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OFFSHORE WORKFORCE DEVELOPMENT THROUGH IMMERSIVE VIRTUAL TRAINING: A PREDICTIVE ASSESSMENT OF TRAINING ENGAGEMENT AND SATISFACTION

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Abstract:

This study examines how immersive virtual training supports offshore workforce development by assessing the roles of Perceived Ease of Use, Perceived Enjoyment, and Training Engagement in predicting Training Satisfaction. The study focuses on the direct effects of Perceived Ease of Use and Training Engagement on Training Satisfaction, together with the mediating role of Training Engagement in translating ease of use and enjoyment into satisfactory training experiences. A quantitative cross-sectional survey was conducted among 154 new hires and personnel newly assigned to offshore installations in the Malaysian oil and gas sector. All respondents had participated in an offshore immersive virtual training programme before completing the questionnaire. The data were analysed using Partial Least Squares Structural Equation Modelling. The analysis included measurement model assessment, structural model assessment, mediation analysis, predictive relevance assessment, PLSpredict, and the Cross-Validated Predictive Ability Test. Perceived Ease of Use and Training Engagement had significant positive effects on Training Satisfaction, with Training Engagement emerging as the strongest direct predictor. Training Engagement also significantly mediated the relationship between Perceived Ease of Use and Training Satisfaction and the

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relationship between Perceived Enjoyment and Training Satisfaction. The model explained 49.1% of the variance in Training Engagement and 58.0% of the variance in Training Satisfaction. Predictive assessment further showed that the PLS model produced lower prediction losses than both the Indicator Average and Linear Model benchmarks. This study contributes to workforce development and training management literature by demonstrating that immersive training effectiveness depends not simply on positive perceptions of the technology but on trainees' active involvement in the learning process. It further strengthens the practical relevance of the model by establishing its out-of-sample predictive ability. The findings offer a management framework for designing user-friendly and engagement-oriented immersive training programmes for newly mobilised offshore personnel.

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Keyword:

Immersive Virtual Training; Offshore Safety Training; Safety Compliance; Virtual Reality Analytics; Workforce Readiness

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Introduction

Preparing employees for offshore oil and gas operations is a significant workforce-development challenge. Offshore installations are characterised by hazardous conditions, complex operational systems, strict safety procedures, and limited tolerance for human error. New hires and personnel newly assigned to offshore locations must therefore develop familiarity with platform layouts, operational routines, safety requirements, emergency procedures, and task expectations before entering the actual workplace. Therefore, offshore training must address the risks associated with human error and the need for effective safety preparation in hazardous industrial environments (Alkhaldi et al., 2017).

Traditional training approaches, including classroom instruction, written procedures, safety briefings, and limited site familiarisation, remain important for introducing technical information. Research on occupational safety training demonstrates that training delivery methods can influence learning effectiveness, highlighting the importance of experiential approaches in high-risk industrial environments (Burke et al., 2006). However, these methods cannot fully recreate the physical complexity, operational uncertainty, and potential hazards associated with offshore environments. Trainees may understand procedures in principle but still encounter difficulty applying them in realistic situations. Effective offshore preparation therefore requires learning experiences that connect procedural knowledge with practical decision-making and situational awareness.

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Immersive Virtual Training provides an alternative approach by placing trainees within interactive simulations that resemble actual offshore environments. Jensen and Konradsen (2018) identified the potential of head-mounted virtual reality systems to support realistic, interactive, and experiential learning, particularly in training contexts requiring practical knowledge and skill development. Through IVT, personnel can explore virtual platforms, identify hazards, practise operational procedures, and rehearse emergency responses without being exposed to real workplace risks. These features make immersive training especially relevant to workforce development because employees can gain preliminary experience before deployment.

Previous studies suggest that immersive environments can encourage active participation, increase learner attention, and improve knowledge processing by moving trainees beyond passive instruction (Makransky & Mayer, 2022). The Cognitive Affective Model of Immersive Learning also proposes that immersion influences learning through cognitive and affective processes associated with presence, interaction, and agency within virtual environments (Makransky & Petersen, 2021).

