



Safety Behavior Analysis in the Drilling Rig Site Operations of Pertamina Hulu Mahakam

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ABSTRACT: PT Pertamina Hulu Mahakam is Indonesia national oil company that produce and operate gas and oil field in Mahakam, East Kalimantan Area. It spreads from swamp delta to shallow water offshore area. In 2022, the company operates 5 drilling rigs, which are 3 Jack Up Rigs and 2 Swamp Barge Rigs. The drilling rig is used to perform the operations of well construction activities for development and explorations wells, from spud, drilling, until well completion. The operations on the drilling rig have a high-risk profile. It involves handling equipment, tools, tripping hazard, lifting operations, moving object, drop object, power system, rotation system, high pressure lines and simultaneous operations.

A safety system, campaign, initiatives, and measurement are deployed on the rig site to keep the rig crew away from incident. Despite safety initiatives in place on the rig site, however, incident still happens. If incident happened, there will be lost of productivity, man hours, medical cost, administration, and dedicated investigation time. The operations need to be stopped and reevaluated again before continuing the job. Due to the most common factor of incident is human factor, hence, to understand how safety initiatives conducted and implemented by people on the rig, the research uses the theory of planned behavior.

The research took sample of questionnaires and interview from personnel on the rig, which are the actors of safety initiatives. It involves direct and indirect method, and comparison between descriptive (manual method) and PLS analysis. On PLS analysis, author compares independently the result between: Direct Measurement (A), Control Belief (B) and Control belief multiply to the outcome evaluation / motivation / power, depend on the factors of the TPB (B x C).

From the result, it is observed that the determinant factors of the theory of planned behavior such as: attitude, subjective norm and perceived behavioral control is confirmed to have effect on the intention and safety incident avoidance. Based on the descriptive analysis, all variable element of TPB have high to very high category, except Direct Measurement of Perceived Behavioural Control (PBC) that falls into medium category. This give indication that the level of control, ease or difficulties of rig workers in performing safety initiatives is low compare to the other factors. It is shown by the questionnaire result that despite they have control in performing safety initiatives, however, when incident happened, they state that they have less control.

On the hypothesis result, the model B x C has the best output from reliability test, however, it is shown that the attitude has no effect on safety behavior intention. This finding relates to the answer on the level of worries and concern on safety of the rig crew which supposed to be undesirable when incident happened, however the answer was more on desirable. This part can be explored more on how the rig worker view the "worry or concern", which due to their nature of their workplace, they might use this as a tool to keep vigilant and awareness on the workplace.

KEYWORDS: organizational behavior, safety behavior, safety rig site, safety leadership, safety culture, theory of planned of behavior.

INTRODUCTION

Safety is the core value of the oil and gas company to perform the operation on the drilling rig site. It is one of the key indicators, tracked by the oil and gas company because it can have impact on the company's business performance and at the end may lead to financial disaster. It is the responsibility of the company to ensure that no technical incident and occupational injury during working on the drilling rig.

PT PHM (Pertamina Hulu Mahakam) is the largest gas producer Company in Kalimantan, currently has 5 drilling rigs in operations. The organization in charge for drilling operations is DRL (Drilling) Department. The operations on the drilling rig have high risk profile that is related with handling equipment, tools, tripping, lifting, moving object, power system, rotations system, co-activity



and simultaneous operations. It is clearly that no one wants to get hurt and got incident during work. They want to come back home safely. Safety campaign and initiatives are deployed on the rig site (HSSE Golden Rule, Speak Up, Teman, CLSR +, job risk assessment, etc) by Contractor and Company. Despite the “nobody wants to have injury” motivation, however incident still happened.

Year of 2022 is the highest number of incidents in PHM – DRL Department. And the main root cause from all of the incidents is human factor. Once there is incident, hence, the injured person requires time for health recovery and a detail investigation is performed. Incident also has effect on company performance. Drilling performance will slow down, the crew will need to have time to go back to enhance performance, so loose opportunity of saving. Some normal practice might need to be modified and steps added into the job in order to perform it safely. Hence, it is important to have safety incident analysisist which relates to human factor. By conducting the analysis form Theory of Planned Behavior, it is expected that there will be outcome that can increase safety behavior to avoids incident.

