International Journal of Science, Environment and Technology, Vol. 7, No 4, 2018, 1152 – 1178

ISSN 2278-3687 (O)
2277-663X (P)

IMPROVED OPERATIONAL SAFETY MANAGEMENT SYSTEM (OSMS) IN OIL AND GAS PLATFORM IN A SYSTEMIC VIEW POINT

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Abstract: An improve operational safety management system (OSMS) model has been developed in a systemic view point by adopting Fire Systemic Safety Management System model with the aim of maintaining risk within an acceptable range in the operations or subsystem of Oil and Gas Platform in a coherent manner, features of Oil and Gas platform which consist of four operational module which are Wellhead (Module A), Separators (Module B), Compressor (Module C) and Electrical Equipment (Module D) have been used in order to illustrate some of the characteristic of the model (i.e. recursive structure and structural organizational). Vertical or horizontal interdependence show how all the sub-systems are linked together for effective management, missing linkage between the sub-systems at different level or recursion means poor performance. This approach had led not only to more effective management of safety in the oil and gas Platform as well as the whole Oil and Gas Organization.

Keywords: Operational Safety Management, Platform, Systemic View Point.

1.0. Introduction

1.1 Background

Historically, industrial revolution in the world has contributed to both social and economic development which gave rise to concerns in safety issues in industries. This led to the creation of International Labour Organization (ILO) in the year 1919 which is saddled with the responsibility for investigation of hazardous activities and their resultant consequences [1]. According to ILO in 1998 occupational accident and non-fatal accident globally are estimated at 350,000 occupational accidents as well as 264 million non-fatal, these estimations influenced the national policies and decision making toward enhancement of safety health legislation [2].

*Received June 19, 2018 * Published Aug 2, 2018 * www.ijset.net*

Controlling the risks related to oil and gas operations has been a subject of expanding imperativeness over recent years. On the other hand, no much attention given by both oil and gas industry and academia to describe what constitutes a viable Safety Management System (SMS) [3]. For instance there is offshore platform Safety Case which is a regulation that emphasized on safety management system (i.e. initial draft of guide on offshore installation on safety issues). Moreover, the safety cases regulations highlights that those components related to safety execution are referred to on the whole as the SMS [4]. Safety management system model confirm that all requirement for safety decision are surrounded by the follow up of line management as well as verifying the decision implementation [5]. Ming [6] describe SMS by means of the objectives, policies, management controls, organization as well as resources used for the management of safety, health and environment (i.e. operational integrity) throughout the oil and gas business cycle.

A major accident that shock the world in the recent time is the Piper Alpha accident, in July 1988 fire caught Piper platform as a result of gas leakage which subsequently led up to explosion where 167 people lost their lives as shown in Figure 1.1 and 1.2, the Piper Alpha accident case is continue to became area of concern particularly related to Enhanced Operational Safety Management system (EOSMS) [7]. In the first place its intensity was such that it could not be disregarded in the oil and gas organizations around the globe, where a certain number of measures have been achieved as a result of the incident. Secondly, some of the causes are applicable to numerous different businesses; deficient in the communication channels of the Safety Management System (SMS), challenges in controlling the exchange between safety as well as productivity [8].

Figure 1.1: Piper Alpha Platform offshore prior to the accident [7].

Figure 1.2: Piper Alpha platform offshore explosion [7].

Accidents like the Piper Alpha disaster as well as other accidents which have occurred world-wide have highlighted the need to develop a proper safety management system for all oil and gas operations. This necessitates the oil and gas industry to take measures to enhance both its safety performance as well as its operational performance, for quite a number of years various approaches have been developed and implemented in order to enhance the safety performance of oil and gas organizations [4]. For instance, application of Inherent Safety principle to the concept of offshore platform designs. Countless attempts have been made to evaluate, develop and implement safety management system in oil and gas industry [9]. In spite of this, not much attention has been given by both academia as well as practitioners toward what establish and describes an effective safety management system, through the structure as well as process from a systemic view point. Both academia and practitioners always address safety issues by focusing on accident immediate causes and technical aspects [3].

2.1.0 Safety Management

In 1970s, safety management as well as safety development became of utmost important in oil and gas industry because of the occurrence of major accident in a workplace [10]. Chemical plant explosion occurred in 1974, Flixboroug disaster which killed twenty eight and injured thirty-six employees [11]. Following the occurrence of this accident, safety case was required from petrochemical industries prior to any project installation [12]. Again, in 1976 accident occurred in Italy (Seveso chemical disaster), which give rise to the adoption of legislation to designs management system on prevention as well as control measure of such accident which resulted to European directive 82/501/EEC (Seveso I Directives) which subsequently was updated as well as reviewed to European directive 96/82/EC (Seveso II) that entirely replaced the previous directives and then to latest review to 2012/18/EU [13]:[14].

The occurrence of piper alpha disaster in 1987 in the North Sea UK, where hundred and sixty-seven employees were killed and injured few employees, come to be the wakeup call for transformation in offshore oil and gas industry safety management system. Eventually, inquiry regarded this accident come up with recommendation for systematic safety management plan as well as provided safety case [10].

2.1.1 Concept of Safety Management Systems

Every industry, that deals with major hazard facilities must established and implement safety management system according to Australian work place safety regulation [15]. SMS establishment and implementation is the primary means of assuring safe operation of major hazard facilities, where a SMS is a comprehensive and combined system for managing health, safety and environmental risk [16].

The academia, regulatory and industry have put a considerable amount of commitment to examine and develop procedures which will help in addressing safety and environment issues [3]. Some institutions have developed their SMS from environmental standard like the ISO 14001 [17]. Environmental management system (EMS) is designated procedure for setting and meeting environmental objectives, it is comprised of policy, evaluation, measurement, implementation, planning, operation, management review as well as continual improvement as shown in Figure 2.1 [18]. Policy deals with an organization's guide decision on environmental problem and having adequate resources required for decision implementation. Planning involves identifying environmental aspect of the organizations products, its services and activities in line with a blue print which identifies the major aspects in the EMS [19]. This suggests identifying the precise measurable goals and objectives. Measurement and evaluation deals with monitoring progress to assess whether or not the objectives are being met likewise the procedures required to remedy possible deficiencies [3]. Review and improvement provides an avenue for routine analysis for steady improvement of the environmental management system with the purpose for raising the organizational environmental performance [18]. The major goal of the SMS as illustrated in the guidelines of the Centre for Chemical Process Safety (CCPS) as to plan, organize, implement and control [20]. The company's goals objectives and development of policy makes up planning [21]. Organization is comprised of establishing structures, defining roles, responsibilities, authority and accountability to achieve the goals [22]. Implementation caters for processes and at the end executes the policy. Measurement, evaluation and correcting performance are part of control aspect [23]. The Hazard management analysis (HMA) is comprised of assessment control, identification as well as recovery, HMA assists in analyzing crucial activities and every safety critical activities by developing SMS record which is a collection of documents [24]. These documents explain and portray how safety is to be managed in an organization; SMS manual is a separate document which reflects the organizations deliberations and responsibilities where expresses the safety objectives of the organization and ways to accomplish the performance, audit, review and continuous monitoring to evaluate and promote the efficiency operations and activities. Likewise, the European Process Safety Centre (EPSC) established guidelines for SMS which includes policy, organizational management procedure and practice, auditing and monitoring as well as review of management [25]. Moreover, the exploration and production forum (E&P) have established guidelines for SMS which comprises of commitment, leadership, strategy, objective, policy, organization, documentations, risk management, evaluation, planning, resources, implementation, monitory and auditing [17]. Ming [6] stressed that the goal of SMS is aimed at providing the basic guarantee for all employee that are likely to be affected by an organization activities are protected, in addition to protecting the asset and the environment from harmful incidents. Guideline set up by the United Kingdom (UKOOA) are aimed at boosting a combined method to manage safety and explosion on offshore installation, where the guidelines consist of a life cycle program management that includes evaluation of hazardous events and selecting specified systems for detecting explosion as well as mitigation measures[26]. Successful health and safety management is another concept to safety, designed and established by the health and safety executive. Major duties of health and safety executive (HSE) includes policy, organizing, planning, auditing and performance review [27]. Emphasis has also, been laid on safety in the marine sector; International Marine Organization (IMO) has approved several advancements aimed at improving fire protection and preventing pollution in ships and vessels (i.e. SMS aims as preventing and managing fire incidents on passenger vessels) [28].

