2008-5435/14/63-132-141
INTERNATIONAL JOURNAL OF OCCUPATIONAL HYGIENE

IJOH 9: 132-141, 2017

ORIGINAL ARTICLE

Assessing and Comparing Human Errors in Technical Operations in Petroleum Wells using Basic and Extended CREAM Technique

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Received June 08, 2017; Revised July 15, 2017; Accepted Agust 23, 2017

This paper is available on-line at *http://ijoh.tums.ac.ir*

ABSTRACT

Excavating operations are among operations with high risk of accidents. Human errors have been identified as the main reason of such hazardous accidents. The present essay is going to scrutinize human errors type and probability in technical services in petroleum wells focusing on comparing acidizing and cementing operations. The basic and extended CREAM method was applied in this research. Initially, the main tasks and sub-tasks were identified in both operations. Then, control modes, common performance condition, cognitive failure probability were determined. In acidizing operations, 61.63% of the control modes were strategic and 7.69% of the opportunistic mode, while they were 25% and 12.5% in cementing operation, respectively. In acidization and cementation operations, the time of day, number of simultaneous goals and sufficiency of training and experience were considered as factors reducing performance. Furthermore, the cognitive failure probability has been more than 0.005 in 34% of sub-tasks in acidization operation, whereas in cementing, the failure probability has been more than this amount in 50% of the sub-tasks. The strategic control mode has held the highest percentage of control modes. In addition, in investigating the comparison of the more hazardous, the percentage of more strategic control in acidization operation indicates that acidization is safer than the cementation one. Considering the higher probability of cognitive failure under the sub-tasks of cementing operations, the probability of failure in the cementing is higher than that of acidization and is more hazardous. Therefore, it needs to implement some measures for decreasing human errors at these hazardous operations.

KEYWORDS: *CREAM technique, Technical operations in petroleum wells, Human error, Cognitive failure*

INTRODUCTION

Texas City Disaster in 1947, Bhopal in 1984, Piper Alpha disaster in 1988, and Texaco Refinery fire in 1994 all have human errors either as a direct cause or an indirect cause. In fact, the human role in safety has not been adequately addressed [1]. Human errors are identified as one of the main reasons for accidents and possible negative impacts on most complex technical sectors [2].

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An occupational accident will temporarily and permanently disrupt the balance in the working environment in which it occurs [3]. Moreover, they are the main factor of accidents in high-risk industries like gas and oil industries [4].

Human is not reliable and human errors have been the cause of accidents. From human error point of view, occupations are considered critical where an error in them leads to catastrophic consequences [5]. Technical services of petroleum wells are considered as such activities. Thus, oil and excavating companies have considered it as one of the top priorities in their plans so as to prevent such disasters in planning stages, gas, and petroleum excavating operations. The companies can provide different engineering and technical services such as wiring, acidizing, mechanical drilling steam test, infectivity, casing running, liner hanger, well testing, coil tubing, and air drilling.

Several accidents have occurred in recent years in excavating operations and human errors have been one of the most important reasons of these accidents' occurrence. Some of these human errors including distraction while cutting cement leading to damage to the face and jaw; being careless about opening the valves respectively and pipe burst; not putting a quoin under the tire resulting in movement of pump truck, breaking the valves and pips, and oil leaking; lack of proper shoes and slipping and falling in oil pit; lack of training in acid mixing leading to the corrosion of the pipes and valves immediately; inattention to the direction of wind blowing leading to the drop of the box's door; inattention to maintenance and bursting the hose of compressor; inattention to using of mask that led to pulmonary diseases; and no use of anti-acid gloves that lead to Acid burn [6]. Therefore, since human errors will end in disastrous accidents, it is necessary to identify and evaluating them.

In this regard, the current study was conducted with the aim of assessing and comparing the acidization and cementation operations in petroleum wells by the Cognitive Reliability and Error Analysis Method (CREAM). The application of CREAM technique to evaluate human errors has many advantages including a systematic structure for defining and quantifying human errors, classification scheme, contextual control model of cognition, and definition of the cause of human errors based on factors related to human, technology and organization [7].

Several studies have been done on human errors using CREAM technique. In 2015, human error using cognitive ergonomics approach was studied in the control room of cement industry. Human errors can be identified by the method of two or more tasks simultaneously, the quality of work experience, training, and comprehensive knowledge of errors [8].

The cognitive human error analysis was scrutinized in the control room of petrochemical industry. As a result, empowerment, the working hours, and common performance conditions (CPCs) identified as factors diminishing work efficiency. It is also important to adopt priority in activities, conduct meetings, announce staff about work permits' due time, hold training sessions, and assess the polluting elements [9].

