A SCALE FOR MEASURING SUSTAINABLE MANUFACTURING PRACTICES AND SUSTAINABILITY PERFORMANCE: VALIDITY AND RELIABILITY

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ABSTRACT

Purpose: In quantitative studies, providing a valid and reliable instrument is necessary to ensure accurate results when measuring sustainable manufacturing practices (SMPs) and sustainability performance (SP). Therefore, the aim of this study to validite and reliabile of the measurements of SMPs and SP.

Methodology/Approach: The population of this study is top managers and senior executives who have experience in the O&GI in Iraq. Two tests were carried out in the present study: the pre-test to establish the validity of the measures, and the pilot test to check the reliability of the measurements.

Findings: In the pre-test, the comments made by six academician experts and three practitioners were used to rephrase the measurements items and modify them according to the requirements of the oil and gas industry (O&GI) and in accordance with the Iraqi environment. Moreover, in the pilot test was identified all the items were reliable and were sufficiently correlated with their constructs.

Originality/Value of paper: This study provides valid and reliable measurements that can give a obtain a deeper perception to researchers, top management and managers in the O&GI on how to measure SMPs and SP.

Category: Research paper

Keywords: sustainable manufacturing practices; sustainability performance; pre-test; pilot test; oil and gas industry

1 INTRODUCTION

Sustainability performance (SP) become an essential issue and a significant concern in the oil and gas industry (O&GI) in Iraq (Ibrahim et al. 2019). This is because of the imbalance among the dimensions of SP that includes: economic, environmental and social sustainability. For example, the report of the ESCWA reported the proportion of Iraqi exports of oil equivalent to 99% of the total annual exports (UN-ESCWA 2018). This establishes the importance of this industry in the economic development in Iraq. Nonetheless, this industry considers the main reason for environmental emissions and social damage (Elhuni and Ahmad 2017).

Actually, due to their nature and size, the O&GI has main impacts of health, safety global and environment (Schneider et al. 2011). Also, particulate matter and

volatile compounds of filters in oil and gas companies cause many diseases, both for workers and the community in the same area, such as cancer diseases and respiratory diseases (EPA 2003). Moreover, the main areas for the Extract and production of oil in Iraq, 70% of them have pollution matters in the environment and involve areas such as Kirkuk, Maysan, Basrah, Salah al-Din, Baghdad and Mosul (Al-Haleem et al. 2013). Nevertheless, to obtain a balance among the pillars of SP, there should be sustainable practices and activities in the O&GI.

In this respect, empirical evidence in literature has confirmed that sustainable manufacturing practices (SMPs): sustainable product design (SPD), sustainable manufacturing process (SMP), sustainable supply chain management (SSCM) and sustainable end-of-life management (SEoLM) (Abdul-Rashid et al. 2017), improve economic, environmental and social sustainability and thus balance it. To achieve this, there should be measurements valid and reliable regarding SMPs and SP.

According to Creswell and Creswell (2018), in quantitative studies, when there is any adapt on one or combine measurements, the prior validity and reliability may not apply for the new measurements. Hence, it has become significant to assessed new validity and reliability for the new measurements before conducting the main study. Therefore, the objective of the study to evaluate the validity and reliability of the measurements of SMPs and SP among the O&GI in Iraq. The results of this study can be beneficial in several aspects. The researchers will have a valid and reliable instrument to measure SMPs and SP, particularly in the O&GI. Besides, top management and managers in the O&GI will obtain a deeper perception of how to measure SMPs and SP.

2 METHODOLOGY

The O&GI is one of the most top sectors that largely contributed to the GDP of Iraq (OPEC 2018). The contribution is very important, especially in employment opportunities and exports. Consequently, the population of this study is top managers and senior executives who have experience in the O&GI in Iraq in parallel to the enormous contribution to the GDP of the country and its large contribution to the environmental and social impacts to the nation because of its harmful operational activities. on the other side, the pre-test was conducted to verify the face validity (Hair et al. 2013). Then, the pilot test was carried out to establish the reliability of the measurements used in the current study (Saunders et al. 2016).

Scaling design of the items will be used on a "6-point Likert scale": "1" = "Strongly Disagree" (SD); "2" = "Moderately Disagree" (MOD); "3" = "Slightly Disagree" (SLD); "4" = "Slightly Agree" (SLA); "5" = "Moderately Agree" (MOA); and "6" = "Strongly Agree" (SA). The reason for using the 6-point Likert scale was to ensure that participants did not easily check the "indifference" option or "midpoint", as usually occur with a 5-point scale. The midpoint means the neutral response when answering the questionnaire with of exist an odd number of

categories used in a scale (Hair et al. 2017). He also emphasised that the researcher usually uses the scale without the midpoint when many respondents are expected to choose neutrals on a particular issue. This is because provides an easy option that needs few efforts and is easily justified (Krosnick and Fabrigar 1997). Garland (1991) argued that the participants would answer based on the content of the questions when given an even number of a response scale. Additionally, participants from Asian countries tend to choose the middle category response than those from Western countries (Si and Cullen 1998, Thrulogachantar and Zailani 2011). It was also found that the validity and reliability of the findings tend to be higher for the even number response scale a six-point in particular (Chomeya 2010) when compared to the odd number response scale (Krosnick and Fabrigar 1997, Andrews 1984, Alwin and Krosnick 1991, Birkett 1986, Coelho and Esteves 2007).