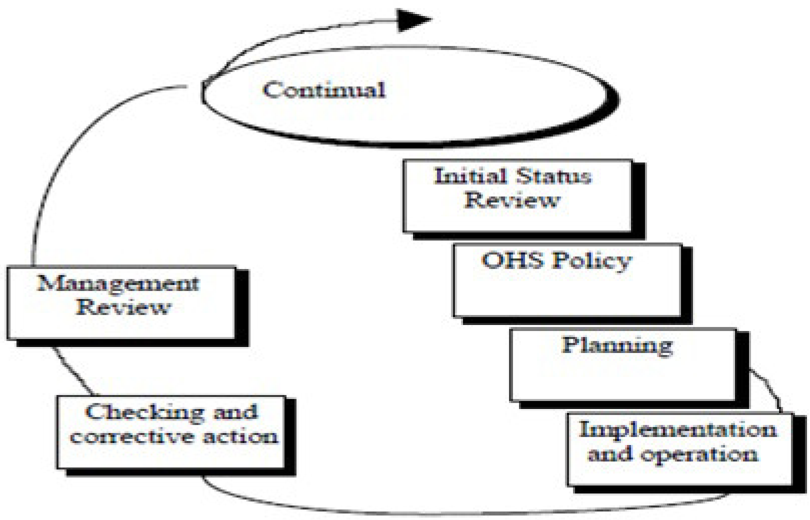


Figure 2.1: Environmental management system model [3]

2.1.2Safety Management System Structure

The primary aspect in process safety management system is leadership, which is displayed through diligence and accountability, enthusiastic accident prevention, alertness and an effective response programme. The general aspect of a management has a wide suitability for small and big companies; it also includes policies for health and safety, structure for implementing policies and defining responsibilities as well as determining accountability. An outline of the safety management system is focused on; [25].

- Avoid doubling information that exists already.
- Incorporating regulatory requirement while integrated system that covers safety, health and environmental requirement.
- Permit possibility for continuous improvement as well as to ensure account of local culture and legislation.
- Taking different forms that embodied the same basic principles.

The Figure 2.2 illustrated the typical management system structure as well as how their element works together [25].

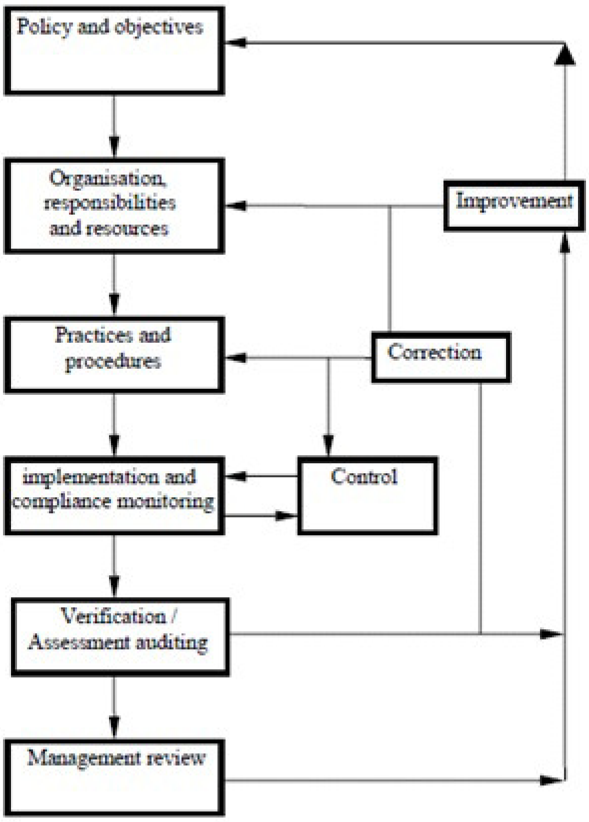


Figure 2.2: Typical Safety Management system structure [3].

2.1.3 General Element of the Safety Management System

2.1.3.1 Policy

Environmental prevention policy progressively utilizes eco-efficiency as an instructing principle for enhancing safety in oil and gas industry [29]. Leadership of the management, accountability as well as commitment are the most important element for the safety management system in offshore oil and gas industry that will lead to implementation of prevention policy, response and emergency preparedness accidents policy, every offshore oil and gas industry must have a strong and vibrant safety policy statement, safety culture as well as goal aim of zero accident [25]

2.1.3.2 Organization

Effective implementation of safety policy in offshore oil and gas industry require adequate organization as well as sufficient resource to run the organization. Organizing and assigning responsibilities to the appropriate personnel as well as in suitable way [25]

2.1.3.3 Management Practices and Procedures

Management practice and procedure in offshore oil and gas industry must implement certain activities right from inception through abandonment as well as disposal; it covers the following activities [25]

- Installation planning, hazard identification, assessment and controls
- Construction
- Operations
- Maintenance and repairs
- Change management
- Reporting, investigation and follow-up of accidents and incidents
- Emergency preparedness
- Education and training
- Personnel's

2.1.3.4 Monitoring and Auditing

Offshore oil and gas industry must audit and monitor safety performance consistently, check for conformity to offshore safety policies and guidelines after the implementation of safety systemic method. Monitoring and auditing must be conducted by independent personnel who are competent to all management practice and procedure; these assure guarantee independent result [25].

2.1.3.5 Management Review

The results and findings obtained from the monitoring and auditing of the safety performance must be reviewed as appropriate to the corrective actions to organization policies and resource [25]. Frequent assessments of the management system are performed as planned as well as effectively producing the anticipated result as possible [20].

2.2.0 Key Characteristics for Safety Management System

Efficiency and success of safety system as well as practical applicability requires the following characteristics [25].

- Safety system must have detail documentation of scope and objectives, procedure and tools, responsibilities plan and resource and measurements.
- Safety system must be flexible to achieved extensive application that will commensurate with every sort of risk and hazards.
- Safety system must be effective to responsible for line management.

3.0.0 Methodology

3.1.0 Systemic safety Management System Method (SSMS)

Systemic can be described as the holistic assessment of a system as well as the evaluation of possible failures in every event related to the system "as product of a working of a system", and within that all likelihood of accident may be observed [30]. "Systemic safety management system (SSMS) has been constructed by employing the concepts of systems and a number of systemic failures that have come to light" [31]. The systemic safety management system (SSMS) of oil and gas Platform model will be derived or modelled from the systemic safety management system of fire safety [32]. The SSMS model proposed to sustain risk in a system within acceptable limit called viable system.

