

---

## Green Inventory and Production Models: Integrating Behavioral Insights with Quantitative Analysis for Smart Urban Development

<sup>1</sup>Pawni,<sup>2</sup> Prof CP Gujar, <sup>3</sup>Ran Vijay Singh

<sup>1</sup>Research Scholar, Department of Business Management, MGCG University, Satna, MP

<sup>2</sup>Head Department of Business Management MGCG University Satna, MP

<sup>3</sup>Research Scholar, Department of Business Management, MGCG University, Satna, MP

---

DOI : <https://doi.org/10.5281/zenodo.20126301>

---

### ARTICLE DETAILS

**Research Paper**

**Accepted:** 24-04-2026

**Published:** 10-05-2026

---

**Keywords:**

*Sustainable Operations, Smart Cities, Theory of Planned Behaviour (TPB), Green Inventory Management*

---

---

### ABSTRACT

Rapid urbanization and digital transformation have increased environmental pressures on urban supply chains and production systems. While smart cities emphasize technological solutions, sustainable inventory and production decisions also require behavioural support alongside quantitative optimization. This study integrates eco-friendly inventory and production models with the Theory of Planned Behaviour (TPB) to examine the adoption of sustainable practices in the Delhi NCR region. Using Structural Equation Modelling (SEM), the study evaluates the impact of attitude toward frugal innovation, subjective norms, and perceived behavioural control on behavioural intention and actual adoption. Results indicate strong measurement model properties, including high internal consistency reliability, with Composite Reliability values ranging from 0.869 to 0.928, and satisfactory convergent validity, with AVE values ranging from 0.689 to 0.812. The structural model explains 60.4% of the variance in behavioural intention and 54.3% of the variance in adoption behaviour, with perceived behavioural control emerging as the strongest predictor. The study further connects behavioural findings with models such as Green EOQ and sustainable lot-sizing, offering an integrated framework that balances cost efficiency with environmental sustainability in smart city

---



---

supply chains.

---

## Introduction

**1.1 Global Sustainability Imperatives and Transformation of Operations Management** The 21st century is marked by rapid industrial growth, urbanization, and globalization, which have significantly strengthened production and supply networks while accelerating economic development. However, these advancements have also intensified environmental challenges such as carbon emissions, resource depletion, and climate instability. Global initiatives like the Paris Climate Agreement and Sustainable Development Goals have urged organizations to integrate sustainability into their operations. Traditionally, operations management focused on cost reduction, efficiency, and service optimization, often overlooking environmental consequences. Core systems like inventory and production planning were designed for economic efficiency, with models such as EOQ ignoring ecological costs. Today, organizations are required to balance traditional performance metrics with environmental indicators like carbon footprint and energy usage. This shift reflects a broader transition toward sustainable and circular production systems. Additionally, digital technologies in smart cities enable real-time monitoring of environmental performance, enhancing transparency and accountability. As a result, sustainable operations are no longer optional but essential for long-term competitiveness and legitimacy.

### 1.1 Development of Green Inventory and Production Models

Green inventory and production models represent a crucial integration of environmental concerns into traditional operations research. Classical EOQ models focused solely on minimizing ordering and holding costs, without accounting for environmental impacts such as emissions or energy consumption. With increasing environmental awareness, researchers have extended these models to include factors like carbon taxes, fuel usage, and emission costs. These green models modify decision-making processes to reduce environmental harm, often encouraging optimized ordering frequencies and sustainable transportation strategies. Similarly, sustainable lot-sizing models balance economic efficiency with ecological considerations, addressing the trade-off between large production batches and increased environmental impact. The integration of lean and green principles further enhances operational sustainability by minimizing waste, reducing energy consumption, and improving process efficiency. Digital technologies such as sensors and analytics support these efforts in smart manufacturing environments. Despite these advancements, adoption remains inconsistent across industries due to cost



concerns, complexity, and uncertainty, indicating that behavioral and institutional factors play a critical role.

## 2.1 Digitalization and Smart Cities Driving Sustainable Operations

Digital transformation has significantly improved operational efficiency by enhancing data visibility and decision-making capabilities through technologies like IoT, AI, and cloud computing. In smart city ecosystems, these technologies integrate industrial, transport, and energy systems, enabling coordinated and sustainable urban management. Real-time monitoring tools allow organizations to track emissions, optimize energy usage, and implement predictive maintenance, improving environmental performance. Digital platforms also enhance transparency by providing stakeholders with clear sustainability metrics, increasing pressure on firms to adopt green practices. However, digital capability alone does not ensure sustainability; organizations may continue prioritizing cost efficiency unless environmental goals are strategically embedded. Managerial commitment and alignment are essential for leveraging digital tools effectively. In rapidly urbanizing regions like Delhi NCR, increasing environmental pressures and regulatory initiatives promote sustainable industrial practices. The combination of digital infrastructure and environmental governance creates a unique context for studying how organizations adopt eco-friendly operational models, highlighting the importance of behavioural factors in driving sustainability.

