Safety Culture of Companies in the Oil and Gas Industry

by

Beshoy Safwat Morees Aziz

13454

Dissertation submitted in partial fulfilment of

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CERTIFICATION OF APPROVAL

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Approved by,

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Associate Professor Dr. Zulkipli b. Ghazali

Universiti Teknologi PETRONAS

Tronoh, Perak SEPTEMBER

2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Beshoy Safwat Morees Aziz

ABSTRACT

This project examines the factors that influence the safety culture in companies of the oil and gas industry. The project highlights and identifies the important factors that affect the safety culture in the oil and gas industry and based on the findings from past researches and a field study, a model of safety culture will be developed.

The report explains in details the review of 48 literature and case studies that are related to the safety culture of companies in different industries but mainly from the oil and gas industry. The literature studied the factors that affect the safety culture and identified the factors that contributed to the occurrence of major accidents.

The factors affecting the safety culture were identified and then categorized into the three main building categories of any system which are structure, behavior and process based on their presence in the literature. The identified factors were ranked according to their importance and frequency in the past literature. Based on that ranking, the structure, behavior and process categories were arranged also based on their importance.

The study compared between the theoretical outcome from the literature review and the experts' point of view in terms of the ranking of the factors affecting the safety culture and the building categories of any system then the findings were studied and a model that emphasizes the most important factors that affect the safety culture in the oil and gas industry. The developed model will contribute greatly in decreasing the number of accidents that take place in the oil and gas industry and will improve the safety culture of companies in the oil and gas industry.

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ABBREVIATIONS AND NOMENCULTURE

UTP	Universiti Teknologi PETRONAS
BP	British Petroleum
O&G	Oil and Gas
GDP	Gross Domestic Product
FDM	Fuzzy Delphi Method
SOCSO	Social Security Organization

CHAPTER 1 – INTRODUCTION

1.1 Background

The oil and gas industry includes the global processes of exploration, extraction, refining, transporting, and marketing of petroleum products. It is also one of the fastest growing industries in which huge investments and large number of man power are employed in the business operations. With the increasing demand for petroleum products by industries and consumers, the oil and gas industry will continue to be the catalyst of economic growth in the world.

Since the explosion of the rig named Piper Alpha that happened in 1988 in the North Sea which led to the death of 167 and the loss of 1.7 billion pounds, the whole world has directed their attention to the importance of Safety culture. However, this is after the British Petroleum wellhead blowout that caused the largest marine oil spill in the history of oil and gas industry, another accident which had happened in 2010 in the Gulf of Mexico, unfortunately claimed 11 lives. After the BP accident, safety culture in companies in the oil and gas industries has become one of the hottest topics that are being studied. Among others, practitioners and academicians have and continuingly trying to identify and examine the factors that influence the safety culture and recommending ways to prevent those accidents from happening.

1.1.1 Importance of the Oil and Gas Industry to the World

Within less than a century, the oil and gas industry has become the most important industry in the world. Studies indicate that oil and gas accounts for half of the humanity's primary supply of energy. Oil alone supplies third of the primary energy[1]. It is considered to be the lifeblood of the world's economy over the past 100 years. It is directly responsible for 2.5 percent of the Gross Domestic Product (GDP) of the world.

Oil and gas occupy a prominent position among the known energy sources in the world and the reasons leading oil and gas to play such a role among the various energy sources are attributable to several factors including the multiplicity of functions that can be performed by oil and gas. They provide heat, light and energy that is required to implement different types of projects that help in the reconstruction and the development of the world's economy.

For example, in the field of transportation, almost 100 percent of the world's transportation systems are powered directly or indirectly by oil and gas except for that minuscule number of electric powered vehicles that cannot move faster than 25 mph without oil. Transportation, in turn, accounts for a sixth of the world's GDP according to the statistics in 1997[1].

According to the most recent statistical review of world energy consumption by BP (British Petroleum), there are 6 sources of energy which are oil, natural gas, coal, hydroelectricity, nuclear energy, and renewable energy. Based on the study, Oil and Natural gas represent more than half of the world energy consumption. The study indicates that demand for oil and natural gas was increasing rapidly since 1988 and it will keep increasing more rapidly for the coming years[2].

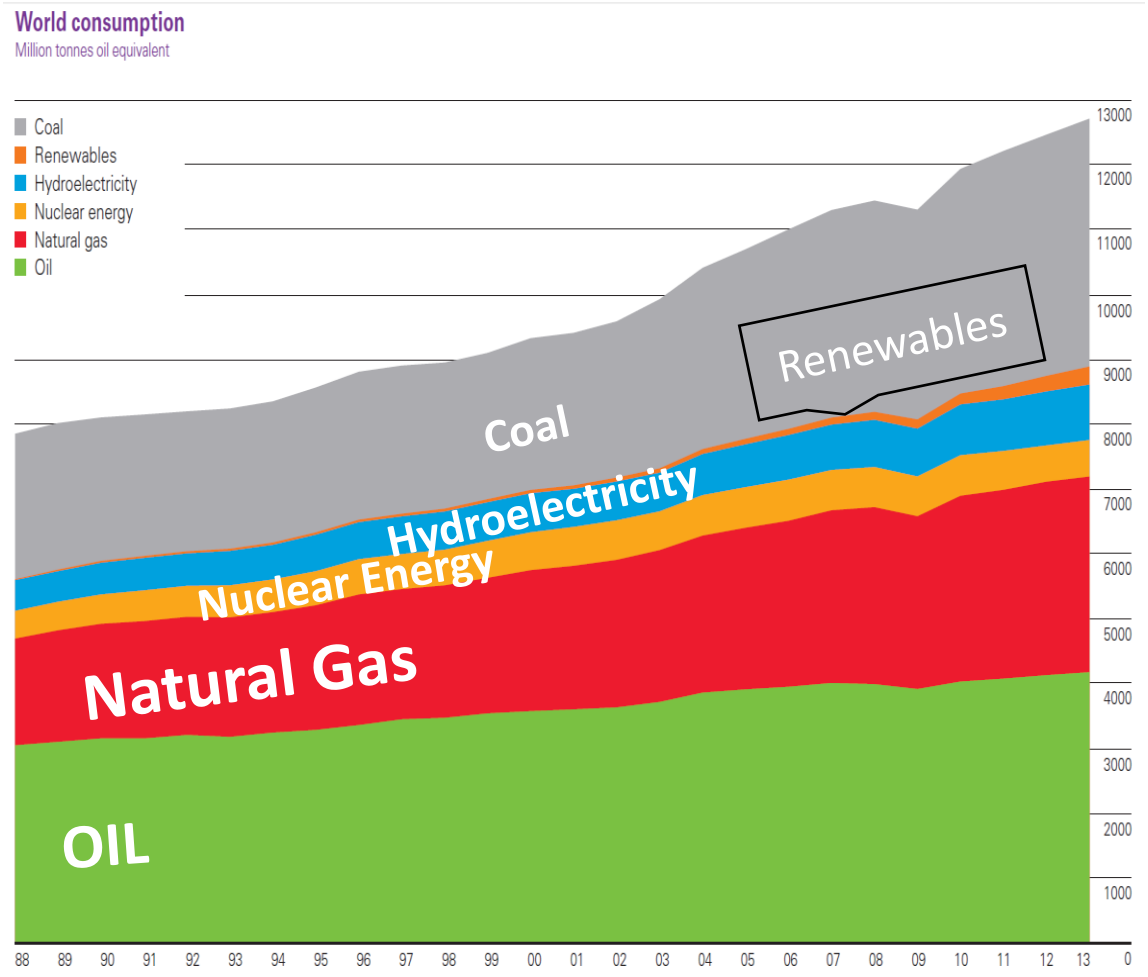

Figure 1: BP Statistical Review of World Energy Consumption 2014

The oil and gas industry are not only critical to the human life but currently, based on numbers, there is no reasonable replacement of the oil and gas in the meantime. According to the Center for the Study of the Built Environment (CSBE), there is only 0.07 percent increase in the usage of renewable energy in the world energy consumption from 1973 to 2009[3]. In 2010, the world's oil production was 82 million barrels per day which is around 5.7 terawatts of power production. On the other hand, in the same year, the world's wind and solar power production was about 34 gigawatts and 3.4 gigawatts respectively[4]. The world's energy production from oil is almost 1500 times the world's sun and wind energy production.

1.1.2 Importance of the Oil and Gas Industry to Malaysia

The oil and gas industry is central to the economic growth of Malaysia. It contributed to fifth of Malaysia's GDP over the past 10 years[5]. The oil and gas products occupies around 25-30 percent of Malaysia's exports. In terms of the governmental revenue, 25 percent is generated by the oil and gas industry. Regarding the world's oil production, Malaysia is the 28th oil producer in the world. The hydrocarbons reserve of Malaysia is estimated to be 20.56 billion barrels of Oil Equivalent (BOE) with a daily production of 1.63 million BOE[6].

