

Examining the Influence of Safety Knowledge on Safety Practice in Malaysia's Outdoor Recreation Sector

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ABSTRACT

The study is focusing safety knowledge and safety practice in Malaysia, using the theory of knowledge, attitude and practice (KAP). The survey utilizes of the respondents among outdoor recreation who involve guides, instructors and staff in Malaysia (n = 300). Safety knowledge and safety practice were assessed using Likert-scale items that have been validated for adventure tourism in Malaysia. Linear regression analyses investigated the impact of safety knowledge (independent variable) on safety practice (dependent variable). The results revealed that safety knowledge is a significant predictor of safety practice, explaining a total of 27% of the variance in safety practice. Higher compliance with safety procedures and greater participation were obtained from practitioners' safety knowledge. Significance of the study provides empirical support for the KAP model in the Malaysian outdoor recreation context. This underlines the importance of security training and knowledge dissemination to improve ground security practices. The implications will be increased safety knowledge among outdoor recreation workers leading to better adherence to standard operating procedures (SOPs) and proactive safety behaviors, potentially reducing accidents.

Keywords- safety knowledge, safety practice, outdoor recreation, Malaysia, KAP model, safety management, linear regression

INTRODUCTION

Outdoor adventure tourism in Malaysia has grown in popularity, but this growth has been accompanied by safety challenges. In recent years, numerous accidents have occurred during hiking, climbing, camping, and other outdoor activities. For example, a tragic landslide engulfed a campsite in Batang Kali, at Selangor Malaysia, in 2022, killing 31 people, and a whitewater rafting trip in 2024 resulted in a triple drowning of participants and the Malaysian authorities have reported 134 hiking accidents in one year, and over a period from 1996 to 2014, 665 mountain hiking casualties (including 47 deaths) were recorded. These incidents underscore the critical importance of effective safety management in outdoor recreation. In response to rising safety concerns, local authorities and organizations have introduced various initiatives. Many have implemented safety awareness campaigns and Standard Operating Procedures (SOPs) to educate the public on safe practices during outdoor activities. Notably, Malaysia's Ministry of Higher Education released a comprehensive Student Outdoor Recreation Safety SOP in 2017 as a guideline for outdoor activities at universities. This SOP covers detailed safety procedures for planning and conducting adventures (e.g., camping, hiking, rock climbing, water sports), defining roles and responsibilities, risk assessment steps, emergency response protocols, and required safety. Adherence to these guidelines is mandatory in higher education institutions, and efforts are underway to elevate them into a national standard for all outdoor providers. However, the existence of safety rules and SOPs alone does not guarantee compliance in the field. Ultimately, the safety outcomes depend on the knowledge of individuals involved and how they practice or enact that knowledge during activities.

The Knowledge, Attitude and Practice (KAP) model provides a useful framework to examine these issues. KAP theory posits a sequential relationship whereby knowledge influences attitudes, which in turn shape

practices. In other words, having the right knowledge is the foundation for developing positive safety attitudes and for engaging in safe practices (behavior). This model has been widely applied in health and safety research; for instance, it has been used to study food safety behaviors, where food handlers' knowledge and attitudes predict their hygiene practices (Kwol et al., 2020). In the context of occupational and adventure safety, knowledgeable employees are generally more likely to adopt safer attitudes and comply with safety procedures. Prior studies indicate that safety knowledge correlates strongly with safety performance outcomes such as reduced accidents and injuries. For example, meta-analytic evidence has shown that employees' knowledge of safety protocols is positively associated with their safety behavior and overall workplace safety outcomes. Griffin and Neal (2000) and Christian et al. (2009) found that workers who are more informed about safety tend to exhibit better safety compliance and participate more in safety activities, ultimately contributing to fewer incidents.

At the same time, research also highlights potential gaps between knowledge and practice. Simply possessing knowledge does not always guarantee its application. Factors such as attitudes, motivation, and contextual support play a mediating role. Neal and Griffin (2006) observed that even well-trained personnel might fail to follow safety procedures if they lack a positive safety attitude or if the organizational climate does not support safe practices. Similarly, Kao et al. (2019) demonstrated that the effect of workers' safety knowledge on their safety behavior was mediated by their attitudes workers with greater knowledge practiced safety more consistently only when they and their supervisors held strong safety attitudes. These findings align with the Theory of Planned Behavior (Ajzen, 1991), which positions attitude toward the behavior as a proximal driver of intention and action. In short, knowledge is crucial but often requires a supportive attitude and environment to translate into behavior. Recognizing this, many safety interventions focus on both educating participants (to build knowledge) and fostering a positive safety culture (to shape attitudes and norms). Another important concept in safety research is the distinction between safety compliance and safety participation. Safety compliance refers to adhering to mandatory safety rules and procedures (the required actions to maintain safety), whereas safety participation refers to voluntary, discretionary behaviors that help improve safety (such as proactively helping others, suggesting improvements, or going beyond the call of duty). Together, these two facets form overall safety practice or performance (sometimes termed safety behavior). This dual-facet view is well-established; for instance, Neal and Griffin (2006) identified compliance and participation as two key components of safety performance, and Christian et al. (2009) found that both components were predictive of accident rates.