BASIC THEORY

Theory of Planned Behavior (TPB)

TPB is a psychological framework that explains how attitudes, subjective norms, and perceived behavioral control influence individuals' intentions and, consequently, their behavior (Ajzen, 1991). It helps understand the factors that lead to the adoption or avoidance of specific behaviours.

Attitude Toward Behavior

Ajzen (2005) explained that attitude towards a behavior is a function based on beliefs which are called behavioral beliefs, namely individual beliefs regarding the positive and/or negative consequences that an individual will obtain from carrying out a behavior (salient outcome beliefs).

Subjective Norms

Ajzen (2005) explains that subjective norms are a function based on beliefs which are called normative beliefs, namely beliefs regarding the approval and/or disapproval of a person or group that is important for an individual regarding a behavior (salient referent beliefs). Ajzen (2006) added, for several behaviors, social references that are considered important also include social references that come from parents, marriage partners, friends, co-workers, and other references related to a behavior.

Perceived Behavioral Control

Ajzen (2006) states that intention and perceived behavioral control influence behavior carried out by individuals, but in general, intention and perceived behavioral control do not have a significant relationship. This is because each individual has full control over the behavior they will display (Nelson, Fishbein, & Stasson; quoted in Abrams & Moura, 2001). Azwar (quoted in Christanti, 2008) added that perceived behavioral control is very important when an individual's self-confidence is in a low condition.

Intention

In the Big Indonesian Dictionary (2008) intention is defined as an aim or goal. The Oxford Dictionary of Psychology (Coleman; quoted in Christanti, 2008) defines intention as a behavioral tendency that is carried out intentionally and not without purpose. Meanwhile, according to Engel et al. (quoted in Sukirno & Sutarmanto, 2007), intention is an individual's self-competence which refers to the desire to carry out a certain behavior.

RESEARCH HYPOTHESIS

Based on the theoretical description of the conceptual framework described above, it can be used as a reference in proposing the following research hypothesis:

H1: Attitude Toward Behavior has a positive and significant effect on Safety Behavior Intention

H2: Subjective Norm has a positive and significant effect on Safety Behavior Intention

H3: Perceived Behavioral Control has a positive and significant effect on Safety Behavior Intention

H4: Perceived Behavioral Control has a positive and significant effect on Safety Incident Avoidance

H5: Safety Behavior Intention has a positive and significant effect on Safety Incident Avoidance

Un-Safe Condition and Un-Anticipated Risk

According to the cause tree incidents analysis, there are strong factors that relates to the safety behavior. These factors are unsafe condition and un-anticipated risk which are added into the theory of planned behaviours that bridge between intention and avoid safety incident. However, un-safe condition and anticipated risk are two factors that in this research are assumed controlled well by company throughout safety management system that is in place with continuous monitoring, surveillance, risk assessment and analysis, mentoring system, coaching system, buddy system, supervisors and training / education program.

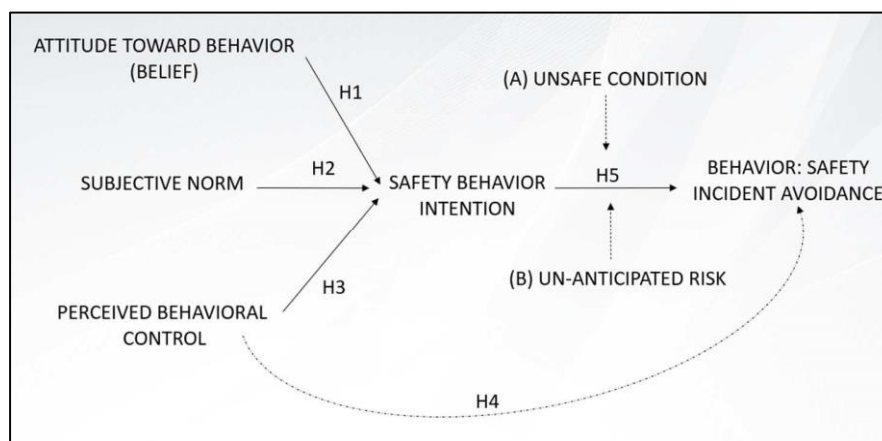


Figure 1. Work Frame Analysis

RESEARCH METHOD

Research Design

The design for this research is started from our background low safety performance of Drilling Team PHM in 2022. The authors used the theory of planned behavior as a basis for observing the safety performance of the rig crew. This study collected data by interviewing the rig crew. The methods for analyzing the data are using two methods, manual scoring and PLS analysis method. The output from the study is proposed for solution, make summary, and give recommendation. This research also produces implementation targets as an improvement for the future.

