**Assessment of Resilience Engineering (RE) Challenges in Safety Culture and Managerial Factors Framework in an Oil Refinery**

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**Abstract**

RE as the inherent capacity of a system to cope with complexity and unexpected events in recent years has attractive considerable attention. But it has some challenges ahead of itself. The real challenge for RE is to recognize that complex systems are dynamics and that dynamic systems may sometimes change from a state of dynamic stability into a state of dynamic instability. In this respect, the current study explores the various challenges and barriers in safety culture indicators and managerial factors framework. In the safety culture area eight indicators and in the management area four criteria were identified because those directly influence on RE. The conclusion which can be argued is that the safety culture and management system have many problems in the refinery. Therefore, if the refinery decides to move toward RE approach, it should improve the safety culture and the management thinking itself at first.

**Keywords**: Resilience engineering, safety, refinery, safety culture, management.

**1. Introduction**

In recent years the concept of RE has attracted considerable attention, especially in the socio-technical systems, such as the nuclear industry, health care, and oil industry(Steen and Aven 2010). The oil industry is regarded as a high risk system due to three characteristics: loss of control can lead to catastrophic outcomes so as to stretch beyond the system boundaries(Tazi and Amalberti 2006; Srivastava and Gupta 2010), there is the high degree of interaction between the components/parts or tasks and activities, at last that there are various uncertainty and variability in all system components(Costella, Saurin et al. 2009). Therefore, the current risk management approaches are not able to perfectly explore and explain situations. So As Hollnagel (2007) cited: “It is a simple fact that whereas technological and socio-technical systems have developed rapidly, and continue to do so, the repertoire of methods to address safety issues has not. There is therefore a clear need for new approaches to risk assessment and safety management, and resilience engineering has been proposed as a solution to satisfy that needˮ. RE that represents a new way of thinking about safety(Dekker, Hollnagel et al. 2006) is the intrinsic ability of an organization to keep or recover quickly to a stable situation so that it can continue operation during and after a major mishap or in the present of continuous stress(Hollnagel, Woods et al. 2006; Steen and Aven 2010). The focus of RE is on work systems in which those are an instance of human systems and complex adaptive systems. Therefore, the central part of resilience is adaptation, the ability of systems and individuals to cope with the variability of their environmental without losing control or totally collapsing(Branlat and Woods 2010). In light of the foregoing, the aim of this paper is assessment of safety culture and managerial factors in order to explore and identify the main challenges and barriers toward RE and adaptive capacity.

**2. Resilience engineering challenges**

2.1. Dynamic complex systems

The real challenge for RE is to recognize that complex systems are dynamics and that dynamic systems may sometimes change from a state of dynamic stability into a state of dynamic instability. This change may be either abrupt or slow. The abrupt change may lead to an accident while the slow change may gradually erode safety margins(Hollnagel, Woods et al. 2006). In order to complex systems can adjust their performance to the conditions, they must certainly be dynamic. Most complex systems of interest are today intractable, dynamic, and performance conditions are always underspecified in such systems(Hollnagel 2007). Because adjustment to these systems cannot be pre-programmed or built-into the systems, they cannot be anticipated at the time of design, and sometimes not even later. Hence, it is not practically possible to design for every little detail or every situation that may arise. Complex systems must be dynamically stable; insofar as the adjustments don't escape of hand but at all times remain under control(Hollnagel, Woods et al. 2006). Oil refining plants are typically complex dynamic systems that have to operate throughout time in the presence of uncertainties(Dimitriadis and Pistikopoulos 1995). These uncertainties are, in general, also dynamic in nature and correspond to variations in either external variables (such as product demands, economic pressure, etc.)or internal process parameters (such as lack of knowledge about risks and their consequences, etc.)(Dimitriadis and Pistikopoulos 1995; Steen and Aven 2010).

2.2. Uncertainties and shape of risks

 While complex dynamic systems evolve over time, as system components interact with each other and with the environment, uncertainties and shape of risks will also change. As a result, the understanding of uncertainty associated with risk of major hazards in these systems should be enhanced(Markowski, Mannan et al. 2010). One measure of resilience is therefore the ability to create foresight, to anticipate the changing shape of risk and uncertainties, before those lead to failure and harm(Hollnagel, Woods et al. 2006).

