

## **FROM INK TO IMPACT: EMPLOYEE INSIGHTS ON SUSTAINABLE MANUFACTURING PRACTICES IN MALAYSIA**

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### **Abstract**

This study investigates the behavioural and knowledge-based factors influencing sustainability practices among employees in an ink manufacturing facility in Northern Malaysia. By integrating the Theory of Planned Behavior and Sustainable Consumption Theory, the research explores how attitudes, perceived behavioral control, subjective norms, and awareness of responsible consumption contribute to efforts in waste reduction and process enhancement. Using a quantitative approach, data was collected through structured surveys distributed to 200 employees and analysed via SmartPLS. Results indicate that subjective norms, perceived behavioral control, and knowledge of ink waste significantly affect attitudes toward waste reduction, while attitude and awareness of responsible consumption are key predictors of process enhancement. Process enhancement emerged as the strongest factor driving the intention to reduce ink waste. The study offers practical implications for industry leaders and policymakers, highlighting the importance of employee engagement, targeted training, and sustainable technology adoption. This research uniquely contributes to the sustainability literature by presenting an employee-centric framework within an under-explored sector in Malaysia.

**Keywords:** Sustainability Practices, Employee Behaviour, Ink Waste Reduction

### **Introduction**

Sustainability in manufacturing has become a central pillar of Malaysia's national development agenda, underscored by the urgent need to mitigate environmental degradation and uphold international sustainability commitments. Anchored by strategic frameworks such as the Twelfth Malaysia Plan and the National Green Technology Policy, the Malaysian government has intensified its efforts to promote sustainable practices across high-impact industrial sectors. One such sector is ink manufacturing, a chemical-intensive industry with considerable environmental implications due to its reliance on petroleum-based pigments, energy-heavy processes, and the generation of scheduled waste. Despite its critical role in supporting sectors like food packaging, electronics, commercial printing, and advertising, ink manufacturing has attracted increasing scrutiny for its environmental footprint. In 2022, Malaysia generated over 4.6 million metric tonnes of scheduled waste, with a significant share attributed to chemical-based industries, including ink production (Department of Environment Malaysia, 2023).

While policy initiatives have advocated for cleaner production and resource efficiency, many manufacturing facilities continue to operate using legacy systems with minimal automation and limited integration of sustainability into daily routines. Often, sustainability practices in these settings are reactive, compliance-driven, and disconnected from operational

realities. Studies reveal that fewer than 40% of Malaysian manufacturers have adopted green technologies despite the availability of governmental incentives (Ang, Narayanan, & Hong, 2021). In this context, ink manufacturing remains a sector of both strategic importance and environmental concern, where progress toward sustainability has been uneven and insufficiently studied.

This study centres on a single ink manufacturing company in Northern Malaysia to explore sustainability implementation from an employee perspective. Adopting a case study approach allows for a deep, context-specific analysis of internal behaviours, challenges, and processes that broader multi-company surveys may overlook. The selected company occupies a key position in Malaysia's ink production value chain, making it an ideal setting for examining how behavioural factors influence sustainability outcomes. A significant gap in the current transition toward sustainable manufacturing lies in the underrepresentation of employees particularly operators, technicians, and supervisors in sustainability planning and decision-making. These frontline workers, who manage ink waste, oversee production processes, and ensure machine calibration, are often excluded from strategic discussions. This top-down approach limits the effectiveness of sustainability initiatives, leading to superficial compliance and a lack of engagement among those best positioned to enact meaningful change (Yuriev, et al., 2020).

To address this gap, the present study investigates the human element of sustainability by examining how employee-level behavioural and knowledge-based factors impact sustainability practices within the ink manufacturing industry. Specifically, it applies the Theory of Planned Behaviour (Ajzen, 1991) and Sustainable Consumption Theory (Liu & Zhang, 2022) to understand how attitudes, perceived behavioural control, subjective norms, and awareness of responsible consumption drive behaviours related to waste reduction and process enhancement. Through this lens, the study aims to inform more inclusive and effective sustainability strategies in Malaysia's manufacturing sector.

### **Research Objectives**

The objectives of this study were to:

1. Explore the relationships between employee-level drivers such as attitudes, perceived behavioural control, subjective norms, and awareness of responsible consumption and waste reduction behavior in ink manufacturing.
2. Assess the mediating role of attitudes and process enhancements in translating these behavioural drivers into sustainability practices.
3. Provide actionable insights for organisations and policymakers to support more effective and employee-inclusive sustainability initiatives within resource-intensive manufacturing sectors.

