INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
HRMARS MANAGEMENT ACADEMIC RESEARCH SOCIETY EXPLORING INTELLECTUAL CAPITAL
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ISSN: 2222-6990

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v11-i17/11400 DOI:10.6007/IJARBSS/v11-i17/11400

Received: *14* August *2021,* ***Revised:*** *16* September *2021,* ***Accepted:*** *29* September *2021*

Published Online: 17 October 2021

In-Text Citation: (Kuan et al., 2021)

To Cite this Article: Kuan, L. H., Adam, N. M., Hung, Y. P., Assim, M. I. S. A., Marzuki, O. F., & Jusoh, N. H. B. M. (2021). Conceptualization of Workers' Safe Behavioral Profile for the Management of Accident Risk at Local Oil and Gas Construction Sites. *International Journal of Academic Research in Business and Social Sciences*, *11*(17), 176–188.

Special Issue Title: Empowering Community and Beyond, iRandau, 2021, Pg. 176 - 188

http://hrmars.com/index.php/pages/detail/IJARBSS | JOURNAL HOMEPAGE

Conceptualization of Workers' Safe Behavioral Profile for the Management of Accident Risk at Local Oil and Gas Construction Sites

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Abstract

Workers' behavior at sites and its associated accident risk are universally recognized as vital to the sustainability of oil and gas industry globally. Recent oil and gas related accidents occurred in Sarawak and various behavioral studies by academical, and industrial fraternities clearly manifested the urgency and necessity to address industry-wide unsafe behavior to protect safety, health, and environmental wellbeing of local communities. The purpose of this study is to conceptualize the research model for future study to address the seriousness of oil and gas related accidents particularly in Bintulu, Sarawak. To that end, the authors had identified personal attributes of oil and gas construction workers that presumably influence their perception of safety climate and safe behavioral potential while at work through literature review. Theory of planned behavior (TPB) was also adopted to provide initial theoretical explanations as to the possible psychological precursors to perform certain types of unsafe behavior while at work, that might well instigate the occurrence of occupational accidents. Combining the conceptualization of personal attributes, perception of safety climate and safe behavioral potentials; and TPB, a research model was therefore being proposed to provide the conceptual framework for future study, including the development of measure instruments and detailed statistical analysis, into the profile of workers' safe behavioral potentials at oil and gas construction sites in Bintulu, Sarawak. To enhance the validity and reliability of research model in future study, it is necessary to explore the appropriateness to adopt the theoretical framework of integrative behavior model (IBM) for the prediction of a behavioral performance and change of behavior by taking into account of a person's skills and abilities required to perform the behavior, environmental constraints stopping such behavioral performance, and the intention to perform such behavior.

Keywords: Conceptualization, Oil & Gas Construction Sites, Management of Accident Risk, Workers' Safe Behavioral Profile

Introduction

British Malaysia Chamber of Commerce (BMCC) advocated that Malaysia's Oil and Gas sector plays an integral role in Malaysia's economy, accounting for roughly one-fifth of the country's national Gross Domestic Product (GDP). In 2017, with an average annual growth of 7.3 per cent, the crude petroleum and natural gas extraction sector was the largest contributor of gross output value at RM125.8 billion with a total value of RM138.6 billion, while service providing activities for petroleum and natural gas extraction sector accounted for another RM12.8 billion (BMCC, 2018). Historically, oil and gas construction activities are potentially entailing major accident hazards with serious repercussions to the safety and health of workers, pollution, direct and indirect financial losses, and threat to the security of energy supply (Christou and Konstantinidou, 2012; CIMAH, 1996).

Sarawak's oil and gas sector has contributed to some noteworthy industrial accidents in the past. Most notably, the fire and explosion at a gas-to-liquid plant in 1997 (Said and Ahmadun, 2007; Hardeveld et al., 2001); a worker was buried alive while fitting strain sensor in a collapsed trench at an interstate gas pipeline worksite (Borneo Post, 2018); fire incident due to pipe rupture at the similar interstate gas pipeline project (Then, 2020); and lastly, an incident involving one fatality and one injury during turnaround maintenance at a local natural gas processing plant (Chong, 2020).