Another study was conducted on human errors in control room of petrochemical industry using CREAM technique by ergonomics approach. The most cognitive failure includes performance error. Additionally, the most important cognitive activities dealt with control process in control room, communicating activity, monitoring, and planning [7].

The other research evaluated nurses' human errors in I.C.U by CREAM technique. Modifying nurses' working shifts and taking applied training courses can be directed to the decrease in the rate of human errors [10].

The effect of work conditions was investigated on the performance of operator (CPCs) and considered the total error probability by CREAM technique in one of the operating regions of gas Transition Company. Any of the CPCs factors were not able to decline operator performance [11]. The CREAM technique was applied to identify that the most effective factors decreasing the operation include working conditions, the available time, and the compatibility between human systems and machines [5].

Because of the nature of the materials and the types of existing work in the acidification and cementing of oil wells, the occurrence of a human error can have irreparable consequences for humans and environmental resources. This is the reason why this operation has been selected in this study. The selection of these two operations was based on incident records and consultation by the specialists of Iran's National Excavation Company.

MATERIALS AND METHODS

The present essay has scrutinized human errors related to cementation and acidization of petroleum wells using CREAM technique. This method holds both the basic and extended ones. The following steps are taken to investigate human errors by CREAM method.

Defining the task steps by Hierarchical Task Analysis (HTA) method: Annett and Ducan developed HTA in 1967. The method explains the main task steps that, in principle, can be analyzed in further detail until the most elementary actions have been found [12]. The hierarchal analysis structure focuses on the intended job and analyzes the necessary steps to do that activity. In fact, the analysis task is commenced by targeting the final goal and the task is divided into smaller components to achieve the goal [14].

Investigating Control Modes and Common Performance Conditions (CPCs) CREAM technique is made up of four control modes known as scrambles control mode, strategic control mode, opportunistic control mode and tactical control mode. Control modes are actually modes figuring out various intervals of fault probability revealing probabilities of human action errors. The human

Published online: September 20, 2017

error probability (HEP) interval of strategic mode is ranged from 0.5 E-5 to 1.0 E-2 and the tactical mode distance is placed between1.0 E-2 and 0.5 E-0, 1.0 E-1. The intervals of scrambled and opportunistic mode are marked from1.0 E-2 and 0.5 E-0, 1.0 E-1 and 1.0 E-0 respectively. Fig. 1 displays the basic operator control modes. Common performance conditions can contribute to determining the cognition of human and action circumstance, which maintain a well-organized foundation for defining the conditions in which the performances are expected to be held. Furthermore, the CPCs have been practiced by CREAM technique to specify sets of probable modes and errors. Table 1 illustrates the CPCs and related Expected effect on performance [12].

In order to obtain CPCs scores, first, the number of times that is expected to reduce or increase performance reliability and not having any significant effect on performance reliability are counted. After gaining total CPCs scores, basic operator control modes are defined to evaluate human performance reliability. The total number of activities optimizing the performance has been subtracted from the total number of activities decreasing the performance ($\beta = \Sigma R - \Sigma I$). The equation 1 is used to determine the total cognitive failure probability [12].

Equation 1:

$$CFPt = 0.0056 \times 10^{0.25\beta}$$

Table 1. CPCs and performance reliability

CPC	Level/descriptors	Expected effect on performance reliability
Adequacy of organization	Very Efficient	Improved
	Efficient	Not Significant
	Inefficient	Reduced
	Deficient	Reduced
Working conditions	Advantageous	Improved
	Compatible	Not significant
	Incompatible	Reduced
Adequacy of MMI and operational support	Supportive	Improved
	Adequate	Not Significant
	Tolerable	Not Significant
	Inappropriate	Reduced
Availability of procedures/ plans	Appropriate	Improved
	Acceptable	Not significant
	Inappropriate	Reduced
Number of simultaneous goals	Fewer than capacity	Not significant
	Matching current capacity	Not significant
	More than capacity	Reduced
Available time	Adequate	Improved
	Temporarily inadequate	Not significant
	Continuously inadequate	Reduced
Time of day (circadian rhythm)	Day-time (adjusted)	Not significant
	Night-time (unadjusted)	Reduced
Adequacy of training and expertise	Adequate, high experience	Improved
	Adequate, limited experience	Not significant
	Inadequate	Reduced
Crew collaboration quality	Very efficient	Improved
	Efficient	Not significant
	Inefficient	Not significant
	Deficient	Reduced

