



FARMERS' KNOWLEDGE, ATTITUDES AND PRACTICES ON OPEN BURNING REGULATION: A CASE STUDY OF SEKINCHAN, SELANGOR

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Abstract

Despite a regulatory prohibition under the Environmental Quality Act 1974, open burning persists in Malaysia. Enforcement challenges are particularly evident in agricultural areas because seasonal farming cycles often involve farmers burning crop residues to clear land. Certain open burning activities, including smallholder cultivation, are permitted under specified conditions. This study explores farmers' knowledge, attitudes, and practices regarding the regulatory controls and the local community's perception of the issue in Sekinchan, Selangor. Employing a mixed-methods approach, the study combined quantitative surveys involving 144 respondents with qualitative interviews and field observations. The data were subsequently triangulated to enhance validity. The findings indicate that farmers have a high level of knowledge of the legal prohibition. They are also willing to participate in government awareness initiatives. However, interview and observational findings suggest that actual compliance with procedural and environmental requirements remains inconsistent. Economic considerations, time constraints, limited access to practical alternatives, and entrenched cultural norms continue to influence farmers' behaviour. The findings indicate gaps between regulatory awareness and implementation. Therefore, integrated enforcement strategies and feasible agricultural alternatives are required to support sustainable environmental governance, agricultural land management, and context-sensitive environmental planning in Selangor.

Keywords: Open burning, Environmental regulation, Paddy farming, Knowledge–Attitude–Practice (KAP), Sustainable agriculture

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INTRODUCTION

Any fire, combustion, or smouldering that occurs in the open air without being directed there through a chimney or stack is considered open burning. It has widespread impacts on human health and air quality (Taweesan et al., 2025), which may extend to neighbouring countries, as reflected in the near-annual transboundary haze in Southeast Asia. To tackle this burning issue and in line with regional commitments, Malaysia incorporated Section 29A into the Environmental Quality Act 1974 (EQA). The provision establishes a general prohibition against open burning on any premises or land. This reflects Malaysia's firm regulatory stance on controlling open burning. The issue is so serious in the country that the legislature amended the EQA in 2024 to impose more stringent penalties. Currently, any person found guilty of contravening the open burning prohibition is liable to a minimum fine of MYR25,000 and a maximum of MYR1 million. The person may also be imprisoned for a term not exceeding five years.

Recognising the operational needs of certain sectors, the Malaysian authority designated several activities as not prohibited open-burning activities (the declared activities), subject to specified conditions. The declared activities include animal and plant disease control, authority fire training, religious rites, and certain agricultural activities. This regulatory structure serves as a balancing mechanism within the legal framework, reconciling environmental protection objectives with socio-economic and cultural considerations. However, the existence of such permitted open burnings also poses practical and interpretive challenges for enforcement, especially in agricultural contexts.

The study aims to examine farmers' knowledge, attitudes and practices (KAP) regarding open-burning regulation. It also analyses community perceptions of farmers' KAP and identifies socio-economic and institutional factors that affect compliance. By linking behavioural insights with regulatory frameworks, the study contributes to a more nuanced understanding of environmental governance in agricultural settings. It would inform more effective and locally responsive management strategies.

LITERATURE REVIEW

Permitted Controlled Open Burning

The EQA prohibition on open burning supports Malaysia's and ASEAN's reduction in crop-burning policy, which aims to reduce air pollution and mitigate the harmful effects of haze from smallholders (ASEAN, 2024). However, the EQA, through the Environmental Quality (Declared Activities) (Open Burning) Order 2003, allows certain declared activities. They are legally exempt from the open burning prohibition, provided they comply with strict procedural conditions. One such declared activity is the burning of paddy stalks before replanting. For

this activity, the regulations require compliance with several conditions (Department of Environment, 2020). First, the paddy stalks must be dried for at least seven days before burning. Second, burning may only be carried out during dry weather between 1:00 p.m. and 5:00 p.m. Third, the burning must be closely monitored and controlled. Fourth, it must not cause a nuisance to nearby residents. Fifth, the resulting smoke must not interfere with traffic, and adequate warning signs must be provided where burning occurs near major roads. Finally, prior notification must be given to the nearest police station. These requirements seek to balance traditional agricultural practices with environmental protection and public safety. Effective regulation of controlled open burning, including declared activities, and ensuring compliance with these conditions are essential for sustainable land management, particularly in environmentally sensitive areas such as peatlands (Sawal & Tsai, 2016).