2.3. Performance variability

Performance variability is another attributor of the complex systems dynamic. It always is because of the variability of the environment and the variability of the constituent subsystems. The consequences of this variability can be both positive and negative. To cope successfully with the complexity of the real world this variability is necessary while unwanted variability may induce a risk or failure in system(Hollnagel 2007). On the other hand, if high variability is likely in a system, there may be the high rate of possible failure. In traditional systems (e.g. the plant under analysis) performance variability, of any kinds, is a threat and that something should be avoided, but in the resilient systems performance variability is unavoidable and it is a source of success as well as failure(Hollnagel 2007). In such case, improving safety requires new tools to perform safety/production tradeoffs and enhance resilience in the face of variability, not constraining it. Such tradeoffs may have long-term consequences, even after a system comes back to normal operation(Dekker, Hollnagel et al. 2006). In the other words, when disruptive conditions persist, harmful consequences of changing safety practices may be misunderstood or underestimated for various reasons, including Merton’s concept of ‘imperious immediacy of interest’(Merton 1936; Dekker, Hollnagel et al. 2006). Underestimating of risks is an important factor in drift toward failure. Therefore, risk perception is of key importance for resilient system.

2.4. Hindsight and foresight perception

Some people always say that efforts for improving the safety of systems have often been overshadowed by hindsight. Based on that, people just rely on their experiences or understanding of what has happened. This situation inevitably influences their anticipation and preparation for what could go wrong and hereby restrains the requisite imagination as an essential element for safety(Hollnagel, Woods et al. 2006). This insight is reactive and tries merely to explain what has happened while today complex systems can no longer wait for accidents, after that think about safety. Another problem that exists about the insight is that error and individual component failure are the main causes of most accidents, i.e., single and simple causes, but it is gradually recognized that it is not adequate to select human error as a specific reason in spite of this thought is a pervasive phenomenon about human thinking(Qureshi 2007; Madni and Jackson 2009). In the plant under analysis, their safety systems just rely on the hindsight, and after the fact they try to hunt a scapegoat. This action leads to block the loop of learning from accidents and incidents. Hence, the hindsight bias misleads people’s interpretation about conclusion of accident investigations(Woods and Cook 2002). In the other words, knowledge of consequence biases our judgment about the processes that led up to that consequence. Hindsight is not foresight because after an accident, all of the critical information and knowledge needed to understand what happened was uncovered. But the knowledge is not available to the people before the accident. In this state, we tend to oversimplify the situation the actual people met, as a result our ability to see the deeper story behind the label human error was blocked. This challenge will solve with escape from hindsight and go to foresight thinking, i.e., anticipation of potential risks before failure or harm occurs(Woods and Cook 2002).

2.5. Barriers against resilience and adaptation capacity

There are many barriers toward the development and implementation resilience and adaptive capacity that have revealed in some studies such as what performed by Gibbs (2009). This case study was performed on marine policymakers in coastal communities. In his study, Gibbs referred to factors such as little experience in managing resilience, no mathematical technique to identify resilience and adaptive capacity outcomes and so on. Studies conducted in different high-risk domains, have identified three basic patterns of adaptive failures or traps that can challenge resilience engineering, including decompensation, working at cross-purposes and getting stuck in outdated behaviors. In Branlat and Woods study it has been recognized how adverse events can occur when systems fail to adapt to disturbances and challenges(Branlat and Woods 2010).

 The application of procedures lay out the challenges and barriers for systems wishing to make progress on resilience using procedures. Based on Dekker study (2003), there exist two (implicit) models of procedures and work that guide how systems think about making progress on safety and resilience: procedure application as rule-following and procedure application as substantive cognitive activity. This study revealed a fundamental double bind when operators fail to adapt procedures while the adaptation is necessary. In this case operator cannot confront the inherent dilemma, and therefore cannot resolve problem or opt out of the situation. To solve such problem and make progress in safety and resilience through procedures, systems require monitoring gap between procedures and practice and understanding the reasons behind it.

One of the keys to improve safety management and resilience is establishing a positive safety culture in the refinery because safety culture is like an umbrella that covers related fields to safety and RE(Oxstrand and Sylvander 2010). Weaknesses in the safety culture are a big barrier against being resilient organizations and progress in safety. In this respect, the role of the managers and their leadership activities in creating and sustaining a safety culture are a keystone factor(Reiman, Pietikäinen et al. 2010). There are several review articles on safety culture (e.g. (Cooper 2000; Flin, Mearns et al. 2000; Guldenmund 2000; Gadd and Collins 2002; Akselsson, Ek et al. 2009) which have well described the subject. Many of these believe that safety culture is the most important factor in the ability of an organization to implement a safety management system(Reason 1997).