## 1.2 Sustainable Operations

The relationship between sustainability and competitiveness has evolved significantly, with sustainability now viewed as a strategic advantage rather than a cost burden. Organizations adopting sustainable practices benefit from improved resource efficiency, reduced energy consumption, and lower operational costs over time. Compliance with environmental regulations also reduces legal risks and enhances corporate reputation. Furthermore, environmentally responsible firms attract investors and customers who prioritize sustainability. Green inventory and production models contribute directly to competitive positioning by optimizing resource utilization and aligning with environmental expectations. For example, green EOQ reduces transportation frequency and fuel costs, while sustainable lot-sizing minimizes waste and enhances efficiency. Lean-green scheduling further improves productivity and energy savings. In smart city environments, where digital transparency increases accountability, organizations adopting sustainable operations gain strategic differentiation. However, the realization of these benefits depends on effective implementation, which is influenced by managerial behaviour, organizational readiness, and institutional support.



### 1.3 Research Gaps and the Need for Behavioral Analysis

Although extensive research exists on eco-friendly inventory models, most studies are heavily quantitative and focus on optimization and simulation. These approaches often assume that organizations will adopt sustainable practices once economic feasibility is established.

However, real-world adoption is far more complex.

Managerial perceptions, institutional pressures, and perceived capability constraints significantly influence decision-making. Even economically viable green models may face delayed or limited adoption due to uncertainty, resistance to change, and perceived risks. This highlights a critical gap between theoretical model development and practical implementation.

To bridge this gap, a behavioral perspective is essential. The Theory of Planned Behavior (TPB) provides a robust framework to understand how attitudes, social pressures, and perceived control shape adoption intentions and actual behavior. Applying TPB to ecofriendly operations enables a deeper understanding of the psychological and institutional drivers influencing sustainable decision-making in smart city environments.

### 1.3 Sustainable Operations and the Theory of Planned Behavior (TPB)

Adoption of eco-friendly inventory and production systems requires moving beyond technical efficiency toward behavioral understanding. Operational transformation is not driven solely by optimization but also by managerial cognition, institutional context, and perceived feasibility.

The Theory of Planned Behavior explains adoption through three key constructs:

- **Attitude:** Managers' evaluation of eco-friendly models in terms of benefits such as cost savings, compliance, and reputation. While positive attitudes support adoption, short-term profitability concerns and uncertainty may weaken them.
- **Subjective Norms:** External pressures from regulations, industry standards, and stakeholders. In smart city ecosystems, these norms play a crucial role in shaping sustainable practices.
- **Perceived Behavioral Control:** Managers' perception of their ability to implement changes, including access to resources, technology, and capabilities. This is often the strongest predictor of adoption, as implementation may require system redesign and process restructuring.



Despite its wide application in other domains, TPB remains underexplored in operations management, particularly in eco-friendly inventory systems.

### Frugal Innovation and Sustainable Operations

An important extension to this discussion is **frugal innovation**, which emphasizes low-cost, resource-efficient solutions. Instead of relying on expensive technologies, it promotes simple, adaptable, and scalable operational changes.

Examples include:

- Adjusting order frequency to reduce emissions
- Optimizing batch sizes to minimize waste
- Rescheduling production to reduce energy peaks

Such incremental improvements require minimal investment but yield measurable environmental benefits, making them highly relevant for developing urban-industrial regions.

### Smart City Context: Kanpur Nagar

The study is situated in the Kanpur Nagar region, a rapidly evolving urban-industrial ecosystem facing significant environmental challenges such as pollution, congestion, and high energy consumption. Smart city initiatives in the region emphasize digitalization, sustainability, and environmental monitoring.

Despite supportive policies and technological infrastructure, adoption of sustainable practices varies across firms. This variation underscores the importance of behavioral factors in shaping operational decisions.

### Research Contribution and Objective

This chapter contributes by integrating behavioral theory with sustainable operations, addressing the gap between model development and real-world adoption. While quantitative models highlight efficiency and environmental trade-offs, their implementation depends on managerial intention and perceived capability.

The study aims to examine how attitude, subjective norms, and perceived behavioral control influence the adoption of eco-friendly inventory and production models in a smart city context. Using Structural



Equation Modelling, it provides insights into how behavioral and institutional factors drive sustainable operational transformation.

