



# An integrated experiment for identification of best decision styles and teamworks with respect to HSE and ergonomics program: The case of a large oil refinery



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## ABSTRACT

Decision making failure is a predominant human error in emergency situations. To demonstrate the subject model, operators of an oil refinery were asked to answer a health, safety and environment HSE-decision styles (DS) questionnaire. In order to achieve this purpose, qualitative indicators in HSE and ergonomics domain have been collected. Decision styles, related to the questions, have been selected based on Driver taxonomy of human decision making approach. Teamwork efficiency has been assessed based on different decision style combinations. The efficiency has been ranked based on HSE performance. Results revealed that efficient decision styles resulted from data envelopment analysis (DEA) optimization model is consistent with the plant's dominant styles. Therefore, improvement in system performance could be achieved using the best operator for critical posts or in team arrangements. This is the first study that identifies the best decision styles with respect to HSE and ergonomics factors.

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## 1. Motivation and significance

The importance of failures in complex systems such as petrochemical units and oil/gas refineries has well been recognized in recent years. In this perspective a major part of system failure has been recognized as a result of human errors. The employees are known as the most important asset of any organization. Health, safety and environment management system are a rating point for an organization, beforehand. It is an essential requirement of competitiveness in assigning ideal personnel to crucial tasks. Previous studies have shown that decision styles modeling is one of the most efficient tools for assigning personnel with suitable characteristics to jobs and tasks. In this study, HSE and ergonomics scores are assumed as performance measurement indicators. Moreover, best decision making styles and teamwork of operators are identified for optimum performance with respect to HSE and ergonomics factors. Comprehensive research in this area shows that this study

is the first in identifying the best decision styles with respect to HSE and ergonomics factors.

## 2. Introduction

The purpose of this study is to identify the best decision making approach and team combination considering HSE management system and ergonomic programs, which could result in improving total efficiency. We can define main objective and sub-objectives of this study as follows. The main objectives:

- Determining the efficient operators, considering HSE management system and ergonomic programs.
- Determining the efficient decision styles, based on HSE management system and ergonomic programs.
- Evaluating the efficiency of simulated teamworks.

The sub-objectives:

- Analysis of demographic variables' effects on HSE factors.
- Correlation analysis between decision styles.

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**Table 1**  
The most well-known causes of failures.

No.	Cause of failure	% of total
1	Insufficient knowledge	36
2	Underestimation of influence	16
3	Ignorance, carelessness and negligence	14
4	Forgetfulness	13
5	Relying upon other without sufficient control	9
6	Objectively unknown situation	7
7	Imprecise definition of responsibilities	1
8	Choice of bad quality	1
9	Others	3

In the following, the HSE and decision styles as key areas in achieving the objectives of this study were examined.

### 2.1. Health, safety and environment

Hazards almost exist everywhere along with technological systems like refineries and petrochemical units. Unfortunately, most of the times they are not identified until an accident occur. Therefore, identification of hazards and risk reduction as preventive measures are important preliminary effort (Lee and Park, 1997; McCoy et al., 2006).

While a safety culture has no well-established scientific support, an integrated concept of health, working environment, environment and safety aspects need to show the company's holistic attitude into "people", "plant" and the "environment" and "social responsibility". The impact of culture differences on safety management is studied in cross-cultural studies (Hsu et al., 2008). The role of nationality on safety performance is also discussed by Mearns and Yule in multi-national company. The management commitments to safety and the efficacy of safety measures are introduced as the most important impacting indicators on human behavior and related hazards (Mearns and Yule, 2009).

Human health in both physical and psychological aspects should be one the first priority for managers (Azadeh et al., 2011). The environmental effects of industries in local and global scales were recognized (has had a great important) in 1960s and 1970s (Crawley and Ashton, 2002). Safety management approach handled by a number of guidelines to implementation and operation of a management system on health and safety (HSE 1991, 1992) consistent with previous standards on quality management (ISO 9001, BS 5750) (Kennedy and Kirwan, 1998). Hoviki et al. (2009) addresses how different workers conceptualize HSE culture, informant differences and HSE aspect varieties.

Five classifications for major causes of engineering disasters presented as: human factors, design flaws, materials failures, extreme conditions and environment and combination of them. The most important causes of failure addressed by May and Deckker are shown in Table 1 (May and Deckker, 2009).

In spite of the fact that one of the major focuses of hazardous industries is safety issue, accident rate with catastrophic outcomes is nearly high. This unacceptable rate of safety system failures guides our research toward the most important known reason of disasters, named "human error" (Kariuki and Lowe, 2006; AICE, 1994). Barraso et al. (2000) have defined human error as "Any human action (or failure to act) which results in an inappropriate or undesirable state of affairs, generally an outcome which detracts from achieving company goals and targets". Inappropriate design of standard operation procedure (SOP) or standard assembly procedure (SAP) is also introduced as important influencing factor and latent reason for unexpected results found during human operation (Yu et al., 1999).

Attention to human as ending point in a process plant and the importance of focus on design of workplace to allow workers

**Table 2**  
Five decision making styles.

Low information use		High information use	
Uni-focus	Decisive	Hierarchical	Systemic
Multi-focus	Flexible	Integrative	

to act in an optimal way that reduces human error and disturbances is emphasized by Kjellen (2007). Management deficiencies and design/operator mismatch are introduced as the major cause of human error (AICE, 1994). Operators must be aware about erroneous conditions, possible failures and consequences of each activity. Learning from error could be a feedback, useful or stressful, for responding in emergency situations (Homsma et al., 2008).

Despite this researches and findings in human error analysis, and while human error rate is decreasing gradually, the ratio of human error cases to the total incidents is reported around 20% (Michlitz, 2000). To further reduction in this ratio and increasing system reliability, it is necessary to try to identify and correct hazardous conditions caused by human interaction. Over the years, management systems have had a major role in presented methods to deal with the unexpected events or emergency situations.

### 2.2. Decision styles

Decision making to choose corrective procedure in unexpected situations in complex systems like process plants is a crucial task. Decision making is a permanent action in real life but it does not have same form evermore. Park and Jung (2004) have suggested a systematic framework guide to construct a diagnosis procedure based on decision making strategies and the test sequencing technique.

A holistic definition of decision making style stated as: "The learned habitual response pattern exhibited by an individual when confronted with a decision situation". It is not a personality trait, but a habit-based propensity to react in a certain way in a specific decision context (Thonholm, 2004).

Why decision making is important? Decisions are important outcomes for individuals, industries and societies. Decision making under time bounded and uncertainty is one of the crucial and significant roles of workers in process plants, especially in highly risk occasions. The know how to improve these outcomes would benefit all these parts. Furthermore, errors resulted from bias in judgment lead decision maker to make some non-compensable actions. As the tasks become more complex, each biased decision is likely to have implications for a broader level of society. Milkman et al. (2009) studied decision making biases taking into account the cost of decision making errors.

The foundation of this study is based on Driver et al. (1993) definition of decision making style. The amount of information and the number of alternatives considered when making decision are identified as the basic effective factors on differences between decision styles. It is assumed that people have two decision-making styles, the primary decision style named as practical style and the second style presented by role based (Driver et al., 1993). Five decision making styles represented by Driver et al. are shown in Table 2:

- Decisive decision style: characterized by unique focus and using needed amount of data.
- Flexible decision style: characterized by multiple focus and using needed amount of data.
- Hierarchical decision style: characterized by unique focus and using broad amount of data.
- Integrative decision style: characterized by multiple focus and using broad amount of data.

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