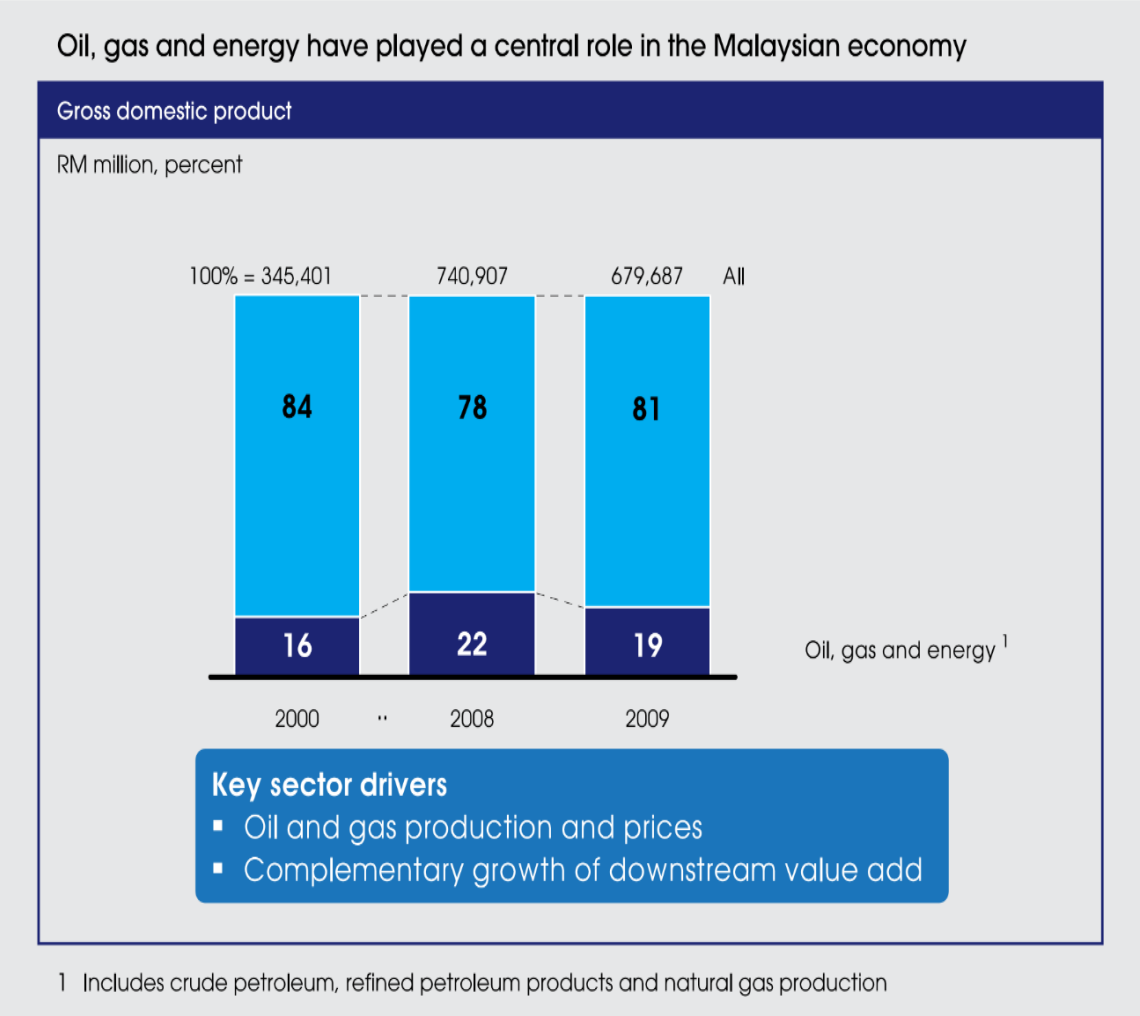

Figure 2: Participation of oil and gas industry in economy of Malaysia

1.1.3 Safety Culture

The term “Safety Culture” was first introduced after the Chernobyl disaster. Since then a number of definitions have been published about Safety Culture. Safety culture can be defined as the ways by which the safety at the workplace is managed. Safety culture is the mirror that reflects the attitude, perceptions, beliefs and the values that employees share in relation to safety. Generally it is the way by which safety is managed at the workplace.

1.1.4 Importance of Safety Culture for the Oil and Gas Industry

Same like any other industry, the oil and gas industry experiences cases of accidents and involves environmental concerns. The difference is that for oil and gas industry, most of the accidents are disastrous[7]. A lot of initiative actions were taken, rules and regulations were tightened and implemented in trying to curb these unwanted incidents. However despite all the effort, accidents still occur.

Past records have shown that the operating environment of oil and gas industry experienced a monumental shift after the occurrence of many accidents that involved the death of large number of workers and the pollution of the environment. As a result, great care and focus are given to the importance of safety culture implementation. In this aspect, the oil and gas companies face many challenges in today’s business landscape such as fatality prevention, the changing role of safety professionals, managing behavioral reliability among increasingly globalization operations, and maintaining a focus on process and personal safety. The key to responding to these challenges is to approach safety performance systematically[8].

1.2 Problem Statement

Many studies and researches were done in the field of health and safety in the oil and gas industries, trying to figure out the causes of the accidents, the factors affecting occupational health and safety, and the possible ways to prevent them from happening. Those studies identified many causes, factors and ways but even after all the number of lives lost, the huge damage occurred, and the great effort spent trying to stop those accidents from happening, outrageous accidents still happen in the oil and gas industry perishing a number of valuable lives and resources[9-12]. According to the recent statistics by the official organisation of social security in Malaysia, 493 cases were reported in 2009, 561 cases were reported in 2010, 578 cases reported in 2011, 565 reported cases in 2012, and 517 reported cases reported in 2013[13].

Table 1: Accidents Reported by SOCSO

Industry / Activity	2013	2012	2011	2010	2009
Crude petroleum and natural gas production	54	61	52	42	36
Manufacture of chemical products	248	238	230	287	262
Petroleum refineries	31	36	41	44	28
Gas manufacture and distribution	70	101	156	76	69
Petrol, lubricating oils, etc.	114	129	99	112	98
Total	**517**	**565**	**578**	**561**	**493**

Source: Social Security Organization (SOCSO) annual report – Malaysia

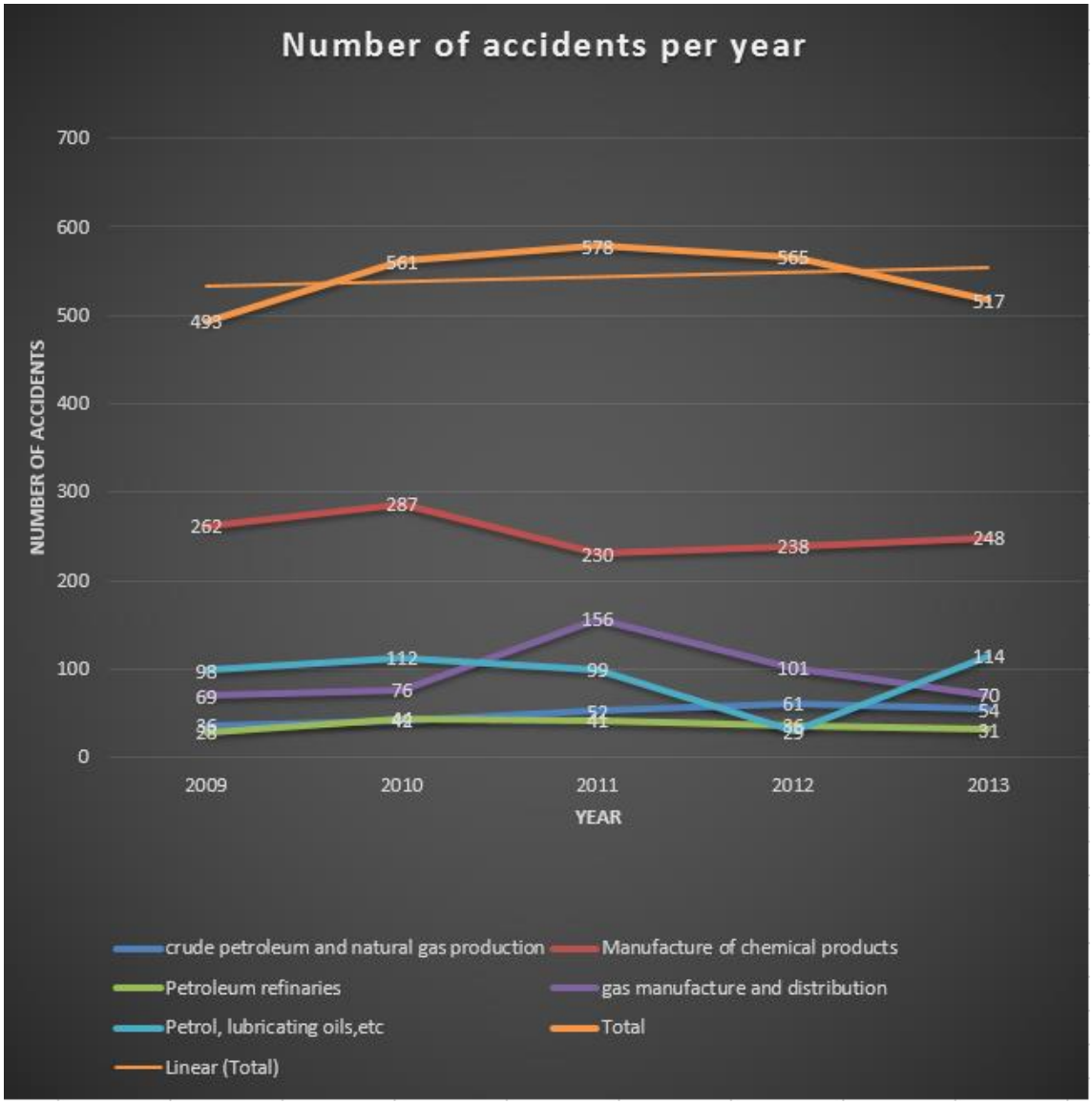

Figure 3: Number of accidents per year for different sectors of the oil and gas industry

The previous literature in occupational safety and accident prevention has found that human error and unsafe behaviour were the two major contributors to workplace accidents[14]. Hence, a study that examines how safety is managed in workplace will be useful in order to formulate safety strategies for the management to mitigate and prevent the occurrence of misshapes or accidents in the workplace through safety attitudes, beliefs, and perceptions of employees towards safety.