  **3. Material and method**

3.1. Oil refinery characteristics

The plant (remain anonymous) under analysis is a refinery with more than 3000 employees and contractors which was established more than 50 years ago. The refinery was included eight operational, two logistic and four administrative units (each of unit itself has several sub-units).

3.2. Method

This study was done in two steps, direct observation and interviewing with people. The study emphasized on two arenas, i.e., management system and resilience safety culture, because those are the keys to successfully establish safety and RE.

In this area, we have assessed five indicators that are most important based on OFSC (2008) and Halama, Kelly et al. (2004) in the resilience safety culture and four criteria in the management system. The measurements were performed by interview and observation. The participators were 68 employees, including managers, supervisors, safety engineers, operators and contractors. The working experience of all participators was between 15-25 years; moreover, documents, records and guiding manuals were reviewed in the observations.

3.3. Measures

3.3.1. Indicators of resilience safety culture

In this study safety culture indicators were included:

* Schedule delay. This indicator that show number of days behind schedule, measured by reviewing schedules and plans, especially in safety area.
* Safety committee. This indicator was measured by number of safety committee meetings that held for a minimum. Its measurement was based on interview.
* Meetings. How many holds duration within a specified time frame. To measure it, there used the interview and review of schedules.
* Safety education. To measure it, we identified percentage of employees who received site specific safety education by interview with the employees.
* Worker's involvement. To measure it, there reviewed near miss and near hit reporting by interview and review documents.
* Competence. This indicator was measured by interview and by determination of pre-hire screening of employees. Here we used the questions, e.g. is action seldom taken against employee who break safety procedures, instructions and rules? Or can you do your work very well?
* Safety training. This indicator was measured by interview and by determination of number of employees or managers that have completed safety training such as OSHA training.

3.3.2. Managerial factors

Promotion of safety management and RE directly depends on managers' attitudes and their commitment to those. In this study, managerial factors were as follow:

* Centralization or decentralization control. Many studies have shown that decentralized control can be better and safer(Hoekstra, van Gent et al. 2002). The way that we utilized to reveal this was based on interview with the managers and operators. To reveal it, we asked questions, e.g. “Have you been participated in important decisions making in your workplace? ˮ
* Management of change (MOC). The aim of doing an MOC is to ensure that the change does not unknowingly increase risk or compromise the safety of the existing process(Schreiber 2008). In this respect, reviewing documentation and interviewing with the managers and operators was the key to reveal the subject. There asked questions from managers, e.g. “don't you have any plan for classification of changes as either permanent or temporary? ˮ
* Risk management and accident analysis. Here, the evaluated criteria were management view about safety and resilience, i.e., hindsight or foresight; reactive or proactive, and that whether management search for hunting culpable or scapegoat people in accidents analysis. What are sources of uncertainty in risk assessment and accident analysis?
* Management commitment to safety and resilience. To measure this item, we used the criteria such as safety budget, sacrifice judgment, attention to feedbacks. The criteria were weighted by questions, e.g. “will the management sacrifice his profit when he invests in safety or should safety rules be cohered even under production pressure? ˮ

**4. Results**

The key findings from this study are presented as two separate tables summarizing key points from the interview on: (1) safety culture indicators, (2) managerial factors.

4.1. The safety culture indicators

One of the strong barriers that prevent progress in safety and RE is negative safety culture. Our experiences in the refinery and other industries show that safety culture plays an important role in this regard. Positive safety culture needs a deep and wide understanding of the refinery safety including the various accident mechanisms of the refinery, as well as a willingness to continuously develop one’s competence and understanding. An effective and resilient refinery safety culture has to promote a constant sense of anxiety that obstructs complacency yet at the same time it has to promote a certain professional pride and a feeling of accomplishment to maintain job motivation and healthy occupational identity(Reiman, Pietikäinen et al. 2010). Based on this perspective, five indicators was the axe of the discussion of interviewers (see OFSC (2008) and Halama et al. (2004), but the last indicator, i.e. wrong religious beliefs was recognized in the meantime of interview and review the accident documents. The interviewees frequently pointed to fate, destiny, and ‘act of God’ in their words. In the other words, they have bizarre belief to these phrases. See table 1.

