

AUGMENTED REALITY VS. MONETARY REWARDS: WHICH DRIVES PRO-ENVIRONMENTAL BEHAVIOR MORE EFFECTIVELY AMONG THE INDONESIAN WORKFORCE?

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Abstract. *Purpose* – This study examines how augmented reality-based green training influences pro-environmental behavior among employees in Greater Jakarta, Indonesia. It also examines the role of green commitment in shaping employees' environmentally responsible actions. In addition, the study investigates whether green financial rewards moderate these relationships. The analysis focuses on how intrinsic and extrinsic motivations interact to influence sustainable behavior in the workplace.

Research methodology – A cross-sectional quantitative survey was conducted among 200 employees in Greater Jakarta using convenience sampling. Structural equation modeling with partial least squares was used to test the hypothesized relationships and moderating effects among the variables.

Findings – The findings show that AR-based green training has a significant positive effect on employees' pro-environmental behavior. Green commitment also has a significant positive effect on pro-environmental behavior. Green financial rewards do not significantly moderate these relationships. The negative interaction coefficients suggest a possible crowding out effect. This implies that in practice, external motivators may dampen the effect of internal motivators, such as training and employee engagement.

Research limitations – The design of this study is cross-sectional, and this restricts the ability to conduct causal analysis. The population studied can only comprise employees within greater Jakarta, and this might restrict the overall ability to generalize findings. Future research focuses on studying changes over longer periods through various designs that can aid in observations over time. Results can also gain more external validity if more demographical samples get studied.

Practical implications – Implementation of organizational measures to increase the qualifications and sustainability-oriented working culture could provide the greatest benefits for the organizations. Moreover, incorporating augmented reality learning into the organizational operations could contribute to this goal. In addition, values associated with sustainability must be embedded into the organizational operations through persistent organizational communications and role-modeling by the leadership. It can be observed from the outcome measurements that the financial incentives are less effective or sometimes even decrease the internal motivation associated with pro-environmental behavior.

Originality/Value – The research adds to the topic of sustainability studies by focusing on the use of augmented reality as a novel approach to environmental education. The work also supplies empirical evidence concerning the boundary conditions of the Motivation Crowding Theory within a workplace sustainability setting.

Keywords: pro-environmental behavior, green commitment, green training, monetary reward, augmented reality.

JEL Classification: M14, Q56, M53.

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1. Introduction

Fossil fuels are costly to extract and consume, generate substantial carbon emissions, and contribute to hazardous pollution (Portillo et al., 2024). In contrast, renewable energy sources are more readily available, environmentally sustainable, and capable of substituting fossil fuels in heating, electricity generation, and transportation systems (Portillo et al., 2024).

Many organizations adopt sustainability practices not only as a reflection of ethical responsibility but also because of their potential financial benefits (Sarraz et al., 2023). These kinds of practices have been shown to improve the performance of organizations while also helping to protect the environment and people's health (Madero-Gómez et al., 2023). Sustainability-focused organizations include environmental, social, and economic goals into their comprehensive strategic frameworks (Gomes et al., 2023).

Many of these strategies are in line with the United Nations Sustainable Development Goal 13, which is about taking action on climate change (Espín & Zabaleta, 2025). For sustainability to happen, policies need to work together, and the SDGs need to be part of business planning (de Almeida Barbosa Franco et al., 2024). Effective sustainability programs encourage employees to adopt pro-environmental behavior in the workplace (Rashid et al., 2024).

Promoting Pro-Environmental Behavior (PEB) requires education and training (Algurén, 2025). The Theory of Planned Behavior (TPB) explains pro-environmental behavior. It supports pro-environmental behavior by explaining why people choose to act in environmentally friendly ways (Batool et al., 2024). The theory of planned behavior describes how attitudes, social norms, and perceived competence influence environmental behaviors (Batool et al., 2024). This insight can assist educators, policymakers, and organizations in designing initiatives that promote environmentally responsible behavior (Algurén, 2025; Widiyanto et al., 2021).

The Theory of Planned Behavior (TPB) is widely used to explain pro-environmental behavior by linking attitudes, social norms, and perceived behavioral control to behavioral intentions (Zulkepli et al., 2024). Past studies indicate that individuals are more likely to perform pro-environmental behaviors when they feel capable of doing so (Arya & Chaturvedi, 2020; Wang & Mangmeechai, 2021). These factors collectively lead to behavioral intentions, which are themselves set up as significant predictors of actual pro-environmental behavior in fields such as education, tourism, and agriculture (Batool et al., 2024; Savari et al., 2023). The general view from the literature supports TPB as a coherent and useful framework for explaining and promoting pro-environmental behavior but especially when it is extended by moral norms and personal values (Ateş, 2020; Ekasari & Zaini, 2020).

Green training allows employees to learn more about the need to conserve the environment and adopt environmentally responsible behavior within the workplace (Mohamad et al., 2024). This type of training highlights the need to integrate the value of the environment within the workplace by wisely utilizing resources and minimizing wastage, among other aspects of the environment (Usman et al., 2023). This green training helps organizations to attain their sustainability goals as it persuades individuals to undertake behaviors that demonstrate alignment with broader environmental approaches (Yafi et al., 2021). This occurs as employees continue to learn and apply the green practices within the workplace (Olaiya & Olaosebikan, 2022).