The problem statement can be summarised in the following:

- Industrial point of view
    - Companies of the oil and gas industry have stringent rules and regulations regarding safety culture but accidents are still happening
    - Number of accidents of the oil and gas industry in Malaysia is not decreasing

- Research point of view
    - Previous studies have indicated that human error and unsafe behaviour were two major contributors to workplace accidents
    - Therefore, a study that examines how safety is managed will be useful in order to formulate strategies to mitigate this situation

1.3 Objectives and Scope of Study

The scope of this study is to determine the factors that affect the safety culture in companies in oil and gas industries based on an intensive literature review of case studies and studies in the field of enhancing the concept of safety culture in oil and gas industry then categorising these factors under the three main basic components of any industry which are behaviour, process, and structure. From there, the direct of objectives of the project can be achieved. The main objectives of the study are:

1. To determine the factors affecting employees' safety culture in the oil and gas industry
2. Identify the most important category and factors affecting the safety of employees in the oil and gas industry
3. To examine the relationships among these factors of employees' safety by categorizing them into structural, behavioural and process factors
4. To develop employees' safety culture model in oil and gas industry in Malaysia

CHAPTER 2 – LITERATURE REVIEW

This chapter will present a review of literature linked with safety culture and the affecting factors in companies in different industries but mainly the oil and gas industry. From previous literature, there has been significant increase in studies related to safety culture and the factors that influence safety culture[15]. This increase due to the modernization and globalization that led to the need for work environment safety management. This study will explain about the role of each factor that affect the safety culture in oil and gas industry.

Safety Culture and the Affecting Factors

In most of the previous literature, safety culture is defined as the ways in which the safety concept is implemented and applied in the workplace which is reflected in the attitudes, beliefs, perceptions, and the values that employees share in relation to safety[16].

In this project, an intensive literature review is done in the scope of studying the safety culture and the affecting factors. The literature review looks into the factors affecting safety culture from a wider point of view, by studying and considering all the factors that were the reason behind the accidents in different industries from the experts' point of view.

After the review of 48 publications from different journals by different authors from all over the world of topics related to the factors affecting safety culture in different industries but mainly from the oil and gas industry, the mentioned factors were listed down and their frequency was monitored trying to figure out the most frequent factors that are important in the point of view of the authors based on their studies and to determine the factors which were the main reason of causing accidents in the case studies. The results from the literature review were tabulated in the following table:

Table 2: Factors affecting safety culture in the reviewed literature

Title	Year	Factors																						
		Behavioral Acts	Psychological	Organizational	Social	Cultural	working interface	Communication	Human	Safety programs	Leadership	Environmental	Language	Management	Knowledge	Attitude	Trust	Experience	Planning	Contractor alignment with safety	Technical	Non-Technical
IMPROVING SAFETY PERFORMANCE BY UNDERSTANDING RELATIONSHIP BETWEEN MANAGEMENT PRACTICES AND LEADERSHIP BEHAVIOUR IN THE OIL AND GAS INDUSTRY IN IRAQ: A PROPOSED MODEL	2011	✓	✓	✓	✓	✓	✓	✓	✓													✓
THE GOVERNMENT CONTROL ON HEALTH, SAFETY, AND ENVIRONMENT OF OIL AND GAS INDUSTRY IN INDONESIA	1994	✓		✓				✓						✓								
HEALTH, SAFETY AND ENVIRONMENT CULTURE IN THE NORWEGIAN PETROLEUM INDUSTRY	2005	✓			✓		✓		✓													
CREATING A CULTURE OF SAFETY AND RELIABILITY IN THE OFFSHORE WORLD	2013	✓		✓		✓	✓		✓	✓												
SAFETY CULTURE STUDY TO IMPROVE SAFETY PERFORMANCE IN ORGANIZATION	2012	✓		✓					✓		✓	✓	✓									
PEOPLE ARE THE KEY TO SAFETY EXCELLENCE: THE BENEFITS OF A STRONG SAFETY CULTURE	2000			✓					✓													
CHALLENGES IN DEVELOPING OCCUPATIONAL HEALTH SERVICES IN AN OIL & GAS COMPANY	2002		✓	✓					✓					✓								
CULTURE AND HSE MANAGEMENT	2002	✓				✓	✓		✓					✓	✓							
THE ROLE OF TRUST IN SAFETY CULTURE	2003			✓					✓		✓					✓	✓					
SAFETY CULTURE CHANGE - A NORWAY CASE STUDY	2006				✓	✓		✓			✓			✓								
CHANGING SAFETY PARADIGMS IN THE OIL AND GAS INDUSTRY	2004	✓		✓		✓			✓	✓	✓											
HIGH PERFORMANCE SAFETY CULTURE	2008			✓		✓		✓	✓		✓			✓								
SAFETY STEP CHANGE AFTER COMPANY ACQUISITION - A JOURNEY TO INCIDENT FREE OPERATIONS	2010			✓					✓	✓	✓				✓			✓				
SAFETY MANGEMENT IN OIL & GAS INDUSTRY - THE HOW'S AND THE WHY'S	2012			✓					✓					✓					✓			
HSE LEADERSHIP-ONE COMPANY'S PROCESS SAFETY JOURNEY	2010			✓					✓		✓			✓								
WORLD CLASS ORGANIZATIONS/WORLD CLASS SAFETY---HOW THE BEST OIL AND GAS CIMPANIES ACHIEVE AND SUSTAIN OUTSTANDING PERFORMANCE	2009	✓					✓		✓		✓			✓				✓				
RELATIVE CULTURE - A KEY TO SUSTAINABLE WORLD CLASS SAFETY PERFORMANCE	2010			✓		✓										✓						✓
CREATING A WORLD CLASS SAFETY WHERE TWO CULTURES COLLIDE	2011	✓			✓			✓	✓				✓									
CHANGING THE E&P SAFETY CULTURE	1998	✓		✓		✓			✓	✓	✓											
EVALUATING CULTURE AND LANGUAGE EFFECTS ON SAFETY	1998					✓							✓			✓						
RISK-WEIGHTED SAFETY CULTURE PROFILING	2008			✓					✓													
HSE AND CULTURE IN THE PETROLEUM INDUSTRY IN NORWAY	2010	✓					✓		✓		✓	✓						✓				✓
SAFETY CULTURES - PUSHING THE BOUNDARIES OF RISK ASSESSMENT	2009											✓					✓	✓	✓	✓		
OUR SAFETY CULTURE: OUR BEHAVIOUR IS THE KEY	2008			✓		✓																
BUILDING A SAFETY CULTURE - OUR EXPERIENCE IN SAUDI ARAMCO	2008	✓		✓		✓			✓					✓								
IMPLICIT ATTITUDES: A NEW MEASURE OF SAFETY CULTURE	2004	✓														✓			✓			
RISK PERCEPTION AND SAFETY IN THE UK OFFSHORE OIL AND GAS INDUSTRY	1996	✓		✓								✓										
WHY IMPROVING THE SAFETY CLIMATE DOESN'T ALWAYS IMPROVE THE SAFETY PERFORMANCE	2010	✓			✓	✓						✓										
ENSURING CONTRACTOR ALIGNMENT WITH SAFETY CULTURE	2010			✓										✓						✓		
THE IMPACTS OF NATIONAL CULTURE ON THE SAFETY CULTURE IN THE GLOBAL OIL AND GAS INDUSTRY	2012				✓	✓		✓	✓													
DEVELOPING EFFECTIVE SITE SAFETY LEADERS IN THE OIL AND GAS INDUSTRY	2014	✓		✓					✓					✓				✓	✓			
EVALUATION OF SAFETY PERFORMANCE AND COMPLIANCE OF WORKERS IN SELECTED OIL AND COMPANIES IN NIGERIA	2014	✓	✓			✓										✓						
RISK PERCEPTION AND SAFETY IN THE OFFSHORE OIL INDUSTRY	1994			✓																	✓	
SAFETY CULTURE MATURITY MODEL: A PROCESS WORTH IMPLEMENTING?	2013																					
CHRONIC UNEASE: A SIGN OF A GOOD SAFETY CULTURE	2014		✓	✓					✓		✓						✓					
STEPS FOR THE BEHAVIOURAL BASED SAFETY: A CASE STUDY APPROACH	2012	✓							✓							✓						✓
SAFETY CULTURE: EFFECTS OF ENVIRONMENT, BEHAVIOUR & PERSON	2012	✓			✓	✓			✓													
IMPACTS OF EMPLOYEES SAFETY CULTURE ON ORGANISATIONAL PERFORMANCE IN SHELL BONNY TERMINAL INTEGRATED PROJECT	2012			✓				✓	✓					✓								
FROM A MULTINATIONAL TO A GENERATIVE SAFETY CULTURE	2014	✓				✓		✓	✓				✓									
SAFETY LEADERSHIP IN THE OFFSHORE OIL AND GAS INDUSTRY	2000			✓					✓		✓			✓								
Frequency		20	4	24	7	16	6	8	27	4	12	5	4	13	2	6	3	5	4	2	1	4

The journals in the table are in reference order of: [7, 10, 11, 17-48]

The factors are categorized into 3 main categories which are Behavioral Factors, Process, and Structural Factors based on their presence in the literature. These 3 main categories are the main building units of any organization. As shown in the following figure:

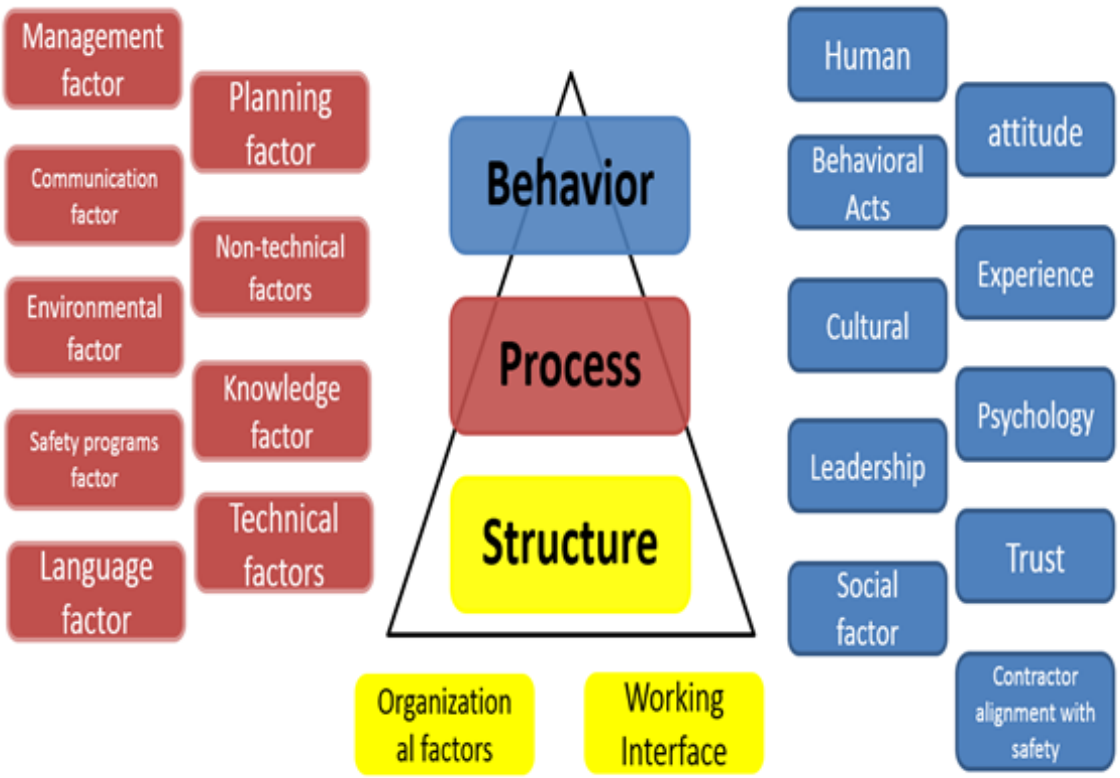

Figure 4: Main categories of factors affecting safety culture in organizations

The factors are categorized and plotted against their frequencies to get this graph:

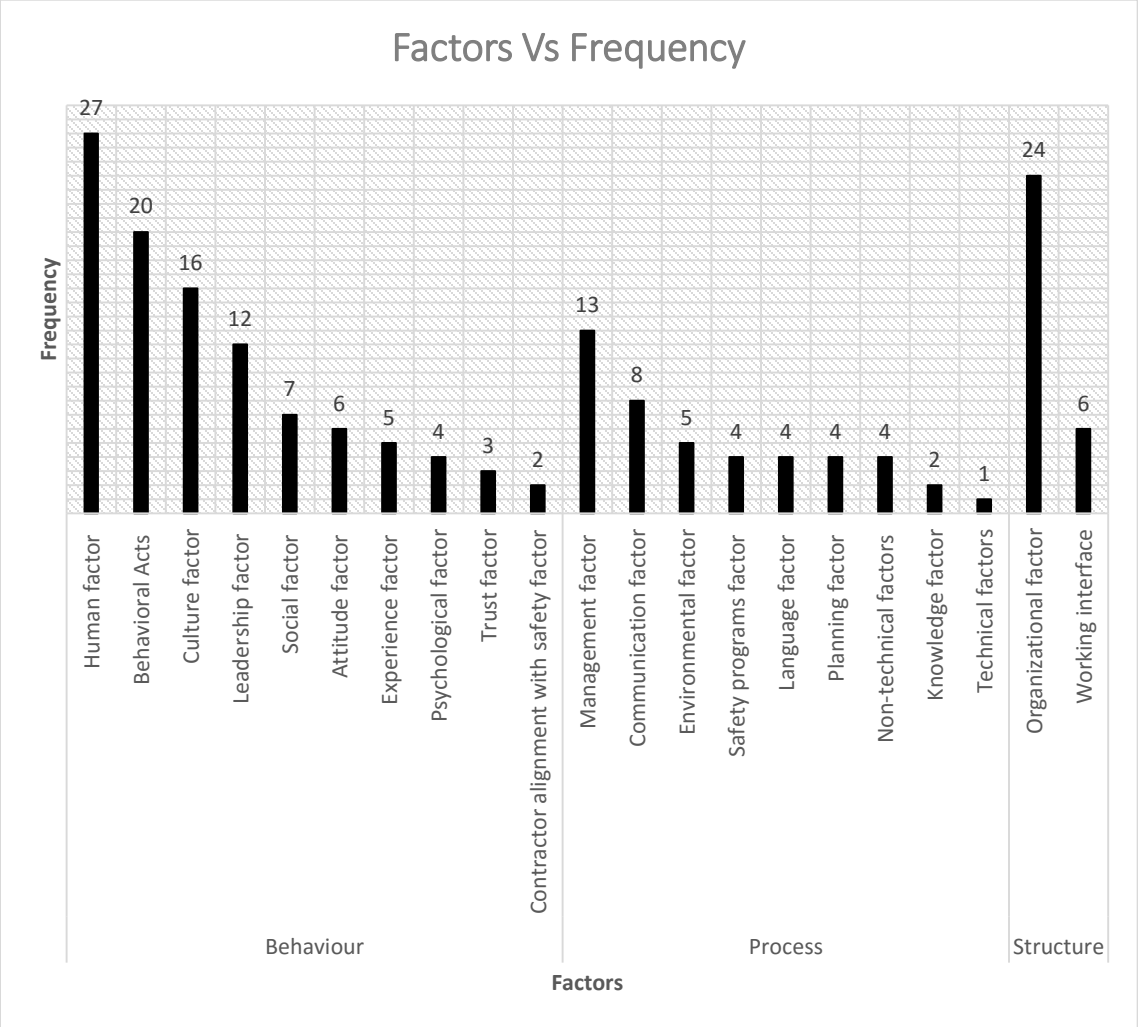

Figure 5: Factors affecting safety culture based on literature review VS frequency of each factor

CHAPTER 3 – METHODOLOGY

3.1 Research Methodology

This particular study is based on researches and surveys in the form of questionnaires conducted on professionals and experts in the oil and gas industry. Researches were carried out to check the initial findings and statistics regarding the factors affecting safety culture in oil and gas industry in the past literature. After that a survey in the form of questionnaire was established that assisted greatly in this study, to get to know the factors affecting safety culture from the point of view of executive and non-executive industry members. The executive members list will include chief executive officers, general managers, senior manager, and engineers in the oil and gas industry. The non-executive members list will include technicians, workers, and everyone involved in working at the site. The figure below will show the flow of this study:

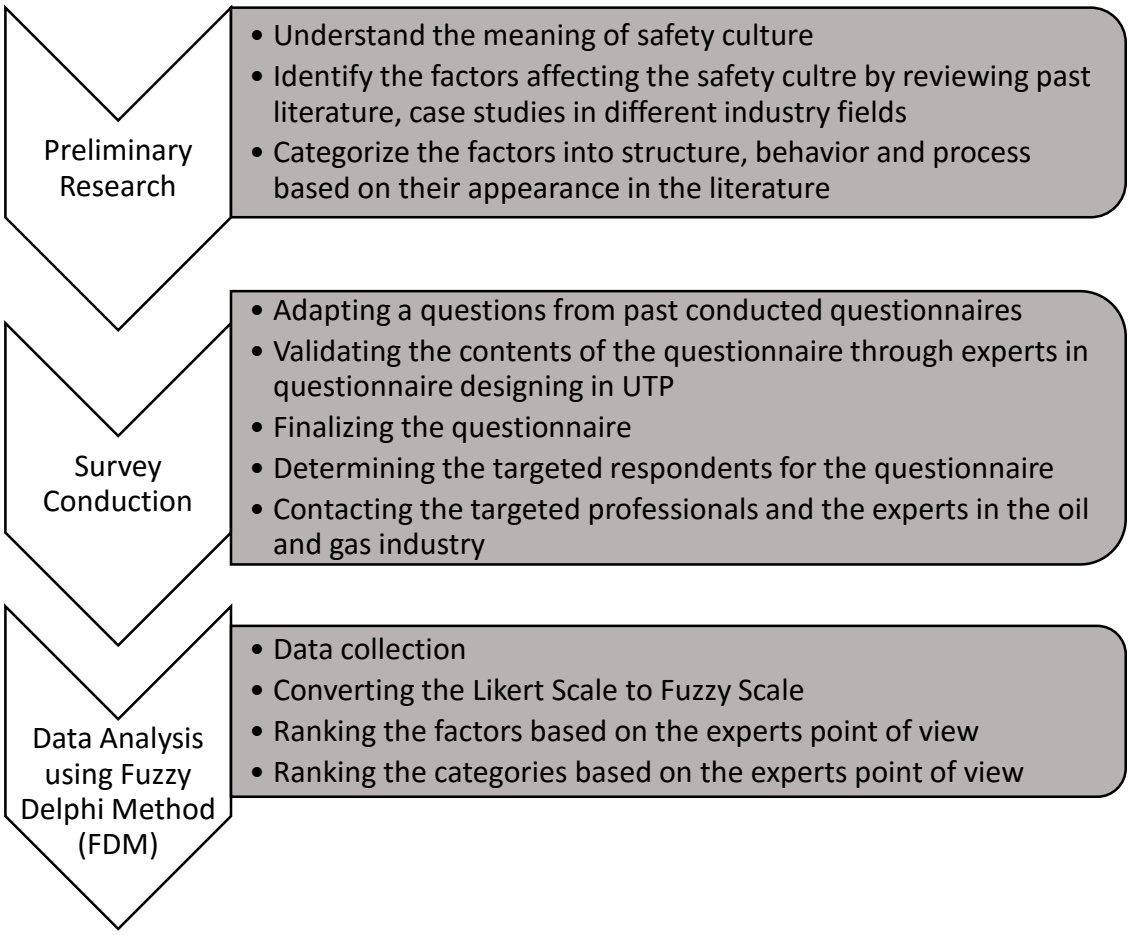

Figure 6: Methodology to be followed in the project to achieve the objectives

3.1.1 Preliminary Research

The preliminary research step was started after finalizing the topic. During the research, the study aimed to fully understand the concept of the safety culture. After understanding the concept, safety culture was investigated in the oil and gas industry. Finally an intensive research was done on identifying the factors affecting the safety culture in different industries so that the effect of those factors would be tested and assessed based on the experience of the professionals from the industry. The aim of this step is to identify the factors that affect the safety culture in other industries other than the oil and gas industry

but at the same time they have a great effect on the safety culture on the oil and gas industries however the researchers never thought that those factor are related the safety culture in the oil and gas industry. This will be confirmed by the questionnaire that will be conducted on the experts from the oil and gas industries.

