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Determination of factors affecting safety practices in Malaysian radiation facilities

Hazmimi Kasim[a,b,*], Che Rosmani Che Hassan[a], Mahar Diana Hamid[a], Sina Davazdah Emami[a], Mahmood Danaee[c]

[a] Department of Chemical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia
[b] Malaysian Nuclear Agency, 43000 Bangi, Kajang, Selangor, Malaysia
[c] Academic Development Centre, University of Malaya, 50603 Kuala Lumpur, Malaysia

ABSTRACT

A substantial amount of research has delved into the nature of safety climate, and subsequently its importance as a leading indicator of safety performance. However, they have mostly been conducted in Western countries via high risk operations. Therefore, this study is focused on the exploratory factors of safety culture practice in the industrial context of Malaysian radiation facilities, specifically by determining the influencing factors, their dependency and significant difference in mean level. This is attempted by adopting and adapting the six-factor Malaysian Safety Tool Kit (MSTK) and the components of safety culture practice as suggested by International Atomic Energy Agency (IAEA) safety series as the Malaysian nuclear and radiation safety tool kit (MRSTK). The exploratory factor analysis representing the MSTK model is therefore partially replicated and applied in the Malaysian nuclear and radiation sector. An alternative nine-factor model has been developed, which consisted of 32 items encompassing these elements accordingly: questioning attitude, communicative information, work environment, management commitment, communication, safety priority, personal view, involvement and prudent approach. The resulting outcomes have displayed statistically significant mean difference among these factors and consequently remained consistent with common safety climate themes. Nevertheless, they have also demonstrated the need to factor in individual response and organization cultural factors in the development of safety climate models intended for usage in Malaysian radiation sector. Furthermore, these findings have also revealed implications regarding the transferability of safety climate models and the type of safety interventions in implementing Occupational Health and Safety (OHS) management strategies more efficiently.

1. Introduction

Over time, organizations having safety responsibility like petrochemical plants and nuclear power plants have developed a safety culture practice to prevent human error and benefit from the positive aspect of human action concomitantly (Klinke and Renn, 2002). These safety practices are generally assessed prior to their implementation to monitor their efficacy via a self-assessment toolkit. Regardless, safety climate research is the most common tool has led to the general consensus regarding the importance of safety climate as a 'leading indicator' for organizational safety (Zohar, 2010). Despite evidences indicating its generalizability across employment groups (Cheyne et al., 2003), organisations (Mearns et al., 2003), and industries (Hahn and Murphy, 2008), limited attention has been expended in the components of safety climate associated with specific industrial sectors or cultural differences. In actuality, the items of each theme are variable and pose high likelihood to be industry- or even company-specific, related to particular work practices or policies (IAEA, 1997). According to Guldenmund (2000), the distinctions between assessments of an organization's basic assumption are more important as they have been assumed to be explanatory regarding its attitude to safety.

Malaysia's involvement in nuclear technology has begun upon the setting up of the country's own Nuclear Agency in year 1972, which has contributed approximately 0.032% of the Gross Domestic Product (GDP) in year 2006–2008 (Ainul and Hazmimi, 2010). Furthermore, the economic transformation plan has detailed Malaysia's exploration for nuclear power plant to fulfil the country's demand for energy security (PEMANDU, 2010). Nevertheless, the amount of work on safety culture practice that has been conducted in nuclear and radiation in the context of Eastern countries like Malaysia is very limited compared to the petrochemical sector. The lack and limited amount of quantitative study regarding safety culture practice assessment in Malaysia itself is

* Corresponding author at: Malaysian Nuclear Agency, 43000 Bangi, Kajang, Selangor, Malaysia.
E-mail addresses: hazmimi@nuclearmalaysia.gov.my, hazmimikasim@siswa.um.edu.my (H. Kasim).

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particularly obvious (Ali, 2011). Thus, the focus of the current study is in testing the exploratory factor structural of a safety climate instrument of Malaysian Safety Toolkit (MSTK) in Malaysian nuclear and radiation sector. Its reliability across petrochemical plants in Malaysia has subsequently yielded the hypothesis that the six-factor model would be factors contribute to the effective safety practices.

A particular point of concern is regarding the extent to which the safety climate instruments developed in the petrochemical sector can be successfully transferred to nuclear and radiation sector, for the purpose of fulfilling the nuclear safety regime requirements. This study has specifically emphasised upon the responsibility of the management hierarchy and individual response, referring to the staff attitude across all levels in responding to and benefiting from the safety culture framework (IAEA, 1991).

Thus, this paper is aiming to determine the factors affecting safety practice assessment for nuclear and radiation among industrial workers in Malaysia using MRSTK, with direct comparisons between factor labels and loading items across these measures. The dependencies and significant mean level between these factors will also be instrumental in identifying and determining safety interventions. These outputs can substantiate the usage and transferability of such safety climate instruments and safety interventions, which are particularly valuable in strengthening the safety culture practice framework.

