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Implementing Green Supply Chain Management in Paper Waste Management at Indonesian Higher Education Institutions: A Case Study of the Paper Recycling Ecosystem

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Abstract. This study examines the implementation of Green Supply Chain Management (GSCM) practices in managing paper waste within Indonesian higher education institutions, focusing on the influence of recycling infrastructure, subjective norms, and recycling awareness on campus sustainability. Employing a quantitative approach with data from 224 students, the study utilized Structural Equation Modelling (SEM) to evaluate relationships among key variables: Paper Waste Capacity (PWC), Subjective Norms (SN), Recycling Awareness (RA), and Ecosystem Sustainability (ES). Findings indicate that enhanced paper waste capacity significantly affects subjective norms around recycling, while subjective norms positively influence individual recycling awareness. Both subjective norms and recycling awareness significantly contribute to ecosystem sustainability, suggesting that GSCM practices, supported by accessible recycling infrastructure and normative reinforcement, can foster a culture of sustainability within universities. This study also highlights the importance of creating a recycling-supportive environment through social campaigns and peer initiatives. The results underscore the broader potential of GSCM as a model for promoting environmentally responsible behaviours in educational settings and beyond. While limited by its specific context, the study calls for further research across diverse institutions and regions to expand understanding of GSCM's impact on sustainability practices.

Keywords. Green Supply Chain Management, Paper Waste Management, Recycling Awareness, Ecosystem Sustainability

1. Introduction

The role of Green Supply Chain Management (GSCM) in enhancing environmental sustainability has garnered significant attention, particularly as industries face escalating pressures to reduce environmental impact and comply with global sustainability standards. Within this context, paper waste management in higher education institutions emerges as an area ripe for innovation. Paper, historically a critical medium for communication and education, is increasingly recognized as a major contributor to environmental degradation due to the deforestation, water use, and pollution associated with its production. Despite the global trend toward digitization, paper consumption in universities remains substantial, fuelled by administrative, instructional, and academic needs. Consequently, these institutions have a

pressing need to adopt GSCM practices to optimize resource usage, manage waste, and promote sustainability (Assumpção, Campos, Plaza-Úbeda, Sehnem, & Vazquez-Brust, 2022).

In Indonesia, where rapid urbanization and economic growth compound environmental challenges, the issue of paper waste in universities underscores the need for a paradigm shift in supply chain practices. Although certain institutions have adopted recycling initiatives, these efforts are often sporadic and lack a cohesive framework. Studies indicate that GSCM, by integrating environmental considerations into the supply chain, can significantly enhance waste management, improve operational efficiencies, and foster a culture of sustainability. However, research on the implementation and impact of GSCM in Indonesian higher education remains limited (Bag & Pretorius, 2022). This study investigates the applicability of GSCM practices within Indonesian universities, focusing on the paper recycling ecosystem as a case study to illustrate the potential for sustainable resource management within academic institutions.

The rationale for exploring GSCM in this context is twofold. First, the scale of paper waste generated in universities represents a significant opportunity to reduce environmental impact. Paper, although recyclable, often accumulates in institutional waste streams due to inadequate collection, awareness, and infrastructure. According to Gopal, Sivaram, and Barik (2019), the annual use of wood and water in the pulp and paper industry generates considerable solid waste and wastewater, necessitating environmentally conscious solutions to mitigate its impact. Secondly, universities, as centres of learning and innovation, are well-positioned to lead by example in promoting sustainability practices. By incorporating GSCM principles, universities can not only reduce their environmental footprint but also instil sustainability values in students, who will carry these principles into various sectors of society (Micheli, Ponti, Craglia, & Berti Suman, 2020).

