Relevance of Virtual Reality in Minimizing Human Errors in Oil and Gas Companies

Author's Details:

(1) **Dr. B.A Anuradha** – Principal of Al-Ameen Institute of Management Studies-University of Mysore

(2) **Mohammed Ali Yahya AlHajj**- Al-Ameen Institute of Management Studies-University of Mysore

Abstract

Errors and mistakes are common in Business. It is important to minimize the effect of the error specially in environments like the oil and gas industry.Mistakes that lead to huge damages to the organization infrastructure resulting in innumerable losses. The major part of the error occurrences is due to the human factors. In this paper, the researchers show how the intervention of technology that eliminates the surprise factor causing such incidences inside the oil and gas industry.Technology like virtual reality (VR) which helps the employee to rehearse himself to get acquainted to situations to know how to react according to the system and organizational policies. Because Error is not accepted in hazardous situations such as digging or maintenance time. The work must be accurate. VR helps the employee to be ready to handle a scenario he has previously been exposed in the VR simulation and to prevent any kind of loss or injury.

Keywords: *Virtual reality, Oil and Gas, Human Error, Technology*

INTRODUCTION

"Human error" refers to any mistake or action made by a human that causes the thing they are doing to be incorrect. This error, or human error, does not account for premeditated errors or negligence. It is the human equivalent of the machine's margin of error (Mulholland, 2018). And according to (Galloro, et al., 2020) The VR platform provides an intuitive and immersive human–computer interface which can be an efficient tool for industrial training and maintenance services that help to deal with human errors.

According to the article (Bairstow, 2016), 80% of the oil and gas accidents were caused by human error. Some incidences cost a lot of money as in Deepwater Horizon oil incident that took place in USA in 2010. This incident was mainly caused by the engineers' deficiency to build enough cement protection and missing gas alarm system (Mullins, 2010) (Pallardy, 2021) . This is one of the many problems in such companies. Many others include the employee's lack of experience in handling the situation and preventing the disaster occurrence before happening. This incident caused a huge environmental catastrophe in the Gulf of Mexico.

The use of VR helps to minimize risk during training, because the VR provides a replicated environment that helps the employee to work with less effort and to learn with minimum losses if mistake had to happened. VR also gives the feeling of comfort to learn from mistakes better than learning from mistakes in real scenario (Ferguson, 2020) .

In operations, human errors always form a threat to both employee and the company in general and it is responsible for 52% of the incidents. It was the main source of a host of famous tragedies (Mulholland, 2018) .

Types of Human Error

According to (Mulholland, 2018) , there are two categories of human errors; Thinking Errors and Action Errors, detailed below:

- Thinking errors are situations where the intended actions are wrong rather than the way they're carried out. Here, an incorrect or flawed plan of action is the cause of the error as opposed to the action itself.
- Action errors are related to times where actions aren't performed as planned, usually because the responsible person is familiar with the process and relies more on instinct than his conscious thought.

Other studies like (Alkhaldi, et al., 2017) classified the Human Errors into the following three main types based on Reasons' classification in 1990:

- Slips: Actions were not carried out as intended or planned.
- Lapses: Actions were missed.

- Mistakes: A plan was inadequate to achieve the intended outcome.

There is also another categorization of subtypes of human errors that is provided by (Adams, 2018).. Such subtypes can be under the previous three main types above and they can be mentioned as follows:

- Failing to perform or omitting a task.
- Performing the task incorrectly.
- Performing an extra or non-required task.
- Performing tasks out of sequence.
- Failing to perform the task within the time limit associated with it.
- Failing to respond adequately to a contingency.

RESEARCH METHODOLOGY

Data for the current study was obtained with the help of a questionnaire, that facilitate to achieve the objectives of this study. The questionnaire was sent to the employees of oil and gas businesses in Yemen. The focus of this study is on staff in the oil and gas business which is one of the research's targeted topics or fields of interest. The analysis is primarily cross-sectional in nature, meaning that the information was acquired from workers just once. The sample is drawn using convenience sampling technique of choosing employees who work for oil and gas companies in Yemen, across public and private sectors.