Table1. Key points from the interview and observation on safety culture indicators (Halama, Kelly et al. 2004)

4.2. Managerial factors

The management attitudes of the personnel were also noted to influence the refinery safety for better or for worse. The role of the managers and their leadership activities in creating and sustaining safety and RE in the refinery is a key factor. The refinery management is based on conventional principles and it is completely centralization, i.e. all decisions depend on top management. As a result of this situation, safety management was changed to a dependent management so as to make decision under any conditions depends upon the approval of the top management. However, the attitudes of management overshadow all safety and RE areas, e.g. risk assessment, accident investigation and so forth. This situation also creates more uncertainty in safety and RE issues. See table 2.

Table2. Key points from the interview and observation on Managerial factors

**5. Discussion**

5.1. Safety culture indicators

The results of interviews and observations showed that the safety culture is critically important for high risk industries such as oil and refining industry. The researches explored that major accidents have linked weaknesses in so-called ‘safety culture’ with organizational incidents. In this respect, the question which rises is that how a researcher is able to measure the culture of a workplace without being a member of that workplace. If indeed culture involves aspects that ‘unwritten’ or ‘unspoken’, they cannot easily be analyzed and measured by people outside of the workplace(Yule 2003). In answer may be said that indicators are a good scale to measure safety culture. There defined various indicators in the literatures. For example, the studies of Halama et al. (2004) recommended a “top 10” list of practical leading indicators among 300 available indicators. In this research, the authors surveyed eight indicators in safety culture areas in addition four criteria in management areas. Safety culture indicators ascertained the important things for research team that can be seen as follow:

The first indicator was schedule delay (SD) which it may be lead to delay claim. In this context, this concept is not the goal of the research. The results of interview and overview of schedule uncovered that delay in all schedules was a routine as more than 95% of them were involved in this problem. The state of SD was worse than others in safety schedules. For example, nine years ago the first author had prepared a proposal about risk assessment in a unit of refinery and sent for research and development office; it was waiting about a year to acquire approve from the refinery management, but in the meantime of this period there occurred a large explosion in one of the hydrogen pipes and imposed a huge loss on the system. After the explosion, the management approved the proposal. If the proposal has been approved in a timely manner, the explosion could be prevented. There exist too many examples about SD that it is one of those. Therefore, SD is a strong barrier against safety and RE progress, as well as productivity in the refinery. The reasons of SD are bureaucracy, irresponsibility, weak position of safety, incomplete design, unforeseen causes, insufficient budget, inefficient communications / co-ordinations, and bad weather. Of course, three of first are most important among the others.

Safety committee plays a key role in creation of safety culture between managers and workers, but the status of the safety committee depends on participations and their level. As such, the safety committee can be assessed by the level of the managers who actively participate in and by the actual implementation of its decisions, whereas the status of safety officer can be assessed by the executive authority assigned to him (e.g., authority to stop production when safety is at risk). The researches highlight the importance of position of the safety committee in progress of safety and RE, but the findings of this research show that not only the safety committee does not authorize to resist against production (when safety regulations are not followed), but also the people that often participate in this committees are from the low hierarchical level. The discussed subjects in the safety committee are often employees' problems such as welfare status rather than safety issues. Safety meetings always hold within specified times, e.g. after accidents, or review important issues (ISOs, procedures, etc.)

Formal safety education in the overall plant and even in the safety office is a dispute issue because most of the safety personnel do not have a formal safety education; however, some of them gain a little safety knowledge by informal safety education, e.g. self education, learn through others media, and so on. This problem is one of big challenges and barriers in the safety management and RE area not only in this plant but also in other plants. In this respect, people have to learn safety by experience and this manner to educate safety can lead to tragedies such as what happen before. The flip side of this matter refers to safety training. As Leiter and Robichaud (1997) pointed out training is the construct linking employees’ experience of burnout and perception of risk at work. Sufficient training is increasing worker's efficacy in managing risks. In the other words, adequate training of safety procedures creates a feel more empowered in workers to handle the risks that they face. Therefore, the quality of safety training influences our control on hazards, what is weak in the refinery. There are weaknesses in the quality of safety training programs. The content of safety programs is superficial, unspecialized, and sometimes even irrelevant. There yearly held too many safety training course, but experiences and observations explored that trainings could have not improved safety knowledge (the workplace cultures resulted in clear differences in how workers applied safety knowledge to their work) of employees, this weakness can in employees' behaviors observe. Furthermore, trainings could have not promoted situation awareness and also decision-making skills in employees so that their decisions relied on a superficial analysis of the situation. The quality of safety training can also influence on the employee's safety competence since the competence refers to what an employee is capable of doing. In turn, this capability requires knowing what to do and knowing how to do(Hollnagel 1993). In addition to weakness in the quality of training, incomprehensible, inaccessible, and inaccurate procedures as well as unsuitable prehire screening are the other issues that the refinery has changed to a low competence or an ultra performing system (Safety < 10-3) as cited by Hollnagel, Woods et al. (2006).