Data Collection Method

The data collection methods are:

1. Quantitative:

- Survey sampling questionnaire for all rigs and all level workers (from supervisors until catering crew)
- Secondary data safety statistic, such as: HSE index of Drilling Contractor Company, Stop Cards, CSMS Audit, HSE Audit, Company reference doc such as: HSE Bridging Document, Company Rule, TKO / TKI (Standard Operating Procedure).

The quantitative method allows us to see the current safety condition based on the statistic and the safety policy that is implemented on the rig site. HSE Index shows how much the safety initiatives implemented, for example, the number of observation card submitted, number of safety meeting and result of incident statistic. The presence of safety procedure and audit result may show how the company engagement and commitment with safety.

2. Qualitative:

- Survey & interview and observation of rig site personnel
- Survey sampling for all rigs and all level workers (from supervisors until catering crew)

Considering this research has an orientation to understand human behavior, a deep analysis into the acquired data from the implemented survey is needed. The result of interview is taken to construct the questionnaire based on the theory of planned behavior and determine the indicator of variable for the research (Table 1). This deeper analysis exists in the form of comparative study. The scales data represent certain points of analysis, and through a comparative study, qualitative data will also be required to do sort of crosscheck towards the reliability and validity of those scale data.



Table 1. Table of Indicator Variables

No.	Researcher	Variable	Indicator
1	Edmund Goh, Brent Ritchie, Jie Wang. 2017.	Attitude toward behavior /belief	Positif value
			Worry
			Anticipate
			Favourable
2	Interview Result	Subjective Norm	Safety Officer
			Client
			Team mate
			Family
3	Edmund Goh, Brent Richie, Jie Wang/	Perceived Behavioral Control	Confident
			Control
			Level of Difficulties
			Completely up to me
4	Mohammad I. Ahmad. 2014	Intention	Expectation
			Desire
			Intention
5	Osly Usman. 2018.	Behaviour	Frequency
			Important

Data Analysis Research Methodology

1. Descriptive Analysis

According to the previous research (Francis, J., 2004). Scoring is carried out using direct measurement and indirect measurement. With the exception of behaviour, the variables in the TPB model are psychological (internal) constructs. Each predictor variable may be measured directly e.g. by asking respondents about their overall attitude, or indirectly e.g. by asking respondents about specific behavioural beliefs and outcome evaluations. Direct and indirect measurement approaches make different assumptions about the underlying cognitive structures and neither approach is perfect. When different methods are tapping the same construct, scores are expected to be positively correlated, so it is recommended that both be included in TPB questionnaires. This manual explains how to construct questions for both types of measure. For Indirect Measurement, the unlikely-likely scale is multiplied by the relevant evaluation score on the extremely bad/extremely good scale.

• **Direct and Indirect Measurement**

The questionnaire was constructed to measure the variable of the TPB. The author also tests before it is launched so that the language is easily understood by rig crews. The score ranges from 1 to 7, least favorable to most favorable with variety of definition, depend on the type of question.

• **Control and Belief / Power**

According to TPB manual, the control belief is multiplied by the outcome evaluation / motivation / power, depend on the factors and all direct and indirect factors will be categorized from very low to very high.

• **Justification of indirect measurements for behavioral belief, normative belief, and control belief**

To obtain theory-relevant information about these control factors, two sets of questions can be posed with respect to each. Respondents can be asked to indicate the perceived likelihood (or frequency) of a given control factor being present (strength of control belief), and the extent to which the control factor’s presence has the power to facilitate or impede performance of the behavior (power of control belief).



2. Partial Least Square Regression (PLS)

When using PLS, there are several evaluations of the structural model (inner outer) and measurement model (outer model). In evaluating the measurement model, convergent validity, discriminant validity, composite reliability and Average Variance Extracted (AVE) were tested. Meanwhile, in evaluating the structural model, the R-squared (R2) test and path coefficient estimation test were carried out.

Later on, PLS analysis, apart from conducting manual calculation for data analyst, author compares independently the result between:

- Direct Measurement (A)
- Control Belief (B)
- Control belief multiply to the outcome evaluation / motivation / power, depend on the factors (B x C)
- This comparison will provide some insight on the validity and relevancy of data on the result related to the factors of safety avoidance based on theory of planned behavior.