### **Scope of Research**

This research was conducted within a manufacturing company located in the Northern region of Malaysia, specifically focusing on the ink production sector. The scope of the study was limited to employees directly involved in manufacturing operations, including roles such as machine operators, technicians, supervisors, and production staff. These individuals were selected due to their direct engagement with processes related to ink waste management, equipment handling, and day-to-day production activities. By concentrating on this specific group, the study aimed to capture in-depth insights into how employee-level behavioural and knowledge-based factors influence sustainability practices within a real-world industrial setting.

## Literature Review

### *Theoretical Foundations*

Globally, the ink manufacturing industry faces increasing pressure to adopt sustainable practices due to tightening environmental regulations and evolving consumer expectations. In developed regions such as the European Union and the United States, regulatory frameworks like REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) and the U.S. EPA's Resource Conservation and Recovery Act are driving ink producers to reduce hazardous emissions and transition toward cleaner technologies, including water-based and bio-based inks. In contrast, the Malaysian ink sector has shown uneven adoption of sustainable practices. Many local manufacturers continue to rely on solvent-based inks and legacy batch processing systems, contributing to high volumes of chemical waste and inefficient energy use. Ang et al. (2021) observed that Malaysia's printing and ink manufacturing sectors generate significant scheduled waste, with less than 40% of medium-sized firms adopting eco-efficient technologies. This gap underscores the need for internal behavioural changes and process improvements as integral components of sustainability solutions.

This study is timely in addressing these issues by going beyond technological upgrades and policy directives. It emphasises the human behavioural factors that influence sustainability outcomes, offering a more holistic understanding through the integration of two theoretical lenses: the Theory of Planned Behaviour (TPB) and Sustainable Consumption Theory (SCT). Together, these frameworks allow for a comprehensive exploration of how employee beliefs, attitudes, and awareness shape sustainability performance in the ink manufacturing context.

### *Theory of Planned Behaviour (TPB)*

The Theory of Planned Behaviour (TPB), developed by Ajzen (1991), is a widely utilised psychological model that explains deliberate behaviour based on three key constructs: attitude, subjective norms, and perceived behavioural control. Attitude refers to an individual's overall evaluation of a behaviour; subjective norms involve perceived social pressures; and perceived behavioural control reflects the perceived ease or difficulty of performing the behaviour. In sustainable manufacturing, TPB helps explain why employees may choose to engage or not engage in behaviours such as ink waste reduction, process optimisation, or energy conservation. Employees are more likely to adopt such behaviours when they believe the outcomes are positive (attitude), perceive that peers and supervisors support them (subjective norms), and feel capable of executing the tasks (perceived behavioural control).

Empirical studies support the relevance of TPB in sustainability contexts. For example, Yuriev, et al. (2020) found TPB to be a strong predictor of pro-environmental behaviour in organisational settings. Chen, et al. (2023) further demonstrated that perceived behavioural control and supportive social norms significantly influenced employees' engagement in environmental practices in manufacturing firms. Moreover, TPB is adaptable to industrial environments like ink manufacturing, where it can guide the design of interventions such as training programs to build confidence (enhancing perceived control), management communication to strengthen norms, and feedback mechanisms to improve attitudes. TPB thus provides both diagnostic insight and practical guidance for fostering sustainable employee behaviour.

### *Sustainable Consumption Theory (SCT)*

Initially rooted in consumer behaviour research, Sustainable Consumption Theory (SCT) is increasingly applied to industrial contexts to explain how informed and responsible

resource use can mitigate environmental harm. SCT encourages actions such as reducing waste, reusing materials, and choosing eco-friendly alternatives.

In ink manufacturing, SCT explains how employee values and awareness influence operational practices. When workers understand the environmental impact of ink production from raw material sourcing to waste disposal, they are more likely to adopt behaviours that support efficient and responsible consumption. This includes minimising spills, reducing overproduction, and identifying reuse opportunities.

Liu and Zhang (2022) emphasise the role of eco-literacy and resource-efficiency training in enhancing sustainable behaviour among industrial workers. Ang, et al. (2021) further argue that internalising responsible consumption improves both environmental and financial performance. SCT complements TPB by introducing a values-based perspective. While TPB focuses on intention and control, SCT frames sustainability as a moral and ecological imperative. The integration of both theories offers a more nuanced understanding of how behaviour and values interact to drive sustainable manufacturing.