Detecting Cognitive Failure Probability (CFP): The cognitive failure probability shows probability of failure for each cognitive failure type. The amounts of cognitive failure probability are added to the system operation action in order to gain the probability of human error. Considerably, the characteristics of common performance conditions are practiced to adapt the nominal Cognitive failure Probability as shown in Table 2 [12]. Equation 2 is used to calculate the CFP representing the probability of final cognitive function. In this equation, CFP0 denotes to the probability of nominal cognitive failure due to Table 2. CII indicates the context influence index providing the numerical value for Common Performance Conditions. The CII value is calculated based on equation 3. Σ reduced and Σimproved expressing the number of improved CPCs and decreased CPCs, respectively. Notably, index of context influence has been suggested to quantify the basic CREAM. Instead of control modes, there are CII values. The values of CII have been scored as -7 to -3, -3 to 1, 2 to 5 and 6 to 9 in strategic, tactical, Opportunistic and Scrambled control modes respectively. In Fig. 1, the CII and control modes are shown in accordance with CPCs scores where the control modes are divided into region to estimate the CII value. The CPCs combined scores for Σ not significant have no effect upon human performance reliability, the value of context influence index is considered as zero. In case CII reaches zero, CFP equals CFP0. Since this condition is for screening stage only, the extended CREAM can be employed in order to execute detailed reliability analysis. As shown in Equation 4, PII has been applied to estimate the specific quantitative effects of the CPCs rather than linguistic cluster of the CPCs effect upon performance reliability. Table 3 presents the values of PII for common performance conditions [15].

Equation 2:

$$CFP = CFP0.\ 10^{0:25\ CII}$$

Equation 3:

$$CII = \Sigma_{reduced} - \Sigma_{improved}$$

Equation 4:

$$CII = \sum_{i=1}^{9} \text{PII}\ (4)$$

Table 2. Nominal cognitive failure probability

Cognitive function	Generic failure type	Basic value
Observation	O1. Wrong object observed	1.0 E_3
	O2. Wrong identification	7.0 E_2
	O3. Observation not made	7.0 E_2
Interpretation	I1. Faulty diagnosis	2.0 E_1
	I2. Decision error	1.0 E_2
	I3. Delayed interpretation	1.0 E_2
Planning	P1.Priority error	1.0 E_2
	P2.Inadequate plan	1.0 E_2
Execution	E1. Action of wrong type	3.0 E_3
	E2. Action at wrong time	3.0 E_3
	E3. Action on wrong object	5.0 E_4
	E4. Action out of sequence	3.0 E_3
	E5. Missed action	3.0 E_2

Table 3. The PII values for Common performance conditions

PC	CPC Level	PII
Adequacy of organization	Very Efficient	-0.6
	Efficient	0.0
	Inefficient	0.6
	Deficient	1.0
Working conditions	Advantageous	-0.6
	Compatible	0.0
	Incompatible	1.0
Adequacy of MMI and operational support	Supportive	-1.2
	Adequate	-0.4
	Tolerable	0.0
	Inappropriate	1.4
Availability of procedures/ plans	Appropriate	-1.2
	Acceptable	0.0
	Inappropriate	1.4
Number of simultaneous goals	Fewer than capacity	0.0
	Matching current capacity	0.0
	More than capacity	1.2
Available time	Adequate	-1.4
	Temporarily inadequate	1.0
	Continuously inadequate	2.4
Time of day (circadian rhythm)	Day-time (adjusted)	0.0
	Night-time (unadjusted)	0.6
Adequacy of training and expertise	Adequate, high experience	-1.4
	Adequate, limited experience	0.0
	Inadequate	1.8
Crew collaboration quality	Very efficient	-1.4
	Efficient	0.0
	Inefficient	0.4
	Deficient	1.4