In the adventure tourism setting, compliance behaviors include actions like conducting equipment checks and following standard protocols, while participation might include initiatives like contributing to safety briefings or reporting near-misses. Effective safety practice thus means not only following the rules but also actively engaging in the continuous improvement of safety on-site. Given the above context, this study focuses on the link between safety knowledge and safety practice among outdoor recreation practitioners in Malaysia. While theoretical frameworks and international research suggest that greater knowledge should lead to better safety practices, there is a need for empirical evidence within the Malaysian outdoor recreation sector specifically. The sector is characterized by unique cultural, environmental, and organizational conditions for example, varying terrain and climate challenges, and as noted, a currently evolving regulatory framework (with no single national adventure safety law but emerging guidelines). By examining how knowledge relates to practice in this context, we can identify whether improving knowledge (through training, certification, etc.) is likely to yield better safety compliance and initiative among Malaysian outdoor providers.

The primary objective of this study is to examine the relationship between safety knowledge and safety practice in Malaysia's outdoor recreation sector. The study hypothesizes that safety knowledge will be positively associated with safety practice, in line with the KAP model. Focus on the direct knowledge practice linkage, acknowledging that attitudes and other factors are important but are beyond the scope of this analysis. The findings will contribute to the literature on adventure tourism safety by providing data from a developing country context and will inform practitioners and policymakers on whether investments in safety knowledge (e.g., training programs, certification courses, dissemination of safety guidelines) can measurably improve safety behaviors on the ground.

LITERATURE REVIEW

Safety Knowledge and the KAP Model

In safety research, safety knowledge typically refers to an individual's awareness and understanding of potential hazards, safety procedures, and risk mitigation strategies in their work or activity domain. According to the KAP framework, knowledge is the first step that influences subsequent attitudes and practices. Launiala (2009), noted that KAP surveys have been widely used to gauge how much people know about a topic, how they feel about it, and how they ultimately behave, especially in public health contexts. Transferring this idea to occupational safety and adventure tourism, one expects that an outdoor guide who is well-versed in safety protocols (e.g., knows how to read weather patterns, use safety equipment, perform first aid) is more likely to value safety and integrate that knowledge into his or her daily practices. Indeed, studies consistently find that higher safety knowledge correlates with safer behaviors. A meta-analysis by Christian et al. (2009) found that safety knowledge had a strong positive relationship with safety performance indicators such as compliance with procedures and reduction in accident involvement. Similarly, Griffin and Neal (2000) proposed a framework where safety knowledge (along with safety motivation) directly influenced safety compliance and participation behaviors, serving as a mediator between safety climate and safety performance. Empirical evidence supports this; employees who score higher on safety knowledge tests or self-assessments tend to have better safety records and engage in more recommended safer practices.

However, knowledge alone is not always sufficient. The translation of knowledge into practice often depends on attitudes and tool use. In other words, having knowledge is necessary but not always sufficient for safe behavior. For instance, if an individual knows the proper procedure but does not believe that safety is important, or if they are not motivated to follow through (perhaps due to time pressure or complacency), the knowledge might not manifest as practice. Neal and Griffin (2006) demonstrated this in a longitudinal study, safety knowledge was linked to later safety behavior, but much of that link was channeled through safety motivation (a construct closely related to attitude). When workers were motivated and had positive safety attitudes, their knowledge was effectively applied; when motivation was low, a "knowledge and behavior gap" was observed. Likewise, research in other domains, such as food safety (Kwol et al., 2020), found that workers' attitudes significantly mediated the effect of knowledge on safe practices. Kao et al. (2019) extended this understanding by showing that both supervisor and worker safety attitudes can moderate or mediate knowledge's impact on behavior in industrial settings. These studies underscore those contextual and psychological factors like attitudes, motivation, and management support condition the strength of the knowledge–practice relationship.

Safety Practice (Behavior)

Safety practice refers to the behaviors and actions that individuals perform to maintain and enhance safety. As discussed, it can be conceptualized in two broad categories, safety compliance (fulfilling the minimum safety requirements such as wearing required protective equipment, following standard procedures, obeying rules) and safety participation (voluntary behaviors that go beyond requirements, such as helping coworkers, suggesting improvements, reporting hazards, and continuously engaging in learning). Both aspects are vital, compliance ensures that baseline precautions are taken, while participation fosters a proactive safety culture where individuals contribute to safety beyond their formal duties.

Research by Neal and Griffin (2006) and others has validated this two-factor structure of safety behavior in various industries. They found that factors like knowledge and attitudes can influence both compliance and participation. Importantly, Christian et al. (2009) showed that these self-reported safety behaviors are not just abstract constructs – they correlate with real safety outcomes like accident rates and injuries, confirming that improving safety practice has tangible benefits in reducing harm. In high-risk contexts such as outdoor recreation and adventure tourism, safety practices can literally be lifesaving. For example, adhering to a checklist (compliance behavior) before a rock-climbing activity, checking ropes, harnesses, anchor points, weather conditions can prevent equipment failure or misjudgment accidents. On the other hand, participation behaviors like voluntarily conducting an extra briefing for participants, or a guide mentoring a less experienced colleague on hazard recognition, can improve group safety beyond the basics. Bentley and Page (2018)

highlighted that in the adventure tourism industry, continuous learning and knowledge-sharing are key to safety innovation and risk management. In their analysis of New Zealand's adventure tourism sector, knowledge and learning processes were identified as critical drivers for improving safety practices and outcomes. This reinforces the idea that organizations should not only enforce rules but also encourage a learning culture where knowledge is actively applied and shared to elevate safety performance.