Description of this model is based on the following:

- Environment
- Structural Recursion
- Autonomy
- Structural Organization

3.1.1 Environment of the Model

Environment of the model regarded as being some situations (i.e. factors) where SSMS model is required to response. Environment is an external system but act on the internal system, it is the origins of all situation in which the system is necessary to response [30]. The SSMS model depends on five commanding functions as well as the extent of SSMS organizational structure to hold all the contextual constraints examines its capability to adapt [7]. The five commanding functions are as follows

- System 1: Safety policy Implementation
- System 2: Safety co-ordination
- System 3: Safety function
- system 3^* : safety audit
- System 4: Safety development
- system 4^*: safety confidential reporting
- System 5: Safety Policy

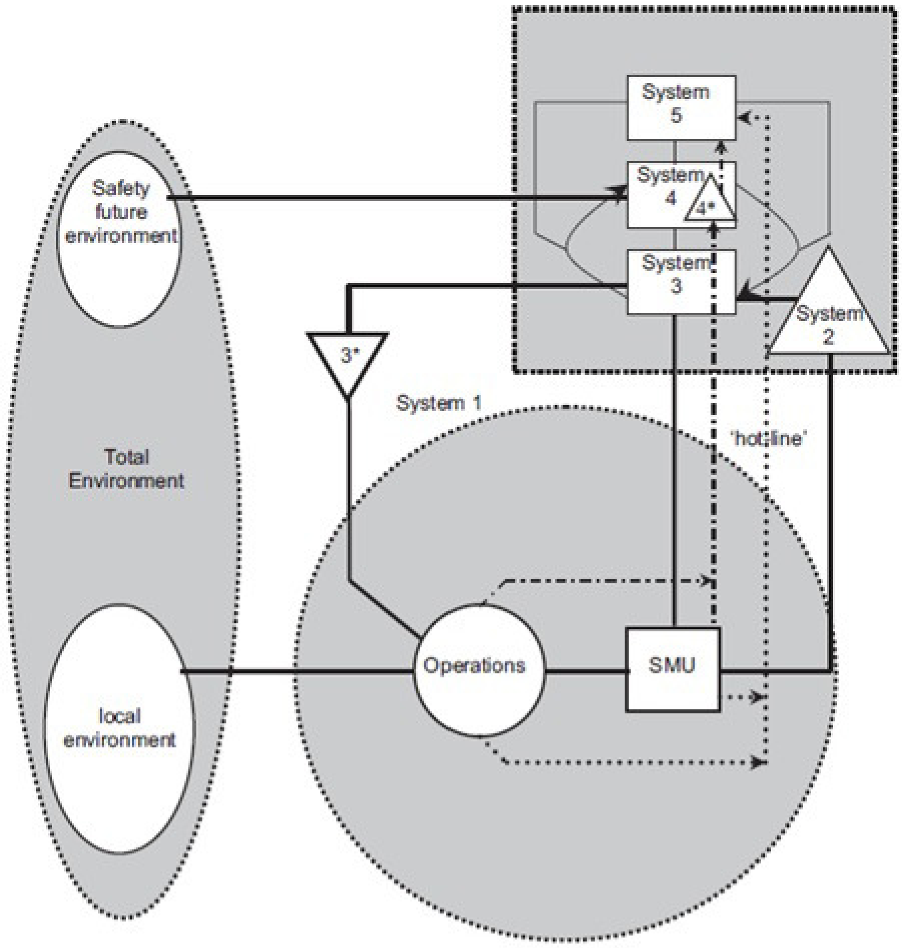


Figure 3.1: Systemic safety management system model (SSMS) [30].

The safety future of environment depends on threat posed on environment as well as opportunities for future safety development. For SSMS to be efficient most interpret, scan and respond to all implicated external factor related to environment, several external factors must be taken into consideration for SSMS model as describe in Table 2.1 [33].

Table 3.1: Environmental External factors

ENVIRONMENTAL FACTOR FOR SSMS		
Socio-Political Factor	**Economic Factor**	**Physical Factor**
Legislation	Insurers	Geography
Safety, Health and Environment	Trading Condition	Location
Standard	Economics Interest	Climate
Regulatory Enforcement		
Major Accident or Disaster		
Professional Bodies		
Public Opinion		
Technology		
Suppliers of Goods and Services		

Trade Unions
Product and Labour Markets
National and Local Cultures

Source: [33]

3.1.2 Structural Recursion of the Model

A recursive is a repetition or recurrence of level where other levels are above or below. Is recursion to be done for the entire organization or just some part of the organization, obviously recursion addresses the entire organization as illustrated in Figure 3.2, where organizational recursion into three level, level 1 or recursion 1 at system 1 accommodate Total Operation (TO) which is the sub-system of interest. Elliptical symbols that involve two important elements represent sub-system [30]: [34].

- Total Safety Management Unit (TSMU) designated by parallelogram symbol in the system.
- Total Operation (TO) designated by circle symbol in the system

The total safety management unit (TSMU) is responsible for the safety management of all the activities being carried out during the operation process within system 1. The total operation is the interaction of all processes involve in an organization to produces products and service, these operation creates risk as a result of processes interaction as well as environment interaction (i.e. external factors). In Figure 3.2, the line linking total safety management unit (TSMU) and total operation (TO) stance for managerial inter-dependence (Santos-Reyes and Beard 2008). The system of interest decompose into level 1(i.e. recursion 1) result to A-Operation (AO) as well as B-Operation (BO), each of these sub-system can be further decompose into another sub-system depending on the decision of the safety management system analyst. For example sub-system (AO) can be decomposed to A1-Operation (A-1O) and A2-Operation (A-2O) as illustrated in Figure 3.2 [30].