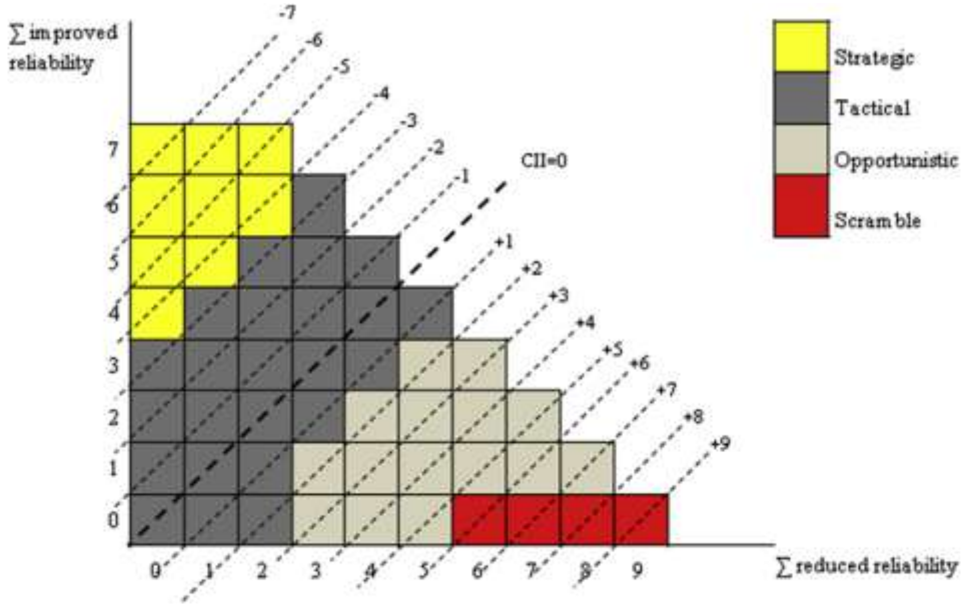

***Fig.* 1.** Context influence index and control modes

RESULTS

Hierarchical Task Analysis in acidization and cementation operations: Table 4 illustrates the results of task identification and the sub-tasks of acidization and cementation services of petroleum wells. Holistically, 5 main tasks and 26 sub-ones have been identified for acidization operation (A.O), 5 main tasks, and 24 sub-ones detected for cementation operation (C.O).

Reliability analysis based on basic version: Based on the steps mentioned in section two, this section specified the relationship between CPCs, the level of performance reliability for each one of the sub-tasks in the cementation and acidization operations as well as the final result of basic CREAM for the above-mentioned operation. For example, Table 5 illustrates the relationship between the CPCs and the level of performance reliability for the sub-task of turning on the truck pump. Notably, the expected effect on the level of performance reliability has been scrutinized. In both cementation and acidization operations, the sub-tasks included 9 and 6 strategic control, 15 sub-tasks had tactical control, 2 and 3 sub-tasks had opportunistic control. In acidization operation, the sub-tasks included compatibility test, acid formulation design, identifying geological layers with (β) control level index equal to -6 and CFPt equal to 0.000177. Remarkably, they scored the highest control level, while the sub-task of identifying the geological layers with (β) control level index equal to -6 and CFPt equal to 0.000177 had the highest control level (strategic control) in cementation operation. Regarding to the lowest control level, the sub-tasks of transmitting acid and other materials to the well location for producing acid had the control level index of 4 and the total error probability of 0.056. Furthermore, the sub-task of displacing acid and its compounds held the control level index of 2 and the total error probability of 0.0177. Hence, they were identified as the lowest control level (opportunistic control) in acidization operation. The lowest control level (opportunistic control) was related to the sub-task of transmitting cement and other additives to the well site for making cement with the control level index of 3 and the total error probability of 0.031489 AND ALSO the sub-task of supplying solution in the present reservoirs at the derrick or at well and adjusting the equipment with the control level index of 2 and the total error probability of 0.0177 in cementation process. Other results are presented in Table 6.

The results presented in Table 6 imply that in the acidic operations, 34.61% of the control modes were strategic, 57.69% and 7.69% were tactical and opportunistic respectively. These numbers are 25%, 62.5% and 12.5% in cementation operation, respectively.

Table 4. Identifying the main tasks and sub-ones in acidization and cementation operation