Continuous learning from events, ‘near miss’ incidents, and accidents is a critical part of high resilience in systems. The various studies, e.g. (Heinrich, Petersen et al. 1950; Bird and Germain 1966; Tye 1976) demonstrated relationship between the number of near misses, minor incidents and major accidents. Therefore, near misses should well be reported and documented because near misses are precursors to accidents that can shed light on preventive mechanisms(Jones, Kirchsteiger et al. 1999). The results of interviews and documents review showed that there observed no motivation among employees for reporting near misses because there governed this thinking which messengers are shot and whistleblowers must be dismissed or discredited. In the other words, the refinery should also have a system to analyze reports and decide whether further investigation or other actions are deemed necessary or not. In the site observations, there have been seen many near misses, e.g. badly supported pipes, thanks, the high probability of H2S leakage, unsafe conditions, the probability of worker fall, etc. that without any specified action exist in the workplace because most people believe that pay attention to near misses is waste of time. In short, underestimation of the actual risk is a result of no considering occurrence of near misses. No considering near misses and accidents occurrence in the refinery can also have the other reasons, e.g. wrong religious beliefs. There explored that this beliefs have a negative effect on learning from near misses and even accidents because many employees and even some of top managers believe that accidents are act of God and therefore those are beyond of control. The phrase is a good defense to shrink and simply blame others [always culpable is victim(s)].

5.2. Managerial factors

The results of the study explored that the management system of the refinery is a centralized model because all decisions normally restricted to one individual or a select few. All orders therefore imposed from top to bottom by top management, or from senior employee with decision authority. They decide that what is permitted, how the refinery should perform work, and how order is assured and dominated as Desouza and Awazu (2005) referred to it. As the refinery is a high risk system so, in abnormal situations there needs fast actions while the process of decision making based on centralized modal is a consuming-time process (see the hierarchy of decision making in the refinery; operator→ head operator → shift operator→ head area→ head operation→ top management); therefore, this management system is not useful for the system survival. Conversely, as many studies, e.g. Hoekstra (2002) have highlighted that a decentralized management is better and safer. Because in decentralized management decision authority distribute across all hierarchal levels of the system, in such systems various changes will early detect. (Of course, an experienced manager is who can distinguish between centralized and decentralized control so as to know when choose which one of those.) Therefore, implementing management of change which is the most important components of process safety management will be a good choice. Of course, the MOC is another challenge in the refinery management system. Said another way, no scientifically and practically exist the possibility for implementation of such a system in the refinery. In deep observation, there explored various change options, including replacement of equipments, modification of operations, development of systems and units as hardware and software, process control changes, modification of procedures and manuals, policy changes, etc., but there did not observe any documents and records so as to show in the refinery the MOC was performed. Hence, the refinery because of its high risk nature requires to a precise and regular MOC so that it monitors and documents more subtle changes. Inattention to changes itself can increase uncertainty and vulnerability. Sources of uncertainty in risk assessment consist of hazard identification, consequences assessment, likelihood estimation of incident occurrence, risk estimation, risk evaluation for tolerability and potential for reduction, and findings record. The findings showed that the refinery has stopped in the first step, i.e. hazard identification. Reviewing deeply results manifested which the refinery has not had a list of existence hazards and risks and therefore the system has located in a critical situation. With regard to this conundrum in the refinery risk assessment system, the system can never anticipate risks related to the future and also unexpected situations. Another thing is that because the employees do not know process risks and hazards in the workplace, their perception and awareness of risks is imperfect. Of course, as Rundmo (1992, 1994)pointed out the risk perception was also affected by satisfaction with the refinery safety procedures, safety training, control, and social support. Safety procedures are another challenge, or said better way, another barrier in the path of safety and RE progress. Those also have imperfects as mentioned before.