The factors that are identified in the literature were categorized into the 3main building categories of any company which are structure, behavior and process. The factors are categorized based on their description in the context of the literature. The aim of this step is to narrow the large number of factors into just 3 main categories so that it will be feasible to build a suitable safety model after conducting the survey. The results from the analysis of the respondents will show the most important factors and categories in the point of view of the experienced professionals throughout their long experience in the oil and gas industry.

3.1.2 Survey preparation

The survey preparation step aimed to verify and rank the factors and their corresponding categories in terms of their importance and effect on the safety culture in the oil and gas industry. This step was achieved by studying and reviewing questionnaires that were conducted before in different literatures the set of questions were revised and finalized by experts in questionnaire designing in UTP. The aim is to choose the questions that will serve the objective and the aim of this study. 30 questions were adapted, each question is investigating the importance of one factor and the corresponding category affecting the safety culture in the oil and gas industry. Some of the questions investigated the same factors but in different ways. The questions were prepared so that will be the answer will be in the form of the Likert Scale from 1 to 7 to stand for extremely unimportant to extremely important respectively.

The questionnaire was distributed to professionals from different companies in different countries, operating onshore and offshore. The response will be recorded and will be analyzed to be used in the model building process. The targeted number of respondents is 20 respondents.

3.1.3 Analysis and Findings

This step directly started after distributing the questionnaires on the experts from the industry. The responses were collected online and then prepared to be analyzed by the Fuzzy Delphi Method (FDM).

The process of analyzing the responses of the experts using the FDM method can be summarized in the following steps:

1. Create title and constructs to be measured
2. Expert determination, the number of experts involved is 16
3. The selection of fuzzy scale
4. Obtain the average value (m1, m2, m3)
5. Specify a value ' d ' (TRHESHOLD VALUE)
    - Conditions can comply with only if the value of threshold (d) for the constructs is ≤ 0.2
6. Determine the percentage of each item and the overall consensus items
    - Conditions can comply with only if the value percentage for constructs is > 90%
7. Determination process of the defuzzification-score (ranked / prioritized items)
    - For defuzzification process, the formula used to make sure the ranking/score for an item, the Formulas is as follows:

$$Amax = 1/3 * (m1 + m2 + m3)$$

3.2 Gantt Chart & Achieved Milestone

The Gantt chart for Final Year Project I and Final Year Project II are shown in the tables below:

Table 3: Gantt Chart for FYP 1

WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SELECTION OF PROJECT TITLE														
PRELIMINARY LITERATURE REVIEW														
SUBMISSION OF EXTENDED PROPOSAL														
PROPOSAL DEFENSE														
REQUISITION OF APPROVAL FOR PRELIMINARY DATA GATHERING														
SUBMISSION OF INTERIM DRAFT REPORT														
SUBMISSION OF INTERIM REPORT														

Table 4: Gantt chart for FYP II

WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DATA GATHERING														
QUESTIONNAIRE DEVELOPMENT AND REVIEW														
CONTACT PROFESSIONALS														
SUBMISSION OF PROGRESS REPORT														
DATA ANALYSIS AND REPORTING														
MODEL DEVELOPMENT														
PRE-SEDEX														
SUBMISSION OF DRAFT FINAL REPORT														
SUBMISSION OF DISSERTATION (SOFT BOUND)														
VIVA														
SUBMISSION OF DISSERTATION (HARD BOUND)														

CHAPTER 4 – RESULTS AND DISCUSSION

The initial results from the literature review, indicate that safety culture can be seen as a concept that describes the values which influence the attitudes and behaviors of its members within an organization. Safety Culture is a part of the overall culture of the organization and is seen as affecting the attitudes and beliefs of members in terms of health and safety performance. The results from the review of 48 research papers on safety culture in different industries all over the world can be summarized in the following:

4.1 Factors affecting safety culture

There is a large number of factors that affect the safety culture at the work place. The number of factors affecting the safety culture at a certain industry increases or decreases from one industry to another depending on the type of the industry and the risk involved in the industry. There is a total of 21 factors identified within the context of the 48 references. Based on the review there are safety culture affecting factors that are almost present in all industries. These factors are the factors of highest frequencies appearing within the context of the 48 reviewed researches as safety culture affecting factors. These factors are human factor (27 times), organizational factor (24times), and the Behavioral acts factor (20 times).

The following table shows the identified factors, their frequency and their category.

Table 5: Categories, frequencies and rankings of Factors based on the literature review

Factor	Category	Frequency (out of 48)	Ranking
Human factor	Behavior	27	1
Organizational factor	Structure	24	2
Behavioral Acts	Behavior	20	3
Culture factor	Behavior	16	4
Management factor	Process	13	5
Leadership factor	Behavior	12	6
Communication factor	Process	8	7
Social factor	Behavior	7	8
Attitude factor	Behavior	6	9
Working Interface	Structure	6	10
Experience factor	Behavior	5	11
Environmental factor	Process	5	12
Psychological factor	Behavior	4	13
Safety programs factor	Process	4	14
Language factor	Process	4	15
Planning factor	Process	4	16
Non-technical factors	Process	4	17
Trust factor	Behavior	3	18
Contractor alignment with safety factor	Behavior	2	19
Knowledge factor	Process	2	20
Technical factor	Process	1	21

4.2 Three main categories of the factors affecting the safety culture

There are 3 main building categories of any industry which are Behavior, Process, and Structure. The factors affecting the safety culture in the literature review are divided among factors related to behavior, 9 factors related to process, 3 factors related to structure.

Based on the literature, the human factor is the factor with the highest frequency in the behavior category, the management factor is the factor with highest frequency in the process category, and the organizational factor is the factor with the highest frequency in the structure category.

4.3 Pilot Survey

The pilot survey has been done on ten students from UTP who are currently undergoing their internships in Malaysia, Egypt and Saudi Arabia. The main aim of the pilot survey was to explore the possible problems that may have negative impacts on the targets of the questionnaire. Some of the respondents gave comments related to the clarity of the question due to high technical terms being used but that was because the questions were adapted from questionnaires that were conducted to get the response of professionals from the industry. The format of the questionnaire was revised and modified. The survey type had been replaced by a more suitable one. After the survey was revised, the questionnaire was distributed to professionals in the oil and gas industry in different companies.

4.4 Questionnaire Survey

Twenty-five copies of the questionnaire were printed and was given to a UTP PhD student who was on a field trip visit to the oil and gas field in Terengganu, Malaysia where different oil and gas companies are operating. It was a good opportunity to get the response of the professionals present at the Terengganu Field due to the variety of the companies which they belong but unfortunately there was no feedback from the experts due to them being busy with the operations so the questionnaire was prepared in the online format and the link was distributed to many professionals in different oil and gas companies operating in different countries. The feedback from the respondents was encouraging as 90 percent of targeted professionals have taken the survey sent to them.

The number of the respondents to the online questionnaire has passed the half of the targeted number which is 20 respondents. 16 respondents have done the survey from big companies with different nationalities, years of experience and job titles. The companies participated in this survey are PETRONAS (Malaysia), Halliburton (Egypt), Kuwait Energy (Kuwait), PETROBEL (Egypt), TOTAL (France), Stream Line Corporation (Oman), Schlumberger (Malaysia), British Petroleum (Indonesia), Schlumberger (France & USA), CH2M (Qatar), Baker Hughes (Qatar).

