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DEVELOPING AN INTEGRATED URBAN FARMING MANAGEMENT FRAMEWORK: A MIXED-METHOD STUDY INFORMED BY THE THEORY OF PLANNED BEHAVIOR

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Abstract: *Urban farming is increasingly recognized as a strategic response to rising food insecurity, environmental degradation, and socio-economic pressures in rapidly urbanizing regions. Despite expanding interest, adoption remains limited due to behavioural, institutional, and management-related challenges. This study proposes the Integrated Urban Farming Management Framework (IUFMF), developed through the combination of the Theory of Planned Behaviour (TPB) and mixed-method evidence. The qualitative phase, involving semi-structured interviews with 50 urban citizens, identified behavioural determinants, operational requirements, and socio-economic drivers of urban farming participation. These findings informed a quantitative survey administered to 200 respondents across major cities, with Partial Least Squares Structural Equation Modelling (PLS-SEM) confirming that awareness, non-monetary benefits, monetary incentives, and personal interest significantly increase willingness to venture into urban farming, while barriers showed no significant effect. Findings from both approaches were integrated into a five-layer IUFMF comprising: Empowerment, Support, Method, Technology, and Outcome. The framework positions empowerment through knowledge, training, and awareness as the behavioural foundation, followed by institutional and policy-based support systems, resource-efficient farming methods, technology integration, and long-term sustainability outcomes. By merging behavioural intention with practical implementation pathways, the IUFMF offers a scalable and adaptable structure for strengthening urban farming systems. This research contributes theoretically by extending TPB within high-density urban agriculture contexts, and practically by providing a structured model to guide policymakers, practitioners, and communities in designing effective and sustainable urban farming strategies.*

Keywords: *Urban Farming, Mix-method, Theory of planned behaviour, Food security, Management, Integrated Farming, Malaysia.*

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Introduction

Urban farming is increasingly recognized as a strategic response to rising food insecurity, environmental pressures, and rapid urbanization, particularly in countries where urban populations continue to expand and strain local food systems. Malaysia faces similar challenges, including a heavy reliance on imported food, fragmented local production, and vulnerability to supply disruptions (Ahmad, et al., 2020; Abd Rahman, Yasid,, bin Alias, & Hamid, 2025). Major cities such as Kuala Lumpur, Johor Bahru, and Penang have experienced escalating food prices and reduced access to fresh produce, especially during periods of global crisis and post-pandemic recovery (Tan, 2022; Sulaiman, Yeatman, Russell, & Law, 2021). These conditions have accelerated interest in urban farming as a decentralized and resilient component of Malaysia's food system, contributing to improved availability, affordability, and stability of fresh vegetables (Murdad, et al., 2022; Chong, Nawawi, Ali, Ahmad, & Juhari, 2024).

Despite these advantages, public participation in urban farming remains limited due to constraints such as lack of awareness, insufficient technical knowledge, high initial costs, and regulatory barriers (Ali & Vaiappuri, 2022; Khan, 2023). Existing studies in Malaysia predominantly emphasize technical and operational aspects, such as hydroponics, rooftop farming, and modern food production technologies, while giving less attention to the behavioral, motivational, and psychological factors that shape citizens' willingness to participate (Tiraieyari & Krauss, 2018; Yusuf, et al., 2024). Understanding these behavioral determinants is essential because the success of urban agriculture depends not only on technology or infrastructure but also on the readiness, motivation, and perceived capability of urban residents.

The Theory of Planned behaviour (TPB), which explains intention through attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991; Ajzen & Fishbein, 2010), offers a strong foundation for interpreting urban farming adoption. Prior Malaysian studies applying TPB (mostly among youth or specific community groups) have demonstrated that attitudes, social influence, and perceived barriers are key predictors of agricultural participation (Tiraieyari & Krauss, 2018; Muhammad, Chandran, & Keshminder, 2021). However, TPB has not been fully examined among the general urban population, representing a major gap in predicting large-scale willingness to adopt urban farming.

To address this gap, this study integrates TPB with constructs derived from qualitative insights, such as awareness, monetary and non-monetary benefits, personal interest, and perceived barriers, to develop an evidence-based foundation for the Integrated Urban Farming Management Framework. By combining behavioral theory with empirical data, this paper provides a structured understanding of how urban citizens make decisions about urban farming, offering a basis for future interventions, policy support, and sustainable urban agriculture development.