Accident investigation is not better than risk assessment in the refinery because the management’s view about accidents is based on hindsight. The management tries merely to explain what has happened and also looks for hunting scapegoats, this also pointed by(Hollnagel, Woods et al. 2006; Størseth, Tinmannsvik et al. 2009). At last in any accident, person(s) hunt as culpable and consequently accident investigation arrives to end. Old technology and relevant problems, e.g. design, equipment layout, ergonomics (e.g. displayers, controllers, valves, and so on), workplace conditions (e.g. breakdown of safety devices, warning, indicators, and so forth), etc. are the cases that pave the way for occurrence an accident. Note that all people in the refinery believed that safety is what the system has, and when install on the system, it will be perpetual. Whereas, it seems that safety and risk are emergent, not resultant, properties, e.g. what pointed out by (Hollnagel, Woods et al. 2006). What have previously been cited does not become certain unless the management has been a firm commitment to safety and RE. The management commitment is a cornerstone for safety programs. The commitment should be demonstrated through actions, such as sustaining safety research budgets, sacrificing production when safety is at risk, attending to safety feedbacks, updating procedures or providing new procedures, etc. what we have explored in the refinery was other things. The safety research budgets have been reduced for various reasons, e.g. giving priority to production, budget deficit, and external pressures. The result of tradeoff between safety and production is also perfectly clear, i.e. first production!

Feedback in all levels of the refinery is a platitude theme and it is more liable to criticism rather than improvement, at least in safety areas. The system does not utilize the feedback to tame complexity, but also use it to enfeeble others. In this situation, the feedback not only tames complexity, but also itself causes to create more complexity in the refinery. In the other side, in parts of the refinery that utilize the feedback because of the existence of bureaucratic and paper proof, the feedbacks are incomplete or delayed.

**6. Conclusion**

In this paper we have pointed at some challenges and barriers toward RE and safety management in safety culture and managerial factors framework. Based on key literature toward RE, document analysis, and interview with people, a set of criteria both in safety culture and in management area identified as serious challenges and barriers in the way of improving RE and safety management. On the other hand, the results of safety culture analysis showed that the refinery has a poor safety culture at least in the examined criteria. In this regard, it was recognized that one of most important success factors in the safety culture area is management commitment. Of course, in addition to management commitment, this paper identified some major weaknesses in the management area, e.g. risk management and accident investigation, the style of control (centralized management), etc. In short, the results explored that not only there exist the weaknesses in the safety culture, but also in the management of the refinery. It can concluded that the RE and safety management are faced with many challenges and barriers in the various areas. The refinery should initially improve its safety culture and management system and then try to move towards RE approach and establish it.

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Table1. Key points from the interview and observation on safety culture indicators (Halama, Kelly et al. 2004)

|  |  |
| --- | --- |
| Indicators  | Result of interview and observation |
| * Schedule delay
 | Too many, especially in safety schedule |
| * Safety committee
 | One per month with platitude subject and partially irrelevant. |
| * Meetings
 | Usually after accidents, or duration of specified time for reviewing a critical issue. |
| * Safety education
 | Lack of safety education in many employees  |
| * Worker's involvement
 | No tendency to report near miss, or near hit, and lack of a system to assess reports. |
| * Competence
 | Poor screening before employment, Poor and outdated knowledge, especially in safety issues. |
| * Safety training
 | Safety trainings with general and impractical issues, few employees and managers |
| * Wrong religious beliefs
 | Believe many managers and operators (more than 60%) to fate role or act of God in accident happening |

Table2. Key points from the interview and observation on Managerial factors

|  |  |
| --- | --- |
| factors | Result of interview and observation |
| * Centralization or decentralization control
 |  completely centralized |
| * Management of change
 | Very poor, and no documentation |
| * Risk management and accident analysis
 | Hindsight and reactive insight about safety and accident. More uncertainty for anticipation of risk and accident investigation, search for hunting scapegoats and culpable person. Lack of situation awareness |
| * Management commitment to safety and resilience
 | Unsustained safety budget, preference of production, less attention than feedbacks, outdated procedures and rules, as well as lack of procedures in some cases. |