Research Particularity

A comparison of similar study which use the theory of planned behaviour is performed by author. Unlike the other literature, this research has particularity in using theory of planned behaviour in workers (front liner) of drilling rig swamp and offshore remote area (which not yet seen in other literatures), using direct and indirect measurement and perform comparison of the result both manual and SEM-PLS analyses. This early finding will be useful as refence for further research.

RESULT AND DISCUSSION

Descriptive Variable Analysis

All variable element of TPB have high to very high category, except Direct Measurement of Perceived Behavioral Control (PBC) that falls into medium category. This give indication that the level of control, ease or difficulties of rig workers in performing safety initiatives is low compare to the other factors.

Table 2. Summary of Descriptive Variable Analysis

No	Variable	Category	Score	Range
1	Attitude Toward Behavior/Believe	HIGH	35.85	-84 to 84
2	Attitude, direct measurement	VERY HIGH	6.63	1 to 7
3	Direct Measurement of Subjective Norm	HIGH	5.17	1 to 7
4	Measurement of Subjective Norm	VERY HIGH	69.64	-84 to 84
5	Direct Measurement of Perceived Behavioral Control (PBC)	MEDIUM	3.51	1 to 7
6	Indirect Measurement of Perceived Behavioral Control (PBC)	VERY HIGH	38.04	-63 to 63
7	Intention statement	VERY HIGH	9.31	1 to 10
8	Generalized Intention	VERY HIGH	6.68	1 to 7

Table 3. Range Category

Range	Very Low	Low	Medium	High	Very High
-84 to 84	-84 to -50.4	-50.4 to -16.8	-16.8 to 16.8	16.8 to 50.4	50.4 to 84
1 to 7	0 to 1.4	1.4 to 2.8	2.8 to 4.2	4.2 to 5.6	5.6 to 7
-63 to 63	-63 to -37.8	-37.8 to -12.6	-12.6 to 12.6	12.6 to 37.8	37.8 to 63
1 to 10	0 to 2	2 to 4	4 to 6	6 to 8	8 to 10

All variable element of TPB have high to very high category, except Direct Measurement of Perceived Behavioural Control (PBC) that falls into medium category.

PLS Analysis

1. Data Validity

The result of convergent validity and discriminant validity show valid question due to the indicators that are used to verify the laten variable has fulfilled the requirement and all the reliability test of all indicator has consistency in measuring of each variable. Since



it at least one validity on this analysis, hence it can be concluded that the data us in this research is valid so it can be used for the next analysis.

Table 4. Outer Model Summary

	A	B	BxC
Convergent Validity			
Convergent Validity Test	PBC3, PBC4, PBC5, SN1, and SN3 invalid.	ATB4 invalid.	ATB4 invalid.
AVE	PBC and SN does not meet the AVE requirements.	ATB does not meet the AVE requirements.	ATB does not meet the AVE requirements.
Discriminant Validity			
Cross-Loading Factor Test Results	Data A, Data B, and Data BxC can be concluded have met the criteria.		
Fornell-Lacker Criterion	Data A, Data B, and Data B xC can be concluded has good discriminant validity.		
Reability Test			
Cross-Loading Factor Test Results	In Data A, it can be concluded that the data is not reliable, indicating that all indicators do not yet exhibit consistency in measuring their respective variables	In Data B and Data BxC, it can be inferred that the data is reliable, indicating that all indicators exhibit consistency in measuring their respective variables.	

2. Data Analysis

The variable of Safety Behavior Intention which effect by the variable of Attitude Toward Behavior, Subjective Norm and Perceived Behavioral Control on those 3 (A, B, BxC) models show similar R-square value with average 30%. The variable of Safety Incident Avoidance, influenced by Perceived Behavioral Control and Safety Behavior Intention in models A and B, has an R-square above 50%. The R-square value for model BxC is 47.9%, and the factor with the greatest influence on Safety Incident Avoidance is Perceived Behavioral Control across all models. The small impact can be observed from the f2 effect size results of each variable, namely Attitude Toward Behavior, Subjective Norm, and Perceived Behavioral Control, on Safety Behavior Intention.