## 2. Literature Review

### 2.1 Evolution of Green Inventory Models

The integration of environmental considerations into inventory theory has gained prominence with the emergence of carbon taxation policies and sustainability reporting standards. Traditional inventory models, particularly the Economic Order Quantity (EOQ), were primarily designed to minimize ordering and holding costs under deterministic assumptions, without accounting for environmental externalities. With increasing regulatory and societal pressure to reduce emissions, researchers have extended these models into Green EOQ frameworks by incorporating carbon emission costs into cost functions.

Empirical and theoretical studies indicate that higher carbon costs lead to reduced optimal order quantities, thereby lowering average inventory levels and associated emissions. Recent advancements emphasize multi-objective optimization approaches that simultaneously balance cost efficiency, emission reduction, and service levels. Additionally, the incorporation of lifecycle assessment and stochastic demand has enhanced the realism of these models. Despite these developments, empirical validation—particularly within smart city ecosystems—remains limited, highlighting a gap between theoretical advancement and practical implementation.

### 2.2 Lean-Green Production Scheduling and Sustainable Lot-Sizing

Lot-sizing models, such as the Wagner–Whitin algorithm, have traditionally focused on optimizing production batch sizes to minimize setup and holding costs over finite planning horizons. Contemporary research extends these models by integrating environmental parameters, including emission coefficients associated with production and setup processes. This results in a multi-objective optimization problem where economic and environmental goals must be balanced.

Lean-green production scheduling further strengthens this integration by combining lean manufacturing principles—such as waste minimization and just-in-time production—with sustainability objectives. Energy-efficient scheduling techniques aim to reduce machine idle time, peak electricity consumption, and operational emissions. Recent studies also explore carbon-aware scheduling algorithms and metaheuristic approaches for solving complex optimization problems. However, despite technological



advancements, practical adoption is often constrained by perceived implementation costs and limited managerial awareness, indicating the importance of non-technical factors.

### 2.3 Frugal Innovation in Sustainable Operations

Frugal innovation has emerged as a critical approach for implementing sustainability in resource-constrained environments. It emphasizes simplicity, cost efficiency, and adaptability, enabling organizations to achieve environmental objectives without significant capital investment. In operations management, frugal strategies include optimizing transportation routes, adopting decentralized renewable energy systems, and implementing low-cost emission monitoring tools.

Recent literature positions frugal innovation as a key enabler of circular economy practices and low-carbon industrial transformation, particularly in developing economies. However, its integration into formal inventory and production modelling frameworks remains relatively underexplored. This gap suggests the need for a more holistic approach that combines technical optimization with context-specific, resource-efficient innovation strategies.

### 2.4 Behavioral Perspective: Theory of Planned Behavior (TPB)

While quantitative models provide valuable insights into optimal decision-making, they often assume rational adoption once economic feasibility is established. In practice, organizational decisions are influenced by behavioral and institutional factors. The Theory of Planned Behavior (TPB) offers a robust framework to analyse such dynamics, positing that behavioral intention is shaped by three key constructs: attitude, subjective norms, and perceived behavioral control.

TPB has been widely applied in domains such as green consumer behaviour, renewable energy adoption, and waste management. However, its application in operations management—particularly in the context of eco-friendly inventory and production systems—remains limited. Integrating TPB into this domain enables the examination of managerial perceptions, social pressures, and perceived implementation capabilities that influence adoption decisions.

### Synthesis and Research Gap

The literature demonstrates a clear transition from traditional cost-centric models to sustainability-oriented operational frameworks incorporating environmental considerations. Nevertheless, the dominant focus remains on quantitative modelling, with insufficient attention to behavioral determinants and