#### *Enhancing Processes and Minimising Ink Waste*

Process enhancement and waste minimisation are critical to sustainable manufacturing, particularly in ink production, which is resource- and energy-intensive. Inefficiencies across stages such as mixing, dispersion, filtering, and filling lead to operational losses and significant environmental harm. These issues are exacerbated by outdated machinery, poor calibration, and lack of automation. Improving processes through strategies like advanced ink management systems, digital monitoring tools, and lean manufacturing techniques can reduce ink waste by over 50% (Krystosiak, et al., 2024). Lean methods such as value stream mapping, kaizen, and just-in-time production help eliminate non-value-adding steps and optimise resource use. Energy efficiency is another area of improvement. Retrofitting equipment with energy-saving components and integrating renewable energy can reduce power consumption by up to 37%, aligning with both cost-saving and climate objectives.

Closed-loop systems offer additional sustainability benefits by recovering and reusing solvents, pigments, and water within production cycles. Studies show these systems can reclaim up to 90% of process waste, reducing environmental impact and raw material dependency. Crucially, employee involvement is essential for process enhancement success. Operators possess valuable knowledge of daily operations and can identify inefficiencies that management may overlook. A culture that empowers employees through training, incentives, and collaboration drives continuous improvement and supports sustainable transformation.

#### *Knowledge and Awareness of Ink Waste*

Employee knowledge and awareness are foundational to sustainable behaviour in ink manufacturing. A well-informed workforce is better equipped to identify waste sources, recognise inefficiencies, and apply environmentally sound practices. Ink waste commonly arises from overproduction, improper blending, equipment issues, and inefficient cleaning. When employees lack understanding of these factors, opportunities for waste reduction are missed. Conversely, training and awareness programs can empower workers to proactively engage in waste-minimising practices.

Aydemir and Özsoy (2020) showed that structured training on waste identification and management significantly improved production efficiency and environmental compliance. Regulatory awareness is also essential understanding Malaysia's Environmental Quality (Scheduled Wastes) Regulations 2005 enhances adherence to safe disposal protocols. Environmental literacy extends beyond technical knowledge. Employees who grasp broader



*Hypotheses Based on Sustainable Consumption Theory (SCT)*

SCT introduces the awareness of responsible consumption as a driver for operational improvements and environmentally conscious behaviours in the workplace. The theory emphasizes that values and understanding about sustainability contribute to changes in production systems.

H7: Awareness of responsible consumption has a positive effect on process enhancement efforts.

*Process Enhancement as a Mediator*

Process enhancement, representing operational improvements such as lean production, closed-loop systems, or smart ink management, serves as a mediating mechanism linking cognitive and value-driven factors with behavioural outcomes.

H8: Process enhancement has a positive effect on employees' intention to minimise ink waste.