The use of Augmented Reality (AR) technology can also improve green learning by providing environmental information through visual and interactive means that can further improve the learner's understanding of sustainability concepts and their importance (Khrais, 2025). The use of AR technology enables the provision of digital information that can be projected over real-life environments, which improves awareness and situational understanding that enables the learner to view the environmental outcomes of their actions (Negi, 2024; Simon et al., 2025).

This type of learning, which involves doing things, makes green training more effective than learning by watching (Ebinger et al., 2022; Mulders et al., 2025).

Augmented reality technology enables green learning by overlaying relevant data over real-world spaces where the learning occurs (Ebinger et al., 2022; Simon et al., 2025). This way, the learner can see the effects of their actual activities, such as the usage of energy and wastage of resources (Kee & Zhang, 2022). Augmented reality technologies translate non-practical notions about the environment to valuable data by connecting the subject to the real world (Khrais, 2025).

Supporting the green education or training process, augmented reality enables users to demonstrate how to perform activities for the betterment of the environment (Khrais, 2025). This enables the learners to perform activities such as energy or waste management in a lesser incorrect manner (Negi, 2024). Environmental knowledge and development of skills are increased through continued training in a simulated environment (Mulders et al., 2025).

AR improves the learning process as it allows the learner to work with real-life situations rather than just learning through reading (Cho & Park, 2023). This increased interaction is associated with increased awareness and retention of sustainable practices (Mulders & Träg, 2023). The use of AR ensures that the learner will apply the learning process to real life (Geriş et al., 2024).

Furthermore, AR reinforces environmentally positive behavior by demonstrating how each act can immediately impact the environment (Latini et al., 2025). By recognizing this, participants will understand that they are more accountable and informed because now they know how their decisions affect the environment (Mulders et al., 2025), which will ultimately lead to greater changes being implemented by participants (Wang & Mangmeechai, 2021).

Finally, AR supports the learner in all their activities and work tasks, and it provides feedback and guidance (Holuša et al., 2023). This is the sort of support that helps good actions towards the environment become habits (Mulders & Träg, 2023). This is the manner by which AR helps connect green training, as it leads to good behavior (Simon et al., 2025).

Motivation crowding theory describes the effects of external rewards or controls on people's intrinsic motivation to engage in environment-enhancing behavior. In this view, individuals demonstrate sympathy for nature and act within their social responsibilities due to personal values that entail intrinsic motivations (Graafland & Bovenberg, 2020). In this case, external instruments such as profit-sharing incentives, monitoring, or strict regulation have the effect of weakening the intrinsic motivations of people to act (Marsiglio & Tolotti, 2020). In this respect, the occurrence of such effects is referred to as the motivation crowding out process, where people demonstrate behavior primarily to gain rewards rather than their own values, and will quit those practices as soon as the reward disappears (Odhiambo et al., 2023a).

The motivation crowding theory helps us understand why some workplace environmental programs work, and others do not. People who already care about the environment may feel less personally responsible when environmental actions are framed as paid tasks or compliance requirements (Graafland & de Bakker, 2021).

Consequently, pro-environmental behaviors like recycling, energy saving, and waste reduction can become less effective or sustainable over time (Saeed et al., 2019). However, the concept of motivation crowding also accounts for the potential crowding-in effect. When rewards are aligned to autonomous support, expressions of appreciation, and group environmental values, they have the potential to enhance intrinsic motivation rather than crowd it out (Lliso et al., 2022).

For example, moderate financial incentives, together with clearly stated environmental objectives and social recognition, are successful in increasing the commitment of the workforce towards environmentally responsible actions (Odhiambo et al., 2023a). Motivation crowding theory states that “Organizations face challenges while designing their environmental policies, as these policies can adversely affect intrinsic motivation among the organization’s workforce”. When incentives are aligned with the values of the organization’s workforce, as opposed to crowding out their intrinsic incentives and encouraging only financial ones, environmentally positive actions can more easily become stable and consistent (Saeed et al., 2019).

A large number of research studies have linked environmental training to pro-environmental behavior. However, the use of augmented reality in green training and the contribution of such trainings to the development of SDG 13 have not yet been explored extensively. The effect of green financial rewards, together with the use of technology-mediated interventions, is also not depicted clearly. The proposed work will address all these aspects, as it will help us better understand pro-environmental behaviors that are consistent with SDG 13.3, which highlights education related to climate change. The findings indicate that employee engagement and green training enhance pro-environmental behaviors, which can be altered by financial rewards. Therefore, this study examined the following research questions:

- Does AR-based green training influence the PEB of employees in Greater Jakarta?
- What is the impact of green commitment on PEB in Indonesian workplaces?
- Does a green financial reward influence both PEB and green commitment?
- What is the effect of providing a financial reward for green actions on the effectiveness of AR-driven green training in promoting PEB?

2. Hypothesis development

2.1. The relationship between AR green training and PEB

Augmented Reality (AR) superimposes digital information on real-world situations. AR increases the fun of learning environmentally friendly behaviors and ecological practices (Simon et al., 2025). AR represents a valuable tool in educating and instilling in people environmental problems and why it is important for them to apply environmentally friendly practices (Khrais, 2025). AR enables an interactive learning procedure that enables people to understand ecological knowledge. It was found that learning with Augmented Reality (AR) improves students’ knowledge of ecology and flood disaster preparedness (Ladykova et al., 2024; Şimşek, 2024).