Safety Knowledge

Specific to outdoor recreation, relatively few empirical studies have quantified the knowledge and practice relationship, especially in Malaysia. One relevant study by Abdul Latif et al. (2021) surveyed Malaysian outdoor recreation participants and found that the implementation of safety management practices (such as training, communication of procedures, management commitment) had a moderate to strong correlation with participants' safety behavior ($r \approx 0.70$, $p < .001$). Although that study focused on organizational practices as the predictor, it underscores that when safety procedures are emphasized (presumably increasing participants' knowledge and awareness), safer behavior follows. Additionally, Vinodkumar and Bhasi (2010) conducted research in an industrial setting (process industry in India) and their findings are instructive, safety knowledge and motivation acted as key mediators between safety management initiatives and safety compliance/participation outcomes. In other words, interventions like safety training improved safety outcomes largely by improving what employees knew (hazard awareness, procedural knowledge) and how motivated they were to apply it. By analogy, in outdoor recreation operations, ensuring that staff possess strong safety knowledge (e.g., of hazard identification, emergency response, equipment use) should empower them to both comply with standard safety procedures and to take initiative in unforeseen situations. Qualitative case evidence also supports this link. Experienced outdoor leaders often cite knowledge gained from training or past incidents as enabling them to make safe decisions in dynamic environments (e.g., recognizing when to turn back before a storm, or how to execute a rescue) – those decisions and actions are the manifestation of their knowledge base in practice. International safety standards reflect this emphasis on knowledge translating to practice.

The ISO 21101,2014 standard for adventure tourism safety management systems, for instance, stresses competence (knowledge and skills) of personnel as a requirement, and ties it to operational control and emergency preparedness (practices) that providers must have in place. By requiring training, assessment of staff competence, communication, and continual improvement (ISO, 2014), the standard implicitly endorses the notion that well-informed and knowledgeable staff will engage in the right safety practices to manage risks. In Malaysia's context, although a unified adventure tourism safety regulation is not yet in force, the adoption of the Ministry of Higher Education's Outdoor Recreation SOP and moves to develop national standards show recognition that raising knowledge and standardizing practices are the path forward to improve safety. In summary, past literature and existing frameworks suggest a clear expectation, Safety knowledge is positively related to safety practice. Workers and participants who know more about safety are generally safer in what they do. However, this relationship is facilitated by supportive attitudes and organizational factors. This study will build on these insights by providing empirical data from Malaysia's outdoor recreation sector, thereby testing whether the global understanding of the knowledge–practice link holds true in this setting. The next sections describe the methodology of our study and the results of the regression analysis undertaken to evaluate the influence of safety knowledge on safety practice.

METHODOLOGY

This research utilized quantitative cross-sectional survey design. The target population consisted of individuals involved in outdoor recreation activities in Malaysia, specifically those in roles responsible for safety (such as outdoor adventure guides, instructors, park rangers, and expedition leaders). We focused on practitioners affiliated with outdoor adventure providers (e.g., adventure tour companies, outdoor education centers, university outdoor clubs) since they are directly tasked with applying safety measures during activities.

A non-probability purposive sampling approach was used to recruit participants, leveraging professional networks and industry contacts in Malaysia's outdoor recreation community. An online questionnaire was distributed via email and messaging apps to prospective participants. A total of $N = 300$ respondents completed

the survey (after data cleaning for completeness).

This sample size is adequate to detect medium effect sizes with sufficient statistical power in regression analyses. Respondents' demographics indicated a diverse representation of the sector, approximately 68% were male and 32% female; the average age was Thirty-three years; participants had a range of experience levels (mean experience in outdoor activities = 7.5 years, SD = 5.4). They represented various outdoor domains including hiking/trekking (60% of respondents had experience leading hikes), rock climbing (34%), water sports like rafting or kayaking (30%), camping and outdoor education programs (45%), among others (many had multi-disciplinary roles). This diversity in background improves the generalizability of the findings across Malaysia's outdoor recreation sector.

Safety Knowledge (Independent Variable)

Safety knowledge was measured using an 18-items scale developed for this study, informed by safety standards and prior research on outdoor safety competencies. The scale covered multiple knowledge domains critical to adventure activities, aligning with elements of Malaysia's SOP and ISO 21101 competencies.

These domains included, Hazard Identification & Risk Reduction (HIRR) – e.g., recognizing hazardous site conditions and judging when risk controls are needed; Personal Protective Equipment (PPE) e.g., knowing how to select, inspect, and correctly use safety gear; Equipment Inspection & Setup (EIS) e.g., knowledge of checking ropes, anchors, boats, etc., and identifying faulty equipment; Emergency Warning Signs (EWS) e.g., knowing thresholds for stopping activities due to weather or participant condition, and early symptoms of common injuries like heat illness; Emergency Response & First Aid (ERFA) e.g., knowing the immediate actions for accidents, first aid steps, and how to activate emergency services; and Communication & Reporting (CNR) e.g., knowledge of communication signals/codes in the field and how to precisely report locations or incidents to authorities.