4.5 Data Analysis Using FDM

The process of analyzing the responses of the experts using the FDM method is done on Microsoft excel and it is shown in details in the appendix section but it can be summarized into the following steps:

1. Create title and constructs to be measured
    - TITLE: SAFETY CULTURE OF COMPANIES IN THE OIL AND GAS INDUSTRY
    - CONSTRUCTS: FACTORS AFFECTING THE SAFETY CULTURE IN THE WORK PLACE
2. Expert determination, the number of experts involved is 16
    - The selection of 16 experts is based on the Jones Twiss, 1978 & stating for Delphi method the number of respondents is 10-50 respondents.
3. The selection of fuzzy scale

Table 6: Conversion from Likert scale into Fuzzy scale

LEVEL OF IMPORTANCE	FUZZY SCALE			LIKERT SCALE
EXTREMELY IMPORTANT	0.9	1	1	7
HIGHLY IMPORTANT	0.7	0.9	1	6
IMPORTANT	0.5	0.7	0.9	5
SLIGHTLY IMPORTANT	0.3	0.5	0.7	4
NOT IMPORTANT	0.1	0.3	0.5	3
HIGHLY NOT IMPORTANT	0	0.1	0.3	2
EXTREMELY NOT IMPORTANT	0	0	0.1	1

4. Obtain the average value (m1, m2, m3)
5. Specify a value ' d ' (TRHESHOLD VALUE)
    - Conditions can comply with only if the value of threshold (d) for the constructs is ≤ 0.2

Table 7: FDM TRHESHOLD Value calculation

EXPERT	ITEM																												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.3	0.3	0.0	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2
2	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.3	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2
3	0.0	0.3	0.0	0.1	0.2	0.1	0.3	0.4	0.4	0.0	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.1	0.2	0.2	0.2	0.3	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0
4	0.0	0.1	0.0	0.2	0.2	0.0	0.1	0.1	0.3	0.0	0.1	0.2	0.2	0.5	0.1	0.2	0.3	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
5	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2
6	0.0	0.1	0.0	0.2	0.2	0.2	0.3	0.1	0.4	0.2	0.0	0.2	0.2	0.1	0.1	0.4	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2
7	0.0	0.0	0.1	0.1	0.0	0.1	0.3	0.1	0.1	0.2	0.0	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0
8	0.1	0.0	0.0	0.5	0.0	0.0	0.1	0.4	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.2
9	0.1	0.0	0.1	0.2	0.2	0.0	0.1	0.3	0.1	0.2	0.0	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2
10	0.0	0.0	0.1	0.2	0.2	0.0	0.1	0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.3	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0
11	0.1	0.0	0.3	0.2	0.5	0.0	0.0	0.1	0.1	0.0	0.3	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.2
12	0.0	0.0	0.0	0.2	0.0	0.1	0.1	0.3	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.0
13	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2
14	0.1	0.0	0.5	0.5	0.5	0.5	0.3	0.1	0.1	0.2	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0
15	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.1	0.2	0.1	0.5	0.2	0.8	0.1	0.6	0.8	0.8	0.6	0.3	0.2	0.2	0.2	0.1	0.5	0.6	0.6	0.6	0.6	0.5
16	0.0	0.1	0.0	0.2	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.0
The value of d per item	0.057	0.084	0.119	0.186	0.169	0.143	0.166	0.219	0.198	0.146	0.146	0.202	0.156	0.209	0.092	0.180	0.218	0.198	0.208	0.194	0.146	0.187	0.216	0.180	0.171	0.156	0.112	0.150	0.165	0.137
The value of d constructs	78.563 / (16 x 30) = 0.16																													

6. Determine the percentage of each item and the overall consensus items
    - Conditions can comply with only if the value percentage for constructs is > 90%
7. Determination process of the defuzzification-score (ranked / prioritized items)
    - For defuzzification process, the formula used to make sure the ranking/score for an item, the Formulas is as follows:

$$Amax = 1/3 * (m1 + m2 + m3)$$

After applying the FDM analysis to the response from the experts, the result was a table of rankings of the tested factors and categories. The following table shows that ranking of the categories based on the point of view of the experts.

Table 8: Results of FDM analysis of the response from the experts

Question number in questionnaire	Category	The value of the score		Ranking
		Fuzzy evaluation	Average of fuzzy number	
24	STRUCTURE	11.400	0.713	1
22	STRUCTURE	12.300	0.769	2
8	STRUCTURE	12.500	0.781	3
29	STRUCTURE	12.600	0.788	4
9	BEHAVIOUR	12.700	0.794	5
18	BEHAVIOUR	12.733	0.796	6
23	PROCESS	12.900	0.806	7
28	BEHAVIOUR	12.933	0.808	8
12	STRUCTURE	13.000	0.813	9
25	BEHAVIOUR	13.033	0.815	10
21	BEHAVIOUR	13.067	0.817	11
13	PROCESS	13.100	0.819	12
14	STRUCTURE	13.200	0.825	13
16	PROCESS	13.467	0.842	14
4	STRUCTURE	13.500	0.844	15
30	BEHAVIOUR	13.567	0.848	16
17	PROCESS	13.633	0.852	17
10	PROCESS	13.633	0.852	17
5	PROCESS	13.667	0.854	19
20	STRUCTURE	13.767	0.860	20
26	BEHAVIOUR	13.833	0.865	21
6	PROCESS	13.867	0.867	22
3	BEHAVIOUR	13.933	0.871	23
7	STRUCTURE	14.033	0.877	24
27	BEHAVIOUR	14.067	0.879	25
11	STRUCTURE	14.100	0.881	26
2	PROCESS	14.300	0.894	27
19	PROCESS	14.300	0.894	28
15	PROCESS	14.500	0.906	29
1	BEHAVIOUR	15.067	0.942	30

The results from the FDM analysis of the data shows that the structure category comes at the top of the list as the most important category based on the experience of the experts. Structure is followed by the behavior as the second most important category then finally comes the process as the least important category.

The results from the FDM have also showed that the factor that was investigated by question number 24 in the survey has been agreed upon by the experts to be the most important factor among the investigated factors. Question number 24 investigated the relation between Safety culture practices and the rewarding monetary aspect for the employees. Money is the main motivator for the world. Everyone is working to get money so if money is used to be a reward for the good practice of the safety culture, everyone will follow the rule as the book says.

The second most important factor chosen by the experts is the presence of accessible means for the employees to report the health and safety concerns. Employees are the first line of defense against any safety and health hazard. Their opinion is very important because they can see the real time, live image of any threat situation so it is extremely important to always provide the suitable means for employees to report their health and safety concerns.

The third most important factor in the point of view of the experts is the presence of an investigation team whose main focus is to analyze the workplace safety. Perhaps the reason as to why the experts consider the investigation team an important element is because they are responsible for a regular checkup on the possible causes of accidents and the surrounding hazards. Having a regular checkup on the causes of accidents will participate greatly in decreasing the number of accidents.

The forth most important factor is the presence of a sufficient number of HSE detectors to ensure adequate evacuation time for the employees in accident cases. Studies have showed that most of the accidents become disastrous because the employees do not have the sufficient time to evacuate the location of the accident. The more time the less the impact of the accidents will be. Therefore, it is crucial to have detector and alarms at every single location at the work place so that in the case of accidents, employees will be alerted early and will be able to save their lives.

The fifth most important factor belongs to the category of behavioral factors. According to the experts, employees must be held liable for their actions. When employees are held liable for their actions, it will be easier to apply the punishment and reward system which will help in promoting the responsible employees and identifying the irresponsible ones.

The sixth most important factor also belongs to the behavioral factors category. Experts have agreed on the great importance of leadership skills in the characters of the employees as part of their behavior. Leadership skills at the workplace makes the individual to always think of the goodness of the surrounding people.

Finally, the experts have agreed on the importance of consulting the employees about their training needs. Every person knows what their points of weakness and strength are, therefore the best outcomes will be achieved when the employees are consulted about what the required trainings they should have.

CHAPTER 5 – CONCLUSION AND RECOMMENDATION

The main aim of this study is to identify the factors that affect the safety culture in the oil and gas industry. This aim was achieved by validating the factors from the literature review through professionals from the industry. The missing connection between the large number of studies done in the field of safety in oil and gas industry with the real situation in the field was found. That connection was achieved by including the opinion and the experience of the professional and experts in the industry through the questionnaire conducted on 16 experts from different oil and gas companies all over the world with different number of years of experience.

The second goal of this project is to find the most important factor that affect the safety culture in the oil and gas industry and that goal was achieved by comparing the results from the literature review with the result from the questionnaire analysis. Based on the literature review, the human factor is the most important factor and it is represented in the behaviour category. On the other hand, Structure is the most important category based on the experience of the experts from the industry. This difference between the literature review and the field study explain the reason why the number of accidents in the oil and gas industry is not decreasing, it is even increasing in Malaysia. Most of the theoretical studies focused on the behavioural factors as the most important however it was found that the structural factors are the most important factors of safety culture in the oil and gas industry.

The Third goal of this project is find the relationship between the factors and the categories that affect the safety culture and that goal was achieved by knowing the ranking of the factors and the categories with respect to each other.

The fourth goal of this project is to develop an applicable model of a safety culture in the oil and gas industry that will be beneficial to practitioners in the oil and gas industry. After the comparison between the literature review and the field study, the new model that is developed based on this study has the main focus on the structural factors as the most

important factors affecting the safety culture in the oil and gas industry. From this point, a new system can be followed by the oil and gas companies which will focus more on the structure as the most important category of factors at the work place.

Finally, in the oil and gas industry, the implementation of safety culture is extremely important. In this study, a big number of factors affecting the safety culture were identified by reviewing a big number of literatures in the field of safety in the oil and gas industry. Those factors were grouped into 3 main categories which are Structure, Behaviour, and Process based on their description in the literature. A questionnaire was developed, total number of 30 questions, each test the ranking of one of the most important factors that affect the safety culture in the oil and gas industry. Ten questions was chosen for every category. After analysing the response from the professional in the industry, it was found that the factors enlisted under the process category was given the highest rankings. The factors in the structure category got lower rankings than the factors in the Process category. The factors enlisted under the behaviour category got lower rankings than the factors in the structure category. Finally, based on the results from the literature review, survey, a model will be build that will focus on the importance of the process factors. The model will improve the safety culture in the oil and gas industry and will effectively reduce the number of accidents that may happen by avoiding them.

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APPENDICES

Factors ranking using Fuzzy Delphi Method (FDM)

Step 1:	CREATE TITLE AND CONSTRUCTS TO BE MEASURED
	TITLE: SAFETY CULTURE OF COMPANIES IN THE OIL AND GAS INDUSTRY
	CONSTRUCTS: FACTORS AFFECTING THE SAFETY CULTURE IN THE WORK PLACE

Step 2:	EXPERT DETERMINATION, the number of EXPERTS INVOLVED is 16 people.

The selection of 16 experts is based on the Jones Twiss, 1978 & stating for delphi method the number of respondents is 10-50 respondents.