Table 5 Summary of Inner Model

	A	B	BxC
R Square Test			
It can be observed that in Data A, Data B, and Data BxC, SIA is more can be explained by the indicator variables than SBI .			
F2 Effect Size Test			
It can be observed that in Data A, Data B, and Data BxC, the variable "Perceived Behavioral Control" has the most significant influence on "Safety Incident Avoidance."			



3. Hypothesis

- The results of hypothesis testing indicate that Attitude Toward Behavior does not have a significant influence on Safety Behavior Intention in all models except for model A.
- Hypothesis testing shows that Subjective Norm has a significant influence on Safety Behavior Intention in models B and BxC.
- Hypothesis testing indicates that Perceived Behavioral Control has a significant influence on Safety Behavior Intention in models A and BxC.
- Hypothesis testing for the variables influencing Perceived Behavioral Control and Safety Behavior Intention on Safety Incident Avoidance shows a significant impact in all models.

From the above explanations, it is evident that model BxC is the most favorable compared to models A and B. This is demonstrated by the results of Convergent Validity and Discriminant Validity tests, as well as better reliability test results, despite Attitude Toward Behavior not having a significant influence on Safety Behavior Intention.

Table 6. Summary of Hypothesis

No	Hypothesis Test		
	A	B	B x C
1) ATB to SBI	H0 is rejected and H1 is accepted	H0 is accepted and H1 is rejected	H0 is accepted and H1 is rejected
2) SN to SBI	H0 is accepted and H1 is rejected	H0 is rejected and H1 is accepted	H0 is rejected and H1 is accepted
3) PBC to SBI	H0 is rejected and H1 is accepted	H0 is accepted and H1 is rejected	H0 is rejected and H1 is accepted
4) PBC to SIA	H0 is rejected and H1 is accepted	H0 is rejected and H1 is accepted	H0 is rejected and H1 is accepted
5) SBI to SIA	H0 is rejected and H1 is accepted	H0 is rejected and H1 is accepted	H0 is rejected and H1 is accepted

CONCLUSION

In general, the factors of safety initiatives based on the theory of planned behavior has influence the safety avoidance intention. This finding is consistent with other study of planned behavior in relation fo safety behavior (Masoud, et.al, 2021). To be noted that the particularity offshore workplace may influence the level of attitude of the workers in responding the questionnaire. There are always some unexpected answers despite it is obvious. The theory of planned behavior can help identified the most and least factors that shaped behaviors. The company may increase or decrease the safety initiatives that relates to the TPB factors in order to increase safety initiatives implementation. Some elements that can be taken as insight from the research as follows:

- The relation of attitude, subjective norm, perceived behavioral control to intention and safety behavior is confirmed with TPB’s model, as shown on similar research in relation with safety behavior
- It is found out that the model A, B, B x C analysis provides different result, hence for PLS simulation, the model can be taken directly the B or B x C for the best result which is justified in this researched.
- Both manual calculation and PLS simulation provides two different results: o Descriptive analysis based on manual calculation: the lowest result goes to the direct measurement (medium category) on perceived behavioral control effect to safety incident avoidance
- PLS analysis: hypothesis result indicate that Attitude Toward Behavior does not have a significant influence on Safety Behavior Intention
- For rig workers, it is found that some degrees of worries are necessarily due to its natural work environment on the rig, they might use this as a tool to keep vigilant and awareness on the workplace. More study and research can be performed to analyzed on this particular subject.
- Despite the intention is there, however, control to avoid safety incident is observed low, this also a finding to dig more for the rig crew. Ideally, they must have a good degree of control of their behavior to avoid incident.
- The recommendation to focus on the safety initiatives in relation with subjective norm and perceived behavioral control will require regular evaluation on the implementation. It is expected at the least to meet the KPI as per objectives.



RECOMMENDATION

The recommendation based on the result of this final project are basically to promote safety initiatives that in relation to the factors of theory of planned behaviour. Despite most of the safety initiatives correlate with the 3 factors, however, for this research, author categorize separately by the most influence safety initiatives into attitude toward behaviour, subjective norm and perceived behavioural control as follows: The safety initiatives which are focus on the subjective norm and perceived behavioral control as table above will be socialized and promoted more on the drilling rig. A yearly planning and KPI are explained in the table 7 and table 9.

Recommendation from Measurement

The table below details the safety initiatives to be re-enforced in relation to the TPB factors.