Participants rated statements such as "I readily recognize site conditions that could escalate risk during outdoor activities" (hazard identification) and "I know the immediate actions to secure the scene and provide aid if an accident happens" (emergency response) on a 7-point Likert scale (1= Strongly Disagree, 7 = Strongly Agree). All items were phrased as ability or awareness statements (focusing on knowledge rather than personal opinions).

The composite safety knowledge score for each respondent was computed as the mean of the 18 item scores. In this sample, the safety knowledge scale exhibited excellent internal consistency reliability, with Cronbach's $\alpha = 0.92$. This suggests that the items cohesively measure a single underlying construct of safety knowledge. Content validity was ensured by mapping the item content to established safety guidelines (e.g., including knowledge elements required by the national Outdoor Recreation SOP and ISO 21101 clauses on staff competence and emergency preparedness). Two expert practitioners reviewed the items to confirm their relevance and clarity before the survey was administered.

Safety Practice (Dependent Variable)

Safety practice was operationalized as self-reported safety behavior and was measured using a 12-item scale. This scale captured both safety compliance and safety participation behaviors, consistent with prior safety performance measures (Neal & Griffin, 2006; Vinodkumar & Bhasi, 2010).

Six items were designed to assess compliance – the extent to which individuals perform required safety actions every time – and six items assessed participation – the extent to which individuals voluntarily engage in extra safety efforts. Example compliance items included "I complete pre-activity safety checks every time" and "I use the required personal protective equipment correctly for each task", reflecting routine adherence to safety rules. Example participation items included "I propose practical changes that improve safety" and "I share lessons learned from incidents or near-misses with my team", reflecting proactive and communicative safety engagement. Respondents rated each statement on the same 7-point Likert scale (1 = Strongly Disagree to 7 = Strongly Agree), indicating how true each practice was of their own typical

behavior in their outdoor role.

A composite safety practice score was calculated as the mean of all 12 items, after verifying through factor analysis that the items indeed loaded on one higher-order factor (with two sub-dimensions). Descriptively, most respondents reported fairly high levels of compliance (e.g., consistently using PPE and checklists) and moderate levels of participation (there was more variance in extra-role behaviors like reporting near-misses or suggesting improvements). The safety practice scale demonstrated good reliability in our sample (Cronbach's $\alpha = 0.90$). Breaking it down, the compliance subscale (6 items) had $\alpha \approx 0.88$ and the participation subscale (6 items) had $\alpha \approx 0.85$, indicating both facets were measured reliably. For analysis, we used the overall safety practice score, but we note that treating compliance and participation separately in future analyses could yield additional insights (e.g., knowledge might predict mandatory compliance differently than it does voluntary participation).

Control Variables

Given the focus on bivariate relationships in this study, we did not include multiple covariates in the regression model; however, we collected basic demographic and background information that could be relevant in interpreting results. For instance, respondents' years of experience in outdoor activities and their highest level of formal education in outdoor recreation (if any certification or training) were recorded. Exploratory checks showed that experience had a small positive correlation with safety practice (more experienced practitioners reported slightly better safety practices), but controlling for it did not significantly alter the knowledge–practice relationship. Thus, for parsimony, results are presented without additional controls. No significant common-method bias was detected in the data (the Harman's single-factor test was below 50%), and all variance inflation factors (VIFs) in regression were under 1.1, indicating that multicollinearity was not a concern.

Procedure

Data collection was carried out over a four-week period. The survey was administered primarily online using a secure form. Participation was voluntary and anonymous. At the start of the survey, respondents were informed about the study's purpose and gave informed consent. They then completed the questionnaire which included the scales described above and some open-ended questions about their perspectives on safety (not analysed in this quantitative study). Respondents took approximately 15–20 minutes to complete the survey.

To ensure quality of data, attention-check questions were embedded (e.g., "Select strongly agree for this item") and responses failing these checks were excluded. Additionally, responses were screened for patterns suggesting lack of engagement (such as giving the exact same rating for all were approximately normally distributed (Shapiro–Wilk test), the plot of standardized residuals vs. predicted values showed no obvious heteroscedasticity, and independence of errors was supported (Durbin-Watson statistic ~ 2.05). Given the single-predictor model, model specification was straightforward and there was no issue of multicollinearity. The report the regression coefficients, including the unstandardized coefficient (B), standard error (SE), standardized coefficient (β), t-statistic, and p-value. We also report the model's R-squared (R^2) to indicate the proportion of variance in safety practice explained by safety knowledge. All results are reported following APA 7th edition style. A significance level of .05 was used for hypothesis testing (with $p < .001$ indicating highly significant results). Additionally, an APA-formatted table is provided to summarize the regression findings.

FINDINGS

Descriptive Statistic and Correlation

Prior to regression analysis, descriptive statistics and bivariate correlations for the key variables were examined. **Table 1** presents the mean and standard deviation for safety knowledge and safety practice, as well as their Pearson correlation.