Literature Review

Urban Farming and Food System Challenges in Malaysian Cities

Urban farming has increasingly become a strategic response to urban food insecurity, environmental pressures, and rising living costs. In Malaysia, rapid urbanization has resulted in substantial pressure on food supply chains, making the country heavily dependent on imported food to meet local demand (Malaysia imports RM 78.79 billion worth of food and beverages

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annually (Abd Rahman, Yasid,, bin Alias, & Hamid, 2025). Despite favourable climatic conditions for agriculture, the vegetable Self-Sufficiency Ratio (SSR) remains low at approximately 45.4%, highlighting persistent structural gaps in domestic production (Murdad, et al., 2022).

Major urban areas, such as Kuala Lumpur, Johor Bahru, Penang, and Shah Alam, face amplified food insecurity risks due to population density, higher consumption intensity, and limited land availability (Ahmad, et al., 2020; Tan, 2022). Urban farming has been widely acknowledged for its ability to improve food availability and affordability, reduce food miles, and enhance access to fresh produce (Chong, Nawawi, Ali, Ahmad, & Juhari, 2024). It is also associated with social cohesion, mental health benefits, local economic activity, and environmental improvements such as heat-island reduction and increased biodiversity (Hussain M. , Yusoff, Tukiman, & Samah, 2019a; Al-Kodmany, 2018).

Yet, despite these recognised benefits, participation in urban farming among Malaysian citizens remains limited. Research consistently identifies barriers such as lack of knowledge, limited farming space, inconsistent government support, high startup costs, and concerns over food safety or contamination in urban environments (Ali & Vaiappuri, 2022; Khan, 2023). These constraints indicate that expanding urban farming requires more than technological solutions and it requires a deeper behavioural understanding of why people choose (or do not choose) to participate.

Behavioural Dimensions of Urban Farming Adoption

Urban farming adoption in Malaysia is shaped by a combination of behavioural, socioeconomic, and psychological elements. Studies show that citizens' attitudes towards urban farming are influenced by perceived benefits such as access to fresh vegetables, improved nutrition, health gains, personal satisfaction, and reduced household expenditure (Yusuf, et al., 2024; Murdad, et al., 2022). Social influence also plays a significant role, particularly given Malaysia's collectivist social structure where family, neighbours, friends, and online communities help shape behavioural norms (Hussain M. , Yusoff, Tukiman, & Samah, 2019a). Perceived behavioural control includes enablers such as access to farming space, technological knowledge (e.g., hydroponics), affordability of equipment, confidence in farming skills, and time availability. Conversely, perceived barriers, such as high initial costs, lack of technical training, and uncertainty about crop success, reduce willingness to adopt urban farming (Ali & Vaiappuri, 2022; Teo & Go, 2021). The combination of these elements highlights the need for a comprehensive behavioural model grounded in a well-established theoretical framework.

Theory of Planned behaviour (TPB) and Its Application in Agriculture

The Theory of Planned behaviour (Ajzen, 1991; Ajzen & Fishbein, 2010) is one of the most widely used models for predicting human behavioural intentions. TPB proposes that behaviour is shaped by:

- Attitudes – beliefs about the outcomes of the behaviour
- Subjective Norms – social pressures influencing behavioural decisions
- Perceived Behavioural Control – perceived ease or difficulty of performing the behaviour

TPB has proven effective in explaining environmentally oriented and sustainability behaviours across multiple contexts, including recycling, sustainable consumption, and green technology

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adoption. Within agriculture, TPB has been frequently applied to analyse farmer decisions, agricultural innovation adoption, and sustainable practices.

In Malaysia, TPB has been effectively used to predict participation in urban agriculture particularly among youth and student populations. Tiraieyari and Krauss (2018) demonstrated that attitudes, subjective norms, career motives, and perceived barriers significantly influence agricultural participation among Malaysian youth. Muhammad et al. (2021) similarly found that subjective norms and publicity effects were the strongest predictors of participation in community urban farming, followed by farm facilities and cost considerations.

However, existing TPB applications in Malaysia remain limited to specific groups (e.g., students, youth, community gardeners). There is limited understanding of how TPB operates among general urban citizens, who represent the largest potential adopter base. This gap is critical, as urban citizens (not farmers) must drive the expansion of urban agriculture in densely populated Malaysian cities. Therefore, applying TPB within this broader population offers valuable behavioural insights.