Table 7. Safety Initiatives Yearly Planning

TPB Factor	Objectives	Safety Initiatives on Rig Site	Target Audience
Attitude toward Belief	Increase positive attitudes towards safety practices within the workplace	KARIB : Kajian Resiko Pribadi (Self Risk Assessment)	All forntliners
		HSE Mandatory Training	All employees
		Speak up: alert co-worker	All employees
		HSE Reward and incentives	All employees
		Weekly safety meeting - learning from event	All employees
Subjective Norm	Foster a positive safety culture by influencing social perceptions and norms.	TEMAN- Tegur Saya Jika Tidak Aman (Alert with when I am not safe)	All employees
		Golden Rule PIP - Patuh Peduli Intervensi (Comply, Care, Intervention)	All employees
		CLSR+ : Company Life Saving Rule Plus (15)	All employees
		HSE Reward and incentives	All employees
		Safety tour – Management Walk around	Rig Crew Supervisor and Top Management
Perceived Behavioral Control	Empower employees to believe in their ability to perform safe behaviors effectively.	Submit safety observation card daily	Rig Crew and visitors
		JRA – Job Risk Assessment	Leader to prepare, involve rig crew relaed to the job, supervisors
		Work Permit	Leader to prepare, involve rig crew relaed to the job, supervisors
		PJSM : Pre-Job Safety Meeting	All crew involve in job related
		Competency Training	All employees
		Comply with safety procedure and regulation	All employees
		Safety Drill	All rig crew on each shift

Table 8. KPI & Target

Safety Initiatives on Rig Site	KPI	Target
KARIB : Kajian Resiko Pribadi (Self Risk Assessment)	Self risk assessment on health and capacity to perform the task	1 daily check up
HSE Mandatory Training	% Compliance	> 95%
Speak up: alert co-worker	Speak up drill	1 per weak
HSE Reward and incentives	Yearly and monthly award	1 Award per Year Mothly Best Observation Card Monthly HSE Incentive
Weekly safety meeting - learning from event	Number of caledoscope	1 Safety moment / Kaledoscop every meeting
TEMAN- Tegur Saya Jika Tidak Aman (Alert with when I am not safe)	Weekly safety tour	2 person per week (different position)
Golden Rule PIP - Patuh Peduli Intervensi (Comply, Care, Intervention)	Relates incident with Golden Rule - every safety meeting	1 per week
CLSR+ : Company Life Saving Rule Plus (15)	Daily best observation card - relate to CLSR+	1 per day
HSE Reward and incentives	Yearly and monthly award	1 Award per Year Mothly Best Observation Card Monthly HSE Incentive
Safety tour – Management Walk around	Once per Month	12 visit per year
Submit safety observation card daily	% of submission	1 obs card per day 1 obs card every rig visit for visitor
JRA – Job Risk Assessment	JRA attached on new ininitatives JRA on every PWT JRA discusssed on pre job safety meeting	> 90%
Work Permit	All mitigation on PTW in place % PTW Audit	> 90%
PJSM : Pre-Job Safety Meeting	% attendant	100 % attendant
Competency Training	% Training compliancy	> 95%
Comply with safety procedure and regulation	% Audit Compliance	2 per year HSE Audit
Safety Drill	number of safety drill	weekly safety drill

Note:

- Implementation can be start in early year, example Q1 of the year
- Evaluation: Every quarter when perform service quality meeting with contractor
- Additional initiatives compare to previous year: Permit to Work audit, speak up drill, and new objectives for HSE and competency training compliancy from 90% to 95%
- Compare to previous plan, the safety initiatives related to subjective norm and perceived behavioral control is now clearly defined on the KPI



Recommendation for Future Research

There are two questions on the questionnaire that are answered with unexpected result. First about worry and concern of the rig crew when there is incident, which supposed to be undesirable (however the answer was more on desirable). And when there is incident, it might outside of the individual control (despite performing safety initiatives) which supposed to be not (however, the answer is balance between desirable and undesirable). This finding can be explored more to have more insight It is advisable to mention in the introduction of questionnaire the relationship between questions, so that the belief and outcome are related, hence the responders may answer the questionnaire more precise and reliable. Another way to develop the research is to extend the theory of planned behavior and included in the analysis and also to combined with other theory in relation with human performance.

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