Step 3:	THE SELECTION OF FUZZY SCALE

The selection of the scale of the review question: according to fuzzy scale

The SCALE of FUZZY-5 SCALE

LEVEL AGREEMENT	FUZZY SCALE			LIKERT SCALE
HIGHLY AGREE	0.6	0.8	1	5
AGREE	0.4	0.6	0.8	4
SLIGHTLY AGREE	0.2	0.4	0.6	3
DISAGREE	0	0.2	0.4	2
HIGHLY DISAGREE	0	0	0.2	1

FUZZY-7 SCALE SCALE

LEVEL AGREEMENT	SKALA FUZZY			SKALA LIKERT
EXTREMELY AGREE	0.9	1	1	7
HIGHLY AGREE	0.7	0.9	1	6
AGREE	0.5	0.7	0.9	5
SLIGHTLY AGREE	0.3	0.5	0.7	4
DISAGREE	0.1	0.3	0.5	3
HIGLY DISAGREE	0	0.1	0.3	2
EXTREMELY DISAGREE	0	0	0.1	1

ARAS TAHAP	FUZZY SCALE			LIKERT SCALE
SANGAT TINGGI	0.6	0.8	1	5
TINGGI	0.4	0.6	0.8	4
SEDERHANA TINGGI	0.2	0.4	0.6	3
RENDAH	0	0.2	0.4	2
SANGAT RENDAH	0	0	0.2	1

ARAS TAHAP	SKALA FUZZY			SKALA LIKERT
SANGAT - SANGAT TINGGI	0.9	1	1	7
SANGAT TINGGI	0.7	0.9	1	6
TINGGI	0.5	0.7	0.9	5
SEDERHANA TINGGI	0.3	0.5	0.7	4
RENDAH	0.1	0.3	0.5	3
SANGAT RENDAH	0	0.1	0.3	2
SANGAT-SANGAT RENDAH	0	0	0.1	1

ARAS KEPENTINGAN	SKALA FUZZY			SKALA LIKERT
SANGAT PENTING	0.6	0.8	1	5
PENTING	0.4	0.6	0.8	4
SEDERHANA PENTING	0.2	0.4	0.6	3
TIDAK PENTING	0	0.2	0.4	2
SANGAT TIDAK PENTING	0	0	0.2	1

LEVEL OF IMPORTANCE	SKALA FUZZY			SKALA LIKERT
EXTREMELY IMPORTANT	0.9	1	1	7
HIGHLY IMPORTANT	0.7	0.9	1	6
IMPORTANT	0.5	0.7	0.9	5
SLIGHTLY IMPORTANT	0.3	0.5	0.7	4
NOT IMPORTANT	0.1	0.3	0.5	3
HIGHLY NOT IMPORTANT	0	0.1	0.3	2
EXTREMELY NOT IMPORTANT	0	0	0.1	1

Step 4: **OBTAIN the AVERAGE VALUE (m1, m2, m3)**

EXPERT	ITEM																														
	1			2			3			4			5			6			7			8			9			10		
1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1
2	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
3	0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1
4	0.9	1	1	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
5	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
6	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9
7	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
8	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9
9	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.9	1	1
10	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
11	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
12	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1
13	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1
14	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
15	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.5	0.7	0.9
16	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1
AVERAGE	0.850	0.975	1.000	0.763	0.925	0.994	0.738	0.900	0.975	0.713	0.869	0.950	0.725	0.881	0.956	0.738	0.894	0.969	0.763	0.900	0.969	0.625	0.800	0.919	0.638	0.813	0.931	0.713	0.875	0.969
	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3

11			12			13			14			15			16			17			18			19			20		
0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1
0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
0.5	0.7	0.9	0.4	0.6	0.8	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1
0.9	1	1	0.9	1	1	0.9	1	1	0.3	0.5	0.7	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1
0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.5	0.7	0.9
0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1
0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9
0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1
0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1
0.9	1	1	0.3	0.5	0.7	0.5	0.7	0.9	0.1	0.3	0.5	0.7	0.9	1	0.1	0.3	0.5	0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7
0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
0.763	0.906	0.975	0.663	0.831	0.938	0.663	0.838	0.956	0.688	0.850	0.938	0.788	0.938	0.994	0.713	0.869	0.944	0.713	0.875	0.969	0.638	0.813	0.938	0.775	0.925	0.981	0.725	0.888	0.969
m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3

20			21			22			23			24			25			26			27			28			29			30		
0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.9	1	1
0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1
0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1
0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9
0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1
0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.4	0.6	0.8	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8	0.7	0.9	1
0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1
0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7
0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7
0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
0.725	0.888	0.969	0.650	0.838	0.963	0.606	0.788	0.913	0.650	0.825	0.944	0.550	0.725	0.863	0.663	0.838	0.944	0.738	0.888	0.969	0.756	0.906	0.975	0.656	0.831	0.938	0.631	0.806	0.925	0.713	0.875	0.956
m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3

STEP 5: **SPECIFY a VALUE ' d ' (TRHESHOLD VALUE)**

EXPERT	ITEM																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.3	0.3	0.0	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2
2	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.3	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2
3	0.0	0.3	0.0	0.1	0.2	0.1	0.3	0.4	0.4	0.0	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.1	0.2	0.2	0.2	0.3	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0
4	0.0	0.1	0.0	0.2	0.2	0.0	0.1	0.1	0.3	0.0	0.1	0.2	0.2	0.5	0.1	0.2	0.3	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
5	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2
6	0.0	0.1	0.0	0.2	0.2	0.2	0.3	0.1	0.4	0.2	0.0	0.2	0.2	0.1	0.1	0.4	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2
7	0.0	0.0	0.1	0.1	0.0	0.1	0.3	0.1	0.1	0.2	0.0	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0
8	0.1	0.0	0.0	0.5	0.0	0.0	0.1	0.4	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.2
9	0.1	0.0	0.1	0.2	0.2	0.0	0.1	0.3	0.1	0.2	0.0	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2
10	0.0	0.0	0.1	0.2	0.2	0.0	0.1	0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.3	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0
11	0.1	0.0	0.3	0.2	0.5	0.0	0.0	0.1	0.1	0.0	0.3	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.2
12	0.0	0.0	0.0	0.2	0.0	0.1	0.1	0.3	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.0
13	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2
14	0.1	0.0	0.5	0.5	0.5	0.5	0.3	0.1	0.1	0.2	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0
15	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.1	0.2	0.1	0.5	0.2	0.8	0.1	0.6	0.8	0.8	0.6	0.3	0.2	0.2	0.2	0.1	0.5	0.6	0.6	0.6	0.6	0.5
16	0.0	0.1	0.0	0.2	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.0
The value of d per item	0.057	0.084	0.119	0.186	0.169	0.143	0.166	0.219	0.198	0.146	0.146	0.202	0.156	0.209	0.092	0.180	0.218	0.198	0.208	0.194	0.146	0.187	0.216	0.180	0.171	0.156	0.112	0.150	0.165	0.137
The value of d constructs	**78.563 / (16 x 30) = 0.16**																													

STEP 6: **DETERMINE THE PERCENTAGE OF EACH ITEM AND THE OVERALL CONSENSUS ITEMS**

	ITEM																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Bilangan Item d ≤ 0.2	16	15	14	14	14	15	11	9	10	16	12	14	16	14	15	14	13	14	14	10	16	11	11	15	14	15	15	15	13	15
The percentage of each Item d ≤ 0.2	100%	94%	88%	88%	88%	94%	69%	56%	63%	100%	75%	88%	100%	88%	94%	88%	81%	88%	88%	63%	100%	69%	69%	94%	88%	94%	94%	94%	81%	94%
Percentage of Overall Item d ≤ 0.2	**91%**																													

STEP 7: DETERMINATION PROCESS OF THE DEFUZZIFICATION-SCORE (RANKED / PRIORITIZED ITEMS)

For defuzzification process, there are 3 that formula can be used to make sure the ranking/score for an item,
Fomulas are as follows:

i. $A_{...} = 1/3 * (m_1 + m2 + m3)$
ii. $A_{...} = 1/4 * (m1 + m2 + m3)$
iii. $A_{...} = 1/6 * (m_1 + m2 + m3)$

EXPERT	ITEM																													
	1			2			3			4			5			6			7			8			9			10		
1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1
2	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
3	0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1
4	0.9	1	1	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
5	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
6	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9
7	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
8	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9
9	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.9	1	1
10	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
11	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
12	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1
13	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1
14	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
15	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.5	0.7	0.9
16	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1
DEFUZZIFICATION PROCESS																														
THE AMOUNT OF EACH ELEMEN	13.60	15.60	16.00	12.20	14.80	15.90	11.80	14.40	15.60	11.40	13.90	15.20	11.60	14.10	15.30	11.80	14.30	15.50	12.20	14.40	15.50	10.00	12.80	14.70	10.20	13.00	14.90	11.40	14.00	15.50
	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3
FUZZY EVALUATION	15.067			14.300			13.933			13.500			13.667			13.867			14.033			12.500			12.700			13.633		
SCORE	30			27			23			15			19			22			24			3			5			17		
THE AVERAGE OF EACH OF THE	0.850	0.975	1.000	0.763	0.925	0.994	0.738	0.900	0.975	0.713	0.869	0.950	0.725	0.881	0.956	0.738	0.894	0.969	0.763	0.900	0.969	0.625	0.800	0.919	0.638	0.813	0.931	0.713	0.875	0.969
	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3
AVERAGE OF FUZZY NUMBER	0.942			0.894			0.871			0.844			0.854			0.867			0.877			0.781			0.794			0.852		
SCORE	30			27			23			15			19			22			24			3			5			17		