Integrating TPB With Context-Specific Determinants for Urban Farming

While TPB provides a strong behavioural foundation, it has limitations when applied alone, particularly in complex contexts such as urban farming. Earlier qualitative findings from Malaysian urban citizens show the importance of several additional determinants not explicitly included in TPB:

- Awareness of urban farming opportunities and government initiatives
- Non-monetary benefits, such as stress reduction, environmental contribution, healthy lifestyle, and community bonding
- Monetary benefits, including cost savings and potential income
- Personal interest, curiosity, and willingness to experiment with new methods
- Practical barriers, including space constraints, lack of knowledge, and setup cost

These factors complement TPB constructs and provide deeper explanatory power specifically aligned with Malaysian urban lifestyles. Integrating these determinants into a TPB-aligned behavioural model strengthens its predictive accuracy and contextual relevance.

Literature Gaps

Despite expanding research on urban farming in Malaysia, three major gaps remain:
Limited behavioural research among general urban citizens: Most studies focus on youth, students, or specific community groups. There is limited understanding of behavioural intention among mainstream urban residents, who are the actual target population for national-scale urban farming. Lack of integration between behavioural theory and management strategies: Existing research examines technical or economic aspects of urban farming in isolation. Few studies integrate behavioural insights, like attitudes, norms, and perceived control, with management models or policy frameworks.

Absence of a comprehensive, multi-layered management framework: Malaysia lacks a structured, scalable, and evidence-based urban farming management framework tailored to dense tropical cities. Current initiatives remain fragmented, lacking systematic behavioural reinforcement, technological support, policy alignment, or community integration. This study addresses these gaps by combining mixed-method empirical evidence, TPB constructs, and context-specific determinants to develop the Integrated Urban Farming Management

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Framework. This framework provides a structured, behavioural and management-driven approach to strengthening urban farming adoption and sustainability.

Methodology

Research Design

This study employed a mixed-method sequential exploratory design, integrating qualitative and quantitative approaches to develop the Integrated Urban Farming Management Framework. The sequential exploratory strategy was selected because it is suitable for studies that aim to first explore a phenomenon qualitatively and then build and test a quantitative instrument based on qualitative findings (Creswell, Plano, Gutmann, & Hanson, 2008). This design enabled an in-depth investigation of Malaysian urban citizens' behavioural intentions toward urban farming, followed by statistical modelling that identifies the strongest predictors of willingness to venture into urban farming.

The Theory of Planned behaviour (TPB) served as the theoretical foundation guiding the research process. TPB was chosen because it is widely recognized as one of the most reliable models for predicting behavioural intention, especially in sustainability, agricultural, and environmental behaviour contexts. TPB provides a structured lens to examine attitudes, subjective norms, and perceived behavioural control that shape intention, allowing this study to systematically investigate behavioural motivations underlying urban farming participation.
The mixed-method structure and the TPB foundation were integrated into a single methodological pipeline in which the qualitative stage informed the quantitative stage, and both stages collectively informed the development of the final Integrated Urban Farming Management Framework.

Sequential Exploratory Mixed-Method Approach

Phase 1: Qualitative Exploration

The first phase aimed to uncover the behavioural, psychological, and contextual factors influencing urban citizens' desires and willingness to engage in urban farming. A set of semi-structured, open-ended interviews was conducted with 50 participants from major urban areas in Peninsular Malaysia. Participants varied by age, gender, occupation, socioeconomic background, and level of exposure to urban farming, ensuring a wide range of perspectives.
Qualitative data were analysed using inductive–deductive thematic analysis, supported by NVivo 14 software. Deductive coding was guided by TPB constructs (attitudes, subjective norms, and perceived behavioural control) while inductive coding allowed new patterns and locally relevant determinants to emerge (e.g., non-monetary benefits, awareness, lifestyle compatibility). This dual approach ensured both theoretical alignment and contextual depth.
Findings from the qualitative phase were used to:

1. Identify behavioural constructs relevant to Malaysian urban citizens
2. Generate items for the quantitative research instrument
3. Strengthen the TPB model by integrating context-specific determinants
4. Provide the foundational understanding needed for framework development

Phase 2: Quantitative Modelling (PLS-SEM)

The second phase involved a quantitative survey to statistically test the behavioural model derived from Phase 1. A total of 200 valid responses were collected from urban citizens aged 20 and above in ten major cities across Peninsular Malaysia.