Reason (1990, 2016) argued that many accidents essentially caused by human errors, behind which lie fallible decisions from organizations and regulators (Hudson, 2014; Salmon et al., 2010), previous studies also revealed that accidents and rule breaking are greatly affected by workers' personal characteristics (Fang et al., 2006; Manjula and De Silva, 2014), workers' safety compliance (Dahl, 2013; Hudson et al, 2002) and workers' personality at work (Pourmazaherian et al., 2017; Seo et al., 2015, Gao et al., 2020), which are collectively presented as workers' personal attributes in this study. Fang et al (2006) posited there are statistical significant interrelationships between personal characteristics, safety climate and individual safety behavior, it is also partially substantiated by Neal et al (2000) and Griffin et al (2000), suggesting that safety climate has independent and positive effects on the determinants of safety behavior and directly on safety behavior itself. Wu et al (2007, 2008, 2011), on the other hand, claimed that safety climate moderated or mediated the relationship between safety leadership (exogeneous variables) and safety performance (endogenous variables), itself a consequence of safety behavior (Neal et al., 2000).

Theory of Planned Behavior

Ajzen (1991, 2020) articulated various aspects of theory of planned behavior (TPB), in which intentions to perform certain types of volitional behavior are supposedly to be predicted, quite accurately, via attitudes toward the behavior, subjective norms, and perceived behavioral control. Intention, in conjunction with perceptions of behavioral control, is poised to explain considerable change in actual behavior. TPB is widely used as a principal model to examine behavioral intentions in medical safety (Lapkin et al., 2015), coal chemical industry (Yao et al., 2020), maintenance support chain for military (Forgaty & Shaw, 2010), food safety (Lin & Roberts, 2020), vehicle repair and service industry (Abu Bakar et al., 2017), road safety (Qi et al, 2021) and consumer behavior (Ahmmadi et al., 2021).

As shown in Figure 1 below, TPB consists of three base components in the shape of attitude towards the behavior, subjective norms, and perceived behavioral control, together form behavioral intentions. Firstly, attitude toward the behavior, which is supposed to

capture motivational aspects that affect a particular behavior, represents the degree to which a person has a favorable or unfavorable assessment of a particular behavior in question. The second determinant is a social factor termed as subjective norm; it is determined by the perceived social pressure from referents for an individual to behave in a certain manner and the motivation to comply with those people's views. The third determinant of intention is perceived behavioral control, also refers to as the perceived ease or difficulty of performing a behavior (also sometimes being understood as perceived self-efficacy), it is presumed to reflect past experience as well as perceived impediments to be encountered while performing a behavior. Lastly, performance of a behavior is a combined function of intention and perceived behavioral control. Interestingly, instead of influencing intention unidirectionally, Sussman & Gifford (2018) claimed that intention may actually affect the social norm and attitude in a reverse-causal direction. A review also showed attitude and perceived behavioral control are strong predictors of intentions across a range of health-related behaviors, proving high efficiency of TBM's application in health-related domains (Godin & Kok, 1996).

Forgaty & Shaw (2010) postulated that attitude towards a behavior is directly proportional to one's behavioral beliefs of the consequences of a behavior multiplied by an assessment on the level of desirability of the consequences for each belief. In other words, favorable or unfavorable behavioral beliefs are closely associated to an individual's perceived desirable or undesirable consequences (attributes of a behavior). In combination with personality traits, general attitude is said to be playing an important role in predicting behavioral aggregates (Ajzen, 1991). Human factors that affect risk-taking attitude in Malaysia's construction industry are said to be work experience, physical health, educational background, professional competence, and emotional intelligence of workers (Moshood et al., 2020).

Subjective norm is determined by two determinants, namely, an individual's normative belief and motivation to comply with these expectations. Normative beliefs are the perceived behavioral expectations of referents (persons, entities, or groups) who are closely associated with that individual such as spouse, family members, colleagues, medias, governmental agencies, non-governmental organizations, etc. Normative beliefs, in combination with an individual's motivation to comply with various referents, determine the prevailing shape and degree of subjective beliefs. Therefore, it is sensible to deduce that normative belief, as with subjective norm, is potentially influenced by social status and certain unique demographic features of an individual.

Finally, perceived behavioral control is founded on the basis of control beliefs and perceived power of the control factor. Generally, the stronger the intention to engage in a behavior, the more likely should be its performance, provided an individual is under volitional control, that is, such person has the liberty to decide on or commit to a particular course of action. Control beliefs are influenced by impression on a behavior through self-experience, social influences, experience of referents and other factors that might increase or reduce the perceived ease of performing a behavior. The above notions are further accentuated by experimental findings indicate effects of the behavioral-belief-intervention (BBI) on attitudes and of the normative-belief-intervention (NBI) on subjective norm, perceived behavioral control, attitudes, and intentions were established (Sniehotta, 2009). In view of the factors influencing control beliefs, similar to subjective norm and normative beliefs, it is reasonable to presume there is a potential existence of relationships between perceived behavioral control and certain aspects of societal and psychological characteristics of a person in question.