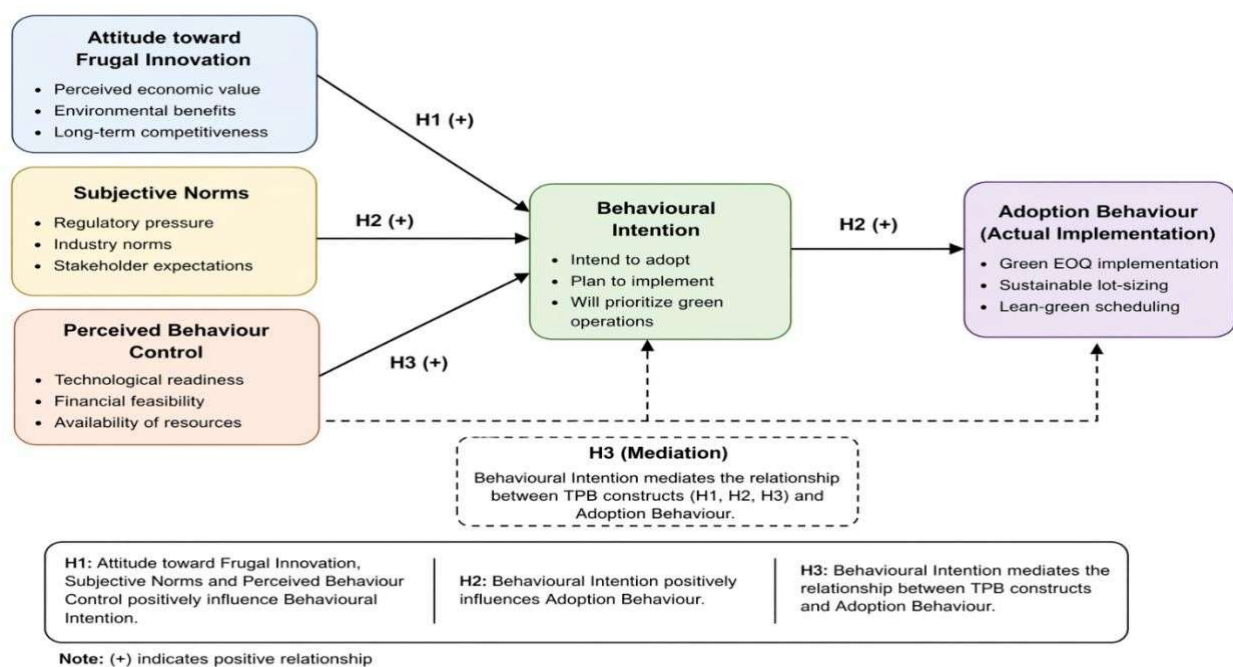
contextual realities. Furthermore, the role of frugal innovation in enabling sustainable operations has not been adequately integrated with inventory modelling approaches.

Importantly, there is a lack of empirical studies examining how behavioral factors influence the adoption of green inventory systems, particularly within smart city environments. This study addresses this gap by integrating the Theory of Planned Behavior with eco-friendly inventory and production models, providing a comprehensive framework to understand both technical feasibility and behavioral readiness for sustainable operational transformation.

### 3. Theory and Hypothesis Formulation

The conceptual framework (Fig. 1) integrates the **Theory of Planned Behavior (TPB)** with the adoption of eco-friendly inventory and production models. It explains how behavioral and contextual factors influence managerial decisions regarding sustainable operations. Frugal innovation attitude reflects managers’ perception that eco-friendly operational practices can deliver both economic and environmental value. Subjective norms capture external pressures from regulatory authorities, corporate governance mechanisms, and societal expectations to adopt sustainable practices. Perceived behavioral control represents managers’ assessment of their ability to implement such systems, including technological readiness and financial feasibility.

These factors collectively influence **behavioral intention**, which serves as the immediate predictor of actual adoption behavior. In this study, adoption behavior refers to the implementation of practices such as Green EOQ, sustainable lot-sizing, and lean-green scheduling.





### Fig. 1: Conceptual Framework

Based on TPB, the following hypotheses are proposed:

- **H1:** Frugal innovation attitude, subjective norms, and perceived behavioral control have a positive effect on behavioral intention to adopt eco-friendly inventory and production models.
- **H2:** Behavioral intention has a positive effect on the adoption of eco-friendly inventory and production models.
- **H3:** Behavioral intention mediates the relationship between TPB constructs (attitude, subjective norms, and perceived behavioral control) and adoption behavior.

This framework links behavioral determinants with sustainable operational practices, offering a comprehensive approach to understanding the adoption of green inventory systems.

## 4. Research Methodology

### 4.1 Research Design

The study adopts a **quantitative explanatory research design** to empirically validate the proposed behavioral–operational framework. **Structural Equation Modelling (SEM)** is employed as the primary analytical technique due to its ability to simultaneously assess measurement validity and structural relationships among latent constructs. SEM is particularly suitable for theory-driven research involving mediation and multi-construct interactions. The empirical context of the study is **Kanpur Nagar**, a rapidly developing urban-industrial region characterized by diverse manufacturing activities and increasing emphasis on digital and sustainable transformation. The region provides a relevant setting to examine the adoption of eco-friendly inventory and production models under both technological readiness and environmental pressures.

A **cross-sectional research design** is used, capturing behavioral perceptions and adoption practices at a single point in time. While longitudinal approaches may offer dynamic insights, cross-sectional SEM is effective for initial theory testing and relationship validation. The model integrates constructs from the Theory of Planned Behavior with operational adoption outcomes, thereby extending TPB into the domain of sustainable operations management.