The theoretical foundation of GSCM encompasses various dimensions, including eco-design, green purchasing, production, logistics, and reverse logistics. Each dimension addresses a specific aspect of the supply chain, working collectively to reduce environmental impact. Eco-design, for instance, encourages products and processes that minimize resource use and environmental footprint, while green purchasing prioritizes materials that support sustainable practices. Green logistics focuses on optimizing transport to reduce emissions, and reverse logistics facilitates recycling and waste reduction (Santoso, Siagian, Tarigan, & Jie, 2022). Together, these practices create a holistic framework for managing resources more sustainably. In the context of universities, GSCM can be adapted to include waste management policies, recycling initiatives, and sustainable procurement practices that collectively reduce paper waste and promote recycling.

To structure the research, this study posits three key hypotheses, grounded in previous research linking GSCM practices with environmental sustainability outcomes. The first hypothesis suggests that an increase in paper waste capacity has a positive effect on subjective norms toward recycling. According to social norms theory, individuals are more likely to engage in behaviours when they perceive them as normative within their community. In this case, the visibility of paper waste receptacles and recycling bins can reinforce social expectations, encouraging students and staff to recycle more actively (Ghadge, Er, Ivanov, & Chaudhuri, 2022). The second hypothesis proposes that these subjective norms, in turn, enhance recycling awareness among students and faculty. Awareness is a critical factor in behaviour change, and social reinforcement of recycling norms can help increase awareness, leading to more sustainable behaviours (Bui, Tsai, Tseng, & Ali, 2020). Lastly, the third hypothesis posits that these subjective norms have a broader impact on the sustainability of the campus

ecosystem. As recycling becomes integrated into campus culture, it contributes to a more sustainable ecosystem, reducing waste, conserving resources, and setting a precedent for environmental stewardship.

The research methodology employs Structural Equation Modelling (SEM) to analyze the relationships between paper waste capacity, subjective norms, recycling awareness, and ecosystem sustainability. SEM is particularly suitable for this study as it allows for the examination of complex relationships among multiple variables, providing insights into the direct and indirect effects of GSCM practices on environmental outcomes (Antwi, Agyapong, & Owusu, 2022). Data were collected through surveys administered to students and faculty across multiple universities in Indonesia, capturing their attitudes, behaviors, and awareness regarding recycling. Additionally, secondary data on paper waste management and recycling rates provided contextual information to support the analysis.

2. Literature review

Green Supply Chain Management (GSCM) has evolved as a significant domain within environmental sustainability, integrating ecological considerations into supply chain operations to reduce waste, promote resource efficiency, and mitigate adverse environmental impacts. Defined by Ahi and Searcy (2013), GSCM extends conventional supply chain management by incorporating green practices across production, distribution, and disposal stages, thus addressing the end-to-end environmental footprint of supply chains. This expanded approach is particularly relevant in the context of higher education institutions, which produce considerable amounts of paper waste due to administrative and academic activities. Within this framework, the recycling of paper and the implementation of sustainable waste management strategies are pivotal for universities seeking to balance operational efficiency with ecological responsibility (Abubakar, Ishak, Bakar, & Uddin, 2022).

The theoretical foundation for GSCM encompasses multiple dimensions, including green purchasing, eco-design, green logistics, and reverse logistics. Each dimension aims to minimize environmental harm and encourage sustainable practices (Santoso et al., 2022). Green purchasing prioritizes sourcing materials that have minimal environmental impact, while eco-design involves designing products with reduced ecological footprints. Green logistics optimizes transportation to decrease emissions, and reverse logistics facilitates the recycling and disposal of waste. These components collectively enable an organization to manage resources sustainably, thereby reducing overall environmental degradation. In the context of universities, which serve as educational and operational hubs, adopting these GSCM practices can cultivate a sustainability-oriented institutional culture (Ghadge et al., 2022).