Nevertheless, investing in immersive technology does not automatically ensure an effective training programme. The usefulness of IVT depends on how trainees experience and interact with the system. A technically sophisticated simulation may still produce weak training outcomes when users find it difficult to operate or fail to engage meaningfully with its activities.

Training Satisfaction is therefore an important management indicator. It reflects trainees' evaluation of the quality, relevance, usefulness, and suitability of a training programme (Sanduvete-Chaves et al., 2013). Although satisfaction does not directly measure operational competence, it provides valuable feedback on whether employees believe that a programme supports their preparation and development. Low satisfaction may indicate problems with system usability, content relevance, facilitation, or programme delivery.

One factor that may shape this evaluation is Perceived Ease of Use, which refers to the degree to which a person believes that using a system requires minimal effort (Davis, 1989). In immersive training, trainees must operate the technology while simultaneously processing safety and operational information. When the interface or controls are difficult to understand, attention may shift away from the learning task. A system that is easy to use may therefore support a more favourable training evaluation.

Perceived Enjoyment may also contribute to the immersive training experience. Enjoyment refers to the extent to which using a system is perceived as intrinsically pleasant or interesting, independently of its expected performance benefits (Davis et al., 1992). Realistic environments and interactive scenarios may capture trainees' interest and encourage them to participate more actively. However, enjoyment may not automatically translate into satisfaction unless it leads to meaningful involvement in training activities.

Training Engagement is particularly important in this process. It represents trainees' cognitive, emotional, and behavioural involvement during learning activities (Fredricks et al., 2004). Engaged trainees are more likely to concentrate, participate, interact with scenarios, and invest effort in completing training tasks. In offshore IVT, active engagement may determine whether trainees experience the programme as relevant and worthwhile. Additionally, the integration of

artificial intelligence into immersive learning systems has begun to enable adaptive and personalised training experiences that respond to individual learner performance (Wazi, Karim, & Noor, 2024).

This study is guided by Social Cognitive Theory, which explains learning through reciprocal relationships among personal factors, behavioural processes, and environmental influences (Bandura, 1986). Within the present study, Perceived Ease of Use and Perceived Enjoyment represent personal perceptions of the immersive environment, while Training Engagement represents behavioural involvement. Training Satisfaction reflects trainees' overall evaluation of the training outcome.

Much of the existing literature assesses immersive training models through statistically significant relationships and explanatory power. However, a model that explains outcomes within one sample may not necessarily predict outcomes in new cases. For training managers, prediction is particularly important because predictive models may support early diagnosis, programme refinement, and evidence-based decisions regarding wider implementation.

Accordingly, this study examines the supported relationships among Perceived Ease of Use, Perceived Enjoyment, Training Engagement, and Training Satisfaction. It also evaluates the model's explanatory and out-of-sample predictive performance using PLSpredict and the Cross-Validated Predictive Ability Test.

Literature Review

Workforce development involves preparing employees with the knowledge, capabilities, confidence, and behavioural readiness needed to perform organisational roles effectively. In offshore operations, this preparation is especially demanding because personnel must operate in isolated and hazardous environments while complying with strict technical and safety requirements.

Immersive training can support workforce development by exposing employees to simulated operational conditions before actual deployment. Rather than learning only through descriptions or static materials, trainees can explore work environments, practise procedures, and respond to scenarios that resemble those encountered offshore. Radianti et al. (2020) demonstrated that immersive virtual reality offers opportunities to enhance educational experiences through interactive and experiential learning environments. Industry implementations of immersive technologies have also demonstrated significant improvements in organisational productivity and operational efficiency (Wazi et al., 2024). However, the effectiveness of such technologies depends on instructional design, learning conditions, and appropriate implementation strategies.

From a management perspective, the value of IVT lies in its ability to provide standardised and repeatable experiential learning. Training can be conducted without disrupting operational activities or exposing participants to actual hazards. However, the effectiveness of this approach depends on both the design of the technology and the behavioural response of the trainee.