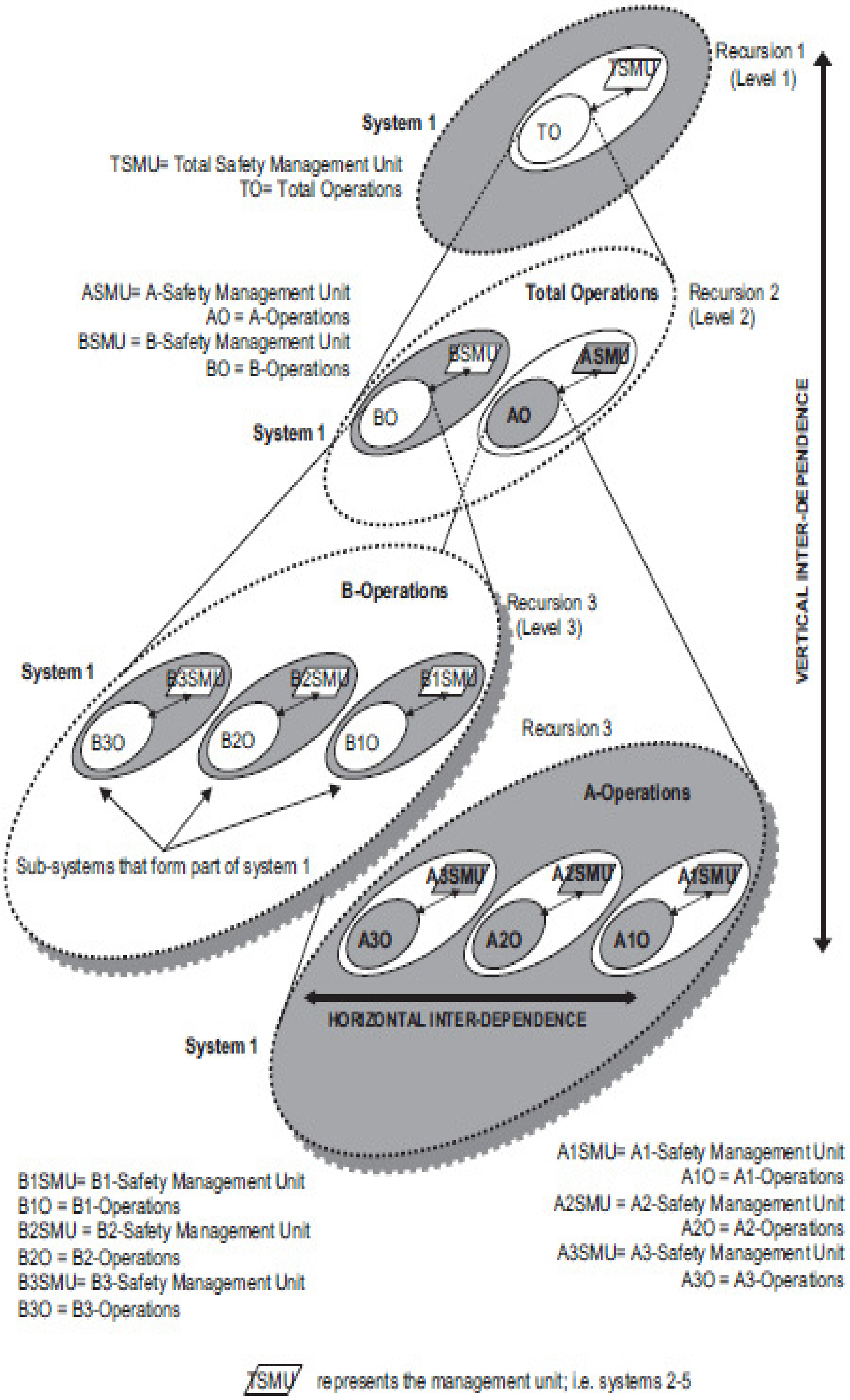


Figure 3.2: Structural recursion of SSMS model [30].

3.1.2.1 Vertical and Horizontal Inter-dependence

Vertical or horizontal interdependence show how all the sub-systems are linked together for effective management, missing linkage between the sub-systems at different level or recursion means poor performance. SSMS model as illustrate in Figure 3.1 and Figure 3.2 is proposed to control safety at two different level of recursion of SSMS model as well as described the basis of SSMS model [30].

3.1.3 Relative Autonomy and Decision Making

The operations that makes up of system 1 must have relative autonomous to carry out their task at the same time subjected to safety management system requirement. Although it is very difficult to decide relative autonomous on complicated matter, but at the same time they should try not to be isolated. Relative autonomy must be exercised within sub-system in line with the safety management system function as a whole [32].

The SSMS model structure favors relative autonomy as well as given solving capacity to the related risk. "Relative autonomy means that each operation of system 1 of the SSMS is responsible for its own activity with minimal intervention of 2-5". SSMS model structural organization permits making decision at local level, the decision made would be distributed all over the entire organization. Decision makers inside system 1 are independently as well as relatively autonomous, based on their understanding on certain risk solution [30].

3.1.4 Organizational Structure of the Model

The model is designed with a basic 'unit' which consist of system 1 to 5, arranged and constructed in such a way that it is necessary to achieved their functional association within them. The organizational safety objectives in Oil and Gas Platform are usually achieved using various operations under system 1, such as oil and gas exploration, transporting oil or gas, and power generation each operation must perform all the five commanding function [7].

System 1: Safety Policy Implementation

System 1 is responsible of all the process interaction between the system and environment in the course of production (risk created due to production) as well as implementing safety policies. System 1 is made of one or more operation within the organizational system and its deals directly with the organizational core activities.The component of system 1 and its environment are shown in Figure 3.1. The square box represent the managerial activity required to perform operation for specific system and safety policy implementation of an organization, the circle encompasses the necessary operation or activities for products and services produced, and finally elliptical symbol stance for environment of system 1[30].

System 2: Safety Co-ordination

System 2 brings together all the activities under system 1 operation. Safety plan from system 3 will be implemented with the assistance of system 2 and system 1, system 3 received about the routine system 1 operation performance. System 1 operational information are gathered and managed by system 1 in order for system 3 to achieve its plan [7].

System 3: Safety Function

The daily safety function of the organization is achieved based on the safety plan of system 3. System 1, 2, and 3* give information regarding system 1 safety performance, in order for the system 3 to develop its safety plans as well as to contact the system 4 for the future needs. In addition system 3 is responsible for system 1 to complete organization's safety plans [7].

System 3* : Safety Audit

System 3* is the subordinate of system 3 to perform audits unannounced within the system 1 operation. System 3* intervenes in system 1 operation according to the safety plan gotten from system 3. System 3 is required to assure that reports of accountability are getting from systems, which indicates not only on the present position of system operations, but also be the same with the entire organizational objective [7].

System 4: Safety Development

Safety development refer to research and development of safety system for non-stop adaptation in an organization, by taking into account of all strength, weakness, threat as well as opportunities of all safety systems. System 4 proposed changes into the organization's safety policies, system 4 functions considered to be part of "effective safety planning". Firstly, system 4 receives safety policy from system 5. Secondly, system 4 senses the entire relevant opportunities and threats from socio-economic in an organization as well as safety future. Thirdly, system 4 proposed the entire require needs for the system 1 performance and its possible future. Finally all the confidential or special information communication is dealt with by system 4 [31].

System 4*: Safety Confidential Reporting

System 4* is the subordinate of system 4 that deal with all the confidential reporting or with the courses that may need immediate and direct intervention of system 5 [7]

System 5: Safety Policy

Safety policy is liable for planning safety policy as well as making standard decisions based on the available alternate safety plans accepted from system 4, system 5 adjudge and select the best possible "alternatives which aim to maintain an acceptable level of safety throughout the organization's operations", and conversely monitors, the relations between system 3 and system 4 [7].

3.3.0 Description ofTypical Oil and Gas Platform

The Oil and Gasplatform is made up of about four operational modules A-D and their safety management system working together as illustrated in Figure 3.2 and 3.3. Table 3.2 outlines all the module operations and their safety management units [35].

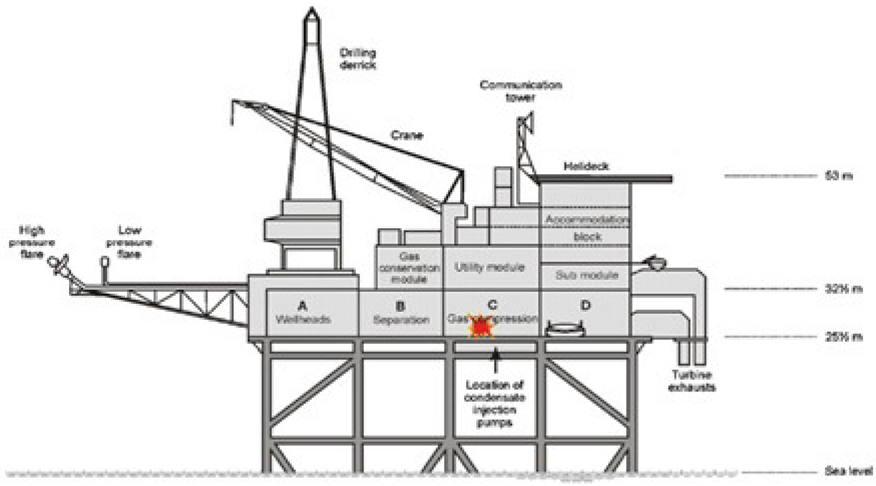


Figure 3.2: Oil and Gas Platform Main Operational Modules [36].