Research by Assumpção et al. (2022) indicates that the adoption of GSCM is influenced by several factors, including organizational commitment, regulatory frameworks, and stakeholder awareness. In developing countries like Indonesia, where GSCM adoption is still emerging, regulatory support and incentives are crucial for fostering green initiatives. Universities are uniquely positioned to lead this transition due to their educational mandate, which allows them to integrate sustainability into both their curricula and operations. Additionally, GSCM practices in universities can contribute to a wider societal shift towards environmental consciousness, as students carry these principles into various professional sectors (Bui et al., 2020).

A core component of GSCM within educational institutions is the recycling ecosystem, particularly the management of paper waste. Paper remains a staple in academic environments despite increasing digitization, and its production has substantial environmental consequences,

including deforestation and high-water usage (Hubbe & Bowden, 2009). Research on recycling behaviors in university settings underscores the need for effective waste collection and recycling infrastructure to facilitate sustainable paper usage. Moreover, integrating subjective norms—socially driven behaviors associated with sustainability—can enhance recycling awareness and participation among students and faculty (Bag & Pretorius, 2022). Studies demonstrate that visible recycling bins and campus-wide campaigns on sustainability can significantly improve recycling rates, fostering a culture that values environmental preservation.

Recent studies also explore the technological dimensions of GSCM, including the application of artificial intelligence and predictive modelling to enhance recycling efficiency. Structural Equation Modelling (SEM) and artificial neural networks are frequently used to analyze the relationships between subjective norms, recycling awareness, and waste management behaviors. For instance, a study by Antwi et al. (2022) applied SEM to examine the influence of subjective norms on recycling behavior, revealing that peer influence and social expectations are key determinants of recycling participation. Such insights underscore the importance of creating an institutional environment that encourages sustainable practices as a normative behavior (Ahmad, Al Mamun, Masukujjaman, Mohamed Makhbul, & Mohd Ali, 2023).

An additional layer of complexity in GSCM adoption lies in the intersection between environmental and operational performance. Research by Bag and Pretorius (2022) suggests that GSCM not only contributes to environmental goals but also enhances operational efficiencies by reducing resource wastage and optimizing logistics. This dual benefit is particularly relevant for universities, which often operate within budgetary constraints and seek cost-effective sustainability measures. By reducing paper waste through efficient recycling systems, universities can lower their operational costs while advancing their environmental objectives (Haghi, Fotovat, & Yaghmaei, 2023). Furthermore, studies by Mutingi, Mapfaira, and Monageng (2014) highlight the importance of performance measurement in GSCM, advocating for metrics that capture both environmental impact and cost savings. These performance metrics enable universities to evaluate the efficacy of their sustainability initiatives, making it easier to justify investments in GSCM practices.

The literature also addresses the role of organizational culture in shaping sustainability outcomes. Green Human Resource Management (GHRM), a related field, emphasizes the role of employee empowerment and environmental collaboration in fostering a culture of sustainability. When employees, including academic staff, are actively involved in sustainability initiatives, they are more likely to contribute to environmental goals. This participative approach aligns with GSCM principles, as it reinforces a shared responsibility for sustainable practices within the institution. Universities can leverage GHRM by involving staff and students in waste management initiatives, thus creating a collaborative environment that supports GSCM implementation (Lee, Qin, & Li, 2022). The economic aspect of GSCM is another area of growing interest, particularly regarding its impact on financial performance. According to Alghababsheh, Butt, and Moktadir (2022), GSCM practices can positively affect financial outcomes by enhancing a company's reputation, attracting environmentally conscious stakeholders, and reducing waste management costs. Although universities are not profit-driven entities, the cost savings associated with reduced waste and improved recycling can make GSCM financially viable. This cost-benefit dynamic is essential for institutions in developing regions, where financial constraints often limit the adoption of sustainability measures. By

demonstrating that GSCM can yield both environmental and economic returns, universities can create a compelling case for green initiatives (Lendzion, 2015).