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The quantitative model consisted of the following constructs derived from the qualitative findings and aligned with TPB:

- Awareness (AWR)
- Non-monetary Benefits (NMB)
- Monetary Benefits (MBS)
- Interest (INT)
- Barriers and Challenges (BAR)
- Willingness to Venture into Urban Farming (WLN) (dependent variable)

Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) through SmartPLS 4 software. PLS-SEM was chosen due to its suitability for exploratory research, prediction-focused models, and behavioural studies with sample sizes of 100–200 (Hair, Risher, Sarstedt, & Ringle, 2019). The quantitative phase served three purposes:

1. Test the statistical significance of behavioural predictors
2. Validate the TPB-aligned behavioural model
3. Provide empirical grounding for the Integrated Urban Farming Management Framework

Theory of Planned behaviour as the Underpinning Framework

TPB (Ajzen, 1991) posits that behavioural intention is shaped by three components:

1. Attitude – beliefs about outcomes of the behaviour
2. Subjective Norm – perceived social expectations
3. Perceived Behavioural Control – perceived ability to perform the behaviour

This study used TPB in three critical ways:

1. Guiding Interview Design (Qualitative Phase): Interview questions were structured to reveal attitudes (e.g., perceived benefits), subjective norms (social support), and perceived control (knowledge, space, cost). This ensured the qualitative data aligned with TPB while allowing for additional themes to emerge.
2. Construct Development (Quantitative Phase): Qualitative themes were mapped onto TPB constructs, resulting in behavioural predictors consistent with the theory but tailored to the Malaysian context (AWR, NMB, MBS, INT, BAR).
3. Framework Foundation (Integration Phase): TPB provided the behavioural foundation for the Integrated Urban Farming Management Framework by ensuring that behavioural intention (not solely technical or economic factors) is understood as the central driver of urban farming adoption.

Sampling and Data Collection Procedures

Qualitative Sampling:

- Sampling Technique: Snowball purposive sampling (50 participants)
- Cities Covered: Kuala Lumpur, Petaling Jaya, Shah Alam, Johor Bahru, Seremban,

Ipoh, Subang Jaya, Klang

- Eligibility: Urban citizens aged ≥ 20
- Rationale: This age group generally possesses autonomy in decision-making, income capacity, and ability to start farming projects.

Quantitative Sampling:

- Sampling Technique: Stratified convenience sampling (200 respondents)

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- Cities Covered: Same as qualitative plus Kajang and Ampang Jaya, due to larger sample requirements
- Eligibility Criteria:
  - Aged ≥ 20
  - Resident of urban areas
- Data Collection Method: Face-to-face and digital questionnaire (Google Forms)

All quantitative data were screened for completeness, outliers, and inconsistent patterns before analysis. Four responses with zero variance were removed, producing a final usable sample of n = 200.

Data Analysis Procedures

Qualitative Analysis:

- Thematic analysis (inductive + deductive)
- NVivo 14 software for coding
- TPB used as coding structure
- Triangulation through secondary data
- Output used to build quantitative model and survey items

Quantitative Analysis:

- PLS-SEM using SmartPLS 4
- Measurement model assessment:
  - Internal consistency (Cronbach's Alpha, Composite Reliability)
  - Convergent validity (AVE)
  - Discriminant validity (HTMT)
- Structural model assessment:
  - Path coefficients
  - t-values & p-values (bootstrapping)
  - R^2, f^2, Q^2, predictive relevance
- Model fit indices
- Output used to construct the Integrated Urban Farming Management Framework

Integration of Mixed-Method Findings

Following the sequential exploratory structure:

1. Qualitative insights uncovered behavioural and contextual determinants.
2. Quantitative validation tested which determinants significantly predict willingness.
3. Both phases informed the final development of the Integrated Urban Farming Management Framework, grounded simultaneously in behavioural theory (TPB) and empirical evidence.