Main tasks	Sub-tasks of acidization operation		Main tasks	Sub-tasks of cementation operation	
A.O.1. performing the operation	A.O.1.1. supplying personal equipment from the store		C.O.1. performing the operation	C.O.1.1. supplying personal equipment from the store	
	A.O.1.2. turning on the truck pump			C.O.1.2. turning on the truck pump	
	A.O.1.3. acid displacement and its compounds			C.O.1.3. cement displacement and its compounds	
	A.O.1.4. removing acid and the compounds inside the truck stirring pump			C.O.1.4. removing cement and the compounds inside the truck stirring pump	
	A.O.1.5. turning on the mixing pump			C.O.1.5. turning on the mixing pump	
	A.O.1.6. acid sampling			C.O.1.6. cement sampling	
	A.O.1.7. pumping acid by the discharge and pressure specified in the program			C.P.1.7. pumping cement by the discharge and pressure specified in the program	
A.O.2. preparation	A.O.2.1. determining the place of truck pump, air compressor, reservoirs, etc		C.O.2. preparation	C.O.2.1 determining the place of truck pump, air compressor, reservoirs, etc	
	A.O.2.2. equipment setting			C.O.2.2. equipment setting	
	A.O.2.3. lining to well crest and the reservoirs			C.O.2.3. lining the well crest and the reservoirs	
	A.O.2.4. supporting the line by safe cables			C.O.2.4. supporting the line by safe cables	
	A.O.2.5. testing lines pressure			C.O.2.5. test engine pressure	
	A.O.2.6. providing solution in the reservoirs in the derrick			C.O.2.6. providing solution in the reservoirs in the derrick	
A.O.3. supplies	A.O.3.1. requiring to purchase acid and its compound		C.O.3. supplies	C.O.3.1. requiring to purchase cement and its compound	
	A.O.3.2. sending requirement to the store			C.O.3.2. sending requirement to the store	
	A.O.3.3. transmitting acid and other additives to the well site for making acid			C.O.3.3. transmitting cement and other additives to the well site for making cement	
A.O.4. receiving necessary confirmations	A.O.4.1. reporting the design and the operation process		C.O.4. receiving necessary confirmations	C.O.4.1. reporting the design and the operation process	
	A.O.4.2. Submitting the calculations			C.O.4.2. Submitting the calculations	
	A.O.4.3. receiving employer's confirmation			C.O.4.3. receiving employer's confirmation	
A.O.5. assessing and identifying	A.O.5.1. laboratory assessment	A.O.5.1.1. studying and identifying geological layers	C.O.5. assessing and identifying	C.O.5.1. laboratory assessment	C.O.5.1.1. studying and identifying geological layers
		A.O.5.1.2. designing cement formulation			C.O.5.1.2. designing cement formulation
		A.O.5.1.3. well age and reservoir rock sample			
		A.O.5.1.4. compatibility test Reservoir rock and the fluid inside the well			C.O.5.1.3. identifying additives necessary for the cement
		A.O.5.1.5. designing acid formulation			
	A.O.5.2. technical evaluation	A.O.5.2.1. analyzing the excavation information of temperature, the fluid weight inside the well		C.O.5.2. technical evaluation	C.O.5.2.1. analyzing the excavation information of temperature, the fluid weight inside the well
		A.O.5.2.2. designing and cementation program design			C.O.5.2.2. designing and cementation program design

Table 5. The relationship between CPCs and the performance reliability level for the sub-task of turning on truck pump in acidization and cementation operations

CPCs	Acidization operations		Cementation operations	
	CPC level	**Expected effect upon performance reliability**	**CPC level**	**Expected effect upon performance reliability**
Adequacy of organization	Efficient	Not Significant	Very Efficient	Improved
Working conditions	Compatible	Not Significant	Compatible	Not Significant
Adequacy of MMI and operational support	Adequate	Not Significant	Adequate	Not Significant
Availability of procedures/ plans	Appropriate	Improved	Appropriate	Improved
Number of simultaneous goals	More than capacity	Reduced	More than capacity	Reduced
Available time	Adequate	Improved	Adequate	Improved
Time of day (circadian rhythm)	Day-time (adjusted)	Not significant	Day-time (adjusted)	Not significant
Adequacy of training and expertise	Adequate, high experience	Improved	Adequate, high experience	Improved
Crew collaboration quality	Efficient	Not significant	Efficient	Not significant
	$\beta = \Sigma R - \Sigma I$ $\beta = 1 - 4 = -3$ **CFPt**= $0.0056 \times 10^{0.25\beta}$=0.000996 ΣPII = -1.8		$\beta = \Sigma R - \Sigma I$ $\beta = 1 - 4 = -3$ **CFPt**= $0.0056 \times 10^{0.25\beta}$=0.000996 ΣPII = -1.8	

Reliability analysis based on extended version: Table 7 indicates the results related to the extended version of CREAM for cementation and acidization operations. Acidization operation specified that from all the identified errors, 35% (9 tasks) related to execution error, 31% (8 tasks) made by planning error, 23% (6 tasks) caused by interpretation error and 11% (3 errors) affected by observation error. From cognitive activities included 31% of execute, 15% of planning and identification each one of them, 8% of diagnosis, communication and verification, 7% of coordination and 4% of monitoring and regulation. The highest level in human errors was detected in the reservoirs by the cognitive failure probability (CFPi) of 0.02 and acid pumping with specific discharge and pressure in the program along with the cognitive failure probability of 0.0199. As a result, errors related to execution and planning were identified as the most important human's errors in acidization operation.