TABLE I Font Sizes for Papers items); no significant issues were found in this regard.

Variable Mean SD Safety

Knowledge

Safety Practice

After data collection, the responses were coded and analysed using SPSS and Jamovi statistical software. Preliminary analyses (descriptive statistics, reliability 1.Safety Knowledge 2.Safety Practice

5.02	0.99	—	.52**
4.89	1.00	.52**	—

analysis, correlation matrix) were conducted before the regression. The safety knowledge and safety practice variables were approximately normally distributed. The mean score for safety knowledge was $M = 5.02$ ($SD = 0.99$) on the 1–7 scale, indicating that on average respondents felt confident in their safety knowledge (above the scale midpoint of 4). The mean for safety practice was $M = 4.89$ ($SD = 1.00$), similarly above the midpoint but with room for improvement toward the maximum of 7. The Pearson correlation between safety knowledge and safety practice was $r = 0.52$, $p < .001$, suggesting a moderate to strong positive association even before controlling for any factors. This provided initial support for our hypothesis that individuals with greater safety knowledge also tend to report better safety practices.

Data Analysis

For the main analysis, employed a simple linear regression model. Safety practice (continuous composite score) was entered as the criterion (dependent variable), and safety knowledge (continuous composite score) as the predictor (independent variable). The regression was estimated using the ordinary least squares (OLS) method. The study checked all necessary assumptions of linear regression, the residuals $N = 300$. **Note, Correlation is significant at the 0.01 level (two-tailed).**

As shown above, the correlation between safety knowledge and safety practice is $r = .52$, which is statistically significant ($p < .001$). This indicates a moderate-to-strong positive relationship, respondents who reported higher safety knowledge also tended to report more frequent or thorough safety practices. This finding provides preliminary support for our hypothesis, setting the stage for the regression analysis to examine the predictive relationship in more detail.

Regression Analysis

A simple linear regression was conducted with safety practice as the outcome variable and safety knowledge as the predictor. The regression model was statistically significant, $F(1, 298) = 111.7$, $p < .001$, indicating that safety knowledge contributes significantly to explaining variance in safety practice. The regression results are summarized in **Table 2**.

The table 2 indicate the model summary, $R^2 = .27$, Adjusted $R^2 = .27$, $F(1, 298) = 111.7$, $p < .001$. The B represents the unstandardized regression coefficient, SE is its standard error, β is the standardized coefficient, and t and p are the test statistic and significance level for each predictor.

The constant (interception) of 2.23 ($p < .001$) represents the expected value of safety practice when safety knowledge is at zero. In the context of our 1–7 scales, an intercept of 2.23 is not directly interpretable in a practical sense (since nobody in the sample truly has zero knowledge), but it provides the baseline of the regression line.

The primary result of interest is Safety Knowledge. The unstandardized coefficient $B = 0.53$ indicates that for each one-point increase in the safety knowledge score, the safety practice score is predicted to increase by 0.53 points on the 7-point scale, on average, holding other factors constant (in this simple model, there are no other predictors). This is a sizable effect, given the range of the scales. The coefficient is positive, as hypothesized, suggesting that greater knowledge is associated with more intensive or frequent safety practices. The coefficient is highly statistically significant ($t(298) = 10.57$, $p < .001$). The 95% confidence interval for B [0.43, 0.63] does not cross zero, reinforcing the conclusion of a positive effect.

The standardized coefficient $\beta = 0.52$ provides a sense of the effect size in standardized terms – it implies that a one standard deviation increase in safety knowledge is associated with a 0.52 standard deviation increase in safety practice. In many social science contexts, a standardized beta above 0.5 is considered a large effect. Here, $\beta = 0.52$ suggests a strong relationship, which is consistent with the bivariate correlation reported earlier (indeed, for a simple regression, β is equal to the Pearson r). The model's $R^2 = 0.273$, indicating that about 27.3% of the variance in safety practice scores is explained by safety knowledge alone. Adjusted R^2 is also 0.270 (very close since we have one predictor), suggesting the model generalizes well. This R^2 value, while not extremely high, is quite respectable for a single predictor model in behavioral research. It indicates that

safety knowledge is an important factor, although roughly 72.7% of the variance in safety practice is left unexplained by this one factor (likely attributable to other personal, situational, and organizational influences, as discussed later).

In sum, the regression analysis supports the hypothesis that safety knowledge has a significant positive influence on safety practice. Practitioners who rated themselves higher in safety knowledge also tended to engage in safer practices, both in terms of complying with required safety measures and taking additional safety initiatives. The positive linear relationship can be visualized (not included here for brevity) as an upward-sloping trend where those high on knowledge cluster towards high practice, and those lower on knowledge often have lower practice scores. No violations of regression assumptions were detected, lending credibility to these results. The residuals showed no pattern when plotted against fitted values, and the distribution of residuals was approximately normal (skewness = -0.24, kurtosis = 2.99, indicating mild deviation but nothing severe). Thus, the linear model seems appropriate for the data.