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Social Cognitive Theory

Social Cognitive Theory proposes that human learning and behaviour are shaped by reciprocal interactions among personal characteristics, behaviour, and the surrounding environment (Bandura, 1986). Individuals learn through observation, practice, feedback, and repeated interaction with meaningful situations.

Immersive virtual environments align with these principles because they allow trainees to observe procedures, rehearse actions, receive feedback, and repeat tasks in simulated conditions. The virtual environment provides contextual exposure, but trainees' perceptions influence how they respond to it. These characteristics are consistent with Social Cognitive Theory, which explains learning and behavioural development through reciprocal interactions among personal factors, behavioural processes, and environmental influences (Bandura, 1986).

Perceived Ease of Use and Perceived Enjoyment represent personal evaluations of the technology. Training Engagement represents the behavioural process through which trainees invest attention and effort in the learning experience. Training Satisfaction represents an outcome reflecting their overall evaluation of the programme.

Perceived Ease of Use and Training Satisfaction

Perceived Ease of Use refers to the extent to which individuals believe that operating a technology will require little effort (Davis, 1989). In IVT, trainees must understand virtual interfaces, controls, navigation systems, and task instructions while also processing training content.

A difficult system may increase frustration and divert attention from safety or operational learning. In contrast, an intuitive system allows trainees to focus on the training tasks rather than the mechanics of operating the technology. This relationship is consistent with Davis (1989), who established Perceived Ease of Use as an important determinant of individuals' evaluations and acceptance of information technology. In immersive training environments, reducing technological complexity may allow trainees to concentrate more effectively on learning activities rather than system operation. Ease of use may therefore affect whether trainees evaluate the programme as effective, appropriate, and professionally designed.

Therefore, hypothesis 1 is derived; **H1: Perceived Ease of Use positively influences Training Satisfaction.**

Training Engagement and Training Satisfaction

Training Engagement refers to the cognitive, emotional, and behavioural investment demonstrated by trainees during learning activities (Fredricks et al., 2004). It includes sustained attention, active participation, effort, interest, and psychological involvement.

Immersive training depends on active interaction. Trainees are expected to move through scenarios, interpret information, complete tasks, and respond to simulated operational conditions. When trainees are genuinely engaged, they are more likely to understand the relevance of the content and perceive that the programme contributes to their preparation. Training Engagement encompasses cognitive, emotional, and behavioural dimensions of

involvement in learning activities (Fredricks et al., 2004). Similarly, Saks (2006) established that employee engagement is associated with important organisational and individual outcomes, providing a theoretical basis for examining engagement as a contributor to training satisfaction.

Research on employee and learning engagement suggests that active involvement is associated with more favourable individual outcomes (Saks, 2006; Saks & Gruman, 2018). Within offshore IVT, engaged trainees are therefore expected to report higher levels of Training Satisfaction.

Therefore, hypothesis 2 is derived; **H2: Training Engagement positively influences Training Satisfaction.**

Training Engagement as a mediator between Perceived Ease of Use and Training Satisfaction

Ease of use may influence satisfaction directly, but part of its effect may occur because a user-friendly system enables trainees to participate more fully. When trainees can navigate the environment without repeated technical difficulty, they can devote greater attention to learning tasks, decisions, and scenario-based activities.

Social Cognitive Theory supports this process because personal perceptions can shape behavioural involvement, which subsequently influences outcomes. A system perceived as easy to use may reduce barriers to participation, strengthen engagement, and ultimately improve satisfaction. From a methodological perspective, mediation analysis is necessary to determine whether the influence of an independent variable on an outcome is transmitted through an intervening variable. Preacher and Hayes (2008) emphasised the importance of evaluating indirect effects using resampling procedures rather than relying exclusively on individual direct relationships.

Therefore, hypothesis 3 is derived; **H3: Training Engagement mediates the relationship between Perceived Ease of Use and Training Satisfaction.**

Training Engagement as a mediator between Perceived Enjoyment and Training Satisfaction

Perceived Enjoyment refers to the intrinsic pleasure associated with using a technology (Davis et al., 1992). In immersive training, enjoyment may be created through realism, exploration, interaction, and active participation.

