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Evaluating Measurements of Workers' Demographic and Psychometric Profile: A Prelude to Sustainable Development of Behavioural Safety in Sarawak's Oil & Gas Construction Industry

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Abstract

Significant accidents in Sarawak's oil and gas construction sites often involve fatality, presumably behavioural related, attracting substantial unwarranted attention from the press. Therefore, it is imperative to develop a measuring instrument to identify and gauge workers' demographic and psychometric attributes that may significantly influence workers' safe behaviour potentials to reduce the risk of occupational accident hazards in a sustainable manner. Thus, this paper evaluates constructs' validity and reliability, and statements' communality of this new instrument to confirm its objectivity and clarity in measuring constructs as intended. A 5-point Likert-type scaled instrument consists of 93 initial statements was created and utilized to evaluate 51 oil and gas construction workers, randomly selected from local-based oil and gas construction service providers. Demographic results indicate most respondents have more than 5 years work experience, with a high level of experiences in occupational accidents, and almost all respondents possessed some kinds of knowledge and experience in accident prevention to different extents. The analysis also found that most demographic and psychometrics statements of initial research framework yielded a high reliability (Cronbach's Alpha > 0.7). High validity (KMO <0.5, $p = 0.000$) in all constructs of personal attributes, perception of safety climate, and safe behaviour potentials are observed. Eventually, a total of 20 statements had been removed, while retaining 73 items mainly due to their high communality (Communality > 0.6) except items BPV3 and LSM5 with

valid dispensations. High communality value indicates that the extracted constructs represent the variables well. Through confirming the validity and reliability of initial research framework, and removal of statements with lower communality, a statistically valid and reliable multi-lingual questionnaires is therefore synthesized for subsequent research.
Keywords: Oil and Gas Construction Workers, Sustainable Development, Demographic and Psychometric Profile, Evaluating Measurements.

Introduction

In 2019, Malaysia was the 5th largest Liquefied Natural Gas (LNG) exporter with annual output of 26.2 million tonnes with approximate world market share of 7% (IGU, 2020; Adilla, 2020). Value of LNG export stood at RM43.5 billion in 2019, increased from RM42 billion in 2018 (Borneo Post, 2020). Sarawak, being one of largest oil and gas producing states in Malaysia, has some noteworthy industrial accidents in the past. To that end, to realize sustainable development goals of safety in Sarawak's O&G construction industry, the main objectives of this study are to synthesize a measuring instrument that could accurately signify theoretical relationships between workers' demographic and other psychometric variables, and their safety behavior at sites; and to evaluate the constructs' validity and reliability, and the communality of statements, of a multi-lingual survey questionnaires set that could accurately represent each construct of research framework for future research.

Most notably, Laeng & Kiew (2022) cited that a worker was killed and three others injured in an explosion at a gas pipeline project. Prior to that, there were four other reported incidents at the project, namely, an explosion between Lawas and Long Sukang on 10 June 2014; a gas leak and explosion on 10 Jan 2018, that led to the evacuation of students from an affected school; a gas leak at Long Segaman in Lawas on 8 May 2019; and an explosion between Long Kawa and Ba Selulong in Ulu Baram on 12 Jan 2020. Although the reasons of the oil and gas accidents in Malaysia were largely unavailable in public domains, 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).

In 2015, United Nations (UN) has adopted 17 Sustainable Development Goals (SDGs) as part of "The 2030 Agenda for Sustainable Development", which is later being adopted by International Labour Organization (ILO). The purpose of SDGs is to ensure concurrent and balanced economic development, social advancement and environmental protection, so as to accomplish a better quality of life for all people and protect all living beings and planet by 2030 (Fonseca & Carvalho, 2019). Target 8.8 of SDG8 (Decent Work and Economic Growth) has clearly demanded the protection labour rights and promote safe and secure working environments of all workers, including migrant workers, particularly women migrants, and those in precarious employment (United Nations, 2015). The authority reckoned that the crux of these disasters is deeply rooted in fallible organizational safety culture and climate for not doing the right thing right, rather than squarely attributed to faulty policies or procedures. In 2019, Malaysia incurred accident rate of 2.71 for every 1,000 workers that brought about the death rate of 3.83 for every 100,000 workers, it is significantly higher than other developed countries such as United Kingdom, Singapore and Japan although it fares slightly better than South Korea (Zaini et al., 2022).