The adoption of GSCM in Indonesian higher education, however, faces several challenges. A study by Ariyanti (2018) points to a lack of regulatory support as a significant barrier to GSCM adoption in Indonesia. Additionally, limited awareness and understanding of GSCM among stakeholders hinder its implementation. Universities often lack the infrastructure and resources needed to establish comprehensive recycling systems, which underscores the need for government support and institutional investment in GSCM. The findings by Janahi, Durugbo, and Al-Jayyousi (2021) further suggest that building a robust GSCM framework requires a collaborative approach, involving partnerships between universities, government agencies, and industry players to overcome resource limitations and drive sustainability in academic settings.

Moreover, the literature highlights the potential for GSCM to contribute to broader sustainability goals beyond campus boundaries. As centers of knowledge and innovation, universities can influence community behaviors by modelling sustainable practices. A study by Leonidou, Eteokleous, Christodoulides, and Eduardsen (2023) indicates that organizations that engage in socially responsible practices often inspire similar behaviors within their communities, creating a ripple effect that extends the impact of GSCM. For Indonesian universities, adopting GSCM practices could have a similar effect, encouraging local communities to embrace recycling and environmental conservation. Such an approach aligns with the principles of corporate social responsibility (CSR), which increasingly emphasizes environmental stewardship as a core component of organizational ethics (Javaid, Haleem, Singh, Suman, & Rab, 2021). The literature underscores the multifaceted nature of GSCM, encompassing economic, social, and environmental dimensions that make it an ideal framework for sustainable waste management in higher education. The adoption of GSCM in Indonesian universities represents an opportunity to reduce paper waste, foster a culture of sustainability, and achieve cost savings through efficient resource management. However, realizing these benefits requires addressing the challenges posed by regulatory constraints, stakeholder awareness, and resource limitations. As the literature suggests, a successful GSCM framework will necessitate an institutional commitment to sustainability, supported by governmental policies and collaborative partnerships. Future research should continue to explore the application of advanced technologies, such as predictive modelling, in enhancing the efficacy of GSCM in academic settings, as well as the broader impact of GSCM practices on community sustainability efforts. Through such initiatives, universities can play a critical role in advancing environmental sustainability, setting an example for other sectors and fostering a generation of environmentally conscious citizens.

3. Research methodology

This study employed a quantitative approach grounded in the positivist research philosophy, which assumes that scientific understanding is derived from observable facts and logical deduction (Neuman & Tan, 2011). The chosen design aligns with the study's objective of examining causal relationships between variables in Green Supply Chain Management (GSCM) practices, particularly in managing paper waste within Indonesian higher education institutions. The research followed a structured process, which included defining the research hypotheses, developing the survey instrument, collecting data, and applying statistical analysis to test the proposed model and Sample

The population targeted in this study comprised final-year students from Creative Media Polytechnic and Krisnadwipayana University, both located in Jakarta, Indonesia. These institutions were selected due to their academic activities that consistently generate paper waste, making them suitable for examining GSCM practices within an educational setting. The sample was chosen based on purposive sampling, focusing on students who engage actively in paper-reliant tasks, such as thesis preparation, which contributes significantly to campus waste production. A sample size of 200 students was determined to be adequate for Structural Equation Modeling (SEM), following established guidelines suggesting a minimum of 200 observations for such analysis.

Data were collected using a structured survey distributed both online and offline. Online surveys were administered to students engaged in industrial internships, while offline surveys were conducted on campus to ensure accessibility for students present during academic sessions. This mixed-mode approach aimed to maximize response rates and minimize data collection biases (Sani, Aisyah, et al., 2022; Sani, Budiyantra, Khair, & Aisyah, 2022). The survey included items that captured demographic information, followed by questions that measured constructs central to the study, such as paper waste management practices, subjective norms surrounding recycling, and awareness of ecosystem sustainability. Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree) were used to quantify responses, facilitating statistical analysis.