Although not the primary focus of this paper, we note that if safety attitude data were included, a multiple regression or mediation analysis could further elucidate the pathways. For instance, a mediation test could examine whether the knowledge → practice relationship is partially mediated by safety attitude. Given literature precedents, we would expect some mediation effect. However, since our current data analysis centers on the direct effect, we proceed to discuss the implications of the direct knowledge–practice link.

DISCUSSION

The purpose of this study was to examine how safety knowledge relates to safety practice among outdoor recreation practitioners in Malaysia. The findings clearly indicate a significant positive relationship; individuals with greater safety knowledge tend to report better safety practices. This result is consistent with the Knowledge–Attitude–Practice (KAP) framework and with prior research in occupational and adventure safety. It contributes new evidence in the context of Malaysia’s outdoor recreation sector, an area that until now had limited empirical data on safety behavior determinants.

The regression results showed that safety knowledge explained about 27% of the variance in safety practice, with a standardized effect size ($\beta = 0.52$) suggesting a substantial impact. In practical terms, this means that efforts to improve what outdoor practitioners know – about hazards, emergency procedures, proper use of equipment, etc. – are likely to yield tangible improvements in what they do on the ground to maintain safety. For example, a guide who has been well-trained to recognize early warning signs of environmental danger (such as changing weather or water conditions) is more likely to take precautionary actions (like adjusting the route or aborting a trip in advance) to avoid accidents. Our data support this; those who “Strongly Agreed” with knowledge items (indicating a high level of knowledge) were generally the ones who also “Strongly Agreed” that they consistently perform safety checks, use PPE correctly, and engage in other safe practices.

This finding aligns strongly with the patterns reported in international literature. Christian et al. (2009) in their meta-analysis found that knowledge had one of the largest effects on safety outcomes among person-related factors, which is echoed here. Vinodkumar and Bhasi (2010) also emphasized knowledge as a mediator linking management safety initiatives to safe behaviors. Our study, focusing directly on knowledge and behavior, reinforces the importance of knowledge. Moreover, the significant knowledge–practice link found in our results echoes the suggestion by Bentley and Page (2018) that continuous knowledge development (learning and training) in adventure tourism operations plays a critical role in enhancing safety. It suggests that the Malaysian outdoor sector is no exception – regardless of cultural or regional differences, knowledgeable practitioners are safer practitioners.

KAP Model Implications, while our analysis did not explicitly test the role of safety attitude, the findings can be viewed in the light of the KAP model. The significant direct effect of knowledge on practice indicates that knowledge has a direct facilitating role in promoting safe behavior. However, as discussed in the literature review, the magnitude of the effect ($R^2 = .27$) also leaves room for other factors. It is likely that safety attitudes and motivations serve as intervening variables that we did not capture in the regression. In a full KAP

analysis, we would expect safety knowledge to positively influence safety attitudes (e.g., valuing safety, feeling responsible and empowered to act safely), which in turn drive safety practices. Prior studies (Neal & Griffin, 2006; Kao et al., 2019) have demonstrated exactly this kind of mediation. The fact that knowledge alone did not explain the majority of variance in practice in our study suggests that indeed other elements like attitude, subjective norms, and perhaps perceived behavioral control (in TPB terms) moderate the translation of knowledge into action. For instance, a highly knowledgeable guide might still take unwarranted risks if they have a thrill-seeking attitude or if the organizational culture tacitly encourages “summit-at-all-costs” behavior. Conversely, strong positive safety attitudes can amplify the effect of even moderate knowledge.

Thus, our findings support the **knowledge base** of the KAP model – confirming that knowledge is fundamentally important – and point to the continued relevance of addressing the **attitude and practice** components. In practice, this means training programs should not only impart knowledge but also address attitudes (e.g., by emphasizing why safety is critical, perhaps through testimonials or case studies that make the knowledge personally meaningful, thereby fostering a safety-first attitude). It also means organizations should cultivate environments where practicing safety is expected, reinforced, and appreciated (safety culture), ensuring that knowledge is acted upon.

Contextualizing in Malaysian Outdoor Recreation, an interesting aspect of this study is its context – Malaysia’s outdoor recreation sector. The strong knowledge–practice relationship observed suggests that Malaysian practitioners are like their international counterparts in that what they know greatly influences how they behave. This is encouraging, as it means interventions proven elsewhere (like comprehensive training and certification programs) could be effective in Malaysia as well. The data also highlight the current state of safety practice, mean scores were relatively high but not perfect, indicating good compliance but potential gaps in full adherence or in voluntary aspects. For example, nearly all respondents agreed they use PPE correctly (a compliance behavior), but fewer strongly agreed they “submit incident and near-miss reports on time” or “help close hazard reports within required timelines” (from the participation items). This might reflect that while basic compliance is being achieved, more could be done to encourage proactive safety management behaviors (like reporting and feedback loops) – an area which often comes only when people internalize the value of safety beyond rules.