11			12			13			14			15			16			17			18			19			20		
0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1
0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
0.5	0.7	0.9	0.4	0.6	0.8	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1
0.9	1	1	0.9	1	1	0.9	1	1	0.3	0.5	0.7	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1
0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.5	0.7	0.9
0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1
0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9
0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1
0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1
0.9	1	1	0.3	0.5	0.7	0.5	0.7	0.9	0.1	0.3	0.5	0.7	0.9	1	0.1	0.3	0.5	0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7
0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
12.20	14.50	15.60	10.70	13.30	15.00	10.60	13.40	15.30	11.00	13.60	15.00	12.60	15.00	15.90	11.40	13.90	15.10	11.40	14.00	15.50	10.20	13.00	15.00	12.40	14.80	15.70	11.60	14.20	15.50
m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3
14.100			13.000			13.100			13.200			14.500			13.467			13.633			12.733			14.300			13.767		
26			9			12			13			29			14			17			6			28			20		
0.763	0.906	0.975	0.669	0.831	0.938	0.663	0.838	0.956	0.688	0.850	0.938	0.788	0.938	0.994	0.713	0.869	0.944	0.713	0.875	0.969	0.638	0.813	0.938	0.775	0.925	0.981	0.725	0.888	0.969
m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3
0.881			0.813			0.819			0.825			0.906			0.842			0.852			0.796			0.894			0.860		
26			9			12			13			29			14			17			6			28			20		

20			21			22			23			24			25			26			27			28			29			30		
0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1
0.9	1	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.9	1	1
0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.9	1	1
0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.9	1	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1
0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9
0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.3	0.5	0.7	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1
0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1	0.7	0.9	1	0.5	0.7	0.9	0.9	1	1
0.5	0.7	0.9	0.5	0.7	0.9	0.4	0.6	0.8	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8	0.7	0.9	1
0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1
0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7
0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.9	1	1	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7
0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
11.60	14.20	15.50	10.40	13.40	15.40	9.70	12.60	14.60	10.40	13.20	15.10	8.80	11.60	13.80	10.60	13.40	15.10	11.80	14.20	15.50	12.10	14.50	15.60	10.50	13.30	15.00	10.10	12.90	14.80	11.40	14.00	15.30
m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3
13.767			13.067			12.300			12.900			11.400			13.033			13.833			14.067			12.933			12.600			13.567		
20			11			2			7			1			10			21			25			8			4			16		
0.725	0.888	0.969	0.650	0.838	0.963	0.606	0.788	0.913	0.650	0.825	0.944	0.550	0.725	0.863	0.663	0.838	0.944	0.738	0.888	0.969	0.756	0.906	0.975	0.656	0.831	0.938	0.631	0.806	0.925	0.713	0.875	0.956
m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3	m1	m2	m3
0.860			0.817			0.769			0.806			0.713			0.815			0.865			0.879			0.808			0.788			0.848		
20			11			2			7			1			10			21			25			8			4			16		

Based on defuzzification process carried out menenunjukkan that CONSTRUCTS: STRATEGIES for TEACHING and LEARNING

Position preference for each item are as follows based on the consensus of experts.

ITEM	CATEGORY	FACTOR	THE VALUE OF THE SCORE		Ranking
			FUZZY EVALUATION	*AVERAGE OF FUZZY NUMBER*	
1	BEHAVIOUR		15.067	0.942	**30**
2	PROCESS		14.300	0.894	**27**
3	BEHAVIOUR		13.933	0.871	**23**
4	STRUCTURE		13.500	0.844	**15**
5	PROCESS		13.667	0.854	**19**
6	PROCESS		13.867	0.867	**22**
7	STRUCTURE		14.033	0.877	**24**
8	STRUCTURE		12.500	0.781	**3**
9	BEHAVIOUR		12.700	0.794	**5**
10	PROCESS		13.633	0.852	**17**
11	STRUCTURE		14.100	0.881	**26**
12	STRUCTURE		13.000	0.813	**9**
13	PROCESS		13.100	0.819	**12**
14	STRUCTURE		13.200	0.825	**13**
15	PROCESS		14.500	0.906	**29**
16	PROCESS		13.467	0.842	**14**
17	PROCESS		13.633	0.852	**17**
18	BEHAVIOUR		12.733	0.796	**6**
19	PROCESS		14.300	0.894	**28**
20	STRUCTURE		13.767	0.860	**20**
21	BEHAVIOUR		13.067	0.817	**11**
22	STRUCTURE		12.300	0.769	**2**
23	PROCESS		12.900	0.806	**7**
24	STRUCTURE		11.400	0.713	**1**
25	BEHAVIOUR		13.033	0.815	**10**
26	BEHAVIOUR		13.833	0.865	**21**
27	BEHAVIOUR		14.067	0.879	**25**
28	BEHAVIOUR		12.933	0.808	**8**
29	STRUCTURE		12.600	0.788	**4**
30	BEHAVIOUR		13.567	0.848	**16**

Sample of the questionnaire

Dear Respondent,

You are invited to participate in a research that is being conducted for the final year project of Bachelor's degree in Universiti Teknologi PETRONAS, Malaysia. The purpose of this study is to examine the factors shaping safety culture of companies in the oil and gas industry in Malaysia.

Your kind participation and responses are very valuable for the success of this research.

If you have any questions or concerns regarding this study, please feel free to contact me via: mobile: (+60143995493), E-mail: beshoys.morees@gmail.com or A.P. Dr Zulkipli Ghazali (+60125088171)

Since the questionnaire is being used strictly for academic purpose, the information gathered will be treated with highest confidentiality.

Thank you for your participation in this study. Your contribution is greatly appreciated.

Beshoy Safwat Morees
Final year, Final semester
Petroleum Engineering Department
Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750, Tronoh, Perak
Malaysia

SECTION A

Please complete the following information

1. **I am working for** *(name of companies)* _____

2. **The location of the company is**

   _____

3. **My job designation is**

   _____

4. **Length of my service in the present role is _____ years**

SECTION B

TITLE: SAFETY CULTURE IN OIL AND GAS INDUSTRY IN MALAYSIA

Please read each of the statement that represents the factors shaping safety culture of oil and gas companies in Malaysia. Please determine the importance level of each of the factors according to the safety culture in your company. Your response will be highly appreciated and treated with the highest level of confidentiality.

Instruction: Circle the appropriate number that best describes the importance of the factors that affect the safety culture in the oil and gas industry in Malaysia by referring the following Likert scale.

Extremely Unimportant (EUI)	Not very Important (NVI)	Not Important (NI)	Fairly Important (FI)	Important (I)	Very Important (VI)	Extremely Important (EI)
1	2	3	4	5	6	7

STATEMENTS		EUI	NVI	NI	FI	I	VI	EI
1.	Full understanding of health and safety risks in the workplace as well as the procedures to minimize them	1	2	3	4	5	6	7
2.	Frequent training which covers all the health and safety aspects in the workplace	1	2	3	4	5	6	7
3.	Employees feel secure and motivated in the workplace	1	2	3	4	5	6	7
4.	Management prioritizes workplace safety by implementing “safety before production” schemes even if it means profit loss	1	2	3	4	5	6	7
5.	Employees abide by the “safety before production” rules even if it means halting the operations	1	2	3	4	5	6	7
6.	Clear communication between managers and employees regarding active operations	1	2	3	4	5	6	7
7.	Regularly informing the employees of recurring causes and factors of accidents	1	2	3	4	5	6	7

8.	Dedicating specialized investigation team who focuses mainly on analyzing workplace safety	1	2	3	4	5	6	7
9.	Employees are held liable for their actions	1	2	3	4	5	6	7
10.	Employees are encouraged to be aware and raise safety concerns that they may have	1	2	3	4	5	6	7
11.	Sufficient health and safety resources are made available to all employees	1	2	3	4	5	6	7
12.	Appointment of a health and safety representative for accident prone areas	1	2	3	4	5	6	7
13.	The expertise and role awareness of the health and safety representative is constantly checked	1	2	3	4	5	6	7
14.	Availability, simplicity and clarity of written rules and regulations to achieve workplace safety	1	2	3	4	5	6	7
15.	Strictly implementing that the contractors obtain work permits before the start of any operation	1	2	3	4	5	6	7
16.	Briefing the contractors about the health and safety regulations in the workplace	1	2	3	4	5	6	7
17.	Ensuring that cultural diversity does not affect communication among the employees	1	2	3	4	5	6	7
18.	Leadership skills of the health and safety representative in the workplace	1	2	3	4	5	6	7
19.	Constant inspection of equipment and tools used in the workplace	1	2	3	4	5	6	7
20.	Availability of emergency teams in the workplace	1	2	3	4	5	6	7
21.	Persistence of the managers to follow up on the reported safety incidents and the actions taken to prevent them	1	2	3	4	5	6	7
22.	Presence of accessible means for employees to report their health and safety concerns	1	2	3	4	5	6	7
23.	Consulting the employees for their training needs	1	2	3	4	5	6	7
24.	Management provides incentives for employees that excel in health and safety	1	2	3	4	5	6	7
25.	Mutual trust between management and employees	1	2	3	4	5	6	7
26.	During the absence of or minimum supervision, employees stay committed to health and safety in the workplace	1	2	3	4	5	6	7

27.	Employees are well experienced and highly capable of running equipment and fulfilling the jobs required	1	2	3	4	5	6	7
28.	Employees ensure that they are well rested and alert before coming to the workplace	1	2	3	4	5	6	7
29.	Sufficient amount of HSE detectors to ensure adequate evacuation time for employees	1	2	3	4	5	6	7
30.	Employees feel comfortable to approach their managers regarding any health and safety concerns	1	2	3	4	5	6	7

Source:
https://docs.google.com/forms/d/1d9WL6wN_JarbTBSp09PxJz0UpYTt2awqH7_3v1eZeX8/viewform?usp=send_form