To ensure validity and reliability was conducted with a small subset of the sample population. Feedback from this preliminary testing led to adjustments in question wording and survey structure, enhancing clarity and ensuring that the questions accurately captured the intended constructs. The survey items were then tested for internal consistency using Cronbach's Alpha, with a threshold of 0.7 or higher considered acceptable for reliable constructs (Malhotra et al., 2017).

Variables and Instrumentation

The primary included paper waste capacity, subjective norms, recycling awareness, and ecosystem sustainability. Each variable was operationalized based on established definitions in the GSCM literature, with tailored survey items developed for accurate measurement:

1. Paper Waste Capacity – measured through questions regarding the volume and management of paper waste generated in academic settings.
2. Subjective Norms – assessed by asking respondents about their perceptions of social expectations related to recycling behaviors on campus.
3. Recycling Awareness – gauged through items on participants' understanding of recycling processes, benefits, and the availability of recycling facilities.
4. Ecosystem Sustainability – measured by items that reflect the respondent's commitment to long-term environmental practices within the campus community.

Table 1 below provides a detailed list of these variables, along with representative survey items. This table is essential for presenting the operational definitions and measurement items in a structured manner.

Table 1. Survey Instrument and Constructs for GSCM Variables

Variable	Survey Item	Likert Scale
Paper Waste Capacity	The paper waste on campus is managed effectively.	1–5
Subjective Norms	Most students I know support recycling initiatives.	1–5
Recycling Awareness	I am aware of recycling facilities available on campus.	1–5
Ecosystem Sustainability	Recycling contributes to the long-term sustainability of our campus environment.	1–5

This table aids in summarizing the key constructs and ensures transparency in how each variable was measured, an approach consistent with best practices in quantitative research.

Data Analysis Procedure

The data analysis process began with data cleaning and preparation, involving coding, verification, and entry into statistical software. Structural Equation Modelling (SEM) was used to test the hypothesized relationships among variables due to its robustness in handling complex relationships and mediating variables, making it ideal for examining causal inferences in GSCM practices (Antwi et al., 2022; Sani, Khristiana, Zailani, & Husain, 2020). SEM was performed using MATLAB, with Confirmatory Factor Analysis Critically to validate the measurement model. CFA helped ensure that the constructs had adequate validity and reliability, confirming that the survey items accurately reflected the underlying theoretical constructs.

To ensure model fit, multiple indices were examined, including the Chi-Square Test, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI). Values close to 1 in CFI and TLI and below 0.08 in RMSEA were considered indicators of good model fit, following established benchmarks. In instances of poor model fit, modifications were made by examining error covariances and adjusting items as needed, maintaining the integrity of the theoretical constructs.

Ethical Considerations

Prior to data collection, ethical approval was obtained from the respective institutions, ensuring that the study adhered to ethical guidelines, particularly regarding informed consent and confidentiality. Respondents were assured that participation was voluntary, and data were anonymized to protect individual privacy. Additionally, the researchers implemented strict data handling protocols to prevent unauthorized access, aligning with ethical standards in social science research.

For clarity, Figure 1 below illustrates the codework of the study, highlighting the hypothesized relationships among paper waste capacity, subjective norms, recycling awareness, and ecosystem sustainability. This visual model serves as a reference for understanding the pathways tested in the SEM analysis and underscores the study's focus on mediating and direct effects within the GSCM context.