Malaysia’s lack of a unified adventure safety regulation (as of this writing) means that the responsibility for safety largely falls on individual operators and practitioners, guided by frameworks like the 2017 MOHE Outdoor SOP. Our results underscore that individual competence (knowledge) is a key piece of the safety puzzle. Even without a legal mandate, well-trained guides and instructors can make a significant difference. In fact, the tragedies mentioned earlier (the Batang Kali landslide and the rafting incident) have spurred calls for better training and certification of outdoor adventure leaders. The knowledge–practice linkage provides empirical justification for these calls, if we can improve the knowledge of those leading trips (for example, knowledge on how to conduct thorough risk assessments, or how to respond to emergency signals like signs of slope instability), we can reasonably expect improved safety practices and potentially fewer accidents.

Furthermore, the relatively high correlation found between knowledge and practice ($r = .52$) suggests that there is already a culture where those who take the time to learn also take the effort to practice safely. This could be due to self-selection (those passionate about safety both learn more and do more) or due to effective training in some organizations. It would be interesting for future research to identify if certain Malaysian outdoor operators or training programs produce consistently higher knowledge (and thus better practice) – for instance, programs adopting international certifications like Wilderness First Aid, Leave No Trace, or UIAA standards might yield higher scores on both knowledge and practice.

Practical Implications, the findings have important implications for stakeholders in the outdoor recreation sector,

- 1) **Training and Education**, Organizations should invest in regular safety training programs for their staff and activity leaders. The topics should cover not only the “what” and “how” of safety procedures but also the “why” to strengthen understanding. Emphasis on comprehensive knowledge – including hazard recognition, emergency response steps, equipment use and maintenance, etc. – is likely to pay off in improved safety

behavior. Our data suggest that even incremental improvements in knowledge (e.g., through short courses, workshops, or on-the-job mentoring) could lead to measurable gains in safe practices.

- 2) **Certification and Standards**, the push to adopt standards like the SOP for Outdoor Recreation and ISO 21101 should continue. Formal certification of guides (ensuring they possess critical knowledge) could be made a requirement for operating certain high-risk activities. This study provides evidence that such requirements could be effective, certified, knowledgeable guides are likely to run safer trips. Industry bodies in Malaysia may consider developing a standardized curriculum or certification scheme (if not already in place) that mirrors the knowledge areas measured in this study (hazard assessment, first aid, equipment, etc.). Over time, this elevates the baseline knowledge level across the sector.
- 3) **Organizational Safety Culture** Managers of outdoor adventure companies should note that knowledge needs a supportive environment. They should encourage open discussion of safety (e.g., debriefings where lessons learned are shared – one of the practice items) and make it easy for staff to apply their knowledge (for instance, providing the proper equipment and resources, establishing clear reporting channels for hazards). When an employee comes forward with a safety concern or suggestion (a sign of knowledge and initiative), management's positive response can reinforce that behavior. This will further close the gap between knowing and doing.
- 4) **Policy Makers**, Government agencies or tourism authorities could use this evidence to justify policies that emphasize capacity-building. For example, subsidized safety training workshops for adventure tourism operators, or integrating safety modules into tourism/hospitality educational programs, could be beneficial. If a national adventure activity safety guideline becomes formalized, it should include provisions for mandatory knowledge competencies (as ISO 21101 does).
- 5) **Participants/Public**, although our study focused on practitioners, the idea of knowledge influencing safety practice can also be communicated to the adventure-seeking public. Outdoor participants should be educated (through pre-trip briefings or public awareness campaigns) about safety protocols, so they too have the knowledge to behave safely (e.g., a hiker knowing why they shouldn't stray from the trail or what to do if separated from the group).

The magnitude of the relationship we found ($\beta \sim 0.5$) is in line with, albeit on the higher end of, those found in similar studies. For instance, Vinodkumar & Bhasi (2010) reported that training (knowledge) had both direct and indirect effects on safety compliance/participation, with indirect effects through motivation roughly in the $\beta = 0.3\text{--}0.4$ range. Our direct effect being 0.52 likely encompasses some of what would be via attitude/motivation (since we did not include those variables, the effect is "total" in a sense). It's noteworthy that our R^2 (0.27) for one predictor is comparable to some multi-factor safety climate models, implying knowledge is one of the stronger single factors. Additionally, Abdul Latif et al. (2021) found a correlation of $r = 0.697$ between safety management practices and safety behavior among outdoor participants. Our correlation of $r = 0.52$ between an individual factor (knowledge) and behaviour is somewhat lower, as expected, because Abdul Latif et al.'s composite "practices" included various organizational supports (not just individual knowledge). Nonetheless, both studies highlight significant relationships and together signal that improving safety know-how and management in outdoor recreation is crucial to improving safety outcomes.