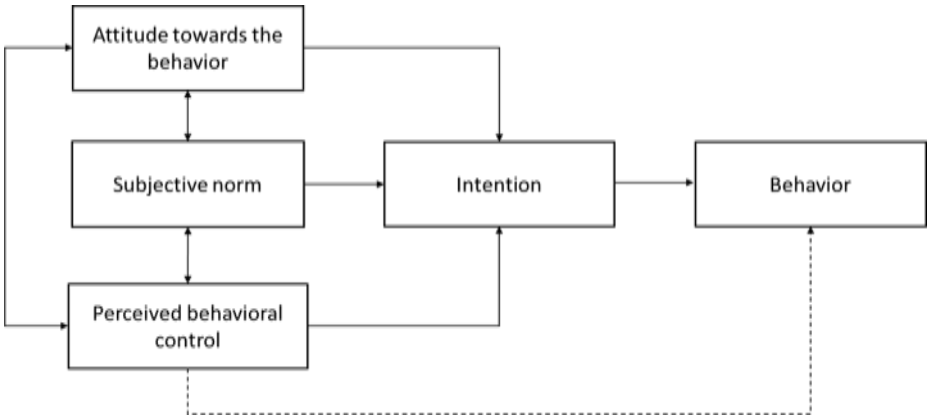

Figure 1: Theory of planned behavior
Source: Ajzen (1991, 2020)

Conceptualization of Constructs

Workers' Personal Attributes

Attributes is defined as "*A quality or feature regarded as a characteristic or inherent part of someone or something"* (Oxford Dictionary, n.d.) and "*a quality, character, or characteristic ascribed to someone or something"* (Merriam-Webster Dictionary, n.d.), henceforth this implies "*attributes*" that encompass the extensive physical, societal and psychological facets of a person. Firstly, Vinodkumar and Bhasi (2009) investigated the relationship between safety climate and personal attributes by taking qualification, age, experience, and job category into account, which are mostly demographic in nature. Fang et al. (2006) and Manjula and De Silva (2014) denoted this as personal characteristic and personal factors, respectively. Dawson et al. (2011) subsequently posited that personal attributes (characteristics and values) include the element of desire or commitment to serve, along with other attainable skills and personal qualities. This argument is partially supported by Mazur et al. (2014) stating that cognitive flexibility, itself part of personal attributes, consists of "*willingness"* to adapt by selecting the suitable mode of response, presumably including the commitment to comply or otherwise. Lastly, personality of a person is frequently analyzed and measured as an integral component of personal attributes in various research and studies (Fruhen et al., 2014; Wakou et al., 2003; Cheng and Hau, 2003; Flint-Taylor et al., 2014). On this account, this study hereafter examines and measures personal attributes of oil and gas construction workers through the aspects of personal characteristics, safety compliance potential (commitment to comply or otherwise) and personality.

Workers' Perception of Safety Climate

Safety climate had been empirically proven to be a valid and strong leading indicator of safety outcomes presumably included safety behavior, safety compliance and safety performance across various industries and countries (Zohar, 2010; Zohar et al, 2015; Lim et al., 2018). Despite the assortment of dimensions being propounded, however the core conceptual dimensions of safety climate remained clear, namely managerial commitment for safety, safety systems and procedures, and training and competence systems related to working safely (Griffin and Curcuruto, 2016). This assertion in principle aligned with Wu et al. (2007 & 2008) where safety climate was measured from the 5 dimensions: chief executive officer's safety commitment and action, manager's safety commitment and action, employee's safety commitment, perceived risk, and emergency response. Jusoh and Panatik (2016) adopted

similar dimensions and were proven as important predictors of safety performance in a Malaysia-based electric and electronic manufacturing plant. Safety climate is also widely acknowledged to be a significant moderator between human's attributes and safety performance / behavior (Zhou & Jiang, 2015; Loh et al., 2018).

Workers' Safe Behavior Potentials

Workers' behavior at workplace influenced health and safety through their personal characteristics in a complex and significant way, and the impacts on task performance may be detrimental and not always be alleviated by job design (HSE, 1999). Human-related errors, or sometimes also denoted as failures, constituted one of the direct causes for some of the landmark industrial disasters such as the ones in Bhopal (1984), Piper Alpha (1988), Chernobyl (1986), and Texaco Refinery (1994) (Jahangiri et al., 2016). Accidents were presumably caused by combinations of active failures (errors and violations by front-line personnel) and latent conditions (consequence of fallible top-level decisions that had delayed-action effects upon the integrity of multiple preventive measures) (Rasmussen, 1982).