The designed questionnaire was divided into 3 sections, which were the first section: focuses on SMPs implemented by oil and gas companies in Iraq, second section: focuses on identifying SP that can be achieved through the implementation of SMPs and the third section: provide a profile of the company and personal. Appendix. 1 states the items in the first and second sections of the questionnaire and the references adapted from them.

3 RESULTS AND DISCUSSION

3.1 Pre-test (validity)

The pre-test process involves face validity. The face validity is done through systematic assessment of the measurement based on subjective judgment by the experts (Hair et al. 2013) to verify the measurement's ability to measure what it is supposed to measure in the study (Hair et al. 2017). They also pointed out that this validation method is commonly used in management and business research. Therefore, the study measurements that adapted from previous studies for the SMPs and SP were sent to six experts who are familiar with the constructs of this study to attest the face validity of the measurements. Additionally, three oil and gas industry's practitioners were also contacted for the same purpose. Their feedback, recommendations and comments have been made. Results of face validity by the experts in the pre-test is shown in Tab. 1.

Table 1 – Results of face validity by experts in pre-test

Expert Type	Variable	Comment	Action
Academicians	SMPs	• Add the words "*Our company practices*" at the below of each dimension of sustainable manufacturing practices.	• "*Our company practices*".
		• Modify the item by changing the word "*Eliminating*" to	• "*Eliminates the use of hazardous materials*

Expert Type	Variable	Comment	Action
		"*Eliminates*" in the item of "*Eliminating the use of hazardous materials during the design of the products*".	*during the design of the products*".
		• Modify the item by changing the worded "*Design the products which will prolong the life of materials*".	• "*Design the products which will prolong its lifetime*".
		• Modify the item by changing the words "*Savings of energy" to "Save energy"* in the item of *"Savings of energy during the manufacturing process*".	• "*Save energy during the manufacturing process*".
		• Modify the item by changing the word "*process*" to "*processes*" in the item of "*Utilise lean production process*".	• "*Utilise lean production processes*".
		• Modify the item by changing the word "*Adoption*" to "*Adopts*" in the item of "*Adoption of sustainable suppliers*".	• "*Adopts of sustainable suppliers*".
		• Modify the item by changing the word "*Using*" to "*Use*" in the item of "*Using a less, cleaner or reusable packaging*".	• "*Use a less, cleaner or reusable packaging*".
		• Modify the item by changing the worded "*Providing recycling support using components and material coding standards*".	• "*Provide recycling support for materials and components used*".
	SP	• Summarising the existing statement below the sustainability performance then put it at the below of each dimension of performance.	• "*In the last three years, please describe your company's achievements for economic performance caused by the current practices (as you described in sections one and two)*".
		• Delete "*s*" from "*emissions*" and add "*es*" to "*gas*" in the item "*Reduced emissions of greenhouse gas*".	• "*Reduced emission of greenhouse gases*".
		• Delete "*s*" from "*wastes*" in the item "*Reduced solid wastes*".	• "*Reduced solid waste*".
		• Delete "*s*" from "*wastes*" in the item "*Reduced liquid wastes*".	• "*Reduced liquid waste*".
Practitioners	Profile of company	• Change the options "*Private/ local*" and "*Private/ foreign*"	• Done.

Expert Type	Variable	Comment	Action
	and personal	in the question "*What is ownership of your company?*" in section three to one option only as "*Private*" and add one more option as "*Foreign*".	
		• Add the options as "OHSAS 18001", "*ISO 29001*" and "*All*" in the question "*Does your company have the following certifications?*" in section three.	• Done.
		• Add the option as "*General Manager*" and "*Chief executive officer*" in the question "*What is your current position in your company?*" in section three.	• Done.

3.2 Pilot Test (reliability)

In fact, after the questionnaire is constructed (Sekaran and Bougie 2016, Kumar 2014), it is necessary to test it before using it to actual data collection (Dawson 2009, Oppenheim 2000, Adams et al. 2014, Fink 2017). This is because, without a trial test, we will not be able to tell if the questionnaire will succeed (Saunders et al. 2016). Moreover, because this study adapted the measurements from different sources (Hair et al. 2014) regarding the constructs of SMPs and SP.