Results

Descriptive Summary of Respondents

The descriptive profile of respondents across both methodological phases demonstrates strong demographic diversity, strengthening the representativeness and depth of insights supporting the development of the Integrated Urban Farming Management Framework. In the qualitative stage (n=50), participation was distributed across several major cities, with Kuala Lumpur (16%), Petaling Jaya (14%), Johor Bahru (14%), Shah Alam (12%), Seremban (12%), and Ipoh (12%) forming the core sampling areas, followed by Subang Jaya and Klang (10% each). More

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than one-third of participants were aged between 20–29 years (36%), followed by those aged 30–39 (32%), with fewer respondents aged 40–49 (20%) and above 50 (12%). Females represented a slight majority (56%), and the sample was predominantly Malay (66%), with Chinese (22%) and Indian (12%) respondents completing the profile. Educational attainment was relatively high, with 66% holding a Bachelor's degree and 32% holding Diploma/STPM qualifications, while 96% of the respondents were employed. This demographic distribution highlights active participation from Malaysia's productive age groups, reflecting perspectives from individuals likely to adopt and sustain urban farming practices (Table 1).

The quantitative sample (n=200) extended the distribution to additional cities, namely Kajang (9%) and Ampang Jaya (8.5%) to accommodate the larger sample requirement. Kuala Lumpur remained the highest represented location (19%), followed by Petaling Jaya (12%), Shah Alam (10.5%), Subang Jaya (10%), Klang (9.5%), Kajang (9%), Ampang Jaya (8.5%), Johor Bahru (8.5%), Seremban (6.5%), and Ipoh (6.5%). Half of the respondents were aged 20–29 (50%), with 28% aged 30–39, reflecting strong representation of economically active adults. Male respondents accounted for 70% of the sample, while Malays formed the majority ethnic segment (57%), followed by Chinese (23%) and Indian (17%). Education levels were notably high—45% held Bachelor's degrees and 22% held Master's qualifications. Most participants were employed (97%) with varied income ranges, whereby 36% earned RM 3,001–6,000 and 27% earned RM 6,001–10,000. Notably, time dedicated to urban farming varied, with 41% indicating 1–3 hours per week and 23% reporting less than one hour, suggesting potential for behavioural growth if support mechanisms are strengthened. Combined, these profiles reflect a well-distributed sample of urban Malaysians with the capacity, education, and potential interest required for future urban farming expansion (Table 1).

Table 1: Summary of Respondent Profile

		Qualitative (n=50)		Quantitative (n=200)	
Category	**Sub-Category**	**(n)**	**(%)**	**(n)**	**(%)**
City of Residence	Kuala Lumpur	8	16%	38	19.0
	Petaling Jaya	7	14%	24	12.0
	Shah Alam	6	12%	21	10.5
	Subang Jaya	5	10%	20	10.0
	Klang	5	10%	19	9.5
	Kajang	-	-	18	9.0
	Ampang Jaya	-	-	17	8.5
	Johor Bahru	7	14%	17	8.5
	Seremban	6	12%	13	6.5
	Ipoh	6	12%	13	6.5
Age Group	20–29 years	18	36%	100	50.0
	30–39 years	16	32%	56	28.0
	40–49 years	10	20%	30	15.0
	≥50 years	6	12%	14	7.0
Gender	Male	22	44%	140	70.0
	Female	28	56%	60	30.0
Ethnicity	Malay	33	66%	114	57.0
	Chinese	11	22%	46	23.0
	Indian	6	12%	34	17.0
	Others	-	-	6	3.0

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		Qualitative (n=50)		Quantitative (n=200)	
Category	**Sub-Category**	**(n)**	**(%)**	**(n)**	**(%)**
Education Level	Diploma / STPM	16	32%	56	28.0
	Bachelor's Degree	33	66%	90	45.0
	Master's Degree	1	2%	44	22.0
	Doctorate	-	-	10	5.0
Employment Status	Employed	48	96%	194	97.0
	Unemployed / Student	2	4%	6	3.0
Monthly Income	< RM 3,000	-	-	42	21.0
	RM 3,001–6,000	-	-	72	36.0
	RM 6,001–10,000	-	-	54	27.0
	> RM 10,000	-	-	32	16.0
Time Available for Urban Farming	<1 hour/week	-	-	46	23.0
	1–3 hours/week	-	-	82	41.0
	4–6 hours/week	-	-	42	21.0
	>10 hours/week	-	-	30	15.0