Literature Review

By integrating constructs from some leading theories such as theory of reasoned action (TRA), theory of planned behavior (TPB), health belief model (HBM) and social cognitive theory, an

Integrated Behavioral Model (IBM) was therefore proposed to identify both distal and proximal variables for the better determination of any behavior (Byers et al., 2017). According to the model, a behavior in question is most likely to occur whenever one has forged a strong intention (or commitment) to perform the behavior, has acquired essential skill and abilities required to perform such behavior, and non-existence of environmental factors or constraints capable of preventing behavioral performance. The model postulates three core determinants of intention, namely, attitude towards performing the behavior, subjective norms, and self-efficacy. It is also suggested that attitude, subjective norms, and self-efficacy are functions of some fundamental beliefs concerning evaluative judgement of performing the behavior, normative proscriptions or behaviors of referents, and specific obstacles to behavioral performance. Personality is sometimes defined as one's stable behavioral tendencies over time or psychological traits that could forecast one's unique behavior (Pereira et al., 2022).

Gao et al (2020) found that personality traits (i.e., agreeableness and conscientiousness) are positively influencing safety behavior among construction workers. Safety attitude (construed as safety compliance potentials) is construed as a reflection of one's belief and feeling about safety policies and other safety-related measures (Wu et al., 2017). Safety attitude is one of the factors influencing one's risk perception which is a critical internal factor of unsafe behavior (Zhao et al., 2021). Ji et al (2019) postulated that safety climate is employee's shared perception of organizational safety policy, procedures and practices within work environment, and it has positive influence on safety behavior as well as moderating effect on the relationships between proactive personality and behavior. Notwithstanding, Hussain et al (2019) provided empirical evidence that safety climate significantly and negatively moderates the relationship between socio-cognitive factors (i.e., attitude towards risky driving) and risky driving behavior among Pakistani drivers. Vinodkumar & Bhasi (2009) claimed that personal demographic (i.e., qualification, age, work experience, job category) may have various extents of impact on perception of safety climate, this claim is well supported by research indicating that personal demographic is significantly correlated to safety climate among electrical workers in India (Baby et al., 2021) and construction workers in Indonesia (Kadir et al., 2022). Tao et al (2021) expounded those demographics properties (i.e., conceptualized as worker's personal characteristic in this study), personality traits and safety attitude are significantly influencing worker's safety behavior to various extent during the commissioning activities in a nuclear plant. Safe behavior potentials are conceptualized as workers tendencies to commit unsafe human failures such as slips, lapses, rule-based and knowledge-based mistakes, routine violations, situational violations, exceptional violations, and optimizing violations (HSE, 1999; Bates and Holroyd, 2012).

Taking into account of the arguments being put forward in connection with the conceptualization and operationalization of three base components: workers' personal attributes (i.e., workers' personal characteristic, personality and safety compliance potentials) , perception of safety climate, and safe behavior potentials (i.e., safety behavior); hypothetical relationships between these base components; and lastly inspired by explanations and arguments expounded by theory of Integrated Behavioral Model (IBM), this study therefore proposes the following integrated research framework, as shown at *Figure 1*, that synthesizes major components of worker's behavioral system and their hypothetical interrelationships as the basis for the development of measure instruments and of strategies for subsequent empirical analysis.

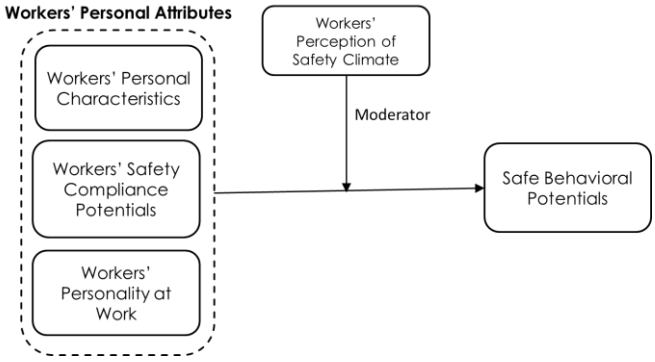

Figure 1: Proposed Research framework
Sources: HSE, 1999; Vinodkumar & Bhasi, 2009; Bates and Holroyd, 2012; Wu et al., 2017; Gao et al., 2019; Ji et al., 2019; Hussain et al., 2019; Baby et al., 2021; Zhao et al., 2021; Tao et al., 2021; Kadir et al., 2022