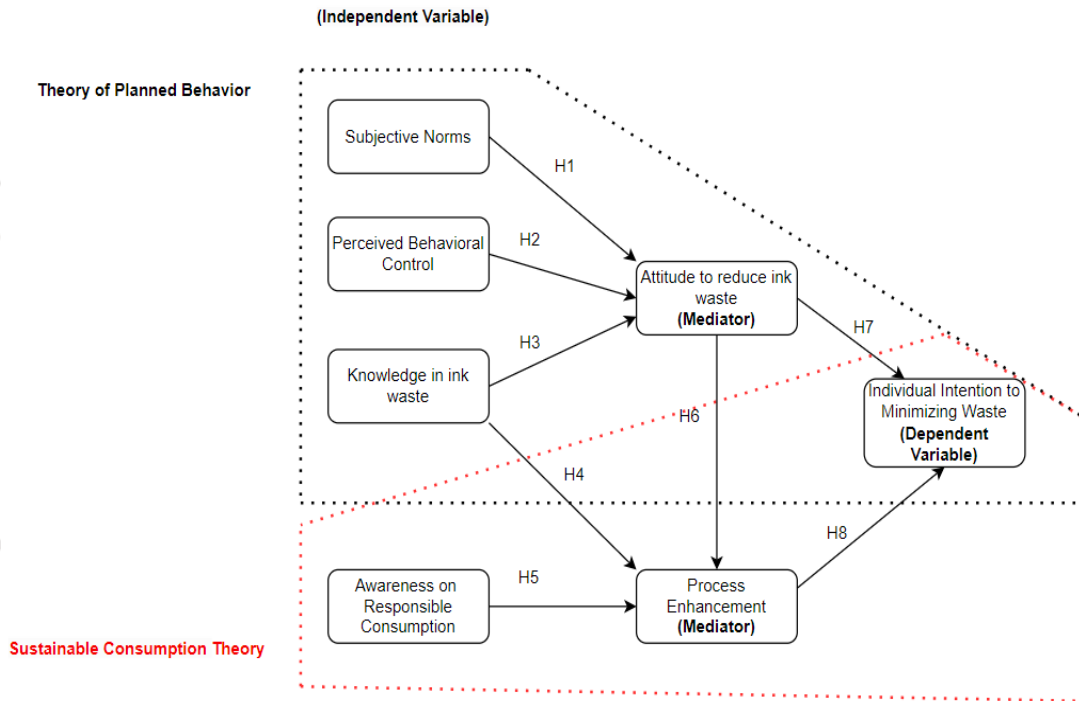


Figure 1: Conceptual Framework

**Research Methodology**

*Sample and Data Collection*

The target population for this study consisted of employees from an ink manufacturing company located in the northern region of Malaysia. Participants included operators, technicians, supervisors, engineers, and managers who were directly or indirectly involved in production, process improvement, and waste management activities.

To ensure adequate representation across job functions and organisational hierarchies, a stratified random sampling technique was employed. Employees were first grouped into four strata based on job roles: (1) operators, (2) technicians, (3) supervisors and engineers, and (4) managers. Random sampling was then conducted within each stratum to achieve proportional

representation. This approach enhanced the generalisability of findings within the organisational context and minimised sampling bias.

A total of 200 valid responses were obtained, exceeding the minimum required sample size of 119, as determined by G\*Power analysis ( $f^2 = 0.15$ ,  $\alpha = 0.05$ , power = 0.95). This ensured sufficient statistical power for subsequent analysis using Structural Equation Modeling (SEM). Data were collected via a self-administered online survey using Google Forms. The survey was distributed along with a formal cover letter outlining the study's purpose, confidentiality assurances, and voluntary participation. The data collection period spanned three weeks, during which two reminder emails were issued to encourage participation. Ethical approval was obtained from the affiliated university, and informed consent was secured from all participants prior to survey completion.

### *Measures*

The survey instrument comprised 40 items organised into eight sections; each aligned with the conceptual framework. The constructs measured included:

1. Subjective Norms
2. Perceived Behavioural Control
3. Knowledge of Ink Waste
4. Attitude Toward Reducing Ink Waste
5. Responsible Consumption Awareness
6. Process Enhancement
7. Individual Intention to Minimize Waste
8. Demographic Information

All construct items were assessed using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Items were adapted from established and validated instruments in environmental behaviour and sustainability literature (e.g., Ajzen, 1991; Aydemir & Özsoy, 2020; Ang, et al., 2021). Minor contextual modifications were made to ensure clarity and relevance to the ink manufacturing setting.

To enhance instrument reliability and validity, several steps were taken:

1. Cronbach's alpha values exceeded 0.70 for all constructs, confirming internal consistency.
2. Confirmatory Factor Analysis (CFA) was conducted to validate construct dimensionality and factor loadings.
3. A pilot test was performed with 10 employees from the target population to assess clarity, comprehension, and contextual appropriateness of the items.

These procedures ensured that the measurement tool was both psychometrically sound and well-suited to capturing employee perspectives on sustainability practices.

### *Common Method Variance*

To address potential common method variance (CMV), both procedural and statistical remedies were employed.

Procedurally, participants were assured of their anonymity and informed that there were no right or wrong answers. This helped reduce the likelihood of social desirability bias or evaluation apprehension. Analytically, the presence of CMV was assessed using Harman's single-factor test. Results showed that no single factor accounted for the majority of variance, suggesting that CMV was not a significant concern. Additionally, full collinearity assessments were conducted using SmartPLS, with all Variance Inflation Factor (VIF) values remaining well below the conservative threshold of 3.3. This provided further evidence that

multicollinearity and CMV were not likely to bias the results. Together, these precautions enhanced the validity and credibility of the study's findings.