However, enjoyment alone may not be sufficient to produce a satisfactory training experience. For offshore personnel, training is expected to provide practical and work-relevant preparation. The value of enjoyment may therefore depend on whether it encourages sustained attention and participation.

Enjoyable immersive experiences may motivate trainees to interact with scenarios, complete tasks, and remain involved in the learning process. This greater engagement may subsequently lead trainees to evaluate the training more positively. Davis et al. (1992) demonstrated the relevance of intrinsic motivation in technology use, suggesting that enjoyment can contribute

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to individuals' willingness to interact with technological systems. Within immersive training environments, this theoretical perspective provides a rationale for examining whether enjoyable learning experiences encourage greater engagement, which may subsequently contribute to training satisfaction.

Therefore, hypothesis 4 is derived; **H4: Training Engagement mediates the relationship between Perceived Enjoyment and Training Satisfaction.**

The proposed framework includes one direct path from Perceived Ease of Use to Training Satisfaction, one direct path from Training Engagement to Training Satisfaction, and two indirect pathways through Training Engagement is shown in Figure 1: Predictive Framework for Offshore Workforce Development through Immersive Virtual Training.

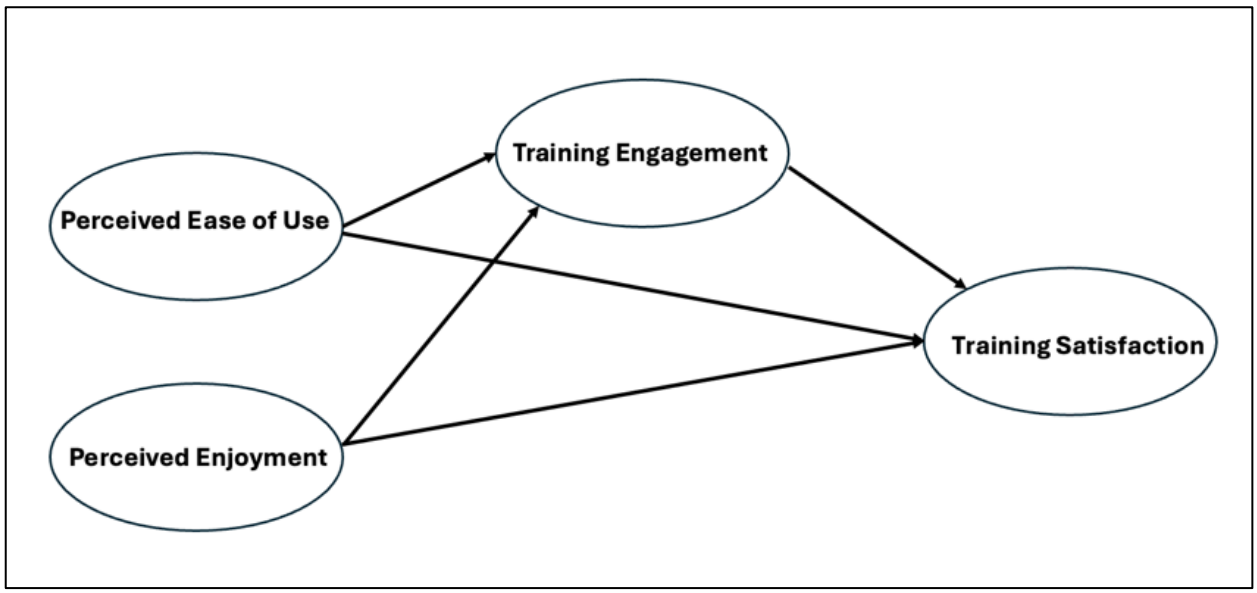

Figure 1: Predictive Framework for Offshore Workforce Development through Immersive Virtual Training

Methodology

Research Design

This study adopted a quantitative cross-sectional survey design. The quantitative research approach is consistent with Creswell and Creswell (2018), who explain that quantitative designs provide a systematic framework for examining relationships among measurable variables and evaluating theoretically derived hypotheses. However, the cross-sectional nature of the present study limits causal interpretation. The approach was suitable because the research examined relationships among latent constructs and assessed both explanatory and predictive model performance.

