to prove and maintain the improvement. The improved and successful safety management can be summarized and recorded as a Benchmarking in the future study as a comparison.

VI. CONCLUSIONS

In this study, the main objectives of lean are to set up one efficiency management system. The system can be studied and applied in a much more easily and efficient way, which is compared to the simple combination of several lean tools. The lean concept, such as DMAIC, can be expanded to many other fields. In general, the safety management in the oil-field mostly focused on the tools and methods which are much more limited and inefficiency. The efficiency of management would be improved if the safety management tools and methods can be upgraded and composed into a system. Based on the case study, it can be told that the DREAM can work if we have enough data. Through the comparison, we can see the advantages of DREAM compared to the current safety management. So the DREAM is recommended.The application of lean concepts to the safety management of oil-field is verified. Also, it made me believe that the application of lean concepts cannot be limited to such a few areas while it has the potential improvement to almost every field.

Another main conclusion is about the application of lean tools. Several lean tools can work better in the oil field management if it can be modified and adjusted based on the real situation in the oil field. Lean tools cannot make mistakes but the wrong way to be applied can make it fail. So lean tools are already everywhere; however, the point is how we can make it work better and more efficiently. To adjust the lean tools, we need to consider our objective to apply lean tools carefully. Based on our application objective, with our professional

knowledge, we should study and modify the lean tools under the "REAL" conditions, not just in a rigid way.

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Appendix – A: Evaluation worksheet for the safety training status

The following worksheet is developed to evaluate how the personnel in the oil field were trained related to the safety issues. The way to use is form is to fill the blank with 1 or 0 for each question. The worksheet was developed in Excel so it's easy to use computer to calculate the total score to judge how the personnel in the oil field were trained. The total score is 140. The score from 140-110 is treated as well-trained-in-safety; 110-90 is treated as normal-trained-in-safety; 90-0 is treated as bad-trained-in-safety.

Evaluation to the Training for the Oil Field Personnel					
Name		Job Title		Evaluation data	
Your Education Background					
PhD		Graduate		Under-Graduate	
Have Working experience (related to the training)?					
Yes			No		
Finish the whole safety training?					
Whole		Greater than Half		Less than Half	
The objectives of the safety training were clear enough?					
Yes			No		
The training material covered most safety issues?					
Yes			No		
The training contents were organized and easy to follow?					
Yes			No		
The safety materials and notes were helpful?					
Yes			No		
The safety training experience was helpful?					
Yes			No		
The time of safety training was sufficient?					
Yes			No		
Were you caught with the safety issues related to the safety training?					
Yes			No		
Do you still remember the key points in your safety training?					
Yes			No		
Know the signs about safety issues (i.e. electric sign)?					
Almost		Half		Little	
Familiar with the first aid?					
Yes			No		
Know the emergence contacts when something happen?					

Yes		No	
Total Score =			

Appendix – B: – Evaluation worksheet for the current safety management

The following worksheet developed by me can help to judge and level the current safety system. If the current safety management system is good enough, it can be added to our benchmarking database. If it's not good enough, the following stages in "DREAM" can be applied.

Current Safety Management Evaluation Survey					
Evaluation Date		Oil Field Name		Evaluation Stuff	
Is the decision-maker familiar with the importance of safety?					
Yes		No			
If no, what's the reason:					
Are the workers familiar with importance of safety?					
Yes		No			
If no, what's the reason:					
This oil field has the safety training program?					
Yes		No			
If yes, how is the training program?					
Good		Normal		Bas	
If no, what's the reason:					
The oil field has the safety supervisor?					
Yes		No			
The oil field has the regular safety checking?					
Yes		No			
If yes, what is the safety-checking frequency?					
The oil field has the record-keeping system?					
Yes		No			
If yes, how long will this record be kept?					
The oil field has the risk-prevention system?					
Yes		No			
If yes, check the following and mark the tools they have					
Kanban		5S			
Monitor		Risk Analysis			
Fall Protection					
Severe Weather Warning					
The workers have the personal protection equipment?					
Yes		No			
Is there any inquired accident before?					
Yes		No			
If yes, what is the frequency?					
Very often		Often			
Some		Little			
Total Score =					
Safety Level =					