## 4.2 Sampling Procedure and Data Collection

Data were collected from **250 respondents** actively involved in inventory management, production planning, sustainability practices, and industrial operations within Kanpur Nagar. A **purposive sampling technique** was employed to ensure that respondents possess relevant decision-making authority or operational expertise, thereby enhancing construct validity. A structured questionnaire was developed using validated scales from prior TPB and sustainability literature. The instrument consisted of two sections:

- (i) demographic information, and
- (ii) construct measurement items.

All items were measured using a five-point Likert scale ranging from “strongly disagree” to “strongly agree.” A pilot study was conducted with 30 respondents to assess clarity and reliability, leading to minor refinements in the questionnaire.

Data collection was carried out through a combination of online surveys and direct professional interactions to ensure adequate coverage. Ethical considerations were maintained by ensuring respondent anonymity and voluntary participation. The dataset was screened for missing values and outliers before analysis.

## 4.3 Measurement Model Assessment

The measurement model was evaluated to ensure the **reliability and validity** of the constructs using SEM.

- **Internal Consistency Reliability:**

Cronbach’s alpha values ranged from **0.780 to 0.884**, exceeding the recommended threshold of 0.70. Composite Reliability values ranged from **0.869 to 0.928**, indicating strong reliability.

- **Convergent Validity:**

Average Variance Extracted (AVE) values ranged from **0.689 to 0.812**, all above the acceptable threshold of 0.50, confirming that constructs explain a substantial portion of variance in their indicators. Factor loadings were predominantly above **0.75**, demonstrating strong item reliability.

- **Discriminant Validity:**



The **Fornell–Larcker criterion** confirmed construct distinctiveness, as the square root of AVE for each construct exceeded its correlations with other constructs.

• **Multicollinearity Assessment:**

Variance Inflation Factor (VIF) values were below critical limits, indicating no significant multicollinearity issues.

Overall, the results confirm that the measurement model is robust and suitable for subsequent structural model analysis.

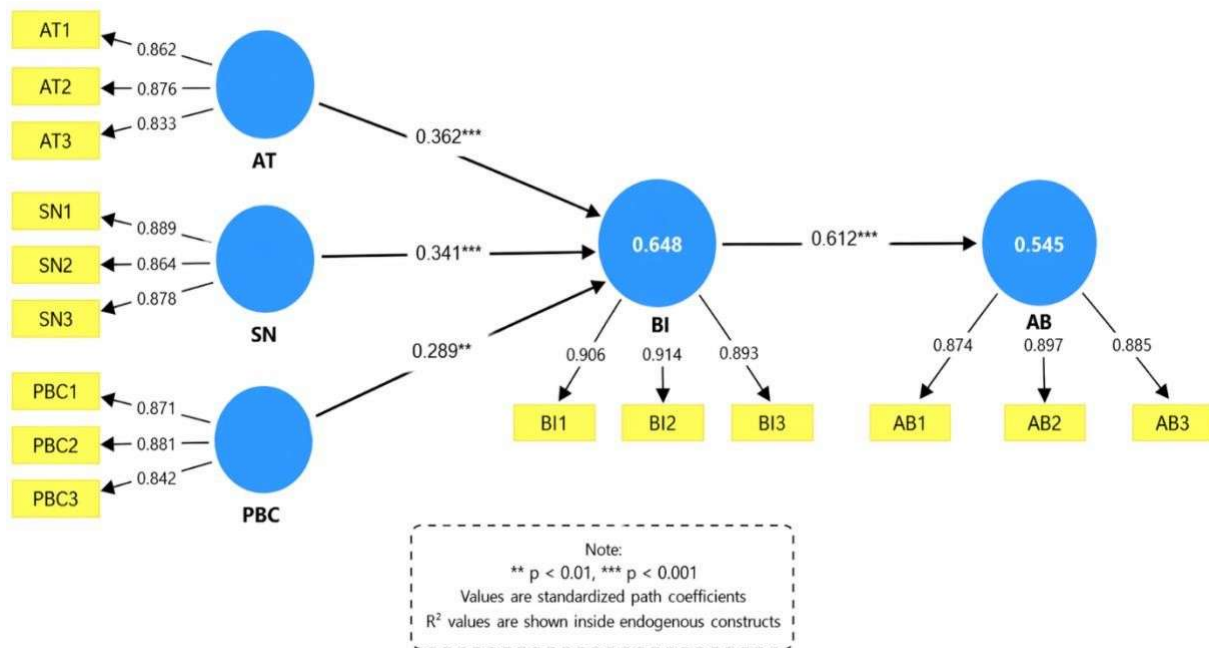


Fig 2. Measurement Model

Table 1: Reliability and Convergent Validity

Construct	Cronbach's Alpha	Composite Reliability (CR)	AVE
AT (Attitude)	0.780	0.869	0.689
SN (Subjective Norms)	0.847	0.906	0.764
PBC (Perceived Behavioural Control)	0.819	0.892	0.734
BI (Behavioural Intention)	0.884	0.928	0.812