In cementation operation, results related to assessing human errors using the extended CREAM method revealed that from all the identified errors, 34% made by planning error, 33% related to execution error, 25% caused by interpretation error and 8% affected by observation error. Cognitive activities included 13% of diagnosis and planning and 8% of identification, verification, coordination and communication. Finally, cognitive activities like monitoring and regulation scored 4% of the errors. The most significant tasks identified with high error probability include the sub-tasks of adjusting the equipment with CFPi of 0.0227 (cognitive activity of regulation and cognitive failure of interpretation), locating the pump, truck, air compressor and reservoirs (cognitive activities of identification and cognitive failure of interpretation) with the error probability of 0.0180 and analyzing the excavation information of temperature, the fluid weight inside the well.

DISCUSSION

The human errors will end into disastrous accidents in technical service at petroleum wells. There is no significant study that analyzed human errors in operations with high-risk potentials like acidization and cementation. The current research was considered as one of the initial steps to assess human errors in the mentioned services and to compare them in terms of being hazardous. Results taken from CPCs and the performance reliability level for the specific tasks demonstrate that the time of day, number of simultaneous goals, sufficiency of training and experience are factors reducing the performance reliability in both acidization and cementation operations. In the study, these three factors are mentioned as decreasing factors of performance reliability certainty [7]. However, working conditions, available time, and availability of procedures/ plans were recognized as factors improving the performance reliability [11]. Moreover, working conditions, available time and adequacy of MMI and operational support were mentioned as the most effective decreasing factor of performance [5].

Difference of tasks in different jobs could also be the reason of differences in the results of various researches. Therefore, it is necessary to diminish human errors and increase performance reliability in both operations by reducing the performance reduction factors. As a result, the manager of project should study and edit operating guidelines and schedule. In this way, there will be enough time between each operation to prepare. Besides, because of the different conditions of each well, the personnel should be trained to be ready for operation repeatedly. It is demonstrated that moving forward to strategic control is to enhance the performance reliability. In other words, reduce the overall probability of a cognitive error [12].

Strategic control involves controlling all elements of the organization at the subjective and conceptual level. Since organizational elements are made up of purposes and strategy, technology, structure, human source, environment, culture, and etc., strategic control is considered the most vital and significant among all these elements [13].

In this research, the lowest control level (opportunistic control) was related to the sub-task of transmitting acid/cement and other additives to the well site for making acid/cement in both acidization and cementation operations and its reason is transportation unit.

There are problems in coordination between transportation and acidization and cementation units. Besides, the percentage of plug in is determined by employer's final view. The kind and quantity of plug in are determined according to contractors' experience, but sometimes the employer's view remains and these two different views cause an error.

Tactical control scored the highest percentage in control modes in both cementation and acidization operations. Even though the performance was based on planning and followed a process with few rules in tactical control mode, the nature of the work needs to promote this type of control into a strategic one where the possibility of human error is much more limited compared to tactical kinds [5]. The percentage of the strategic control modes are less than the tactical control ones in both operations, so necessary measures should be conducted to move forward to strategic control. It comes off by training, updating of guidelines, administrative methods, and encouraging personnel. As the percentage of the strategic controls in acidization operation is more than the cementation one from the viewpoint of being more hazardous, this operation is safer.

The most percentage of total declared errors in acidization operation have includes the failure of Execution, and in cementation operation have includes the failure of planning. The errors can be reduced by planning and consulting with experienced people, having more supervision before and during operations, accurate training and personnel selection based on the nature of work.

In acidization, preparation is one of the main task preparation includes two sub-tasks with high-risk probability. Therefore, setting the equipment and providing solution in the reservoirs in the derrick are among the critical sub-tasks. The considerable point is that setting the equipment in both studied operations has the highest cognitive failure probability. Therefore, it is essential to perform such activities as technical training and the holding of smell workshops repeatedly and has epidemically studying for knowing errors.

To reduce the errors and provide solutions in the reservoirs, professional personnel noticing properties of the well should be employed in the derrick. Pumping acid by the discharge and pressure specified in the program is one of decretive sub-tasks in acidization operation and for reducing probability.