AR helps make complex environmental information easier to interpret by illustrating it with clear visuals. AR can also enable an individual to realize the effects their activities have on the surrounding environment and gain an understanding of the world's environments through their own experiences (Mulders et al., 2025; Simon et al., 2025). By allowing them to observe immediate outcomes based on their own choices, the individual becomes motivated to make sustainable choices. By utilizing AR, students can interact with their learning materials and classmates; this allows them to become more engaged with sustainability issues and topics (Sahib & Waahib, 2024; Valladares Ríos et al., 2023).

Research shows that AR improves environmental education for learners of different ages. Ozturk found that primary school students who used AR had greater environmental awareness and more positive attitudes toward nature conservation (Ozturk & Akcay, 2023). This finding indicates that augmented reality can be effective in various educational contexts for enhancing sustainability awareness. AR also supports sustainability in places beyond learning institutions, such as preserving cultural heritage. Museums are applying AR to make museum visits more enjoyable and to help conserve cultural heritage. This example reveals how versatile this technology can be to aid in sustainability objectives (Ariza-Colpas et al., 2024).

Scientific evidence indicates that environmental training enhances recycling and environmental activity engagement (Ahuja et al., 2023; Mulders & Träg, 2023). Environmental training has a stronger effect on voluntary pro-environmental behavior than on other types of behavior (Donmez-Turan & Kiliclar, 2021). This effect is influenced by environmental knowledge, which helps explain how training leads to pro-environmental behavior (Mansoor & Wijaksana, 2023; Xie & Lu, 2022).

Sharing environmental knowledge further increases awareness and encourages pro-environmental behavior. Environmental attitudes and intentions affect how environmental commitment leads to pro-environmental behavior, showing their important role (Liu et al., 2020). Effective interventions should focus on building environmental knowledge and values to support sustainable behavior (Liu et al., 2020).

Many studies agree that green training improves pro-environmental behavior. Green training has been shown to improve environmental performance and workplace sustainability (Thevanes & Arulrajah, 2020). Green training in universities benefits students and supports sustainable practices (Odhiambo et al., 2023b). Green training also improves skills and motivation related to environmental performance, which supports pro-environmental behavior (Usman et al., 2023). Overall, these findings show that green training increases environmental awareness in both workplaces and educational settings. Based on these results, this study proposes the following hypothesis:

H1: *AR green training significantly encourages pro-environmental behavior.*

2.2. The relationship between green commitment and PEB

Research shows that employee sustainability behavior is influenced by how workers perceive Corporate Social Responsibility (CSR) (de Almeida Barbosa Franco et al., 2024). Perceived CSR increases moral awareness, support from coworkers for environmental actions, green commitment, and pro-environmental behavior found that green commitment, environmental awareness, lifestyle, and self-efficacy influence pro-environmental behavior among Ma-

Malaysian students. According to Foster et al. (2022), Malaysian students' pro-environmental behavior is affected by their green commitment, environmental awareness, lifestyle, and self-efficacy. Their findings demonstrate the significance of attitudes and behavior in promoting environmental sustainability. Other studies have mostly focused on leaders' environmental commitment, sustainable human resource management, corporate social responsibility, and pro-environmental behaviors (Saeed et al., 2019). However, the direct relationship between individual green commitment and pro-environmental behavior has received limited attention. To address this gap, this study proposes a new research hypothesis that examines this relationship. Therefore, this study proposes the following hypothesis:

H2: *Green commitment significantly encourages pro-environmental behaviour.*

2.3. The moderating effect of green monetary reward on the relationship between green commitment and PEB

This study aims to explain how green reward systems motivate employees to follow and commit to environmental standards (Hameed et al., 2022). It also examines how rewards linked to environmental management influence both internal and external motivation to support pro-environmental behavior (Kim & Lee, 2022). This study examines the moderation role of green self-efficacy between green commitment and pro-environmental behavior (Muhammad Ali & Nisar, 2023). This study reveals the impact of green human resource management on the way workers feel when they act environmentally friendly (Hayyat et al., 2023).

It is also important to note how leaders can help create a supportive green behavioral climate (Saleem et al., 2021). Studies indicate that financial incentives can significantly impact pro-social behavior, potentially extending to pro-environmental actions as well (Alt & Gallier, 2021). However, some evidence suggests that financial rewards can undermine the effectiveness of actions for the environment and can extinguish intrinsic motivation (Graafland & de Bakker, 2021; Steinhorst & Klöckner, 2018). This research suggests that financial rewards can have a negative or unclear impact on actions that benefit the environment.

Current research does not explain the impact of monetary incentives on the correlation between environmental commitment and pro-environmental behavior. To bridge the research gap, a new hypothesis was developed for the current research to analyze the effect of money on the relationship between green commitment and green behavior:

H3: *Green monetary rewards significantly moderate the relationship between green commitment and PEB.*

2.4. The moderating effect of green monetary reward on the relationship between AR green training and PEB

Several studies explored the influence of monetary incentives on the correlation between green training and pro-environmental behavior. Some studies show that combining strict environmental targets with monetary incentives can reduce the success of emissions reduction efforts (Onabowale, 2025). Other studies suggest that monetary rewards can motivate employees to use what they learn in green training and turn it into pro-environmental actions (Saleem et al., 2021). Some researchers, on the other hand, argue that giving individuals

financial rewards for doing things that are beneficial for the environment may make them less motivated to do so (Sharpe et al., 2022; Steinhorst & Klöckner, 2018).