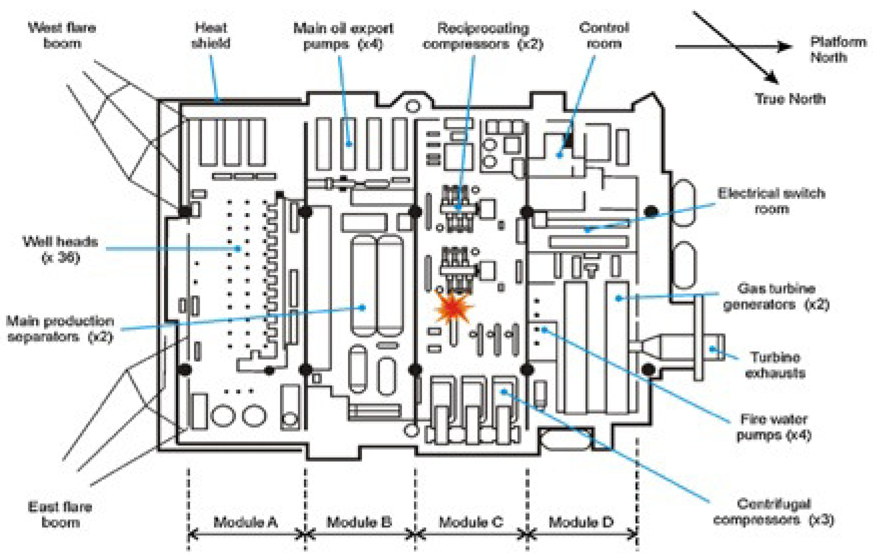


Figure 3.3: Oil and Gas Platform Main Processing Deck Plan View 1988 [36].

Table 3.2: Total operations and their safety management unit of Oil and Gas Platform

OIL AND GAS PLATFORM OPERATION	SAFETY MANAGEMENT UNIT
Module A Operation (OAM)	Module A Safety Management Unit (SMUAM)
Module B Operation (OBM)	Module B Safety Management Unit (SMUBM)

Module C Operation (OCM)	Module C Safety Management Unit (SMUCM)
Module D Operation (ODM)	Module D Safety Management Unit (SMUDM)

Where

- Module A consist of wellhead
- Module B consist of separators
- Module C consist of gas compression equipment
- Module D consists of electrical equipment

The modules consisted of Christmas tree or well head and were arranged in 12 in each row of 3 making it 36, the module for production consists of two major production separators, separator for separation of gas and water from the oil [10].

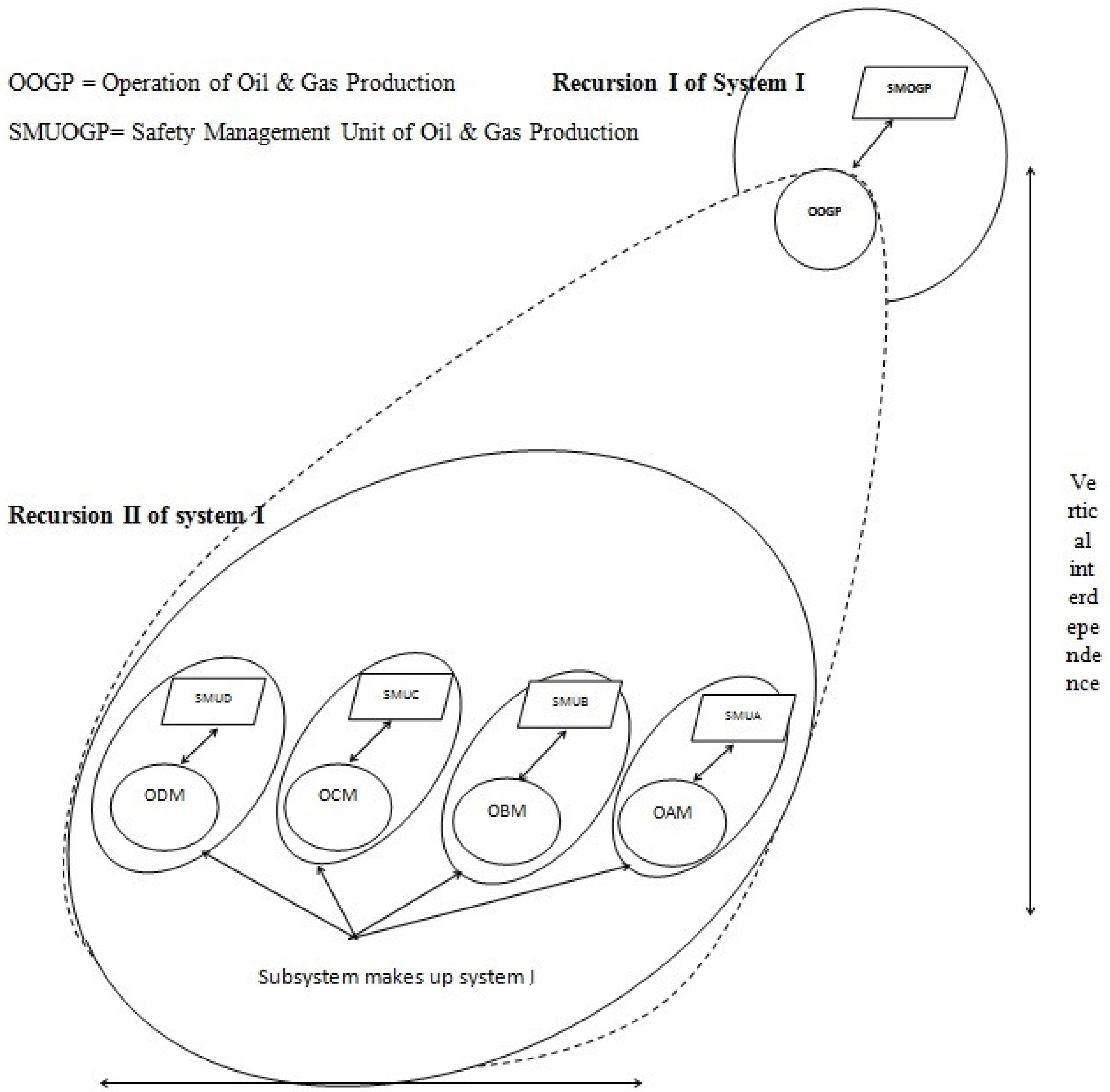
4.0 Result, SMS Model and Discussion

4.1.0 Safety Management SystemforOil and gas Production Platform Model

4.1.1 Recursive Structure of the Platform

SMS oil and gas modelling begins by connecting the subsystem in the system 1 both vertically and horizontally. Oil and gas organization was divided into three levels as illustrated in Figure 4.1. Level 1 of system 1 comprises of the two most important areas in oil and gas industry, Operation of Oil and Gas Production (OOGP) and Safety Management Unit of Oil and Gas Production (SMUOGP). The OOGP is an interaction in all the process that is conducted for production and service while SMUOGP concern all safety management activities involved in managing oil and gas production operation.

Recursion of OOGPinto A-operational module (OAM), B-operational module (OBM), C-operational module (OCM) and D-operational module (ODM) as illustrated Figure 4.1. Decomposition of the operations into different recursion above identifies the steps of importance or interest in safety management system that will be focused on.



Horizontal Interdependence

SMUAM = Safety Management System of Module A, OAM=Operation of Module A, Module A = Well head
SMUBM = Safety Management System of Module B, OBM=Operation of Module B, Module B =Separator
SMUCM = Safety Mgt. System of Module C, OCM=Operation of Module C, Module C =Gas compressor
SMUDM = Safety Management System of Module D, ODM=Operation of Module D, Module D = Electric equip.