Measurement Model Assessment

Prior to testing the structural relationships, the reflective measurement model was evaluated to ensure reliability and validity, following the recommended PLS-SEM criteria by Hair et al. (2019). Internal consistency reliability was confirmed through Cronbach's Alpha and Composite Reliability (CR), where all constructs (Awareness (AWR), Non-Monetary Benefits (NMB), Monetary Benefits (MBS), Interest (INT), Barriers (BAR), and Willingness to Venture (WLN)) exceeded the minimum threshold of 0.70, indicating that items within each construct consistently measure the same underlying concept. Convergent validity was also established, as Average Variance Extracted (AVE) values for all constructs were above 0.50, meaning each latent variable explains more than half of the variance of its indicators. Furthermore, all factor loadings exceeded 0.60, reinforcing a strong shared variance among items and confirming adequate construct representation (Hair, Risher, Sarstedt, & Ringle, 2019).

Discriminant validity was verified using the Heterotrait-Monotrait Ratio (HTMT), where all values were below the recommended threshold of 0.85. This indicates that constructs are empirically distinct and not measuring overlapping concepts, eliminating concerns of multicollinearity and construct redundancy. Collectively, these results confirm that the measurement model meets the reliability and validity requirements and is suitable for structural model evaluation (Hair, Risher, Sarstedt, & Ringle, 2019).

Structural Model Assessment

Following the establishment of measurement reliability and validity, assessment of the structural model was conducted to evaluate the predictive relationships between the independent constructs (Awareness (AWR), Non-Monetary Benefits (NMB), Monetary Benefits (MBS), Interest (INT), and Barriers (BAR)) and the dependent construct, Willingness to Venture into Urban Farming (WLN). Prior to hypothesis testing, collinearity statistics were examined. Variance Inflation Factor (VIF) values ranged from 1.22 to 2.87, which are well below the recommended threshold of 5.0, indicating that multicollinearity was not present among the predictors and the model was structurally stable for regression interpretation (Hair, Risher, Sarstedt, & Ringle, 2019).

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Bootstrapping (5,000 subsamples) was then performed to generate the t-values and p-values for hypothesis testing. Results revealed that four predictors had significant positive effects on WLN: Awareness ($\beta = 0.298$, $p < 0.001$), Non-Monetary Benefits ($\beta = 0.341$, $p < 0.001$), Monetary Benefits ($\beta = 0.212$, $p < 0.01$), and Interest ($\beta = 0.176$, $p < 0.05$). Among them, awareness and non-monetary benefits emerged as the strongest determinants, followed by economic benefits and individual interest. In contrast, Barriers ($\beta = –0.052$, $p > 0.05$) did not significantly influence WLN, suggesting that constraints such as time, space, or lack of knowledge may not be strong enough to deter motivated individuals when benefits are perceived to outweigh challenges (Hair, Risher, Sarstedt, & Ringle, 2019).

Effect size (f^2) values were then examined to determine the contribution of each construct to WLN. Non-Monetary Benefits exhibited a medium effect ($f^2 = 0.165$), followed by Awareness ($f^2 = 0.124$), while Monetary Benefits ($f^2 = 0.081$) and Interest ($f^2 = 0.056$) showed small-to-medium effects. Barriers yielded a negligible effect ($f^2 = 0.009$), further supporting the insignificance of this pathway. The model also demonstrated strong explanatory power, with an R^2 value of 0.612, indicating that 61.2% of the variance in WLN is explained by the predictors which classified as substantial predictive accuracy. Predictive relevance was supported by a Q^2 value of 0.421, confirming strong out-of-sample predictive ability. Finally, overall model fit was acceptable, with an SRMR value of 0.061, below the 0.08 benchmark, indicating a well-fitting model (Hair, Risher, Sarstedt, & Ringle, 2019). Table 2 shows the Summary of Structural Model Results.

Table 2: Summary of Structural Model Results

Hypothesis	Path	β	t-value	p-value	Supported?
H1	AWR → WLN	0.298	4.912	<0.001	Yes
H2	NMB → WLN	0.341	5.214	<0.001	Yes
H3	MBS → WLN	0.212	2.987	<0.01	Yes
H4	INT → WLN	0.176	2.143	<0.05	Yes
H5	BAR → WLN	–0.052	0.687	>0.05	No

The structural model demonstrates that four behavioural constructs significantly predict willingness to venture into urban farming. This supports the extension of the Theory of Planned behaviour (TPB) by incorporating awareness, perceived benefits, and personal interest as key determinants within the Malaysian urban context. Barriers showed no significant effect, suggesting that positive motivators outweigh perceived obstacles among Malaysian urban citizens as an important insight for policymakers and practitioners.