In order to reduce the probability of failure in this regard, in addition to a regular program for acidization, systematic repair and caring of equipment should be done. The probability of cognitive failure in two sub-tasks of cementation operation also needs special care for reducing errors. Accordingly, for determining the place of truck pump, air compressor, reservoirs, also for analyzing the excavation information of temperature, the fluid weight inside the well should be used with previous experiences and have enough invention. The higher probability of cognitive failure under the sub-tasks of cementing operations, the higher the probability of failure in the cementing than that of acidization, and it is more hazardous. The main reason is the problem of cement design. The tightness of the cement earlier than the specified time leads to closure the coil pipes in the well. It will be too hazardous and can be a considerable expense. Some of the limitations of this research include: difficult access to blocks and petroleum wells because of limitations in traffic by controller organization, the limitation of operation time, excessive relocation of equipment among different locations of petroleum wells, occupational stress, the lack of tendency among personnel to answer, and the lack of coordination among the personnel of operation.

Table 6. Results of basic CREAM for acidization and cementation operations

MAIN TASKS	SUB-TASKS	ΣI	ΣR	β	CFPt	CONTROL MODE	MAIN TASKS	SUB-TASKS	Σ I	Σ R	β	CFPt	CONTROL MODE
Acidization operation							**Cementation operations**						
A.O.1	A.O.1.1	1	2	1	0.009957	Tactical	C.O.1	C.O.1.1	1	2	1	0.056112	Tactical
	A.O.1.2	4	2	-3	0.000996	Tactical		C.O.1.2	4	1	-3	0.000996	Tactical
	A.O.1.3	1	3	2	0.017708	Tactical		C.O.1.3	2	3	1	0.056231	Tactical
	A.O.1.4	2	2	0	0.005612	Tactical		C.O.1.4	2	1	-1	0.003149	Tactical
	A.O.1.5	2	1	-1	0.003149	Tactical		C.O.1.5	2	0	-2	0.001771	Tactical
	A.O.1.6	1	1	0	0.005621	Tactical		C.O.1.6	2	1	-1	0.003149	Tactical
	A.O.1.7	2	3	1	0.009957	Tactical		C.O.1.7	2	2	0	0.005612	Tactical
A.O.2	A.O.2.1	3	1	-2	0.001771	Tactical	C.O.2	C.O.2.1	3	1	-2	0.001771	Tactical
	A.O.2.2	1	2	1	0.009957	Tactical		C.O.2.2	0	2	2	0.017708	Opportunistic
	A.O.2.3	3	2	-1	0.003149	Tactical		C.O.2.3	3	2	-1	0.003149	Tactical
	A.O.2.4	2	3	1	0.009957	Tactical		C.O.2.4	1	3	-2	0.001771	Tactical
	A.O.2.5	0	5	-5	0.000315	Strategic		C.O.2.5	0	5	-5	0.000315	Strategic
	A.O.2.6	2	2	0	0.005611	Tactical		C.O.2.6	1	3	2	0.017708	Opportunistic
A.O.3	A.O.3.1	0	1	1	0.009957	Tactical	C.O.3	C.O.3.1	2	1	-1	0.003149	Tactical
	A.O.3.2	2	0	-2	0.001771	Tactical		C.O.3.2	2	0	-2	0.001771	Tactical
	A.O.3.3	0	4	4	0.056221	Opportunistic		C.O.3.3	1	4	**3**	0.031489	Opportunistic
A.O.4	A.O.4.1	5	0	-5	0.000315	Strategic	C.O.4	C.O.4.1	4	0	-4	0.000561	Strategic
	A.O.4.2	3	2	-1	0.003149	Tactical		C.O.4.2	2	2	0	0.005612	Tactical
	A.O.4.3	1	1	0	0.005612	Tactical		C.O.4.3	1	1	0	0.005621	Tactical
A.O.5 / A.O.5.1	A.O.5.1.1	6	0	-6	0.000177	Strategic	C.O.5 / C.O.5.1	C.O.5.1.1	6	0	-6	0.000177	Strategic
	A.O.5.1.2	5	0	-5	0.000315	Strategic		C.O.5.1.2	0	5	-5	0.000315	Strategic
	A.O.5.1.3	4	0	-4	0.000562	Strategic		C.O.5.1.3	0	5	-5	0.000315	Strategic
	A.O.5.1.4	6	0	-6	0.000177	Strategic							
	A.O.5.1.5	6	0	-6	0.000177	Strategic							
A.O.5.2	A.O.5.2.1	5	0	-5	0.000315	Strategic	C.O.5.2	C.O.5.2.1	4	1	-3	0.000996	Tactical
	A.O.5.2.2	5	0	-5	0.000315	Strategic		C.O.5.2.2	0	5	-5	0.000315	Strategic

Table 7. Results related to extended CREAM for cementation and acidization operations