Bates and Holroyd (2012) and HSE (1999) reasoned that human failures can be further categorized into slips of action (fail to carry out an actions, probably due to distraction); lapses of memory (forget to carry out an action); rule-based mistakes (application of rules or procedures onto wrong objects / activities); knowledge-based mistakes (owing to novelty of situation or inexperienced personnel), routine violations (when rule-breaking has become a norm); situational violations (in view of work pressure such as constraints in time; manpower; equipment; or even extreme weather conditions); exceptional violations (overwhelmed by false belief that rule-breaking is inevitable or its benefits outweigh the risks); and optimizing violations (thrill or glory seeking). Safe behavior potentials, in this study, is defined as one's tendency to act safely at workplace, hence minimizing human failures.

Proposed Research Model

In view of the arguments being put forward in connection with the conceptualization of three base components: workers' personal attributes, perception of safety climate, and safe behavioral potentials; hypothetical relationships of between these base components; and lastly inspired by explanations and arguments expounded by theory of planned behaviors (TPB), this study therefore proposes the following research model (Figure 2) to illustrate its detailed components and their hypothetical interrelationships as the basis for the development of measure instruments and of strategy for succeeding statistical analysis.

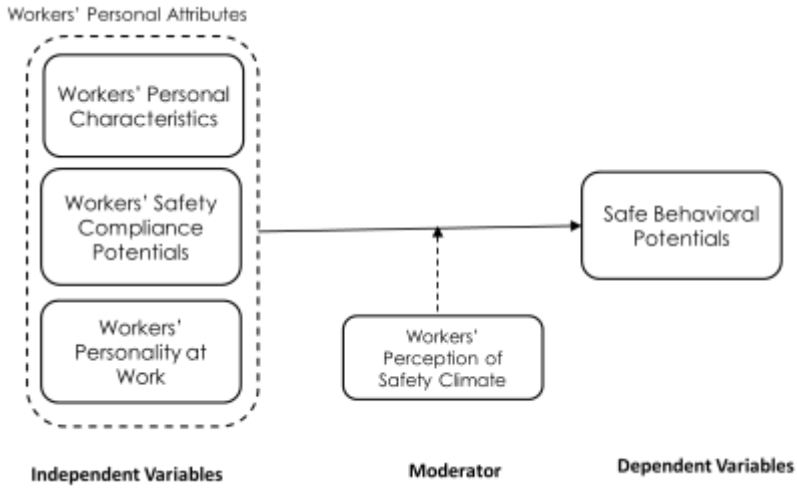

Figure 2: Model constructs to illustrate the relationship between workers' personal attributes and safe behavior potentials, moderated by perception of safety climate
Sources: Vinodkumar and Bhasi (2009); Fang et al (2006); Manjula and De Silva (2014); Dawson et al (2011); Mazur et al (2014); Fruhen et al (2014); Wakou et al (2003); Cheng and Hau (2003); Flint-Taylor et al (2014); Zohar (2010); Zohar et al (2015); Lim et al (2018); Griffin and Curcuruto (2016); Wu et al (2007 & 2008), Jusoh and Panatik (2016); Zhou & Jiang (2015); Loh et al (2018); Zhou & Jiang (2015); Rasmussen (1982); Bates and Holroyd (2012)

Future Research

An initial measurement instrument, with proposed measured items (variables) representing respective constructs, should be developed to facilitate the future in-situ pilot test with predetermined number of respondents which are constituted by various spectrums of workers from oil and gas construction service providers. This is to ensure the eventual measurement instrument is statistically significant and be able to provide a valid and reliable representation of the research model for the final explorations and analyzations of underlying interrelationships between workers' personal characteristics, their perception of safety climate and safe behavioral potentials.

To enhance the validity and reliability of the research model in future, it is recommended to further explore the appropriateness to adopt the theoretical framework of integrative behavior model (IBM) for the prediction of performance of a behavior by taking into account of distal and proximal determinants such as a person's underlying beliefs, skills and abilities necessary to perform the behavior, and environmental constraints preventing such behavioral performance (Yzer et al., 2004; Fishbein & Yzer, 2003).

Acknowledgement

The precious advice and support given by UPMKB academic especially the members of supervisory committee, and administrative staffs in this study are highly treasured and cherished.

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