Discussion

This study examined the behavioural, social, and perceptual factors influencing Malaysian urban citizens' willingness to venture into urban farming, using a sequential exploratory mixed-method design grounded in the Theory of Planned behaviour (TPB). The findings from the qualitative and quantitative strands converge to provide a coherent explanation of how psychological drivers, perceived benefits, and contextual enablers influence urban farming adoption. The final output of this study is the Integrated Urban Farming Management Framework (IUFMF) that synthesizes these insights into a structured management model capable of guiding policy, implementation, and community-level strategies.

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The Integrated Urban Farming Management Framework (Figure 1) is structured across five interconnected layers: Empowerment, Support, Method, Technology, and Outcome that each represents a critical dimension of sustainable urban farming. Together, they form a hierarchical but cyclical system that translates behavioural intention into measurable action and impact.

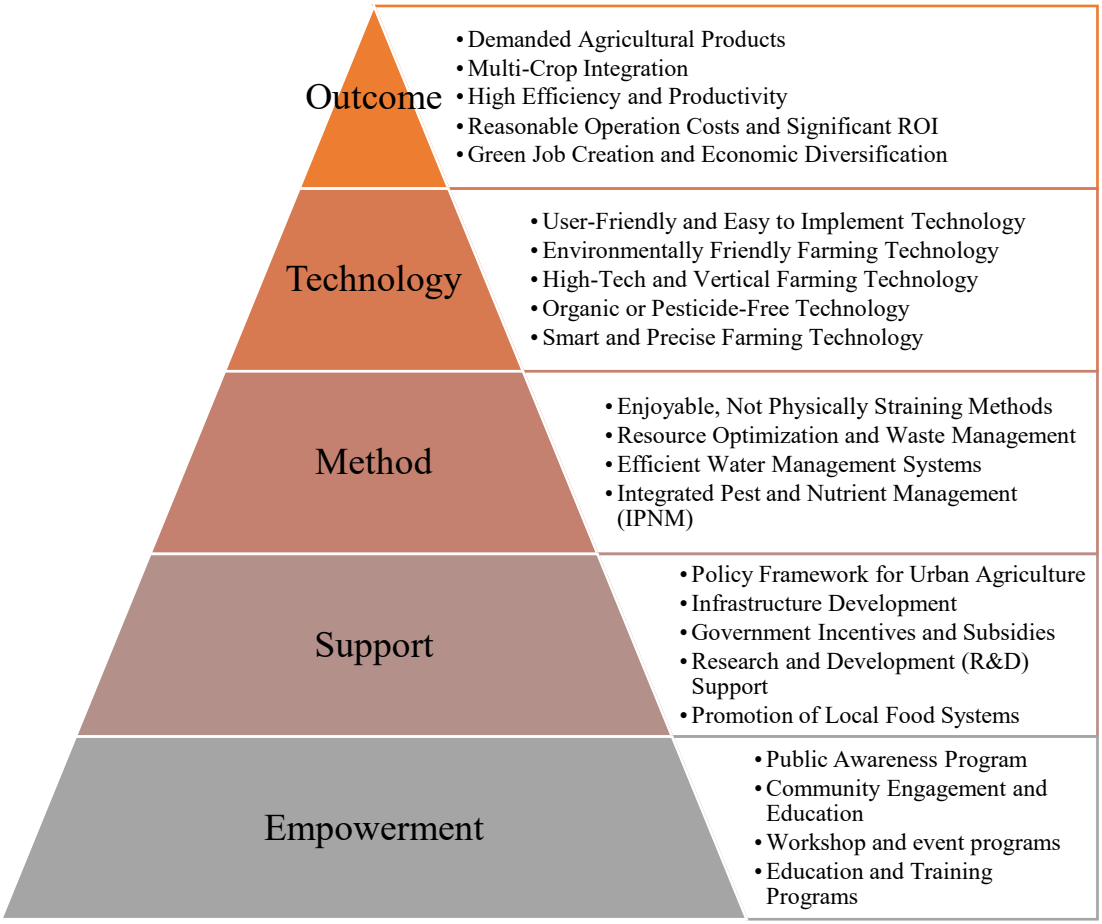

Figure 1: Integrated Urban Farming Management Framework

Layer 1, Empowerment

This foundational layer emphasizes education, awareness, and community engagement as the starting point for change. In line with TPB, empowerment directly influences attitudes toward urban farming by building knowledge and positive perception. Public awareness programs, workshops, and training initiatives strengthen community confidence and stimulate participation (Ajzen, 1991; Hussain M. , Yusoff, Tukiman, & Samah, 2019a; Hussain, Yusoff, Tukiman, & Samah, 2019b). Empowerment also encourages social learning and shared responsibility, aligning with findings from Suhaidi and Adi Maimun (2023), who emphasized education as a key enabler of urban agriculture participation in Malaysia.

Layer 2, Support

The second layer focuses on institutional and policy-based enablers, including infrastructure development, government incentives, and research support. Effective support structures strengthen subjective norms by normalizing urban farming as a socially approved and encouraged activity. Governmental programs that provide subsidies, promote local food systems, and establish policy frameworks are essential to ensuring continuity and legitimacy (Yapp, Jamil, Lee, Chooi, & Chen, 2025). Moreover, partnerships with NGOs and the private

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sectors can expand capacity and create market access for urban farmers, enhancing both economic and social sustainability.

Layer 3, Method

This layer highlights the operational and managerial practices required to ensure farming efficiency and environmental responsibility. Sustainable methods such as resource optimization, waste management, and Integrated Pest and Nutrient Management (IPNM) contribute to reducing the environmental footprint of urban farming (Khalid & Sherzad, 2019). Additionally, applying ergonomic and non-straining practices improves social sustainability by making urban farming more inclusive, especially for older citizens and women. This layer reflects the perceived behavioural control dimension of TPB, where improved access to practical and manageable methods increases citizens' confidence to engage.