Figure 4.1: Recursion (Level I and II) structure of Oil and Gas Operational Safety Management System.

4.1.2.2 SMS Recursion 1 and 2 of oil and gas Platform

The OAM, OBM, OCM and ODM are the operations which already identified by recursion 1 and 2, all these subsystem being modelled together by using zigzag line and non-stop (continuous) line as illustrated in Figure 4.2

Safety Management System of Oil & Gas Production Platform

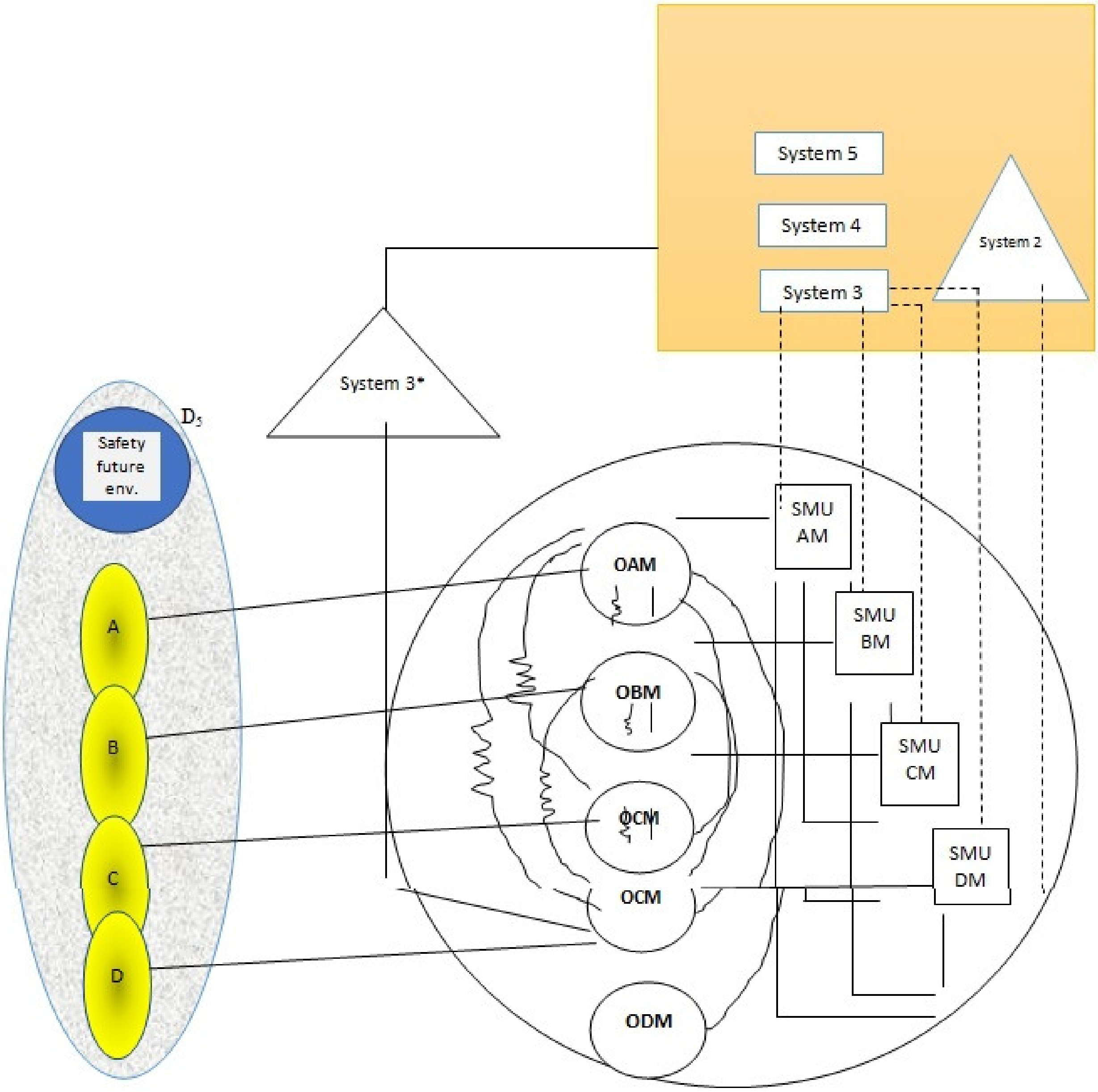


Figure 4.2: Structural Organization of Recursion I and II of Oil and Gas Operational Safety Management System

System 1: Implementation of Safety Policy on Oil and Gas Platform

System 1 function: system 1 executes safety policy, where the sequences of operations OAM, OBM, OCM, and ODM are responsible of executing the safety policy on the Platform. These operations carryout all the activities related to production.

Subsystem operational interdependence: The subsystem or operations in system must have certain degree of dependence on each other. the modelling network in Figure 4.2, the zigzag line (1 - 6) represent the horizontal interdependence in the system 1of OAM, OBM, OCM, and ODM which may be weak or strong depending on physical interdependence as explained in Table 4.1, and non-stop line (1' – 6') represent the communication channels among the operations.

Operations and their related safety management unit (SMUs) are the managerial activity within safety management units (SMUAM, SMUBM, SMUCM and SMUDM) and their related operations (OAM, OBM, OCM, and ODM) of the Oil and Gas Platform, where A_4 and B_2, , C_6 and D_4, B_5 and C_3, A_5 and C_2, B_6 and D_3,A_6 and D_2,are all stance for two-way communication channel within their safety management unit, and A_1, B_1, C_1, and D_1 stance for communication channel between operations and their respective safety management system.

Managerial interdependence between the safety management units in Piper Alpha platform, all the safety management system are interdependence based on this SSMS modelling where A_4 and B_2, C_6 and D_4,A_5 and C_2, B_5 and C_3,B_6 and D_3,A_6 and D_2 are the communications channels, if any changes occurs from the set up criteria in the operations of any platforms will immediately communicated to all safety managements units simultaneously. Therefore all the SMUs get access to the consequences of events that is happening so that measures will be implemented within their operations and communicate quick report through communication channel (A_3, B_4, C_5 and D_6,) to system 2, where the information received by system 2 to processes corrective action through the communication channel within SMUs as summarized in Table 4.3 and through communication channel within SMUs and system 2 and system 3 as summarized in Table 4.4.

System 2: Safety co-ordination on Oil and Gas Platform

System 2 of the modelling process in Piper Alpha platform is responsible for co-ordinating all the needed activities to be implemented in the system 1's operations or subsystems. The information on safety plans in system 3 will be implemented by system 1 and system 2 management units through the communication channels D_5, A_2,C_4 and B_3 as illustrate in Figure 4.3. In addition system 3 receives information on routine offshore installation from system 1 operational performance. System 2 collects and manages all the system 1 operation’s safety information in order to achieve the system 3 safety plans.

System 3: Function of Safety on Oil and Gas Platform

The function of system 3 of Oil and Gas Platform is liable for sustaining the risk in system 1 within acceptable limits. To accomplish its responsibility on an everyday basis correspond to its own plans as well as procedure and standard safety plan accepted from system 4. These plans is aimed to expects and pro-active on preserving the risk that will arise from system 1 operation within an acceptable range. System 3 request associated and not associated data of system 1 safety performance from system 1, 2 and 3^* in order to develop its safety plans. Again system 3 responsible of designing all the required resource for system 1 in order to achieves all plans for safety.