SUB-TASKS		COGNITIVE ACTIVITY	COGNITIVE FUNCTION	COGNITIVE FAILURE TYPE		CFP_0		CFPI	
A.O	**C.O**	**A.O C.O**	**A.O C.O**	**A.O**	**C.O**	**A.O**	**C.O**	**A.O**	**C.O**
A.O.1.1	C.O.1.1	Execute	Execution	E5	E5	0.003	0.003	0.005986	0.003215
A.O.1.2	C.O.1.2	Execute	Execution	E2	E2	0.003	0.003	0.001064	0.002705
A.O.1.3	C.O.1.3	Co-Ordination	Planning	P1	P1	0.010	0.010	0.035481	0.010715
A.O.1.4	C.O.1.4	Execute	Execution	E1	E1	0.003	0.003	0.004238	0.002768
A.O.1.5	C.O.1.5	Execute	Execution	E4	E4	0.003	0.003	0.001893	0.002674
A.O.1.6	C.O.1.6	Identification	Execution	E1	E1	0.003	0.003	0.003000	0.002865
A.O.1.7	C.O.1.7	Execute	Planning	P2	P2	0.010	0.010	0.019953	0.010000
A.O.2.1	C.O.2.1	Identification	Interpretation	I1	I1	0.020	0.020	0.007096	0.018031
A.O.2.2	C.O.2.2	Regulation	Interpretation	I1	I1	0.020	0.020	0.035566	0.022700
A.O.2.3	C.O.2.3	Execute	Execution	E1	E1	0.003	0.003	0.001340	0.002705
A.O.2.4	C.O.2.4	Execute	Execution	E5	E5	0.003	0.003	0.003366	0.003444
A.O.2.5	C.O.2.5	Diagnosis	Execution	E1	E1	0.003	0.003	0.000267	0.002356
A.O.2.6	C.O.2.6	Co-Ordination	Planning	P2	P2	0.020	0.010	0.020000	0.011350
A.O.3.1	C.O.3.1	Communication	Planning	P1	P1	0.010	0.010	0.015849	0.009016
A.O.3.2	C.O.3.2	Communication	Planning	P1	P1	0.010	0.010	0.003548	0.009016
A.O.3.3	C.O.3.3	Execute	Planning	P2	P2	0.010	0.010	0.007943	0.011749
A.O.4.1	C.O.4.1	planning	Planning	P2	P2	0.010	0.010	0.000794	0.008128
A.O.4.2	C.O.4.2	Verification	Interpretation	I1	I1	0.020	0.020	0.012619	0.002000
A.O.4.3	C.O.4.3	Verification	Interpretation	I1	I1	0.010	0.020	0.010000	0.002000
A.O.5.1.1	A.O.5.1.1	Identification (A.O) Diagnosis (C.O)	Observation	O2	O2	0.007	0.007	0.000442	0.005071
A.O.5.1.2	A.O.5.1.2	Identification (A.O) Planning (C.O)	Observation (A.O) Interpretation (C.O)	O2	I1	0.007	0.02	0.000442	0.015172
A.O.5.1.3	A.O.5.1.3	Planning (A.O) Diagnosis (C.O)	Interpretation (A.O) Observation (C.O)	I1	O2	0.020	0.007	0.003170	0.00531

A.O.5.1.4		Diagnosis	Execution	E1		0.003		0.000119	
A.O.5.1.5		Planning	Interpretation	I1		0.020		0.000796	
A.O.5.2.1	C.O.5.2.1	Monitoring	Observation (A.O) Interpretation (C.O)	O2	I1	0.007	0.020	0.000442	0.016257
A.O.5.2.2	C.O.5.2.2	Planning	Planning	P2	P2	0.010	0.010	0.000631	0.007586

CONCLUSION

According to cementation and acidization operations belongs to critical processes and human error in them will cause irrecoverable effects, it's recommended to do control measures for those of tasks and sub-tasks that have high probability of human errors. Appropriate control measures are taken based on the risk factors that exist in the risk management documentation. In short, the needed measures to decrease human errors are:

- doing precision inspections employment and choosing the most suitable ones for each position, especially sensitive jobs.
- Employment education and individual acquaintance with risk centers and public and expertise security guidelines.
- setting up daily and periodic educations proportional to operating actions.
- Issuing work permits before starting of non-routine work.
- Full understanding of the workforce with the instructions of Simultaneous operations–SIMOP.
- Management of work environment risks through the implementation of codified programs shifting and correct shifts in such a way that, in addition to overcoming the dangers of individuals, excessive fatigue and human error can be prevented.

ACKNOWLEDGMENTS

Authors wish to extend their gratitude to Iran's national excavating company.

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