Data collection in the research process usually begins with a pilot test (Cooper and Schindler 2014). Saunders et al. (2009) defined a pilot test as "small-scale study to test a questionnaire, interview checklist or observation schedule, to minimise the likelihood of respondents having problems in answering the questions and of data recording problems as well as to allow some assessment of the questions' validity and the reliability of the data that will be collected".

There are many essential purposes for conducting the pilot test include understanding or interpreting questions by respondents (Kumar 2011, Sekaran and Bougie 2010) and clarity of wording of the questions and estimate achievement times (de Vaus 2002, Adams et al. 2014). Also, the pilot test will help to clarify the extent the flow and sequences of questions (Bryman and Bell 2015, Oppenheim 2000), as well as it will enable to get some evaluation of the validity of the questions and the potential reliability of the data to be collected (Saunders et al. 2016). In order to achieve the purposes of the pilot test, Bell and Waters (2014) suggested to give the respondents a short questionnaire attached to the original questionnaire of the study includes a set of questions to know the following: (1) How long did it take to complete the questionnaire?, (2) were the questionnaire instructions clear?, (3) are there any unclear or vague questions? If there is, please specify, and why?, (4) do you have any objection to answering any question?, (5)

do you think any major topic has been deleted?, (6) do you think the layout of the questionnaire is clear/ attractive? and (7) any other comments?

Indeed, to make sure the questionnaire has achieved the purposes mentioned above (Oppenheim 2000), the pilot test should be conducted with respondents who are similar to those that will be used in the full study (Saunders et al. 2016, Zikmund et al. 2013, Hair et al. 2014). Naturally, the closer the link between the pilot sample and the final sample, the better (de Vaus 2002). In view of this, the reliability test must be carried out.

Principally, reliable measurements mean that they achieve the same result on repeated occasions (de Vaus 2002). Cronbach's alpha was used for this purpose based on the recommendations of a number of researchers (DeVellis 2016, Saunders et al. 2016, e.g. Colton and Covert 2007). Cronbach's alpha ranges from 0 to 1, the lowest acceptance value .70 (Hair et al. 2013). Moreover, the item analysis method was used by Corrected Item-Total Correlation test to estimate the reliability of responses within an instrument (Colton and Covert 2007, Field 2009), as well as, explains the most correlated items with the construct, meanwhile the value of any item is less than .30, it is deleted (Nunnally and Bernstein 1994, Field 2009, Hair et al. 2017). Bradburn et al. (2004) recommended that no more than 10-12 participants are sufficient to detect the difficulties and weaknesses in the pilot test questionnaire. Likewise, van Belle (2008) recommended that the sample size for the pilot test should be not a minimum of 12 participants. While Fink (2013) stated that the minimum number of participants for a pilot test is 10 (cited in Saunders et al. 2016). In short, the literature has illustrated that the sample of the pilot test is few and is not considered an issue either in quantitative or qualitative studies (Khattab and Wahid 2015). Thus, 12 sets of questionnaires were distributed; all the questionnaires that were returned were usable. Using SPSS.V.25, the reliability of the measurements and the item analysis was analysed (Field 2013, Pallant 2011), as displayed in Appendix. 2.

Based on the pilot study feedback by the seven questions that attached to the original questionnaire of the study (Bell and Waters 2014), certain words were reconstructed to provide a better understanding to respondents in the main survey. Also, the pilot test revealed that on average, respondents took about 15 to 20 minutes to complete the survey instrument. In addition, Tab. 3 shows that the result of reliability ranges from .794 to .906 suggested that all the Cronbach's alpha values were greater than .70, which indicate that the 56 measurements were reliable (Hair et al. 2014). Besides, based on the item analysis, all the items correlate higher than .30 for the Corrected Item-Total Correlation, which ranged from .344 to .946. These indicate that all items are correlated with their constructs. Therefore, all items have been retained without the need to delete any of them.

4 CONCLUSION

In conclusion, providing a valid and reliable instrument is necessary to ensure accurate results when measuring SMPs and SP. In this respect, two tests were

carried out in the present study: the pre-test to establish the validity of the measurements, and the pilot test to check the reliability of the measurements. In the pre-test, the comments made by academician experts and practitioners were used to rephrase items and modify them according to the requirements of the O&GI and in accordance with the Iraqi environment. Moreover, in the pilot test, some important findings were identified: an average, respondents took about 15 to 20 minutes to complete the questionnaire, the response rate was 100% high, all the items were reliable and were sufficiently correlated with their constructs. Therefore, this study provides valid and reliable measurements that can give a better understanding to researchers, top management and managers in the O&GI on how to measure SMPs and SP.

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