In these situations, workers might care more about money than about being responsible for the environment. This change can make people less likely to remain committed in the long term, especially if rewards are removed. While monetary rewards may work in the short term, they can reduce internal environmental motivation if not carefully designed (Silvi & Padilla, 2021; Steinhorst & Klöckner, 2018).

Scholars emphasize the importance of well-considered environmental target design to avoid negative results (Graafland & de Bakker, 2021; Odhiambo et al., 2023a). The present study does not illustrate the impact of monetary reward on the association between green training and environmentally positive behavior. The new hypothesis and framework are presented in the existing findings (Figure 1) to fill the gap in the current literature:

H4: *Green monetary rewards significantly moderate the relationship between green training and PEB.*

3. Research methodology

3.1. Research design and methodological approaches

The research employed a cross-sectional survey to examine the relationship between AR-based green training and other variables, such as green commitment, green rewards, and eco-friendly behaviors exhibited by employees in the Greater Jakarta area, Indonesia.

The hypotheses were tested using Structural Equation Modeling with PLS as the methodology, grounded in predetermined theories. This was based on the reasons that PLSSSEM is apt for handling complicated models that may consist of latent constructs and moderation/mediation hypotheses (Ghozali, 2021; Sarstedt et al., 2014). This was also apt for this study as it was more exploratory and intended to increase the development of existing theories as per Figure 1 below:

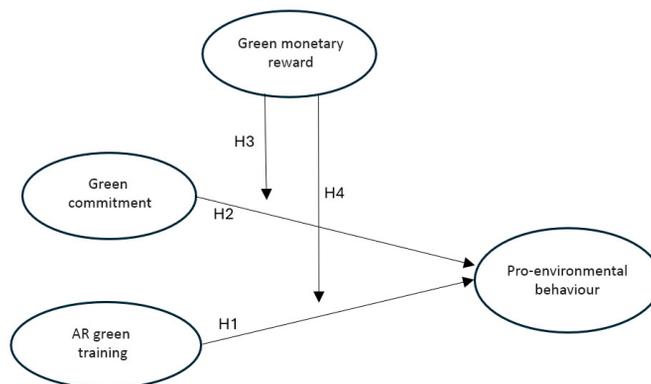


Figure 1. Research framework

3.2. Population and sampling method

This study used convenience sampling because it was practical, and there was no complete list of the target population (Creswell, 2014). The participants were employees from different organizations in Greater Jakarta, Indonesia. This sampling method made data collection faster but may have reduced the extent to which the results represent the broader population. The sample size was determined using commonly accepted guidelines for PLS-SEM analysis. The study applied the 10-times rule, which suggests a minimum sample size of five to ten times the number of measurement indicators (Sarstedt et al., 2014). Because the study used 33 indicators, the required sample size ranged from 165 to 330 respondents. A total of 200 valid responses were collected, which met and exceeded the minimum requirement. These data were appropriate for evaluating the proposed relationships and for fulfilling the research objectives.

3.3. Data collection

The online survey form was distributed using email and WhatsApp through Google Forms from June to December 2024. Anyone who responded to the survey form was informed about consent and privacy. A total of 250 survey questionnaires were distributed, and 235 responded to the survey form. After discarding 35 incomplete survey forms, the remaining information was analyzed using Rasch model analysis to assess its validity.

Person measure analysis was then applied to detect response bias, which led to the removal of 35 responses with unacceptable MNSQ values (Boone et al., 2014; Sumintono, 2014). This careful screening process made the final dataset more reliable and valid. The questionnaire used a Likert scale from 1 (strongly disagree) to 5 (strongly agree) to measure attitudes, perceptions, and behavioral intentions.

3.4. Research instrument

The questionnaire items were adapted from the work of (Afsar et al., 2018; Saeed et al., 2019). All measurement items used in this study are shown in Table 1.

Table 1. Research instrument (source: authors, 2024)

Item	AR Green Training (GT)
GT1	AR modules with quizzes and videos for environmental awareness.
GT2	AR checklists or flowcharts for eco-focused training.
GT3	Virtual libraries can be accessed through augmented reality.
GT4	AR highlights training schedules that focus on green priorities.
GT5	AR tools track skills and provide mentoring for environmental learning.
GT6	AR provides real-time tips for recycling and travel planning.
GT7	AR posters and campaigns are displayed in common areas.
GT8	Virtual classrooms and training modules in AR.
GT9	AR overlays showing workspace environmental impact.
GT10	AR tools for rotational training and progress tracking.