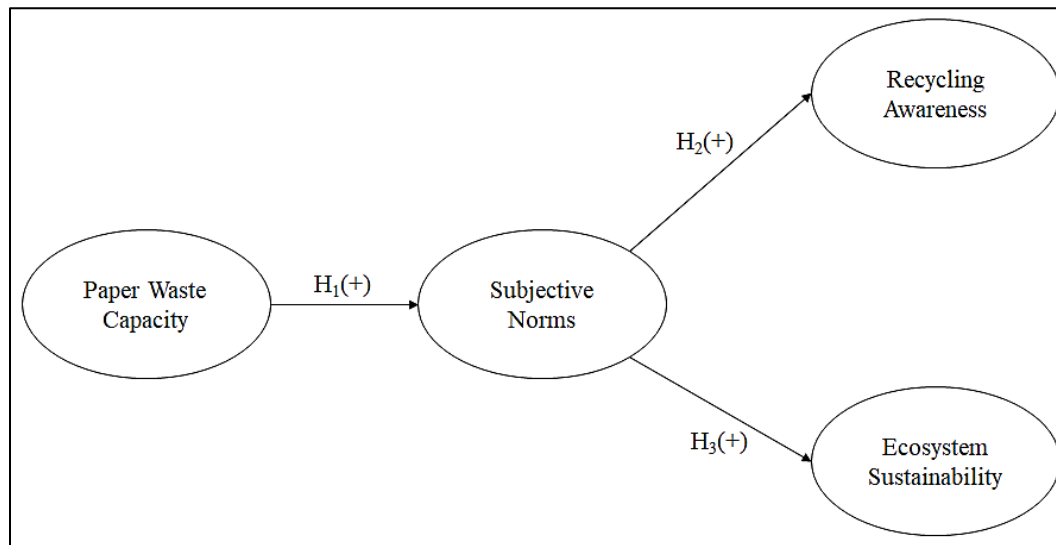


Figure 1. Conceptual Framework of GSCM Impact on Ecosystem Sustainability in Higher Education

The study's reliance on self-reported survey data introduces potential biases, such as social desirability bias, which may influence responses on sensitive issues like environmental behavior. Furthermore, the sample was limited to students from two universities in Jakarta, which may constrain the generalizability of the findings across other educational institutions or geographic locations. Future studies could expand on this research by incorporating additional universities and exploring longitudinal data to assess the persistence of GSCM practices over time. This methodological framework provides a comprehensive approach to examining the influence of GSCM practices on sustainability within an academic setting, offering insights into the potential for sustainable supply chain management practices to foster a culture of environmental responsibility among students and staff. This approach aligns with broader goals of promoting eco-conscious behaviors within institutions and contributes to the growing body of knowledge on sustainable practices in educational environments.

4. Results and discussion

Descriptive Analysis

The study analysed responses from 224 participants from two Indonesian universities, Creative Media Polytechnic and Krisnadwipayana University, which provided a representative sample of students engaged in activities that generate significant paper waste. The gender distribution was nearly equal, with 50.44% female and 49.56% male respondents. Most respondents were under 21 years old, consistent with the typical age range of university students. This demographic data aligns with the characteristics expected in the Indonesian higher education setting, where younger students often play active roles in environmental initiatives.

Structural Model Results

The structural model was analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) to examine relationships between variables, including Paper Waste Capacity (PWC), Subjective Norms (SN), Recycling Awareness (RA), and Ecosystem Sustainability (ES). The model's fitness was assessed through indices such as RMSEA, CFI, and TLI, with each indicating adequate model fit. The multicollinearity test results, shown in

Table 1, confirmed that all items had VIF values below the threshold of 10, suggesting no significant multicollinearity issues among indicators.

Table 1. Multicollinearity Test Results

Item	VIF	Item	VIF
PWC1	1.449	RA1	2.025
PWC2	2.470	RA2	3.072
PWC3	7.136	RA3	2.296
PWC4	8.507	RA4	1.345
SN1	12.645	ES1	1.688
SN2	10.997	ES2	1.555
SN3	1.685	ES3	1.578
SN4	7.580	ES4	2.476
SN5	4.603	ES5	2.359

These results confirmed the model's validity and reliability, ensuring that subsequent analyses reflect accurate constructs of recycling awareness, subjective norms, and their impact on sustainability in educational institutions.

Hypothesis Testing and Findings

Each hypothesis was evaluated based on the t-values and significance levels obtained from SEM analysis, confirming the relationships hypothesized in the study. A P-value threshold of <0.05 and a t-value greater than 1.96 were used to determine significance.