Research Methodology

Design of Measurement Instrument

Questionnaires were developed upon reviewing previously mentioned literature and in alignment with initial model constructs. The questionnaires were initially articulated in English, followed by translation into simple Bahasa Malaysia by a professional translator. Content validation was carried out by 5 subject matter experts (SME) who are professionals with a minimum of 10 years' experience in occupational safety and health, and emergency response in oil and gas related industry. The content was then amended in accordance with SME's recommendations as required by Lawshe's Content Validity Ratio (Ayre and Scally, 2014) to reflect its suitability and relevancy to the prevailing industry's conditions. The questionnaire consists of 5 sections: Part A - Workers' personal characteristics (demographic information), Part B- workers' safety compliance potentials, Part C – workers' personality at work, Part D – workers' perception of safety climate at work, and Part E – safe behavioral potentials. All in all, there were a total of 93 questions. Part B, C, D & E are constituted by statements with five-Likert type scale response options (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). The Part A (workers' personal characteristic) comprised of 13 demographic and personal experience related questions (PS1-PS13). Part B (workers' safety compliance potential) gathered information, via 10 focused statements (V1-V10), about their inclination to comply with safety and health related rules, particularly statutory requirement in particular. Part C (workers' personality at work) consists of 18 statements (PA1-PA9; PC1-PC9) through which information about the personality traits of a respondent is elicited. Part D (workers' perception of safety climate at worksite) obtained workers' perceived safety climate at their respective worksite includes 36 statements separated into 4 components (TMC1-TMC10; SMC1-SMC10; ER1-ER7; PR1-PR9). Part E (safety behavioral potentials) mustered information about workers' potential to commit human errors at worksite through 16 statements segregated into 2 components (BPV1-BPV8; LSM1-LSM8).

Procedure to Take Sample

The respondents were construction workers aged 18 years old or above at that material time, from various trades and designations, employed by oil and gas service contractors and vendors. A statement for consent was attached to questionnaires to ensure respondents' understanding and approval prior to their participation. The questionnaires, with both English and Bahasa Malaysia versions, in hardcopy were delivered to focal persons of each cluster (premise), i.e.3 clusters in total. The survey at sites was administered but not guided by author or focal persons. Acknowledgement of written consent from respondents had been obtained prior to their participation during briefing sessions. Sample of 50 or more is deemed adequate for pilot study (Sandvik et al., 1996; Hertzog, 2008).

Results and Discussion

Descriptive Statistic

With reference to *Table 1*, out of 54 sets of questionnaires being distributed, 51 were complete and suitable for statistical analysis. It was revealed that 56.9 % of the respondents are aged between 25 and 38, which represents a relatively young workforce. In addition to that, 45.1 % and 27.5% of respondents worked in the oil and gas industry for less than 5 years and between 6 to 10 years respectively. The workforce in this study was predominantly male (72.5 %) as compared to female (27.5 %). 54.9 % of the respondents were married with child or children whereas 35.5 % were single, this observation is corresponding to the finding that 78.4 % of the respondents had expressed at least 1 or more family members require their support. Percentage of monthly-paid workers, both permanent and contracted staffs, from main contractors (53.0 %) and sub-contractors (45.1 %) in relation to daily-paid workers implied that the workforce was receiving stable incomes albeit the renumeration received was not within the scope of this study. The fluidity of personnel movement from one provider to another might be vindicated by the finding that 72.5 % of the respondents worked for their respective current companies for less than 5 years.

It is also suggested that the workforce was relatively well-educated as 96.1 % of the respondents received at least secondary or even tertiary education, implying that the comprehension of formal safety requirements might not be a concern. The study also revealed that a majority of the respondents under the study possessed some healthy traits as 72.5 % are nonsmoker and 52.9% are nondrinkers, with 27.5% identified themselves as occasion drinkers at best. 80.4% of the respondents indicated they had experienced occupational injuries, illnesses, or environmental pollution between 1 to 3 times, with another 13.7% between 4-6 times, either through their own encounters or from observing the others. Furthermore, 98.0% reported that they had violated established safety-related rules between 1 to 3 times. Similarly, 98.0% had identified themselves as at least having some basic knowledge and experience in safety, health, and environment (HSE), in which 25.5% had carried out occupational risk management activities such as job hazard analysis (JHA) and risk assessment (RA) before.