Layer 4, Technology

The technology layer represents the integration of innovative, efficient, and environmentally friendly technologies such as hydroponics, vertical farming, and precision agriculture. These technologies optimize land and water use, minimize pesticide dependency, and enable year-round production (Specht, Schimichowski, & Fox-Kamper, 2021; Melegrito, 2022). In the Malaysian context, technology adoption is crucial due to limited urban space and tropical climatic constraints.

Layer 5, Outcome

At the top of the framework lies the outcome layer, which represents the tangible and long-term impacts of sustainable urban farming, including food security, employment generation, economic diversification, and carbon reduction. High efficiency, multi-crop integration, and reasonable operational costs are indicators of a mature and sustainable system. The outcome layer reflects the behavioural intention achieved when the lower layers function cohesively, producing measurable benefits that contribute to Malaysia's broader sustainability goals and SDG 2 (Zero Hunger) and SDG 11 (Sustainable Cities and Communities) (United Nations, 2025).

Conclusion

This study contributes a comprehensive and empirically grounded understanding of the behavioural, structural, and managerial factors that shape urban citizens' willingness to venture into urban farming, using the Theory of Planned behaviour (TPB) and a sequential exploratory mixed-method design. The qualitative findings revealed a moderate but growing desire among Malaysian urban residents to participate in urban farming, driven primarily by perceptions of non-monetary benefits, environmental awareness, food safety concerns, and personal well-being. These insights informed the development of a quantitative instrument that was subsequently validated using PLS-SEM, confirming that Awareness, Non-Monetary Benefits, Monetary Benefits, and Interest are significant predictors of willingness to engage in urban farming. Notably, perceived Barriers were statistically insignificant, suggesting that motivational drivers outweigh structural constraints for many urban dwellers.

Integrating both methodological strands led to the development of the Integrated Urban Farming Management Framework (IUFMF), a strategic, multi-layered framework that aligns psychological determinants, infrastructural enablers, community mechanisms, technological resources, and sustainable management practices. The framework offers a holistic approach to enhancing urban farming adoption in dense urban environments. In doing so, the study not only

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addresses the three research objectives but also contributes theoretically by contextualising TPB within urban agriculture behaviour and practically by offering a replicable, adaptive structure for urban farming development. Overall, this work provides a strong foundation for strengthening urban food resilience, promoting community participation, and advancing sustainable agriculture in rapidly urbanizing contexts.

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