AB (Adoption Behaviour)	0.856	0.912	0.777
-------------------------	-------	-------	-------

All values satisfy recommended thresholds:

- Alpha > 0.70
- CR > 0.70
- AVE > 0.50

Table 2: Discriminant Validity (Fornell–Larcker Criterion)

Constructs	AT	SN	PBC	BI	AB
<b>AT</b>	<b>0.830</b>				
<b>SN</b>	0.541	<b>0.874</b>			
<b>PBC</b>	0.603	0.577	<b>0.857</b>		
<b>BI</b>	0.689	0.655	0.742	<b>0.901</b>	
<b>AB</b>	0.614	0.598	0.701	0.768	<b>0.882</b>

(Diagonal values =  $\sqrt{AVE}$ )

## 5. Behavioral Adoption Implications of Eco-Friendly Inventory and Production Models

### 5.1 Behavioral Readiness for Green EOQ Implementation

The empirical findings indicate that perceived behavioral control (PBC) exerts the strongest influence on behavioral intention (BI), highlighting that managerial perception of feasibility, resource availability, and technological capability is critical for adopting eco-friendly inventory practices. In the context of Green EOQ, behavioral readiness reflects managers’ confidence in integrating environmental parameters—such as carbon costs and emission considerations—into traditional inventory decisions.

This suggests that adoption is not solely driven by economic optimization but by the perceived ability to implement such models. Organizations with adequate digital infrastructure, data monitoring systems, and operational flexibility are more likely to transition from conventional EOQ to environmentally sensitive



frameworks. Conversely, low perceived control can hinder adoption despite positive environmental attitudes.

Furthermore, the significant relationship between BI and adoption behavior (AB) confirms the mediating role of intention, indicating that managerial confidence must translate into deliberate intent before actual implementation occurs. Thus, successful Green EOQ adoption depends on behavioral preparedness alongside technical feasibility.

### 5.2 Sustainable Lot-Sizing: Role of Normative and Attitudinal Drivers

The results also demonstrate that **subjective norms (SN)** significantly influence behavioral intention, emphasizing the role of regulatory pressure, organizational culture, and stakeholder expectations in shaping sustainable decisions. In sustainable lot-sizing, this implies that production batch decisions increasingly incorporate environmental considerations beyond traditional cost trade-offs.

Managers are more likely to adopt emission-sensitive production planning when institutional frameworks—such as environmental regulations, corporate sustainability policies, and industry standards—actively promote green practices. While **attitude (AT)** toward frugal innovation positively contributes to behavioral intention, its effect is comparatively weaker than PBC and SN, suggesting that favorable perceptions alone are insufficient to drive adoption.

This highlights that sustainable lot-sizing adoption is both **institutionally embedded and behaviorally driven**, requiring not only positive managerial outlooks but also supportive external pressures and practical feasibility. In smart industrial contexts, such as **Kanpur Nagar**, normative alignment plays a crucial role in translating sustainability goals into operational practices.

### 5.3 Lean-Green Scheduling as a Behavior- Driven Operational Strategy

The strong positive relationship between **behavioral intention (BI)** and **adoption behavior (AB)** confirms that intention is the most immediate predictor of implementing sustainable operational practices. In the case of lean-green production scheduling, this implies that organizations with a clear managerial commitment to sustainability are more likely to adopt energy-efficient and emission-conscious production planning techniques.

Lean-green scheduling involves integrating environmental considerations into production sequencing, such as reducing idle energy consumption, optimizing machine utilization, and aligning operations with sustainability targets. These changes require both organizational commitment and technical capability.



The findings suggest that even in digitally advanced industrial environments, technological infrastructure alone is insufficient. Instead, behavioral readiness acts as the key enabler that converts sustainability intentions into actionable strategies. Therefore, lean-green scheduling should be viewed not merely as an optimization tool but as a behaviorally enabled operational transformation.