2. Literature review

2.1. Factors contributing to the practices of safety culture in managing high risk and hazard

A good safety culture is comprised of three characteristics, namely: (1) norms and rules for dealing with risk; (2) safety attitude; and (3) reflexivity on safety practice (Cox et al., 1998). It can be described as the routine practice in managing risk and hazard, which differs according to organizational priority and people attitude towards work safety (Chauvin et al., 2007). An analysis of the culture encompasses analysing the relationship between individuals (i.e. perception, attitude, psychological), behavioural (i.e. safety-related behaviour) and organizational (i.e. safety management system, audit, safety policy) characteristics within each measurement method (Parker et al., 2006). Furthermore, Cooper (2000) has also defined safety climate as a summary of molar perceptions shared by employees regarding their working environment. Meanwhile, Guldenmund (2000) has argued for it to be deemed as an alternative indicator of safety performance, with emphasis on its validity. Moreover, safety climate and safety culture have not been referred to as separate entities, but rather the different approaches towards achieving the same goal of determining the importance of safety within an organisation. Safety climate in particular has been utilised to analyse the safety culture related to a person's attitude, perception and behaviour; it is a systematic tool in analysing an organisation's safety practice (Abdullah et al., 2009).

Besides, the perception of organisational safety culture has been consistently and independently associated with corporate safety performance (Fernández-Muñiz et al., 2014). Prior to rolling out new changes or transformations, the safety climate is measured beforehand to ensure the strength of the organizational safety performance. However, relevant safety issues may vary substantially between studies, ranging from global scales that represent a single factor to measures depicting up to sixteen different dimensions (Flin et al., 2000).

Generally, factors contributing to the safety practices have been assessed using several assessment tools for various sectors. Table 2.1 has displayed some of the tools that has been used in the oil and gas, petrochemical, railway and nuclear power industries respectively (Health and Safety Executive, 2005).

Despite the substantial amount of studies designed on assessment tools, they are generally developed for application in specific industry and country, such as the oil and gas, nuclear, or rail industry in United State of America, United Kingdom, Brazil, Mexico and China. The Safety Climate Assessment Toolkit (Cox and Cheyne, 2000) in particular has been designed to assess the safety culture in offshore environments, which has combined several assessment methods. They include: questionnaire survey, focus groups, behavioural observations and situational audits, which collectively suggests of describing and exploring the efficacy of health and safety management systems. The tool has been adopted as the Malaysian Safety Tool Kit (MSTK), which has been utilised in the study entitled "Occupational Health and Safety Practices in the Petrochemical Industries of Malaysia" (Isha, 2012). MSTK has been used to assess the combination of work environment, individual attitudes and perceptions on management commitment. The six- factor model has consequently contributed to the OHS practice and analysis, substantiating its reliability as an instrument. These findings supported (Abdullah et al., 2009; Ali, 2004; Desa et al., 2013; Hee, 2014; Ismail et al., 2009; Ismail et al., 2010; Ramli, 2014; Rashid, 2012; Sukadarin et al., 2012) that have described safety management, safety priority, involvement, management, supportive environment and personal views as influential factors of safety practices in Malaysian manufacturing and construction sectors.

Evidences of successful investigation in safety climate instruments are available, but they have been mostly drawn from specific industries. Therefore, a comparison across industries is lacking, whereas the current assessment tool is focused more on the level of policy and managerial commitments rather than individual commitments in monitoring their response.

Currently, radiation safety in Malaysia is still inadequate and limited to quantitative studies on safety culture practice (Ali, 2011). Furthermore, the factors of individual commitment, manager's commitment and policy commitments have not been identified clearly and are not quantifiable compared to other sectors in Malaysian workplace. Additionally, correlations and significant studies regarding safety culture variables and safety performance are also woefully insufficient (Ali, 2007; Sangau, 2012).

In nuclear and radiation facilities, the safety culture framework is answerable to the management hierarchy and staff attitude across levels in responding to and benefiting from the framework (IAEA, 1991). IAEA safety series in particular have recommended the factors of a questioning attitude, a rigorous and prudent approach, and the necessary communication in assessing the staff attitude towards effectively monitoring individual commitment to safety.

After Fukushima's nuclear event, Yang (2014) has identified two key issues for the incident, which are: technical issues, and human and organization errors. The specific technical issues of hazard, combined hazards, explosion and multi-unit feature for the occurrence have been grossly underestimated. Meanwhile, the human and organization errors include: unstable human societies (Sornette, 2015), operational miscommunication, harsh working environment, the lack of safety practices and preparedness to encourage the anticipation for severe accidents, failure to effectively utilise operational experience feedback, and the lack of a questioning attitude (Tronea and Ciurea, 2014). An effective safety system is deemed to be in place if employees display fast responses to any risks and hazards in cases of accident or emergency situation (Wachter and Yorio, 2014).

Nevertheless, the effectiveness and validity of the safety practice assessment tool must be assessed and developed, tailored to each industry respectively whereby difference may present across sectors and organization. Varying levels of understanding may pose as a challenge to organisations, rendering it necessary for leadership and communication skills to be evaluated and improved, for the purpose of managing risk and hazard-related personnel. The nuclear industry specifically must extend beyond their hub to learn and strengthen their safety culture approaches (IAEA, 2016) and every personnel in facilities is suggested to responsible and play their role in strengthening the safety practices (Yang, 2014).

Therefore, a detailed examination of the factors and relationships