1. **H1: Paper Waste Capacity Influences Subjective Norms toward Recycling**
The relationship between PWC and SN was significant ($P < 0.05$, $t > 1.96$), affirming that an increase in the capacity for handling paper waste positively affects subjective norms surrounding recycling. This finding aligns with studies suggesting that visibility and availability of recycling infrastructure can reinforce recycling behaviors by creating a normative environment supportive of sustainability (Antwi et al., 2022).
2. **H2: Subjective Norms Enhance Recycling Awareness**
Subjective norms had a statistically significant impact on RA ($P < 0.05$, $t > 1.96$). This suggests that social expectations and peer influence encourage individual awareness regarding recycling practices, consistent with the theory that behavioral norms shape individual environmental awareness and participation (Herth & Blok, 2022).
3. **H3: Subjective Norms and Recycling Awareness Influence Ecosystem Sustainability**
Both SN and RA showed significant positive effects on ES ($P < 0.05$, $t > 1.96$), confirming that fostering a culture of recycling and environmental awareness contributes to broader campus sustainability goals. This result highlights that when students and staff perceive recycling as a communal expectation, it enhances overall ecosystem sustainability—a finding that supports previous research in environmental behavior (Uehara, Sakurai, & Hidaka, 2022).

Discussion

The study's findings underscore the potential of GSCM practices, particularly within the framework of educational institutions, to advance sustainability objectives. By confirming the hypothesized relationships, this research demonstrates that increased paper waste management capacity, coupled with strong subjective norms and heightened recycling awareness, fosters an ecosystem-oriented sustainability culture in universities. The significant relationship between PWC and SN suggests that simply increasing the accessibility and capacity of recycling facilities can directly influence attitudes and behaviors toward recycling on campus. This observation is particularly relevant in higher education institutions, where recycling behaviors are not always consistent due to limited infrastructure or awareness. Similar to findings by Leonidou et al. (2023), this study corroborates the importance of structured, accessible waste management solutions in promoting environmental consciousness.

The second hypothesis, confirming that SN positively influences RA, points to the power of social influence in shaping sustainable practices. Subjective norms serve as an essential factor in bolstering individual commitment to recycling by fostering a supportive environment where recycling is not only expected but encouraged. This aligns with Ajzen's Theory of Planned Behavior, which states that perceived social pressure can significantly influence individuals' intentions to engage in certain behaviors. The positive impact of SN and RA on ES underscores the cumulative effect of normative influence and individual awareness on institutional sustainability. As universities strive to become role models for environmental responsibility, these findings emphasize that achieving campus sustainability involves more than just technical solutions; it requires cultivating a mindset that values environmental stewardship among students and staff. This study's results suggest that embedding GSCM principles within university operations could make a substantial impact, not only reducing paper waste but also establishing a campus-wide culture of environmental responsibility, as suggested by Lee et al. (2022).

Implications for Policy and Practice

The research implications extend to institutional policies and environmental programs aimed at increasing recycling participation within universities. The significant relationship between waste capacity and subjective norms suggests that investing in visible and accessible recycling infrastructure may be an effective strategy to drive behavioral change. Universities could benefit from initiatives that make recycling an integral part of campus life, potentially supported by sustainability education programs that reinforce the importance of environmental conservation. Additionally, promoting subjective norms through social campaigns or student-led initiatives could amplify recycling awareness and commitment. By leveraging peer influence, universities can create a recycling-friendly environment that encourages students to adopt sustainable behaviors even outside campus boundaries. These approaches would support a university's sustainability objectives and potentially inspire similar behaviors within surrounding communities, extending the influence of GSCM beyond campus borders.