Reliability, Validity, and Communality

As illustrated in *Table 2*, workers' attributes were measured by 3 core components: workers' personal characteristic, workers' safety compliance potentials, and workers' personality. Workers' personal characteristic construct (PS1-PS13) indicated a KMO value of 0.517 at a significance level of *p=0.000*, with communality range of 0.314-0.898 of which PS6 (0.314) was the lowest in communality value. In addition, Workers' safety compliance potential

construct (V1-V10) showed a KMO value of 0.845 at a significance level of *p=0.000*, with communality range of 0.344-0.813 of which V3 (0.593) and V6 (0.344) were the least in communality values. Finally, Workers' personality constructs were measured through *agreeableness* construct and *conscientiousness* construct. Agreeable construct (PA1-PA9) indicated a KMO value of 0.566 at a significance level of *p=0.000*, with communality range of 0.376-0.821 of which PA2 (0.493), PA4 (0.480), and PA9 (0.376) were at the lowest end of communality range. Conscientiousness construct (PC1-PC9) possessed a KMO value of 0.708 at a significance level of *p=0.000*, with communality range of 0.448-0.772 of which PC6 (0.558) and PC7 (0.448) were at the lowest segment of the range.

Workers' perception of safety climate was divided into 4 core components, namely, company top management's safety and health commitment (TMC1-TMC10), site manager's safety and health commitment (SMC1-SMC10), emergency response (ER1-ER7), and perceived risks (PR1-PR9). Firstly, company top management's safety and health commitment construct showed a KMO value of 0.815 at a significance level of *p=0.000*, with communality range of 0.586-0.838 of which TMC5 (0.586) and TMC10 (0.595) had the lowest communality values. Secondly, site manager's safety and health commitment construct indicated a KMO value of 0.793 at a significance level of *p=0.000*, with communality range of 0.591-0.879 of which SMC8 (0.591) and SMC10 (0.592) located at bottom of communality range. Thirdly, emergency response construct demonstrated a KMO value of 0.861 at a significance level of *p=0.000*, with communality range of 0.253-0.840 where both ER1 (0.253) and ER5 (0.525) were at the lowest section of communality range. Finally, perceived risk construct indicated a KMO value of 0.720 at a significance level of *p=0.000*, with communality range of 0.522-0.885 among which PR7 (0.535) and PR8 (0.522) had the lowest communality values. Workers' safe behavior potentials were measured through violations (BPV1-BPV8); and lapses, slips and mistakes (LSM1-LSM8). Violations construct possessed a KMO value of 0.697 at a significance level of *p=0.000*, with communality range of 0.146-0.837 where BPV3 (0.496), BPV4 (0.146) and BPV5 (0.549) were at the lowest spectrum of communality range. Lapses, slips, and mistakes construct showed a KMO value of 0.763 at a significance level of *p=0.000*, with communality range of 0.545-0.822 among which LSM4 (0.572), LSM5 (0.597) and LSM6 (0.545) were the items with 3 lowest communality values.

According to Bernard et al (2020), they have discussed in their study that the KMO assesses the sampling suitability, determining whether or not the responses provided with the sample are sufficient. For a decent factor analysis to continue, it must be near to 0.5. Additionally, Kaiser (1974), values for the KMO should be at least 0.5 (just acceptable), between 0.7 and 0.8 are acceptable, and beyond 0.9 are outstanding. The KMO measure, which may be barely accepted, is 0.417, which is near to 0.5. In this study, the value of KMO for the construct of conscientiousness is 0.708, construct of site manager's safety and health commitment is 0.720, the construct of perceived risks is 0.720 and construct of lapes, slips and mistakes is 0.763 and this value is consistently in the study and as stated by Kaiser (1974) that the value of between 0.7 and 0.8 are acceptable. On the other hand, the value of 0.7 for other study the construct will be use for the extracted into construct-concern (Supramaniam et al., 2019). Rasheed and Abadi (2014), declare that the construct value is more than 0.5 is a considerable to be reasonable.

Reliability

Cronbach's Alpha is a measure of internal consistency, in other words, how closely associated a set of measured items within a group (model constructs). This test is considered to be a

measure of scale reliability. SPSS analysis indicated Cronbach's Alpha of the initial model constructs is 0.926, which when above the threshold of 0.7 is considered as internally consistent.