System 3^*: Safety Audits on Platform

The System 3^* is the subordinate of system 3 and is responsible for carrying out a sporadic auditin Oil and Gas Operational facility. Intervention of system 3^* into system 1 installation operation is in line with the safety plans standard from system 3 as illustrate in Figure 4.2

System 4: Safety Development on Platform

The development of appropriate strategic standard and safety plans are the key element for positive functioning of system 1, 2, and 3 in piper field. Accomplishing system 4 function depends on system 5 (safety policy) as illustrated in Figure 4.3.

System 5: Safety Policy on Platform

System 5 is liable for designing safety policies as well as making standard decisions, based on assigning strategic standards and safety plans from system 4 in the piper field. System 5 designs and select feasible alternative in order to maintain the viability of the focus on management safety system. Figure 4.2 illustrate how system 4 depends on system 5.

4.2.0 Results

Table 4.1: Recursion II Operational Interdependence (Platform)

Zigzag line	Physical Interdependence		Description
	Strong	**Weak**	
1	X		A-module (well head) flowed Oil, Gas and Water (i.e. production from reservoir) to B-module (Separator)
2	X		Separated Gas from B-module compressed in C-module

		(Gas compressor)
3	X	D-module given electrical power to water injection pump's motor, main oil line pump's motor and condensate pump's motor
4	X	Separated Gas from B-module flowed into condensate knock out drum to three centrifugal compressor then to two compressors
5	X	Module D given electrical power water injection pump's motor, main oil line pump's motor and condensate pump's motor (powered all electrically driven equipment)
6	X	D-module powered all electrically driven equipment where emergency generator was applied to powered critical services for instance strategic valve as well as air instrument

Table 4.2: Safety Management Unit and their Operation on Platform

SMUs	OAM	OBM	OCM	ODM
SMUA	A_1			
SMUB		B_1		
SMUC			C_1	
SMUD				D_1

Table 4.3: Managerial Interdependence between SMUs on Platform

SMUs	SMUA	SMUB	SMUC	SMUD
SMUA		A_4	A_5	A_6
SMUB	B_2		B_5	B_6
SMUC	C_2	C_3		C_6
SMUD	D_2	D_3	D_4	

Table 4.4: Managerial Interdependence between Systems on Platform

SMUs	SYSTEM 2	SYSTEM3
SMUA	A_3	A_2
SMUC	B_4	B_3
SMUD	C_5	C_4
SMUD	D_6	D_5

4.3.0 Discussion

Safety management system (SMS) oil and gas platform was modelled by adopting systemic methods with the aim of maintaining the risk between the acceptable limit. Systemic Safety Management System model was applied to the Oil and Gas production Platform, safety management system of the Platform were modelled base on the structural recursion and structural organization of SSMS model. Safety management system using systemic method covers five functional coordinated systems that are necessary to be interrelated, system labelled from 1 to [31].

Safety policy implementation is the bedrock of safety management system which executed with the aid of different operations worked interdependently upon each other as illustrated in the new SMS modelled which is System 1 (i.e. safety policy implementation). Jone and Ariffin [38] revealed that there must be successful implementation of safety policy before achieving effective safety management system in Oil and Gas Industry.Safety policy implementation is achieved through the assistance of the other systems right from system 2 to system 5.

Safety co-ordination (i.e System 2) is work to assured that all those operations of system 1 are managed and operated base on the agreed policy on the Oil and Gas production Platform.Safety function (i.e. System3) assured that all the safety policy on the Platform executes its function very well. The subsystems within system 3^* is the subordinate of system 3 in carrying out the function of audit sporadically, then Safety development (i.e. system 4) takes care of identifying weakness, strength, treat as well as developing strategic standard in line with systemic changes on the Oil and Gas production's safety policies. Eventually, Safety Policy (i.e. system 5) is liable for instituting safety policies in line with the challenges (weakness, strength and threat) from system 4 for the entire Oil and Gas production Platform.

These five systems in this model of the Oil and Gas production platform, demonstrated and explained the role of each management system personnel (i.e. system role means the role of employee's managing the system). Again, the five systems in SSMS model have something in common with key management element found in the existing safety management approach such as environmental management system (EMS), although the approach does not include structural organization from a systemic view point [9]:[38]:[39].

The new SMS model of oil and gasis designed based on focusing the recursion or level of operation involved in oil and gas production platform (i.e. OAM, OBM, OCM and ODM). These operational modules were associated, monitored and control, through Horizontal and Vertical interdependency of the systems in order to retain the risk level between the acceptable ranges in every level of operation. Having risk level within the acceptable level in organizations means that health, safety, and environmental performance is at the acceptable level of risk [40].

Systemic safety management system (SSMS) incorporates relative autonomy, that is every operation in system 1 is responsible for its own activity accompanied by minimal interference from the other system 2 to 5 by permitting decision making at local level there after communicating to the entire organization [31]. These decisions were made locally according to the safety policy and task specification, the subsystem SMU and OOGU responsible for the decision making in system 1 based on the communication channels as illustrated in Figure 3.2, and explained in Table 4.2, 4.3, 4.4. Consequently, every operation (OAM, OBM, OCM, and ODM) safety decision relatively autonomous in order to achieve organizational safety policy effectively.

5.0 CONCLUSION

CONCLUSION

A SSMS model can be described as a systemic sequence of interconnected systems which are planned in the organizational structure. The five systems of the SSMS model are planned to retain risk within a bearable limit in the life cycle of the operations. The SSMS organization of oil and gas industry is proposed to manage safety in an intelligible manner by treating an organization interdependently both vertically and horizontally. The horizontal and vertical interdependent are managed through the interrelations (i.e. communication channels) around the different operations. These channels outlined fittingly so as to react to the necessities as displayed in the organizational operations.

REFERENCES

[1] Hakkinnen, J. P. (2005). 'Appendix 1.24: International Labour Organization (ILO)' [online] 526-526. Available fromhttp://www.sciencedirect.com/science/article/pii/B0123694000005275 [20/07/2013].

[2] Hamalainen, P., Takala, J., and Saarela, L. (2006).. 'Global Estimates of Occupational Accident'. Journal of Safety Science [online] 44 (2), 137-156. Available from http://www.sciencedirect.com/science/article/pii/S0925753505000871[06/03/2013]

[3] Santos-Reyes, J., and Santos-Reyes, D. (2002). 'Assessment of safety Management Systems in Oil and Gas Industry'. Offshore Technology Conference [online] OTC 14164. Available from http://www.onepetro.org/mslib/app/Preview.do?paperNumber=OTC-14164-MS&societyCode=OTC [28/07/2013]

[4] HSE (2006) A Guide to the Offshore Installations (Safety Case) Regulatio' [online] Available from http://www.hse.gov.uk/consult/condocs/offshore.pdf [09/04/2013]

[5] Pappas, J. A. (1994) 'Safety and Risk Management on Offshore Process Installations during Design and Construction'. Journal of Loss Prevention in the Process Industry [online] 7 (4), 345-351. Available from http://www.sciencedirect.com/science/article/pii/0950423094800480 [06/07/2013]

[6] Ming, K. T. (1994) 'Application of a Quality Management System Approach to Health, Safety and Environment'. Offshore South East Asia, Proceeding of the 11th Conference and Exhibition World Trade Centre, Singapore, 6-9 December, 739-745

[7] Singh, B., Jukes, P., Poblete, B., and Wittkower, B. (2010) '20 Years on Lessons Learned from Piper Alpha. The Evolution of Concurrent and Inherent Safe Design'. Journal of Loss Prevention in the Process Industries [online] 23 (6), 936 – 953. Available from http://www.sciencedirect.com/science/article/pii/S0950423010000975[20/07/2013]