Perceptions on Open Burning Prohibition

Perceptions of the open burning prohibition vary across stakeholder groups. Urban residents and haze-prone communities generally view it as necessary for public health, but farmers may see the prohibition as disruptive to traditional practices or livelihoods (Costanza & Moody, 2011). Farmers often prefer open burning because of its cost and time efficiency, especially when alternatives are unaffordable or unavailable (MARDI, 2019). Socioeconomic factors, including income, education, and land tenure, further influence stakeholders' views on open burning and their willingness to comply with regulatory controls (Aminrad et al., 2013). To transition farmers away from open burning, ASEAN (2024) states that awareness and incentive programmes should be provided, along with encouragement to adopt alternative disposal methods such as composting, mulching, and mechanised clearing.

Knowledge, Attitudes, and Practices (KAP)

The KAP framework provides a lens for understanding the relationship among knowledge, attitudes, and behaviour in environmental compliance. Studies on sustainable agriculture indicate that farmers' KAP are shaped by socio-environmental conditions, agricultural experience, and policy interventions. For instance, Liao et al. (2022) found that farmers' perceptions of environmental degradation and agricultural policies significantly influence their attitudes and adoption of sustainable farming practices. In contrast, studies in Malaysia indicate a persistent knowledge-practice gap, in which individuals understand regulations but continue environmentally harmful practices due to convenience, cultural norms, or cost (Ariffin, M., & Wan Yacoob, 2017). In agriculture, farmers may, in principle, comply with prescribed activity requirements but often prioritise efficiency and tradition over environmental or legal considerations

(Costanza & Moody, 2011). Attitudes shaped by trust in government, perceived fairness of enforcement, and social norms strongly influence whether knowledge translates into compliance (Aminrad et al., 2013). Misunderstanding or inconsistent application of exemptions can lead to confusion and selective compliance. The KAP framework thus helps identify gaps among awareness, attitudes, and behaviour (Ariffin & Wan Yacoob, 2017). This would inform the government about targeted interventions such as awareness programs, subsidies for alternatives, and participatory enforcement.

Literature Gaps

Research on stakeholder perceptions and experiences, particularly among farmers, villagers, and local authorities, remains limited (Mustafa et al., 2017). In addition, the legal exemptions applicable to declared activities are poorly understood, leading to confusion and inconsistent compliance. Few studies have employed qualitative or mixed-method approaches to capture the socio-cultural, economic, and institutional factors influencing compliance. This leaves the underlying motivations and constraints largely unexplored. Furthermore, aspects such as infrastructure limitations, community awareness, and enforcement capacity that affect open-burning practices have not been studied comprehensively. Moreover, few studies integrate legal regulatory frameworks with behavioural analyses of farmers' knowledge, attitudes, and practices (Ariffin & Wan Yacoob, 2017), which leaves important gaps in understanding how policy measures translate into on-the-ground compliance in agricultural communities. Addressing these gaps is crucial to inform more effective environmental governance and policy implementation.

Detection and Impacts of Unlawful Open Burning

Due to its dispersed and sometimes concealed nature, unlawful open burning is difficult to monitor. The authority detection methods include public complaints, ground inspections, satellite imagery, and spikes in PM_{2.5} or air pollution index readings (DOE, 2020). Open burning releases PM, CO, NO_x, and SO₂, which may lead to respiratory illnesses, eye irritation, and stress, particularly among vulnerable populations such as children and senior citizens (Zikri Zahari et al., 2016; Costanza & Moody, 2011). Open burning also contributes significantly to particulate air pollution, particularly PM₁₀, which is commonly associated with regional haze episodes in Malaysia. Studies have shown that although land-use changes may influence local air quality, extensive agricultural open burning remains a major contributor to elevated particulate concentrations during haze events (Zikri Zahari et al., 2016). Other than that, farmers benefit economically from burning, but they also face legal risks and long-term soil degradation.