End of Table 1

Item	AR Green Training (GT)
GT11	AR surveys and dashboards are used to assess training needs.
GT12	AR bulletin boards share training updates.
Item	Environmental Commitment (GC)
GC1	The organization values green initiatives.
GC2	Energy conservation is prioritized.
GC3	Water conservation is essential.
GC4	Minimizing disposables is vital.
GC5	Waste control is significant to the organization.
Item	Environmental Reward (GR)
GR1	Monetary and nonmonetary rewards for environmental achievements
GR2	Public recognition of environmental performance
GR3	Rewards for good to outstanding environmental performance.
GR4	Financial incentives for strong environmental performance.
GR5	Nonfinancial incentives for strong environmental performance.
GR6	Rewards for innovative green initiatives.
GR7	Communication of employee environmental excellence.
GR8	Incentives for eco-friendly behaviors
GR9	Rewards for acquiring green skills.
Item	Pro-Environmental Behaviour (PE)
PE1	I recommend eco-friendly Practices to help improve the organization's performance.
PE2	I take part in environmental programs at my workplace.
PE3	I share environmental knowledge with my colleagues.
PE4	I question work practices that may harm the environment.
PE5	I think about the environmental impact before I take action.
PE6	I willingly take on environmental tasks beyond my job duties.
PE7	I conserve resources such as electricity and water.
PE8	I practice energy-saving behaviors.
PE9	I minimize paper use by printing double-sided when possible.
PE10	I recycle materials such as paper, cans, batteries, and oil.
PE11	I carry out my duties in environmentally responsible ways.
PE12	Compared to colleagues, I reduce waste and encourage recycling.
PE13	I fulfill my duties with environmental responsibility.
PE14	I carry out my job responsibilities in environmentally sustainable ways.
PE15	I complete my work tasks in a way that considers the environment.

3.5. Measurement model validation

Factor analysis was conducted within the SEM framework to validate the measurement model. Confirmatory factor analysis using the PLS-SEM approach was then applied to assess convergent validity, discriminant validity, and construct reliability. This process ensured that the observed indicators accurately represented the latent variables. It also confirmed that the questionnaire items properly measured the intended theoretical constructs (Sarstedt et al., 2014).

3.6. Data analysis techniques and tools

Data screening was performed for the first time through Rasch model analysis with the help of the WINSTEPS computer software version 5.2.1.0. Person measure analysis was employed to enhance the reliability of data and remove inappropriate responses (Boone et al., 2014; Sumintono, 2014). Responses with MNSQ values beyond the acceptable limit of 0.5 to 1.5 were removed.

After cleaning the data, the most significant analysis was conducted using SmartPLS 3.2.9. SmartPLS 3.2.9 was used to examine the measurement and structural models using SEM. The measurement model was assessed using confirmatory factor analysis. This involves the assessment of the factor loadings, convergent validity, discriminant validity, Cronbach's alpha, or the composite reliability of the model, respectively (Sarstedt et al., 2014). The structural model was tested using hypothesis testing, path coefficient analysis, and moderation analysis with interaction terms to interpret the impact of green financial rewards (Sarstedt et al., 2014).

4. Results and discussion

4.1. Demographic data

The study surveyed 200 employees across various organizations in Greater Jakarta, Indonesia (see Table 2).

Table 2. Demographic data (source: authors, 2024)

Demographic data		Frequency	%
Gender	Female	82	41
	Male	118	59
Age	19–20 years	10	5
	21–30 years old	93	46.5
	31–40 years old	79	39.5
	41–50 years	16	8
	More than 50 years	2	1
Education	High School Equivalent	20	10
	Diploma	20	10
	Bachelor's Degree	127	63.5
	Master's and above	33	16.5
Work experience	Less than 5 years	102	51
	Less than 10 years	75	37.5
	Less than 20 years	20	10
	More than 20 years	3	1.5
Company type	Private National	70	35
	Government Institutions	40	20
	State-Owned Enterprises	33	16.5
	Entrepreneurs	27	13.5
	Multinational Companies	12	6
	Start Up	18	9

End of Table 2

Demographic data		Frequency	%
Job level	Newbies	34	17
	Staff-Officer	75	37.5
	Supervisor	30	15
	Manager	21	10.5
	Senior Manager	17	8.5
	Director	23	11.5

4.2. Measurement model analysis

The measurement model shown in Table 3 demonstrates adequate validity and reliability for all constructs. All indicator loadings for green financial reward, AR green training, pro-environmental behavior, and green commitment are above the minimum threshold of 0.60. These findings suggest that each item significantly contributes to its related construct. Although some loadings are below 0.70, they are acceptable for exploratory research. These values do not weaken the overall validity of the constructs (Sarstedt et al., 2014).

Table 3. Validity and reliability test results (source: authors, 2024)

Items	Loading factor (>0.7)	Cronbach's alpha (>0.6)	Composite reliability (>0.6)	AVE (>0.5)	Remarks
GR1	0.764	0.748	0.841	0.569	Valid and reliable
GR4	0.756				
GR6	0.726				
GR8	0.771				
GT1	0.772	0.863	0.893	0.512	Valid and reliable
GT10	0.719				
GT11	0.711				
GT12	0.660				
GT3	0.733				
GT5	0.712				
GT6	0.700				
GT7	0.710				
PE1	0.686	0.802	0.858	0.503	Valid and reliable
PE11	0.679				
PE14	0.704				
PE15	0.746				
PE3	0.704				
PE8	0.733				
GC1	0.830	0.703	0.834	0.627	Valid and reliable
GC4	0.742				
GC5	0.801				

Notes: GR = Green Financial Reward; GC = Green Commitment; AGT = AR Green Training; PE = Pro-Environmental Behavior.