Validity

With reference to *Table 2*, the initial model constructs, analyzed in isolation, unanimously indicate a KMO value of more than the threshold of 0.5 at a significant level of $p = 0.000$ for each construct: workers' personal characteristics (0.517); workers' safety compliance potentials (0.845); agreeableness (0.566); conscientiousness (0.708); company top management's safety and health commitment (0.815); site manager's safety and health commitment (0.793); emergency response (0.861); perceived risks (0.720); violations (0.697); lapses, slips and mistakes (0.763). The result shows that each construct possesses high internal consistency, therefore suggesting this measurement instrument might be appropriate to be deployed in subsequent research as it is likely to yield useful and representable results from factor analysis.

Communality

Extraction communalities are estimates of the variance in each variable accounted for by the constructs. High communality value (> 0.6 for sample size of less than 100) indicates that the extracted constructs represent the variables well, hence the measured items should be retained, or to be removed for subsequent analysis. A total of 20 measured items are removed as their respective communality values are less than 0.6 whereas a total of 73 items are retained for having higher communality values except 2 items (BPV3 and LSM5), refer to **Table 2** for items removed. Constructs with items being removed are: workers' personal characteristics (1 items - PS6); workers' safety compliance potentials (2 items - V3 and V6); agreeableness (3 items - PA2, PA4 and PA9); conscientiousness (2 items – PC6 and PC7); company top management's safety and health commitment (2 items – TMC5 and TMC10); site manager's safety and health commitment (2 items – SMC8 and SMC9); emergency response (2 items – ER1 and ER5); perceived risks (2 items – PR7 and PR8); violations (2 items – BPV4 and BPV5); lapses, slips and mistakes (2 items - LSM4 and LSM6). Items that have been retained although the respective communality values are below threshold of 0.6 are: BPV3 (0.496) and LSM5 (0.597). There are 2 critical justifications for their retention: Firstly, BPV3 and BPV4 (exceptional violations) as well as LSM5 and LSM6 (rule-based mistakes) respectively measure the same dimensions. Hence the risk of not measuring the complete dimensions of violations and mistakes in future research, if they are excluded, grossly outweighs their omission. Secondly, Yong and Pearce (2013) postulated that variables with communality of > 0.2 can be retained for analysis since the aim of factor analysis is to try and explain the variance through the common factors. Consequently, these arguments are particularly useful to provide justification for their inclusion, instead of other removed items with higher communality values, especially for BPV3.

Conclusions

Through affirming validity and reliability of the research framework, and removal of measured items (i.e., statements) with low communality from initial questionnaire, a statistically valid and reliable multi-lingual questionnaire for subsequent research was therefore synthesized. On that note, through content validation by local SMEs and participation of from local workers, these multi-lingual questionnaires in English and Bahasa Malaysia were tailored to

reflect ethnic compositions, cultural diversities, and localized uniqueness of oil & gas workers in Sarawak. The subsequent research may utilize this newly developed measurement instrument for the purposes of explicating the empirical relationships, including path analysis, of personal characteristics, safety compliance potentials, personality at work, perception of safety climate at worksite and safe behavior potentials with the objective to establish the holistic safety behavioral profile of oil and gas construction workers in Sarawak to reduce the risk of occupational accidents in a sustainable fashion.

Table 1
Demographic Information

Parameters	**Scales**	**Frequency**	**Percentage**
Age (N=51)	18-24	7	13.7 %
	25-31	18	35.3 %
	32-38	11	21.6 %
	39-45	5	9.8 %
	46 & above	10	16.6 %
Gender (N=51)	Male	37	72.5 %
	Female	14	27.5 %
Marital status (N=51)	Single	18	35.5 %
	Married with no child	5	9.8 %
	Married with child / Children	28	54.9 %
No of family members to be supported (N=51)	None	11	21.6 %
	1-2	17	33.3 %
	3-4	19	37.3 %
	5-6	3	5.9 %
	7 and above	1	2.0 %
Status of employment (N=51)	Subcon daily paid	2	2.0 %
	Subcon monthly paid under contract	12	23.5 %
	Subcon permanent staff	11	21.6 %
	Main con monthly paid under contract	19	37.3 %
	Main con permanent staff	8	15.7 %
Duration of service in present company (N=51)	<1 year	6	11.8 %
	1-5 years	37	72.5 %
	6-10 years	7	13.7 %
	11-15 years	0	0.0 %
	>15 years	1	2.0 %