### **Integrated Implication**

Overall, the results validate that attitude, subjective norms, and perceived behavioural control jointly influence behavioural intention (H1), which in turn drives adoption behaviour (H2), with behavioural intention acting as a mediator (H3). This confirms that the transition toward eco-friendly inventory and production systems is not purely a function of economic efficiency but is strongly shaped by behavioural and institutional factors.

Green EOQ, sustainable lot-sizing, and lean-green scheduling should therefore be understood as outcomes of behavioral alignment, where managerial cognition, normative pressures, and perceived capability collectively determine the extent of sustainable operational transformation.

### **7. Managerial Implications**

The findings offer important implications for managers, policymakers, and urban administrators seeking to advance sustainable operations. The strong influence of perceived behavioral control (PBC) on behavioral intention highlights the need for organizations to invest in technological readiness, data infrastructure, and sustainability capabilities. Managers should be equipped with decision-support systems, carbon tracking tools, and training programs that enable the integration of environmental parameters into routine inventory and production decisions.

Organizations must prioritize capacity-building initiatives to enhance managerial confidence and operational autonomy in implementing green practices. The significant role of subjective norms (SN) further suggests that sustainability must be embedded within organizational culture and governance systems. Firms should institutionalize environmental accountability by incorporating sustainability metrics into performance evaluation and strategic planning. From a policy perspective, regulatory authorities should design clear and consistent sustainability frameworks, supported by incentives such as tax benefits, subsidies, or carbon credits. These measures can strengthen normative pressures and encourage wider adoption of eco-friendly operational models.



Importantly, since behavioral intention (BI) acts as a mediator, policy interventions should not only raise awareness but also enhance perceived feasibility. Demonstrating successful case implementations and providing practical guidelines can significantly improve managerial willingness to adopt green practices.

In the context of Kanpur Nagar, coordinated governance across industrial clusters and urban agencies can further accelerate sustainability adoption. The use of digital dashboards, transparency tools, and sustainability reporting systems can reinforce accountability and strengthen ecosystem-level transformation.

## 8. Theoretical Contributions

This study makes three key contributions to the literature. First, it extends the application of the **Theory of Planned Behavior (TPB)** to the domain of eco-friendly inventory and production systems, an area where behavioral perspectives have been relatively underexplored. By empirically validating the role of attitude, subjective norms, and perceived behavioral control, the study broadens the theoretical scope of TPB within operations management.

Second, the research bridges the gap between **behavioral theory and quantitative operational models**. While prior studies largely focus on optimization-based approaches, this work integrates psychological determinants with sustainable operational practices, offering a more holistic understanding of adoption behavior.

Third, the study contributes to the smart city sustainability discourse by demonstrating that technological advancement alone is insufficient for environmental transformation. Instead, behavioural readiness, managerial cognition, and institutional support emerge as critical enablers of sustainable operational change. This highlights the importance of integrating human and organizational dimensions into sustainability frameworks.

## 9. Limitations and Future Research Directions

Despite its contributions, the study has certain limitations. The use of a cross-sectional research design restricts the ability to capture dynamic changes in behavioral intention and adoption over time. Future studies may employ longitudinal designs to better understand how behavioral factors evolve and influence sustained operational transformation.



The empirical focus on Kanpur Nagar may limit the generalizability of findings to other regions with different regulatory, infrastructural, or industrial contexts. Future research can undertake comparative cross-regional studies to enhance external validity.

Additionally, the study relies on perception-based measures, which may not fully capture actual operational performance. Future research should integrate objective data, such as inventory costs, emission levels, and production efficiency metrics, to develop hybrid empirical-modelling frameworks.

Further theoretical extensions could incorporate perspectives such as the Resource-Based View (RBV) and Institutional Theory to deepen understanding of strategic and environmental drivers of sustainable operations.

## 10. Conclusion

This study examined the behavioural determinants influencing the adoption of eco-friendly inventory and production models within smart city environments. Grounded in the Theory of Planned Behaviour and validated through Structural Equation Modelling, the findings confirm that attitude, subjective norms, and perceived behavioural control significantly influence behavioural intention, which in turn drives adoption behaviour.

Among these factors, perceived behavioural control emerged as the most influential, underscoring the importance of technological readiness, resource availability, and implementation feasibility in enabling sustainable operational transformation. Subjective norms reinforce adoption through institutional and regulatory pressures, while attitude reflects the cognitive evaluation of sustainability benefits.

The results demonstrate that practices such as Green EOQ, sustainable lot-sizing, and leangreen scheduling are not adopted solely on the basis of technical or economic feasibility. Instead, their successful implementation depends on behavioural alignment, managerial commitment, and supportive institutional frameworks.