Internal consistency reliability is supported by Cronbach's alpha values ranging from 0.703 to 0.863, all of which exceed the minimum acceptable level. The recommended standard is also met by composite reliability values, which range from 0.834 to 0.893. These results indicate that the items within each construct consistently measure the same underlying concept.

Table 4. Fornell-Larcker criterion (source: authors, 2024)

Construct	FR	GC	GT	PEB
GRW	0.755			
GC	0.615	0.792		
AGT	0.836	0.695	0.715	
PEB	0.756	0.765	0.819	0.709

Notes: GR = Green Financial Reward; GC = Green Commitment; AGT = AR Green Training; PE = Pro-Environmental Behavior.

Convergent validity is demonstrated by average variance extracted values between 0.503 and 0.627. All AVE values are higher than the minimum required, which means that each construct contributes to more than half of the variance in its indicators (Sarstedt et al., 2014). The results show that the measurement model is both accurate and dependable. The constructs show strong internal consistency and adequate convergent validity, providing a sound basis for further structural model analysis.

Discriminant validity was assessed using the Fornell-Larcker criterion. This method examines at the square root of the AVE for each construct and how it relates to other constructs. The diagonal values in Table 4 show the square roots of the AVEs (Sarstedt et al., 2014). To demonstrate discriminant validity, these values must exceed the correlations with other constructs. This supports discriminant validity and shows that each construct represents a distinct part of the pro-environmental framework.

4.3. R-Square value

The fit of the model to the data is quite satisfactory as its R-Square value is 0.766 (Table 5). The mode explains the variability of 76.6% in Pro-Environmental Behavior (PEB). It leaves unexplained 23.4% of the variability of the pro-environmental behavior. This implies that some important variables are not in the model.

The high R-squared value indicates that the included variables have a significant impact on PEB. Policies or interventions that enhance these variables are likely to promote environmentally sustainable practices.

Figure 2 shows that green training is the most influential factor, accounting for 31.9% of the effect on PEB. Green commitment is the second most important factor, contributing 29.8%. Monetary rewards have a smaller but still meaningful influence, accounting for 20.6%.

Table 5. R-Square value (source: authors, 2024)

	R-Square
Pro-environmental behavior	0.766

This means that green training at work can help workers learn more about environmental issues and how to live in a way that helps for the environment. Training like this makes people more aware of environmental problems and explains why sustainability is important. It also shows how workers can help lessen the damage to the environment.

The training programs provide practical sustainability skills that will help employees apply environmentally friendly practices in their daily work activities. As a result, employees are more likely to change their behavior for the better. These changes include recycling, conserving energy, using sustainable materials, and reducing waste.

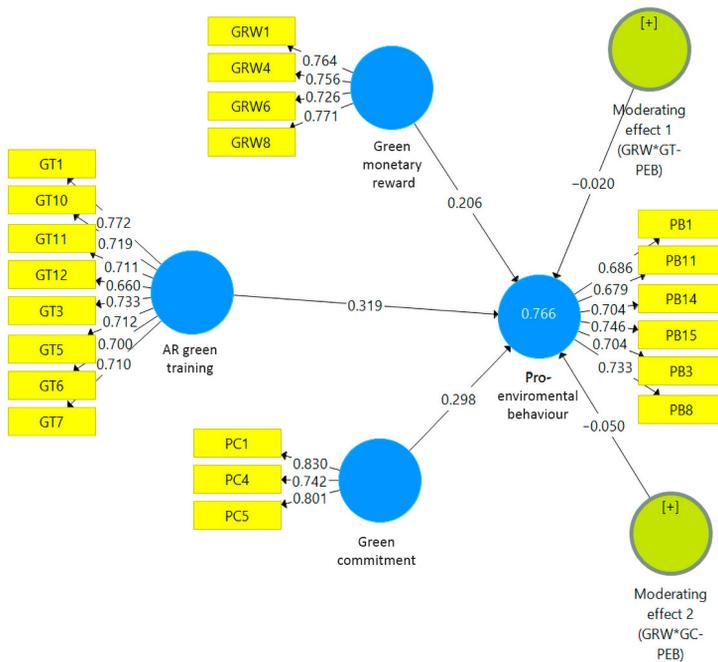


Figure 2. Outer model

4.4. Hypothesis testing

Table 6 shows the analysis of the results, which shows an interesting link between the study's main variables. It focuses on Green Commitment (GC) and AR Green Training (AT) as factors that affect PEB.

AR green training and pro-environmental behavior (H1). The results indicate that AR-based green training has a positive and statistically significant effect on pro-environmental behavior ($\beta = 0.319$, $t = 3.600$, $p < 0.001$). Thus, H1 is supported. So, H1 is correct. Those who are exposed to green training from an AR-based system are more inclined to perform actions that are beneficial to the environment.