Research Design

The researchers used both quantitative and qualitative methodologies in this study since it is concerned with the quantity of participants as well as the correctness of the data. The purpose of this study is to discover and investigate the details of the condition. The importance, dimensions, and reality of a situation are discussed in qualitative analysis.

Research Sample

In this research, the sample size is restricted to a group of oil and gas professionals are working in Yemen who have shown an interest in participating. The technique should be divided into two steps, which include targeting the sample of the study, and determining the results of the survey. All of these steps have been taken into consideration over the course of this research.

Data Collection

The researchers collected answers from 176 individuals. The data collection process took some months to complete. For the purpose of analysis, the researchers organized their data into tables and figures. A question was raised about the average number of mistakes that happened in traditional training and what is expected in VR training according to their experience. This question has one chosen answer from four possible answers.

RESULTS AND FINDINGS

The results obtained from the 176 respondents concerning the estimation of the average number of mistakes that occurred during the training, either in VR or Traditional training. Table 1 shows the sample's age frequencies and their experience is shown in Table 2.

Table 1 Respondents Age

Age	**(30 - 39)**	**(40 - 49)**	**(50 or More)**	**Total**
Public	32	30	8	**70**
Private	70	32	4	**106**
G/Total	**102**	**62**	**12**	**176**

Table 2 Respondents Experience

Experience	**6 to 10**	**11 to 20**	**Senior > 20**	**Total**
Public	14	40	16	**70**
Private	66	31	9	**106**
G/total	**82**	**71**	**25**	**176**

The results between two sectors prove some differences in responses, as mentioned in tables 3 and 4:

Table 3 Respondents in both sectors

	Private		**Public**	
	VR	Traditional	VR	Traditional
1 – 2 times	58	-	-	-
3 – 5 time	48	51	-	20

More than 5	-	55	-	50
Not Sure	-	-	70	-
Total		106		70

Table 4 Respondents Percentage in both sectors

	Private		Public	
	VR	Traditional	VR	Traditional
1 – 2 times	55 %	-	-	-
3 – 5 time	45 %	48%	-	29%
More than 5	-	52%	-	71%
Not Sure	-	-	100 %	-
Total		100%		100%

As seen in Table 3 above, this table shows only the number of both private and public sector respondents who are taking part in the current study. In total, there are 106 participants from the private sector and only 70 participants from the public sector. Their responses are represented in percentages as in table 4.

In table 4 above, in the private sector, around 55% of the respondents find VR has less average occurrence than traditional training. Approximately the same percentage of VR and traditional training respondents have no difference, and the average will be the same 3-5 mistakes during training. However, only 52% of private respondents found that the average may take more than 5 times in traditional training until the employee learns the task.

It is also noticed in table 4 that in public sector, 100% of the respondents or all the respondents were not sure about the effect of VR training as they are not familiar with this kind of technology. But most of them, 71%, are certain that the average of mistake occurrence in traditional training is 5 times more than mistakes in VR. The rest of the public sector respondents is 29% who answered that in traditional training the average is between 3-5 times.

To sum up, the analysis above revealed the following results:

- 55% of the private sector respondents said that VR training was safer than traditional training because there are fewer mistakes in VR training than there are in traditional training.
- There is a difference between the respondents of private and public sector opinions in the sense that in the public sector, employees don't have any experience regarding VR training.

Chi-Square Test

We use the Chi-square test as method to find the significant relationship between the respondents in private and public sector and their chosen opinions.

Regarding the respondents' answers of the average error occurrences on the traditional Training. We first calculated the expected value (table 6) using the equation $-(Raw\ Total \times Column\ Total)/Grand\ Total -$ for each observed value in the table 5 below:

Table 5 Observed values for Traditional Training Answers

	Private	Public	Total
3 – 5 time	51	20	**71**
More than 5	55	50	**105**
Total	**106**	**70**	**176**

Table 6 Expected values for Traditional Training answers

	Private	Public
3 – 5 time	42.8	28.2
More than 5	63.2	41.