Study Limitations and Future Research

While the study contributes valuable insights, several limitations should be acknowledged. The reliance on self-reported data may introduce biases such as social desirability, as participants may overstate environmentally favourable behaviours. Future studies could address this limitation by incorporating observational data or employing longitudinal methods to assess changes in behaviour over time. Moreover, the study was conducted in a limited geographic area within Indonesia, potentially restricting the generalizability of the findings. Expanding the study to include multiple institutions across

diverse regions could provide a broader perspective on GSCM adoption and its impact on university sustainability. Additionally, exploring technological advancements, such as IoT-enabled waste tracking systems, could offer new insights into optimizing recycling processes within academic settings. This study reaffirms the role of GSCM in fostering a culture of sustainability within universities. By validating the proposed model, the research highlights the significance of recycling infrastructure, social influence, and environmental awareness in promoting sustainable behaviors. Universities adopting GSCM practices stand to benefit not only in terms of environmental impact but also by enhancing their social responsibility profiles, contributing to a more sustainable future.

5. Conclusion

This study underscores the effectiveness of Green Supply Chain Management (GSCM) practices in promoting sustainability within higher education institutions, focusing specifically on the recycling of paper waste. By examining the interplay among paper waste capacity, subjective norms, recycling awareness, and ecosystem sustainability, the findings affirm that GSCM can create significant, positive shifts in campus environmental practices. The confirmed hypotheses establish that when universities provide adequate recycling infrastructure, they not only facilitate paper waste reduction but also positively influence normative behaviors around recycling. This supports the assertion that structured, accessible waste management solutions can drive institutional sustainability, as indicated in prior research on environmental practices in academic settings. A key contribution of this research lies in demonstrating the role of subjective norms in bolstering recycling awareness, which in turn influences sustainable behaviors within the campus ecosystem. The significant correlation between social expectations and recycling awareness suggests that fostering a supportive community environment can encourage greater adherence to recycling practices. This aligns with the Theory of Planned Behavior, which identifies social influence as a determinant in promoting environmentally responsible behaviors. When recycling is perceived as a normative, valued behavior, students and staff are more likely to incorporate it into their daily routines. Consequently, universities that adopt policies supporting sustainability campaigns and peer-led initiatives can further enhance recycling participation, thereby extending the benefits of GSCM practices beyond mere infrastructure improvements.

This study also contributes to the literature by highlighting the cumulative impact of recycling infrastructure and social influence on ecosystem sustainability. It is evident that physical resources, such as recycling bins and waste processing facilities, must be complemented by institutional efforts to cultivate environmental awareness and a sustainability-focused mindset among students and faculty. As universities increasingly prioritize sustainability goals, these findings suggest that combining GSCM with education-focused initiatives could yield a comprehensive framework for promoting sustainable behaviors. Such a model could transform university campuses into sustainable ecosystems that serve as models for other sectors and communities, extending the influence of GSCM practices on a larger societal scale. Despite its contributions, this research has limitations, particularly regarding the generalizability of the findings. The study's focus on universities within a specific geographic region restricts the extent to which these results can be applied universally. Future research could address this limitation by expanding the scope to include diverse institutions across various cultural and regional contexts, enabling a more comprehensive understanding of GSCM's impact within higher education. Furthermore, the reliance on self-reported data introduces potential bias, which could be mitigated in future studies through the use of

observational or longitudinal methodologies. Future research could also explore the integration of advanced technologies, such as IoT and data analytics, to enhance waste management and tracking systems within universities. In conclusion, this study reaffirms the value of GSCM in creating sustainable educational institutions. By validating the impact of recycling infrastructure and social influence on environmental sustainability, the findings contribute to a growing body of evidence supporting GSCM as a pathway to foster environmentally responsible behaviors within universities. The broader implications extend beyond academia, suggesting that institutions willing to invest in sustainable practices can cultivate a culture of environmental stewardship that benefits both their immediate campus and the surrounding community. As universities adopt and refine GSCM frameworks, they are poised to play an influential role in the global sustainability movement, setting a precedent for integrating eco-conscious practices within educational, corporate, and community settings.

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