Meanwhile, enforcement agencies face challenges due to limited resources, personnel, and surveillance capacity.

RESEARCH METHODOLOGY

Earlier studies on open burning, waste management, and environmental behaviour in Malaysia have largely relied on either quantitative or qualitative approaches with limited methodological integration (Ariffin & Wan Yacoob, 2017; Badrum & Mapa, 2021). Such approaches constrain a comprehensive understanding of stakeholder perceptions and the structural factors underpinning persistent non-compliance. It is essential to bridge this gap in designing context-sensitive enforcement mechanisms and adaptive environmental policies.

The current study, therefore, employs a mixed-methods design that integrates quantitative surveys with qualitative interviews and field observations to capture both measurable patterns and contextual explanations. The quantitative survey collects data on farmers' KAP regarding the open-burning regulatory controls. Meanwhile, interviews with local community representatives offer contextual insights and deeper explanations of farmers' observed behaviours and the challenges they face. Structured field observations were conducted to document open-burning activities, complementing survey and interview data. The use of multiple data sources enabled methodological triangulation, allowing findings from different methods to complement and validate one another (Denzin, 1978). This enhances the reliability and depth of the analysis (Creswell & Plano Clark, 2011).

Sekinchan, Selangor was selected as a study area for its significant agricultural activity, particularly paddy cultivation. As one of Malaysia's major rice-producing areas, Sekinchan experiences seasonal agricultural cycles that often involve burning crop residues for land clearing and pest control, making it highly relevant for the study. In addition, Sekinchan presents an important regulatory and planning context. The coexistence of intensive farming activities with residential settlements creates enforcement complexities.

Quantitative Research

For quantitative research, a structured, closed-ended Likert-scale questionnaire was used to collect standardised data on farmers' KAP levels. The questionnaire was divided into several sections with items developed based on prior studies and regulations on open burning. The research instrument was validated through expert review using the Content Validity Index (CVI) to assess the relevance, clarity, and suitability of the questionnaire items. This was followed by a pilot study involving 20 farmers to evaluate the instrument's clarity and internal consistency. Reliability was assessed using Cronbach's alpha. The questionnaire comprised 19 items across three constructs, namely Knowledge ($\alpha = 0.620$),

Attitude ($\alpha = 0.613$), and Practice ($\alpha = 0.679$), with an overall reliability coefficient of 0.679. Given the exploratory nature of the study and the small pilot sample, these values were considered acceptable for establishing the instrument's internal consistency (Hair et al., 2019). The questionnaire was subsequently retained for the main survey.

Based on the Krejcie and Morgan (1970) table, a sample of 144 respondents was drawn from a population of 2,886 farmers in the study area. Village heads and the Penghulu assisted in identifying farmers actively engaged in paddy cultivation. Questionnaires were then distributed purposively among eligible farmers until the target sample size of 144 respondents was achieved. Data were analysed using SPSS, employing descriptive statistics, namely frequencies, percentages, means, and standard deviations, to summarise farmers' KAP regarding open-burning regulations. Since the study aimed to identify general trends rather than test hypotheses, descriptive analysis was used to capture key patterns relevant to policy and intervention planning. Although Likert-scale responses are ordinal, the mean and standard deviation were used to summarise overall response trends and facilitate interpretation across multiple items, consistent with approaches adopted in previous KAP studies (Liao et al., 2022). Given the exploratory nature of the study, using mean scores was considered appropriate for identifying general response patterns among respondents.

Qualitative Research

The qualitative component involved semi-structured interviews with local community members residing in the study area. Participants were selected through purposive sampling, with random selection applied among adult residents to obtain diverse perspectives. Despite efforts to obtain additional participants, only four residents consented to the interviews. They comprised an equal number of males and females from different professional backgrounds. The participants were selected as community representatives residing near agricultural areas and were considered capable of providing contextual insights into local open-burning practices and their impacts.