The survey was administered after respondents had participated in an offshore immersive virtual training programme. This allowed participants to evaluate the system and their level of engagement based on direct training experience.

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Population And Sample

The target population consisted of new hires and personnel newly assigned to offshore installations in the Malaysian oil and gas sector. Purposive sampling was employed because respondents were required to have participated in the relevant IVT programme.

A total of 157 questionnaires were distributed electronically. Following data screening, 154 usable responses were retained, representing a response rate of 98.1%. The individual trainee was the unit of analysis.

Research instrument

The research instrument was a structured self-administered questionnaire. The first section collected demographic information, including gender, age, educational background, offshore experience, and job category.

The second section measured Perceived Ease of Use, Perceived Enjoyment, Training Engagement, and Training Satisfaction. The measurement items were adapted from established literature. Perceived Ease of Use was adapted from Davis (1989), while Perceived Enjoyment was informed by Davis et al. (1992). Training Engagement was adapted from Fredricks et al. (2004), Saks (2006), and Saks and Gruman (2018). Training Satisfaction was measured using items adapted from Sanduvete-Chaves et al. (2013). Training Satisfaction was operationalised with reference to the Training Satisfaction Questionnaire developed and examined by Sanduvete-Chaves et al. (2013), which provides an established foundation for assessing participants' evaluations of training experiences.

All items were measured using a seven-point Likert scale ranging from 1, strongly disagree, to 7, strongly agree.

Before the main study, the questionnaire underwent expert review, pre-testing, and pilot testing to assess content relevance, clarity, and contextual suitability.

Data Analysis

SPSS was used for preliminary data screening and descriptive analysis. SmartPLS 4 was used to assess the measurement and structural models.

The measurement model was evaluated through indicator loadings, Cronbach's alpha, composite reliability, average variance extracted, the Fornell–Larcker criterion, cross-loadings, and the heterotrait–monotrait ratio. The evaluation procedures followed established recommendations for Partial Least Squares Structural Equation Modelling (PLS-SEM), including the assessment of internal consistency reliability, convergent validity, and discriminant validity (Hair et al., 2022). Discriminant validity was additionally evaluated using the heterotrait–monotrait ratio, as proposed by Henseler et al. (2015).

The structural model was assessed using variance inflation factors, coefficient of determination, effect sizes, predictive relevance, path coefficients, and mediation analysis. Bootstrapping with 10,000 resamples was used to determine the significance of the direct and indirect relationships. The statistical significance of indirect effects was evaluated using

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bootstrapping procedures, consistent with the resampling-based approach to mediation analysis recommended by Preacher and Hayes (2008).

PLSpredict and CVPAT were used to assess out-of-sample predictive performance. The predictive losses generated by the PLS model were compared with the Indicator Average and Linear Model benchmarks. Out-of-sample predictive performance was assessed in accordance with Shmueli et al. (2019), who established guidelines for evaluating predictive performance in PLS-SEM using PLSpredict. The Cross-Validated Predictive Ability Test was further employed following Liengaard et al. (2021) to compare the predictive performance of the PLS model against relevant benchmark models.

Results

Respondent Profile

Among the 154 respondents, 76.6% were male and 23.4% were female. The largest age category was 36–45 years, representing 42.2% of the sample, followed by respondents aged 26–35 years at 39.6%.

Most respondents held bachelor's degrees, while 42.9% reported more than one year of offshore experience. The sample was almost evenly distributed between new hires and personnel preparing for their first offshore assignment. New hires represented 50.6% of the respondents, while first-time offshore assignees represented 49.4%.

Measurement Model Assessment

The measurement model demonstrated satisfactory internal consistency and convergent validity. Indicator loadings were generally above 0.70, with one Training Satisfaction item retained at 0.691. Cronbach's alpha values ranged from 0.731 to 0.921, composite reliability values ranged from 0.847 to 0.933, and average variance extracted values ranged from 0.536 to 0.653 as shown Table 1: Measurement Model Assessment.