[8] Pate-Cornell, E. M. (1993) Learning from the Piper Accident: A Post-mortem Analysis of Technical and Organizational Factors [online] Available from http://engineeringfailures.org/files/Learning%20from%20the%20Piper%20Alpha%20Accident.pdf [14/08/2012]

[9] BS 8800 (2004) Occupation Health and Safety Management Systems – Guide[online] Available from http://www.safety.ncl.ac.uk/uploads/BS%208800%202004%20Occupational%20Health%20&%20Safety%20management%20Systems%20-%20Guide%202004.pdf [26/07/2013]

[10] CCPS (1989) Guidelines for Technical Management of Chemical Process Safety. US: American Institute of Chemical Engineers

[11] IChemE (2013) IChemE Safety Centre*: HSE Accident Report* [online] Available from http://www.icheme.org/resources/safety_centre/products/hse_accident_reports.aspx[20/07/2013]

[12] Hudson, P. T. W (2003) 'Applying the Lessons of High Risk Industries to Health Care' Journal of Quality Safety Health Care 12(13), 17-112

[13] European Commission Environment (2013) Chemical Accident (Seveso I, II and III) Prevention, Preparedness and Response [online] Available from http://ec.europa.eu/environment/seveso/ [13/07/2013]

[14] Mitchison, N., and Papadakis, A. (1999) 'Safety management system under seveso II: Implementation and assessment'Journal of loss prevention in the process industries [online]

12 (1), 43-51. Available from http://www.sciencedirect.com/science/article/pii/S0950423098000369[13/07/2013]

[15] Pearse, W., Gallagher, C., and Bluff, L. (2001) Occupational Health & Safety Management System Proceeding of the First National Conference [online] Available from http://www.workcover.nsw.gov.au/formspublications/publications/Documents/ohs_management_systems_4231.pdf [20/07/2013]

[16] NTWORKSAFE (2009) 'Safety Management Systems: Guide for Major Hazard Facilities' [online] Available from www.safeworkaustralia.gov.au [04/07/2013]

[17] E&P Forum (1994) Guidelines for the Development and Application of Health, Safety and Environmental Management System [online] available from http://www.workcover.nsw.gov.au/formspublications/publications/Documents/ohs_management_systems_4231.pdf [20/06/2013]

[18] EPA (2013) Environmental Management System (EMS) [online] Available from http://www.epa.gov/EMS/ [20/06/2013]

[19] Islam, N., Martinez, I., Mgbeoji, I., and Xi, W. (2001) Environmental Law in Developing Countries. IUCN Environmental Policy and Paper No. 43, IUCN, Gland: Switzerland

[20] CCPS (2011) Guiding for Auditing Process Safety Management System. 2nd edn. New Jessey: Willey and Son.

[21] NSW (2011) Harzardous Industry Planning Advisory Paper NO 9: Safety Management [online] available from http://www.planning.nsw.gov.au/LinkClick.aspx?fileticket=Vy9ebBw5cR0%3D&...[20/07/2013]

[22] IHSS (2007) Safety Management System Toolkit [online] Available from http://www.ihst.org/Portals/54/SMS-Toolkit.pdf [08/08/2013]

[23] OSHA (2000) Process Safety Management [online] Available from https://www.osha.gov/Publications/osha3132.html[25/06/2013]

[24] Bentley, P., and Sockley, J. (1992) 'Hazard Management and Safety Management Systems: A Structured Approach'. Offshore Technology Conference [online] OTC 6925. Available from http://www.onepetro.org/mslib/app/Preview.do?paperNumber=OTC-6925-MS&societyCode=OTC [20/07/2013]

[25] EPSC (1994) European Process Safety Centre Safety Management System. IChemE. UK : Ruggby

[26] UKOOA (1995) *Guidelines for Safety and Explosion Hazard Management.*UK Offshore Operators Association, London: UK

[27]HSE (1997) Successful Health and Safety Management HSG65 [online] Available from http://www.hseni.gov.uk/hsg65_successful_h_s_management.pdf [27/07/2013]

[28] Othman, R. M. (2003) Effectiveness of Safety Management System (SMS) by Malaysian Shipping Companies in Compliance to the International Safety Management (ISM) Code [online] available from http://www.ismcode.net/research_projects/wmd_2003_paper.pdf [20/06/2013]

[29] Huppes, G., Davidson, D., Kuuper, J., Van Oers, L., Udode, A., and Warringa, G. (2007) 'Eco-efficienct environmental policy in oil and gas production in The Netherlands' Journal of Ecological Economics [online] 61, 43-31. Available from www.researchgate.net/...Ecoefficient_environmental_policy_in_oil_and... [10/07/2013]

[30] Santos-Reyes, J., and Beard, A. (2008) 'A systemic approach to managing safety'. Journal of loss Prevention in the process industries [online] 21(1), 15-28. Available from http://www.sciencedirect.com/science/article/pii/S0950423007001167[05/07/2013]

[31] Santos-Reyes, J., and Beard, A. (2009) 'A Systemic Analysis of the Edge Hill Railway Accident'. Journal of loss prevention in the process industries [online] 41(6), 1133-1144. Available from http://www.sciencedirect.com/science/article/pii/S0001457508000869 [09/07/2013]

[32] Santos-Reyes, J., and Beard, A. (2001). 'A Systemic Approach to Fire safety Management' Fire Safety Journal [online] 36 (4), 359-390. Available from http://www.sciencedirect.com/science/article/pii/S037971120000059X[01/07/2013]

[33] Warring, A. (1996) *Safety Management System*. US: Chapman & Hall

[34] Kontogiannis, T., and Malakis, S. (2012) 'Recursive Modelling of loss of Control in Human and Organizational Process: A Systemic model for Accident Analysis'. Journal of Accident Analysis and Prevention [online] 48, 303-316 http://www.sciencedirect.com/science/article/pii/S0001457512000498[12/07/2013]

[35] Pate-Cornell, E. M. (1993) Learning from the Piper Accident: A Post-mortem Analysis of Technical and Organizational Factors [online] available from <http://engineeringfailures.org/files/Learning%20from%20the%20Piper%20Alpha%20Accident.pdf> [14/08/2012]

[36] Shallcross, C. D. (2013) 'Using Concept Maps to Assess Learning of Safety Case Studies-The Piper Alpha Disaster'. Journal Education for Chemical Engineers [online] 8, e1-

e11. Available from http://www.sciencedirect.com/science/article/pii/S174977281300002X [08/08/2013]

[37] Jone, E., and Ariffin, B. (1994) 'Implementing Operations Integrity Management (OIMS)'Society Petroleum Engineer International, [online] SPE 27287. Available from http://www.onepetro.org/mslib/app/Preview.do?paperNumber=00027287&societyCode=SPE > [09/07/2013]

[38] Druker, P. (1986) Management tasks, Responsibilities, Practices [online] available from <http://www.slideshare.net/siddharthgtyagi/management-tasks-responsibilities-practices-by-peter-drucker> [20/07/2013]

[39] OHSAS 18002 (2000) Occupational Health and Safety Management Systems Guidelines for the Implementation of OHSAS 18001 [online] available from http://www.bre.polyu.edu.hk/research/ConstrSafetyAtHeight/archive/Fall_from_Height_Sol_Int/IntOrgGuideline/OHSAS18002.pdf[27/07/2013]

[40] Weldon, D., and Wallace, J. (2006) 'The and How for HSE ManagementSystems'. Society Petroleum Engineers International [online] SPE 98472. available from http://www.onepetro.org/mslib/app/Preview.do?paperNumber=SPE-98472-MS&societyCode=SPE [08/07/2013]