The study repositions eco-friendly operational models as behaviourally driven strategic innovations, rather than purely mathematical solutions. It emphasizes that sustainable competitiveness in smart cities requires the integration of digital capabilities with human decision-making and organizational readiness.

As urbanization accelerates, achieving low-carbon and resource-efficient operations will depend not only on advanced technologies but also on managerial intent, institutional support, and adaptive organizational



behaviour. Sustainable smart cities will therefore emerge from the alignment of technological innovation with behavioural transformation.

## References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Bouchery, Y., Ghaffari, A., Jemai, Z., & Dallery, Y. (2012). Including sustainability criteria into inventory models. *European Journal of Operational Research*, 222(2), 229–240. <https://doi.org/10.1016/j.ejor.2012.05.018>
- Benjaafar, S., Li, Y., & Daskin, M. (2013). Carbon footprint and the management of supply chains: Insights from simple models. *IEEE Transactions on Automation Science and Engineering*, 10(1), 99–116. <https://doi.org/10.1109/TASE.2012.2203304>
- Govindan, K., Azevedo, S. G., Carvalho, H., & Cruz-Machado, V. (2014). Impact of supply chain management practices on sustainability. *Journal of Cleaner Production*, 85, 212–225. <https://doi.org/10.1016/j.jclepro.2013.06.026>
- Alam, M. Z., Hoque, M. R., Hu, W., & Barua, Z. (2020). Factors influencing the adoption of mHealth services in a developing country: A patient-centric study. *International Journal of Information Management*, 50(April 2019), 128–143. <https://doi.org/10.1016/j.ijinfomgt.2019.04.016>
- Albert, M. (2019). Sustainable frugal innovation - The connection between frugal innovation and sustainability. *Journal of Cleaner Production*, 237, 117747. <https://doi.org/10.1016/j.jclepro.2019.117747>
- Berrouiguet, S., Barrigón, M. L., Castroman, J. L., Courtet, P., Artés-Rodríguez, A., & Baca-García, E. (2019). Combining mobile-health (mHealth) and artificial intelligence (AI) methods to avoid suicide attempts: The Smartercrises study protocol. *BMC Psychiatry*, 19(1), 1–9. <https://doi.org/10.1186/s12888-019-2260-y>
- Blümel, E. (2013). Global challenges and innovative technologies geared toward new markets: Prospects for virtual and augmented reality. *Procedia Computer Science*, 25, 4–13. <https://doi.org/10.1016/j.procs.2013.11.002>
- Hossain, M., Levänen, J., & Wierenga, M. (2021). Pursuing Frugal Innovation for



- Sustainability at the Grassroots Level. *Management and Organization Review*, 17(2), 374–381. <https://doi.org/10.1017/mor.2020.53>
- Ninglasari, S. Y. (2021). Determinants of Online Zakat Intention amongst Muslim Millennials: An Integration of Technology Acceptance Model and Theory of Planned Behavior. *Shirkah: Journal of Economics and Business*, 6(2), 227. <https://doi.org/10.22515/shirkah.v6i2.387>
- Popovskyi, T., & Dluhopolska, T. (2025). *Forecasting Demand for Eco-Friendly Vehicles Using Machine Learning Technologies in the Era of Management 5 . 0*. 1–27.
- Riaz, M., & Lodhi, S. (2025). Beyond BMI: Exploring obesity trends in the south Asian region. *Obesity Pillars*, 13(August 2024), 100156. <https://doi.org/10.1016/j.obpill.2024.100156>
- Tolulope o. Olorunsogo. (2024). Integrating iot in pediatric healthcare: a systematic review of current applications and future directions for pancreatic diseases and obesity tolulope o Olorunsogo1. *International Medical Science Research Journal*, 4(3), 305– 318. <https://doi.org/10.51594/imsrj.v4i3.923>
- Wang, T., Fan, L., Zheng, X., Wang, W., Liang, J., An, K., Ju, M., & Lei, J. (2021). structural equation model with the self-determination theory approach. *Journal of Medical Internet Research*, 23(8), 1–15. <https://doi.org/10.2196/24546>
- Yang, C. (2022). Digital contact tracing in the pandemic cities: Problematizing the regime of traceability in South Korea. *Big Data and Society*, 9(1) <https://doi.org/10.1177/20539517221089294>
- Zhang, Y., Ahmad, A., Azman, N., & Mingxia, W. (2023). The Effect of Perceived Usefulness, Perceived Ease of Use, and Social Influence Toward Purchase Intention Mediated by Trust in Live Streaming Platform. *Journal of Law and Sustainable Development*, 11(9), e1284. <https://doi.org/10.55908/sdgs.v11i9.1284>