Table 1: Measurement Model Assessment

Construct	Loading range	Cronbach's alpha	Composite reliability	AVE
Perceived Enjoyment	0.795–0.811	0.731	0.847	0.649
Perceived Ease of Use	0.725–0.848	0.813	0.876	0.640
Training Engagement	0.759–0.808	0.835	0.884	0.603
Training Satisfaction	0.691–0.768	0.921	0.933	0.536

Discriminant validity was established using the Fornell–Larcker criterion and HTMT. The square root of the AVE for each construct exceeded the relevant inter-construct correlations. The HTMT values for the constructs retained in the model were below the recommended threshold of 0.90.

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Direct Effects

Perceived Ease of Use had a significant positive effect on Training Satisfaction. This indicates that trainees reported greater satisfaction when they perceived the immersive training system as straightforward and easy to operate.

Training Engagement also had a significant positive effect on Training Satisfaction and emerged as the strongest direct predictor. This result suggests that active cognitive, emotional, and behavioural involvement is central to trainees' evaluations of immersive training.

Table 2. Supported Direct Hypotheses

Hypothesis	Relationship	Result
H1	Perceived Ease of Use → Training Satisfaction	Supported
H2	Training Engagement → Training Satisfaction	Supported

Mediation Effects

Training Engagement significantly mediated the relationship between Perceived Ease of Use and Training Satisfaction. The indirect effect was $\beta = 0.153$, with a t-value of 2.954 and a p-value of 0.002.

Training Engagement also significantly mediated the relationship between Perceived Enjoyment and Training Satisfaction. The indirect effect was $\beta = 0.234$, with a t-value of 3.443 and a p-value below 0.001.

Table 3. Supported Mediation Hypotheses

Hypothesis	Indirect relationship	β	t-value	p-value	Result
H3	PEOU → TE → TS	0.153	2.954	0.002	Supported
H4	PE → TE → TS	0.234	3.443	<0.001	Supported

The results show that ease of use contributes to satisfaction both directly and through engagement. Enjoyment, by contrast, contributes to satisfaction through engagement rather than as an independent direct predictor.

Explanatory Power And Predictive Relevance

The model explained 49.1% of the variance in Training Engagement and 58.0% of the variance in Training Satisfaction. These values demonstrate moderate explanatory power.
The Q^2 values were 0.453 for Training Engagement and 0.410 for Training Satisfaction. Both values were greater than zero, confirming predictive relevance.

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Table 4. Explanatory Power and Predictive Relevance

Endogenous construct	R^2	Q^2
Training Engagement	0.491	0.453
Training Satisfaction	0.580	0.410

Training Engagement produced the strongest effect on Training Satisfaction, with an f^2 value of 0.295. Perceived Ease of Use had an f^2 value of 0.099. For Training Engagement, Perceived Enjoyment produced an f^2 value of 0.239, while Perceived Ease of Use produced an f^2 value of 0.122.

Table 5. Effect Sizes for Supported Relationships

Relationship	f^2
Perceived Enjoyment → Training Engagement	0.239
Perceived Ease of Use → Training Engagement	0.122
Perceived Ease of Use → Training Satisfaction	0.099
Training Engagement → Training Satisfaction	0.295

Predictive Performance

The CVPAT results showed that the PLS model produced lower prediction losses than the Indicator Average benchmark for Training Engagement, Training Satisfaction, and the complete model. The differences were statistically significant.

The PLS model also produced significantly lower prediction losses than the Linear Model benchmark. Although the differences were smaller, they remained significant for both endogenous constructs and the overall model.

Table 6. Cross-Validated Predictive Ability Test Results

Benchmark	Construct	PLS loss	Benchmark loss	Mean difference	t-value	p-value
Indicator Average	Training Engagement	0.289	0.395	−0.106	3.986	<0.001
Indicator Average	Training Satisfaction	0.336	0.427	−0.092	3.319	0.001
Indicator Average	Overall model	0.322	0.418	−0.096	3.708	<0.001
Linear Model	Training Engagement	0.289	0.310	−0.021	2.376	0.019
Linear Model	Training Satisfaction	0.336	0.352	−0.017	2.007	0.046
Linear Model	Overall model	0.322	0.340	−0.018	2.623	0.010

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The negative mean differences indicate that the PLS model generated lower predictive loss than the two benchmarks. These findings confirm that the model has practical predictive capability beyond the original estimation sample.