The TPB argues that this can be understood in terms of attitude and perceived control of behavior. AR training will enable them to learn more about the environmental problems

Table 6. Path analysis (source: authors, 2024)

Hypothesis	Original sample (O)	T statistics (O/STDEV)	P values	Results
AGT → PEB	0.319	3.600	0.000	H1 accepted
GC → PEB	0.298	4.391	0.000	H2 accepted
GRW*GC → PEB	-0.050	1.318	0.094	H3 declined
GRW*AGT → PEB	-0.020	0.549	0.292	H4 declined

Notes: *Moderating Effect, GR = Green Financial Reward; GC = Green Commitment; AGT = AR Green Training; PE = Pro-Environmental Behavior.

by demonstrating its capability to impact the environment. They will also enable them to experience imaginary environmental scenarios. The attributes will enable an individual to feel more favorably disposed towards carrying out actions for the benefit of the environment. The attributes also enhance an individual's confidence in carrying out responsible behavior towards the environment. A person feels able to undertake actions for the benefit of the environment when they believe them to be important and possible.

This finding aligns with previous research indicating that comprehensive and experiential learning enhances environmental knowledge and awareness. Improved knowledge and awareness have been shown to support sustainable behavior (Ladykova et al., 2024; Mulders et al., 2025; Simon et al., 2025; Şimşek, 2024). The result also aligns with earlier studies on green training. Previous research has demonstrated that environmental training promotes recycling, energy conservation, and voluntary environmental actions (Ahuja et al., 2023; Donmez-Turan & Kiliclar, 2021; Mansoor & Wijaksana, 2023; Xie & Lu, 2022).

Green commitment and pro-environmental behavior (H2). The analysis indicates that green commitment can have a significant positive influence on pro-environmental behavior ($\beta = 0.298$, $t = 4.391$, $p < 0.001$). This means that H2 is supported. People who care about the environment on a personal level are more likely to do things that benefit the environment.

In the theory of planned behaviour, green commitment is an individual attitude that is personal and positive towards the environment. Green commitment also displays a feeling of moral duty. Moral duty is an internalization process that is involved in influencing an individual's future actions. When individuals have internalized environmental beliefs, they are more inclined to act in a manner that is beneficial to the environment.

This finding is consistent with earlier studies showing that green commitment and sustainability-oriented values predict pro-environmental behavior (de Almeida Barbosa Franco et al., 2024; Foster et al., 2022). Prior research has shown that such commitment helps convert environmental awareness into actual behavior. The present result extends this work by demonstrating that green commitment can directly influence individual behavior. This effect persists even in the absence of organizational or leadership-related factors.

The role of green monetary rewards in the relationship between green commitment and PEB (H3). The effect of green commitment on green monetary rewards is not statistically significant ($\beta = -0.050$, $t = 1.318$, $p = 0.094$). Hence, H3 is not supported. The findings indicate that monetary rewards do not enhance the relationship between green commitment and pro-environmental behaviors.

The motivation crowding theory clarified this finding. The theory proposes that external rewards can diminish intrinsic motivation. When rewards are introduced, people may start to care more about external benefits than their own values. In this study, individuals with a strong commitment to the environment may not necessitate financial incentives to behave responsibly.

However, giving individuals financial rewards to do something may make them less likely to do it for moral or value reasons. The interaction coefficient is slightly negative but not significant. The result suggests there is crowding out. The result is comparable to findings indicating financial incentives have a crowding-out effect on intrinsic environmental motivations (Graafland & de Bakker, 2021; Steinhorst & Klöckner, 2018). Although there is evidence supporting positive outcomes regarding the use of incentives (Alt & Gallier, 2021), it appears there is some limitation to these findings. The use of incentives is probably not too successful on an individual who is highly motivated to go green.

The role of green money rewards in the AR green training and the PEB relationship (H4). There was no statistically significant moderating effect of green monetary rewards on the relationship between AR green training and pro-environmental behavior ($\beta = -0.020$, $t = 0.549$, $p = 0.292$). Thus, H4 lacks support. This result indicates that financial incentives do not enhance the efficacy of AR green training on pro-environmental behavior.

From the perspective of the theory of planned behavior, AR green training already improves attitudes toward environmental action. It also increases perceived behavioral control by building knowledge and skills. When people feel knowledgeable and empowered, additional funding does not make them more likely to act.

Another explanation could stem from the motivation crowding theory. It could be hypothesized that monetary incentives could distract people away from learning. It could further result in a reduced level of internalization of environmentally responsible actions. The effectiveness of the motivation of the training could thus be impacted adversely.

This finding is in line with previous studies, which show the effectiveness of incentives in promoting behavioral change over a shorter period. Such incentives cannot bring sustained behavioral change in alignment with intrinsic values (Sharpe et al., 2022; Silvi & Padilla, 2021; Steinhorst & Klöckner, 2018).

4.5. Discussion

This research presents several theoretical contributions by integrating and expanding the Theory of Planned Behavior (TPB) and motivation crowding theory within the context of pro-environmental behavior.

First, this study extends the “Theory of Planned Behavior” (TPB) by recognizing that green training with AR technology is a crucial indicator of pro-environmental behavior. In previous “theory of planned behavior” studies, pro-environmental behaviors were explored in relation to “attitudes,” “subjective norms,” and “perceived control,” and it has now been found that AR green training simultaneously increases all three factors. People’s attitudes towards nature will become more positive after AR training. They will feel they can accomplish actions that benefit nature. This makes it easier for people to do what they say they will do. This

contribution demonstrates that technology-based learning can more effectively engage TPB mechanisms compared to conventional training methods, particularly in addressing complex environmental issues.