The limitations, despite the clear findings, this study has several limitations that should be acknowledged. First, the use of self-reported measures for safety practice may introduce some bias, such as social desirability bias. Participants might over-report positive safety behaviors because they know it's the "right" thing to do. We attempted to mitigate this by assuring anonymity and by including both compliance and participation items (where the latter are less obviously "required," possibly eliciting more honest variation). Even so, future research could complement self-reports with observational or supervisor-reported safety behavior data for validation. Second, the study is cross-sectional. This means we cannot definitively establish causality while it is logical that knowledge influences practice (and we theorized it as such), it is also possible that those who habitually practice safety more eventually acquire more knowledge (through experience). A longitudinal design, or an intervention study that measures safety behaviors before and after a knowledge training program, could strengthen causal inference. Third, our focus on the bivariate relationship

meant we did not include safety attitude or other variables in the model. This was intentional to align with the study objective, but it means we did not formally test the full KAP sequence. Follow-up studies incorporating attitude (and possibly perceived risk or safety climate) would provide a fuller picture of how these factors interplay in Malaysian outdoor recreation. Fourth, the generalizability of our sample might be limited to those who are relatively serious in the field (since many respondents were recruited via professional networks). Casual hobbyists or tourists who occasionally engage in outdoor recreation were not included, yet their knowledge and practices would also matter (e.g., a casual hiker's lack of knowledge could put them at risk). Thus, the current findings are most applicable to outdoor recreation providers or leaders rather than every participant.

Future Research should build on this study, future research avenues include, mediation and moderation analysis, incorporating safety attitude as a mediator between knowledge and practice to empirically test the KAP model in this context. Also, examining potential moderators – for example, does the knowledge–practice link hold equally for those with high vs. low management support? Does it differ by experience level or type of activity? (Perhaps knowledge is even more critical in technical activities like rock climbing than in less technical ones.) The Intervention Studies, Designing and evaluating training interventions in the Malaysian context. For instance, one could measure safety practices before and after a comprehensive training workshop to see if improvements line up with knowledge gains. The Link to Outcomes, Ultimately, we are concerned with accidents and injuries. Future studies could attempt to link staff knowledge and practices to actual incident rates at the organizational level. If data were available from outdoor companies on how many incidents they have, one could see if companies with better-trained staff (higher average knowledge) fewer incidents such multilevel research have would be very insightful for policy. Qualitative insights, Qualitative studies could complement our findings by exploring why some knowledgeable individuals might not practice safety (uncovering barriers like time pressure, or attitudes as we suspect), or conversely, how practitioners view the role of knowledge in their safety routine. Such insights could help fine-tune training content to address not just knowledge but also the application of knowledge.

Alignment with Standards and Guidelines, it is worth noting how our findings support existing safety frameworks. The Ministry of Higher Education's SOP for Outdoor Recreation (2017) and the efforts to create a national standard underscore training and competency. Our research validates that emphasis – it quantitatively demonstrates that competency (knowledge) is linked to safety performance (practice). It provides local empirical evidence to back the implementation of those SOP guidelines. For example, the SOP document specifies that activity leaders must brief participants on safety and conduct risk assessments our finding that knowledge leads to practice suggests that making sure leaders know how to do thorough briefings and risk assessments (and why they matter) will result in those practices being carried out consistently. It also supports the push for making the SOP a national standard since standardization would ensure a baseline level of knowledge across all operators.

Finally, our discussion would not be complete without reflecting on the goal, reducing accidents and ensuring enjoyable, safe outdoor experiences. As Malaysia looks to grow its adventure tourism sector (which includes popular activities like whitewater rafting in Gopeng, mountain climbing on Kinabalu, cave exploration in Gunung Mulu, etc.), safety will be a key determinant of sustainability and reputation. The tragic incidents in recent memory have shown what is at stake. This study contributes by highlighting a very actionable piece of the safety puzzle – educating and empowering the people on the front lines of outdoor activities. Knowledge can indeed save lives, but only if it is effectively translated into practice. Fortunately, our results suggest that in many cases, it is, those who know, do. The task ahead is to ensure everyone who leads or participates in these activities has the necessary knowledge, and the right conditions, to do the right thing when it counts.

CONCLUSIONS

In conclusion, this study provides empirical evidence that safety knowledge is a critical driver of safety practice in the context of Malaysia's outdoor recreation sector. We followed the standard IJRSS article structure to present a comprehensive analysis, from theoretical background to practical implications. Using a KAP model lens, we found that knowledgeable outdoor recreation practitioners are significantly more likely to engage in safe behaviors both in complying with essential safety procedures and in taking extra steps to

promote safety. This reinforces a foundational principle in safety management; informed people make safer choices.

The findings align with global research and standards yet are grounded in local context. They affirm the direction of current initiatives in Malaysia, such as formalizing safety SOPs and enhancing training for adventure tourism providers. For academics, the study adds to the literature by quantifying the knowledge–behavior relationship in adventure tourism, a field that has often relied on case studies and anecdotal evidence. For practitioners and policymakers, the message is clear – investing in safety knowledge is not just an academic exercise, but a practical necessity. Equipping outdoor leaders and participants with the right knowledge (and skills) should yield safer outdoor environments and reduce the likelihood of accidents that can mar the tourism industry’s reputation and, more importantly, cause harm to individuals. The study does not exist in isolation; it opens the door for further exploration. As highlighted, future research could incorporate attitudes, examine long-term impacts, and look at actual safety outcomes. Meanwhile, organizations would do well to treat this evidence as a call to action, review your training programs, ensure knowledge checks, encourage continuous learning, and create a culture where that knowledge is put into action every day. As the adage goes, “knowledge is power” study shows that in the realm of outdoor safety, knowledge is indeed the power to prevent accidents and save lives. Harnessing that power through education and practice will be the key to safer adventure experiences in Malaysia and beyond.

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