Discussion

Perceived Ease of Use and Training Satisfaction

Research on employee and learning engagement suggests that active involvement is associated with more favourable individual outcomes (Saks, 2006; Saks & Gruman, 2018). Within offshore IVT, engaged trainees are therefore expected to report higher levels of Training Satisfaction.

Perceived Ease of Use significantly influenced Training Satisfaction. Trainees were more likely to evaluate the programme favourably when the immersive system was straightforward and required limited effort to operate.

This finding is particularly relevant in offshore workforce development because participants may differ in their familiarity with virtual technologies. When trainees struggle with controls, navigation, or system instructions, their attention may be diverted from safety and operational content. Usability therefore becomes part of the learning experience rather than merely a technical feature.

For management, the finding suggests that IVT implementation should include intuitive interfaces, clear instructions, structured tutorials, and adequate technical orientation. Improving ease of use can directly strengthen satisfaction while also making it easier for trainees to become actively involved.

Training Engagement and Training Satisfaction

Training Engagement was the strongest direct predictor of Training Satisfaction. This suggests that trainees evaluate immersive training most positively when they are actively involved in the learning process.

The result supports the view that the value of immersive training lies in meaningful interaction rather than visual realism alone. Trainees are more likely to recognise the programme's usefulness when they participate in scenarios, make decisions, practise procedures, and receive feedback. In workforce-development terms, engagement reflects whether trainees are psychologically and behaviourally invested in the programme. Training managers should therefore evaluate not only attendance or completion but also the quality of participation during IVT.

The importance of meaningful learning processes is consistent with immersive learning research, which emphasises the influence of cognitive and affective mechanisms on learning experiences (Makransky & Mayer, 2022; Makransky & Petersen, 2021). From an organisational perspective, Saks and Gruman (2018) further highlighted the relevance of engagement and socialisation resources for newly appointed employees. Together, these perspectives provide a theoretical basis for understanding why trainees' active involvement may be important in shaping their evaluations of immersive training programmes.

The Mediating Role of Training Engagement Between Ease of Use and Satisfaction

Training Engagement significantly mediated the relationship between Perceived Ease of Use and Training Satisfaction. This indicates that ease of use contributes to satisfaction partly because it allows trainees to become more involved in the learning activities.

A user-friendly system removes barriers that might otherwise interrupt participation. When trainees can operate the environment confidently, they can focus on tasks, procedures, and situational information. This deeper involvement subsequently improves their evaluation of the programme.

The finding demonstrates that usability should not be managed separately from engagement. Technical design influences behavioural participation, which in turn shapes satisfaction.

The Mediating Role of Training Engagement Between Enjoyment and Satisfaction

Training Engagement also mediated the relationship between Perceived Enjoyment and Training Satisfaction. This finding clarifies the role of enjoyment within offshore training.

Enjoyment is valuable when it encourages trainees to remain attentive, explore scenarios, and participate actively. However, enjoyment should not become the final objective of the programme. An immersive environment may be visually appealing or entertaining without contributing to operational preparation.

The results show that enjoyment becomes meaningful when it is converted into engagement. Training designers should therefore use realism, interaction, and challenge to support active learning rather than simply to create novelty.

Predictive Performance

The model demonstrated satisfactory explanatory and predictive performance. It explained 49.1% of Training Engagement and 58.0% of Training Satisfaction, while the Q^2 values confirmed predictive relevance.

More importantly, the model significantly outperformed the Indicator Average and Linear Model benchmarks. This indicates that the proposed relationships are not limited to explaining the original sample. They also provide useful out-of-sample predictions.

For management research, this distinction is important. Statistical significance shows whether relationships exist, while predictive assessment indicates whether the model may be useful when evaluating future trainees or training cohorts.

Managerial Implications

The findings offer several implications for organisations managing immersive training programmes.