Second, the proposed study advances the Theory of Planned Behavior (TPB) by confirming the researcher's assumption that green commitment is an individual-level variable distinct from the commitment variable used in prior studies. In previous research, commitment was primarily viewed as an attitude or an intention to act. On the other hand, the results also show that green dedication is positively predictive of taking responsible environmental actions due to the internalization of green values.

Third, the study contributes to the motivation crowding theory by demonstrating that green monetary rewards do not strengthen intrinsically motivated pro-environmental behavior. The insignificant moderating effects identified in the analysis indicate a crowding-out mechanism. Even when incentives are framed as supporting environmental goals, they do not make people more likely to act because they are committed to the goals or because they are learning. The implication of this finding generalizes the motivation crowding theory to the context of sustainability and the environment, suggesting that crowding-out effects can occur even when incentives are aligned.

Finally, by incorporating both the TPB model and the motivation crowding theory, we gain deeper insight into human behavior related to the environment. This study has demonstrated that internal factors such as knowledge, commitment, and perceived control are sufficient to promote environmentally supportive activity. Moreover, external money incentives have little explanatory power. This all-encompassing model helps interpret the learning context in which incentives become ineffective, specifically when one possesses strong values and learns extensively through experiences. Overall, this study makes a contribution to the field of sustainability and human behavior in emphasizing the value of internal motivations and cognitive processes. Internalized values and informed capability offer deeper explanations for pro-environmental behavior than financial incentives, thereby strengthening both theories and clarifying the limited effectiveness of green monetary rewards in fostering lasting environmental behavior.

This research is significant because it provides recommendations for organizational managers interested in encouraging environmentally responsible behaviors within their organizations.

In the first place, managers could consider using green training based on augmented reality to encourage employees to behave more environmentally friendly. On the other hand, using AR during training affects people's satisfaction with the environment. Moreover, AR enables workers to understand the effect of their daily activities on the sustainability dimension by showing how their actions affect the environment.

Secondly, managers should place greater emphasis on encouraging workers to be more committed to the green cause. The finding has indicated that commitment to the green cause relates to a key indicator of green actions. This commitment can be achieved by managers informing workers of the green cause, involving workers in any green activities, or rewarding workers without giving them financial rewards. This helps the workers to feel that it is part of their responsibility to be green.

Thirdly, consider the use of money as a reward very carefully. This is because the finding shows that money rewards do not improve the role of a training commitment in promoting environmentally responsible behavior. Overreliance on rewarding could be detrimental to the internal motivation of the individual. Instead, involvement in green projects and non-monetary reward recognition appear to be effective. It is important for the manager to emphasize the role of internal motivation rather than using the strategy of compliance. It is to be noted that a learning strategy incorporating values appears to be a strong motivator in promoting environmentally responsible behavior instead of one based upon monetary rewards.

5. Conclusions

This study investigated the effects of Augmented Reality (AR) – based green training and green commitment on employees' pro-environmental behavior in Indonesian workplaces, and examined whether green monetary rewards alter these relationships. Based on the theory of planned behavior and motivation crowding theory, the analysis shows that internal motivational factors are more important than financial incentives in encouraging sustainable behavior at work. The results indicate that AR-based green training has a significant positive effect on pro-environmental behavior. This effect occurs because AR training improves employees' environmental understanding. It also supports more positive attitudes toward sustainability. In addition, AR training increases employees' confidence in their ability to act in environmentally responsible ways. A strong direct effect on pro-environmental behavior also comes from a strong commitment to being green. Employees who internalize environmental values are more likely to act sustainably, voluntarily, and consistently. In contrast, green monetary rewards do not significantly influence the effects of training or commitment. The negative interaction results suggest a possible crowding-out effect. Financial incentives may shift attention away from internal environmental values.

This research aims to provide a number of contributions to the existing body of knowledge. First, the TPB will be refined because the paper intends to show the effectiveness of green training based on augmented reality towards encouraging people to perform activities in favor of the environment. The research will validate the importance of green commitment in workplace sustainability in relation to value internalization. The findings also add to the motivation crowding theory by showing that money rewards don't work as well when people are already highly motivated. By integrating both theoretical perspectives, the study clarifies the conditions under which financial incentives are unlikely to support long-term behavioral change.

This study has several limitations that point to opportunities for future research. Because the data were collected using a cross-sectional design, causal inferences should be made with caution. Future studies could adopt longitudinal or experimental approaches to assess long-term effects better. Moreover, the emphasis on organizations in the Greater Jakarta area could limit the results in general terms. Replicating the study in various regions and settings could increase the external validity of the results. Future studies must also employ objective measures of behavior. Future studies could also investigate other types of green incentives and explore the role of crowding-in and crowding-out effects in their results.

Author contributions

Conceptualization, MGH; methodology, MGH; software, MGH and KI; validation, MGH; formal analysis, KI; investigation, MGH and KI; resources, MGH and KI; data curation, MGH, EO, and KI; writing original draft preparation, MGH, EO; writing review and editing, MGH, EO, and KI; supervision, MGH; project administration, MGH. All authors have read and agreed to the published version of the manuscript.

Data availability statement

Open dataset: <https://zenodo.org/records/18180897/files/Open%20Dataset%20BMEE.xlsx?download=1>

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