Then, we calculated the Chi-Square by using the next formula, which illustrated in the next table 7 for each value of *O*.

$$X^2 = \sum_{i=1}^{k} \left(\frac{(O_i - E_i)^2}{E_i} \right)$$

Table 7 Chi-Square Calculation- traditional training

O	*E*	*(O-E)*	*(O-E)2*	*(O-E)2/E*
51	42.8	8.2	67.2	1.6
55	63.2	-8.2	67.2	1.1
20	28.2	-8.2	67.2	2.4
50	41.8	8.2	67.2	1.6
		X²		**6.6**

And to find degree of freedom (df), we calculated it by using the equation $(df = (r-1) \times (c-1))$. In this case $df = (2-1) \times (2-1)) = 1$

Using the Chi-square Distribution with significance level of α = 0.05 and df = 1, we found X^2 tabular value is 3.841 which less then X^2 calculated value.

And to calculate the P-value we used excel function = CHISQ.DIST.RT(Value of X^2,df), which in this case CHISQ.DIST.RT(6.6,1) ~ = 0.010

Table 8 X2 and P-value of Traditional training

	Value	df	p
X²	6.6	1	0.010
N	176		

We suggested the below hypothesis:

- **Null Hypothesis**: there is no significant relationship between the public and private sectors respondents and their opinions in evaluating the average error occurrences in traditional training.
- **Alternate Hypothesis**: there is a significant relationship between the public and private sectors respondents and their opinions in evaluating the average error occurrences in traditional training.

As the P- value less then significance level of α = 0.05, we can accept the alternate hypothesis, and there is a significant relation between the sectors respondents and their opinions in evaluating the average error occurrences in traditional training.

The same process has been done to the VR training opinion answers. We calculated the expected value (table 10) for each observed value in the table 9 below:

Table 9 Observed values for VR Training answers

	Private	Public	Total
1 – 2 times	58	-	**58**
3 – 5 time	48	-	**48**
Not Sure	-	70	**70**
Total	**106**	**70**	**176**

Table 10 Expected values for VR Training answers

	Private	*Public*
1 – 2 times	34.9	23.1
3 – 5 time	28.9	19.1
Not Sure	42.2	27.8

Then, we calculated the X^2, which illustrated in the next table 11 for each value of *O*.

Table 11 Chi-Square Calculation- VR training

O	*E*	*(O-E)*	*(O-E)2*	*(O-E)2/E*
58	34.9	23.1	533.6	15.3
0	23.1	-23.1	533.6	23.1
48	28.9	19.1	364.8	12.6
0	42.2	-42.2	1780.8	42.2
0	19.1	-19.1	364.8	19.1
70	27.8	42.2	1780.8	64.1
		X²		**176.4**

And to find degree of freedom (df), we calculated it by using the equation $(df = (r-1) \times (c-1))$. In this case $df = (3-1) \times (2-1)) = 2$

Using the Chi-square Distribution with significance level of α = 0.05 and df = 2, we found X^2 tabular value is 5.991 which less then X^2 calculated value 176.

And to find the P-value we used excel function = CHISQ.DIST.RT (Value of X^2,df), which in this case CHISQ.DIST.RT(176.0,2) ~ = 0.000

Table 12 X2 and P-value of VR

	Value	df	p
X²	176	2	0.000
N	176		

We also, suggested the below hypothesis:

- **Null Hypothesis**: there is no significant relationship between the public and private sectors' respondents and their opinions in evaluating the average error occurrences in Virtual Reality training.
- **Alternate Hypothesis**: there is a significant relationship between the public and private sectors' respondents and their opinions in evaluating the average error occurrences in Virtual Reality training.

As the P- value less then significance level of $\alpha = 0.05$, we can accept the alternate hypothesis, and there is a significant relation between the sectors respondents and their opinions in evaluating the average error occurrences in Virtual Reality training.

CONCLUSION

The purpose of this study was to determine if there is a difference between virtual reality training and traditional training in terms of the occurrence of mistakes. The results of the study indicated that Virtual Reality training helps in minimizing occurrences of errors and is useful in minimizing the time required for an employee to learn the tasks. It also helps in reducing the damage that takes place throughout the learning process.

The findings of the research confirmed the relevance of virtual reality (VR) in training for enhancing learning by way of repetition and avoiding errors during training.

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