First, ease of use should be treated as a strategic training-design requirement. Organisations should invest in clear interfaces, intuitive controls, guided tutorials, visible instructions, and

responsive technical support. Technical difficulty can interfere with learning and reduce satisfaction. Previous research has examined the application of virtual reality training for offshore workers, highlighting its relevance to workforce skills development in industrial environments (Sulaiman et al., 2020). The present study extends this research direction by focusing on the experiential and behavioural factors associated with Training Satisfaction, providing a management-oriented perspective on the design and evaluation of immersive training programmes for offshore personnel.

Second, training managers should prioritise active engagement. Offshore IVT should require trainees to identify hazards, navigate work areas, complete procedures, make decisions, and respond to simulated situations. Passive observation is unlikely to generate the same level of involvement.

Third, enjoyment should be designed to support the training purpose. Realism, interaction, feedback, and scenario-based challenges can make learning more interesting, but these features should always remain connected to operational objectives.

Fourth, organisations should include ease of use, engagement, and satisfaction in post-training evaluation systems. These measures can help identify weaknesses in programme design and guide decisions regarding improvement or wider implementation.

Fifth, the model can serve as an early diagnostic tool. Low ease-of-use scores may indicate that trainees require additional system orientation. Low engagement scores may signal that scenarios lack relevance, interaction, challenge, or effective facilitation.

Finally, Training Satisfaction should not be treated as a substitute for workforce competence. It should be combined with knowledge testing, performance evaluation, supervisor feedback, safety behaviour, and practical competency assessment.

Theoretical Implications

The study extends Social Cognitive Theory by demonstrating that personal perceptions influence outcomes through different pathways in immersive training.

Perceived Ease of Use influences Training Satisfaction directly and indirectly through Training Engagement. Perceived Enjoyment influences satisfaction through engagement. This distinction shows that personal perceptions do not automatically produce favourable outcomes. Their value depends partly on whether they generate meaningful behavioural involvement.

The findings also reinforce the central role of engagement as the behavioural process linking trainees' experiences with their evaluation of the programme. In offshore IVT, behavioural investment appears to be more important than favourable perceptions alone.

Methodologically, the study contributes by combining structural explanation, mediation testing, and out-of-sample predictive assessment. The use of PLSpredict and CVPAT provides stronger evidence of practical model usefulness than reliance on path significance and R^2 alone.

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Limitations and Future Research

The study has several limitations. First, the cross-sectional design limits conclusions about changes in perceptions, engagement, and satisfaction over time.

Second, the study used Training Satisfaction as a training outcome. Satisfaction is an important management indicator, but it does not directly measure operational competence or workforce readiness.

Future studies should connect the model with knowledge retention, hazard-recognition performance, procedural accuracy, task completion, safety behaviour, and supervisor evaluations.

Third, the study was conducted in one national offshore context. Replication in other organisations, countries, and safety-critical industries would improve the generalisability of the findings.

Fourth, the study relied primarily on self-reported responses. Future research could incorporate system-generated behavioural data, including task time, error rates, repetitions, decision accuracy, and interaction records.

Finally, future studies may use longitudinal or experimental designs to determine whether engagement and satisfaction predict later workplace performance and operational preparedness.

Conclusion

This study demonstrates that analytics-supported immersive VR training can provide a practical and scalable approach for improving offshore readiness among new personnel. The system combined a realistic offshore platform simulation, structured learning modules, safety route familiarisation, equipment labelling, and a mobile analytics dashboard.

The PLS-SEM results showed that Safety Compliance was the strongest predictor of IVT effectiveness, followed by Platform Familiarity and Operational Readiness. The pilot study showed high levels of task familiarity and perceived productivity after VR exposure, while participants completed emergency escape tasks below the required three-minute threshold. User feedback also indicated that the system was intuitive, stable, immersive, and suitable for further training deployment.

Overall, the study supports the use of immersive VR and analytics as a data-driven training approach for offshore oil and gas operations. The findings contribute to the development of safer, more interactive, and performance-oriented training systems for high-risk industrial environments.

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