Parameters	Scales	Frequency	Percentage
Duration working in oil & gas industry (N=51)	5 years or less	23	45.1 %
	6-10 years	14	27.5 %
	11-15 years	5	9.8 %
	16-20 years	5	9.8 %
	>20 years	4	7.8 %

Table 1
(continued)

Parameters	Scales	Frequency	Percentage
Smoking habit (cigarette) (N=51)	Nonsmoker	37	72.5 %
	1-5 sticks a day	3	5.9 %
	6-10 sticks a day	10	19.6 %
	11-15sticks a day	0	0.0 %
	16-20 sticks a day or more	1	2.0 %
Drinking habit (alcohol) (N=51)	Nondrinker	27	52.9 %
	Occasional drinker	14	27.5 %
	Regular drinker (weekends drinker)	10	10.0 %
	Very frequent drinker (daily drinker)	0	0.0 %
	Heavy drinker	0	0.0 %
Education level (N=51)	Below primary	1	2.0 %
	Primary	1	2.0 %
	Secondary	14	27.5 %
	Vocational certificate / certificate /diploma	20	39.2 %
	Degree or higher	15	29.4 %
Experience in occupational injuries, illnesses, and pollution at worksite through observation of others or by own encounter (N=51)	1-3 times	41	80.4 %
	4-6 times	7	13.7 %
	7-9 times	2	3.9 %
	10-12 times	0	0.0 %
	>12 times	1	2.0 %

Table 1 (continued)

Parameters	Scales	Frequency	Percentage
Experience in rule violation (N=51)	1-3 times	50	98.0 %
	4-6 times	0	0.0 %
	7-9 times	1	2.0 %
	10-12 times	0	0.0 %
	>12 times	0	0.0 %
Knowledge and experience in safety and health (N=51)	No knowledge & experience	1	2.0 %
	Basic HSE knowledge from internal safety inductions	17	33.3 %
	HSE knowledge from inductions & NIOSH approved courses	20	39.2
	Experience as safety / work supervisor, involving in JHA & risk assessment	13	25.5
	Expert in HSE management	0	0.0 %

Source: Authors' analysis using SPSS

Table 2
Validity, reliability, and communality of initial constructs

Construct Name	Question Coding	KMO	Sig.	Communality	Removed Items	Remark
Workers' personal Characteristic	PS1 – PS13	0.517	0.000	0.314 – 0.898	PS6 (0.314)	
Workers' safety compliance potential	V1 – V10	0.845	0.000	0.344 – 0.813	V3 (0.593); V6 (0.344)	
Agreeableness	PA1 – PA9	0.566	0.000	0.376 – 0.821	PA2 (0.493); PA4 (0.480); PA9 (0.376)	
Conscientiousness	PC1 – PC9	0.708	0.000	0.448 – 0.772	PC6 (0.558); PC7 (0.448)	
Company top management's safety and health commitment	TMC1 - TMC10	0.815	0.000	0.586 – 0.838	TMC5 (0.586); TMC10 (0.595)	
Site manager's safety and health commitment	SMC1 - SMC10	0.793	0.000	0.591 – 0.879	SMC8 (0.591); SMC10 (0.592)	
Emergency response	ER1 – ER7	0.861	0.000	0.253 – 0.840	ER1 (0.253); ER5 (0.525)	

Perceived risks	PR1 – PR9	0.720	0.000	0.522 – 0.885	PR7 (0.535); PR8 (0.522)	
Violations	BPV1 – BPV8	0.697	0.000	0.146 – 0.827	BPV4 (0.146); BPV5 (0.549)	*BPV3 (0.496)
Lapses, Slips and Mistakes	LSM1 – LSM8	0.763	0.000	0.545 – 0.822	LSM4 (0.572); LSM6 (0.545)	*LSM5 (0.597)

*** Note:** Communality <0.6 but yet is retained, with valid dispensation, due to risk of non-representation in future research.

Cronbach Alpha of overall research framework is 0.926 to indicate internal consistency or reliability (>0.7)

Source: Authors' analysis using SPSS

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