## Research Results

### *Demographic Profile of Respondents*

The sample comprised individuals across multiple organizational roles within the ink manufacturing company, including operators (53%), technicians (22%), supervisors (15%), and managers (10%). To capture a comprehensive range of perspectives on sustainability practices, respondents were selected from key functional departments, including production, quality control, maintenance, and process engineering. This cross-departmental representation enabled a more holistic understanding of sustainability implementation throughout the facility. A stratified random sampling approach was employed to ensure proportional representation based on job role and department. While operators formed the largest portion of the sample reflecting their predominance within the workforce targeted inclusion of technicians, supervisors, and managers helped to mitigate overrepresentation bias and enrich the data with input from various levels of organisational authority. The predominance of operator responses aligned with the study's focus on operational-level sustainability practices, particularly in relation to waste reduction. At the same time, insights from supervisors and managers provided valuable context for examining cross-level factors such as subjective norms and perceived behavioural control. Overall, the demographic profile supports the robustness and relevance of the findings by ensuring broad organisational coverage in the exploration of sustainability behaviours and attitudes.

## Discussion

The findings of this study affirm that subjective norms (H<sub>1</sub>), perceived behavioural control (H<sub>2</sub>), and knowledge of ink waste (H<sub>3</sub>) significantly influence employees' attitudes toward reducing ink waste. These results are consistent with the Theory of Planned Behaviour (TPB), reinforcing the principle that when individuals feel supported by social expectations, perceive themselves as capable, and possess relevant knowledge, they are more likely to develop favourable attitudes toward sustainable actions. This underscores the importance of social influence, self-efficacy, and targeted education in driving environmental responsibility at the individual level.

In line with the Sustainable Consumption Theory (SCT), the study revealed that awareness of responsible consumption (H<sub>5</sub>) significantly drives process enhancement. This suggests that operational improvements are more strongly motivated by a broad understanding of environmental responsibility than by technical knowledge alone. Notably, the direct relationship between knowledge of ink waste and process enhancement (H<sub>4</sub>) was not statistically significant. This distinction highlights that while knowledge contributes to attitudinal change, it is the overarching awareness of sustainability that effectively translates into systemic operational practices.

The analysis further showed that attitude toward reducing ink waste had a marginal effect on process enhancement (H<sub>6</sub>) but a significant influence on the intention to minimise waste (H<sub>7</sub>). This indicates that attitudes play a more direct role in shaping individual behavioural intentions than in driving structural changes. Importantly, process enhancement emerged as the strongest predictor of waste minimisation intention (H<sub>8</sub>), confirming its role as a critical mediating construct. This reinforces the idea that operational transformation serves as the conduit through which values and attitudes are operationalised into concrete, sustainable behaviours.

From a theoretical standpoint, the integration of TPB and SCT proved valuable in capturing both psychological and organizational drivers of sustainability. This dual-framework approach offers a comprehensive lens for understanding how individual beliefs (e.g., attitudes and perceived control) and collective awareness (e.g., responsible consumption) interact to shape pro-environmental intentions and practices. These findings are consistent with prior research by Yuriev, et al. (2020) and Aydemir & Özsoy (2020), which advocate for employee-centered approaches to industrial sustainability.

Although the study focused on a single ink manufacturing company in northern Malaysia, the insights particularly those related to behavioural pathways, training strategies, and process improvement can be cautiously generalised to other firms within the ink sector and similar resource-intensive industries. This is especially relevant in Southeast Asia, where organisations often face parallel sustainability pressures and workforce engagement challenges. However, any generalisation should account for contextual variables such as company size, technological maturity, regulatory environment, and organisational culture.

Overall, the study contributes to a growing body of evidence emphasising that activating employee knowledge, awareness, and behavioural control is critical for advancing sustainability goals. The findings offer practical guidance for organisations seeking to embed environmental responsibility into everyday operations through workforce engagement and systemic process improvements.

### **Recommendations**

Despite its contributions, the study acknowledges certain limitations. The single-company case study design may constrain the generalisability of results. Additionally, reliance on self-reported data introduces the possibility of response bias, and the exclusion of top management and external stakeholders omits potentially influential perspectives. Future research should address these limitations by incorporating multi-site comparisons, longitudinal designs, and broader stakeholder involvement. Further theoretical integration with models such as organisational support theory, institutional theory, or innovation diffusion theory could also enrich the explanatory power of the framework.

In summary, this study reinforces the notion that sustainable transformation in manufacturing is not merely a function of technology or compliance, but is deeply rooted in employee behaviour, organisational culture, and cognitive engagement. By fostering pro-environmental attitudes, enabling individual agency, and aligning operational processes with sustainability goals, organisations can advance toward more responsible, efficient, and economically sustainable manufacturing practices.

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