The interviews were intended to complement, rather than generalise, the quantitative findings. As the qualitative component was designed to provide contextual explanations rather than achieve data saturation, a small number of strategically selected community representatives was considered sufficient for methodological triangulation. An interview guide comprising open-ended questions was developed to explore participants' perceptions of farmers' knowledge, attitudes, and practices regarding open burning. Interviews were transcribed verbatim and analysed using thematic analysis.

Additionally, structured non-participant observation was conducted to complement the survey and interview data. Observations were scheduled during and immediately after the paddy harvesting season, when crop-residue burning is most likely to occur under local agricultural practices. This timing enabled the study to capture open-burning activities during the period when occurrence is expected to be highest. To ensure consistency and intra-observer reliability, a standardised checklist was used to systematically record instances of open burning and assess whether site conditions complied with the requirements for declared activities. Data obtained from the observation checklist were analysed using descriptive and frequency-based approaches. Observations were conducted on five occasions using the same standardised checklist to maintain consistency across sessions. Environmental features, such as the distance between paddy fields and adjacent roadways or residential areas, were summarised descriptively to provide contextual understanding of the study area.

Limitations

The current study has several limitations. It included only four resident interviews and five observation sessions, which may not capture all perspectives or seasonal variations. Furthermore, survey responses were self-reported and may therefore be subject to social desirability bias, whereby respondents overstate compliance with environmental regulations. To minimise this limitation, survey findings were triangulated with interviews and field observations. Future studies may employ inferential statistical analyses to examine the influence of demographic characteristics on compliance behaviour across different farming communities. Despite these limitations, the current study combined quantitative and qualitative data through methodological triangulation, thereby enhancing the credibility and validity of the findings by cross-checking evidence across multiple methods. This reduced bias and increased confidence in the study's conclusions (Creswell & Plano Clark, 2011).

ANALYSIS AND DISCUSSION

This section presents the study's findings and interprets them in relation to the research objectives. The results are structured to first describe farmers' quantitative survey data on their KAP. It is followed by insights from qualitative interviews with residents that provide a contextual understanding of community perceptions and concerns. Field observational data are then presented to validate and complement the survey and interview findings. Finally, the section integrates the three data sources through triangulation to highlight any consistent patterns or divergences.

Farmers' Level of Knowledge, Attitudes and Practices (KAP)

The socio-demographic profile of the respondents shows that the majority were male (93.1%), while female respondents accounted for only 6.9%. Most respondents had SPM as their highest educational qualification (75.4%). About 9.8% held STPM, or a diploma, and only 0.9% held a degree. A small proportion (13.9%) stated other forms of education. As for age, the largest groups were 56 years and above (29.9%) and 46-55 years (28.5%). This is followed by those aged 36-45 (20.8%), 26-35 (13.9%), and 18-25 (6.9%). Regarding personal income, 45.8% earned no more than RM3,000 per month, 16.7% earned between RM3,001 and RM6,000, 2.8% earned between RM6,001 and RM10,000, and the rest reported no personal income.

Table 1: Farmers' KAP Overall Scores

Domain	Mean	Standard Deviation
Knowledge	4.03	0.78
Attitudes	4.20	0.69
Practices	4.11	0.73

The study's findings reveal that respondents demonstrated a strong overall knowledge of open burning ($M = 4.03$, $SD = 0.73$) with consistently high mean scores across all measured items. They showed a clear understanding of the definition of open burning ($M = 4.16$, $SD = 0.76$) and were aware of its environmental impact, particularly its contribution to local and regional haze ($M = 3.91$, $SD = 0.90$). The respondents were generally knowledgeable about the need to inform the authority before burning ($M = 3.92$, $SD = 0.85$). However, the relatively higher SD indicates variability in farmers' understanding of the matter. Besides that, knowledge of the permissible conditions for burning was higher and more consistent ($M = 4.13$, $SD = 0.73$). While general safety concepts were well understood, familiarity with specific procedural requirements, such as creating firebreaks, showed slightly greater variability ($M = 3.92$, $SD = 0.79$). The relatively uniform knowledge levels among respondents likely reflect their similar educational backgrounds. The results highlight that although respondents are generally well-informed, ongoing education is needed to address gaps in technical and procedural knowledge and ensure comprehensive awareness.

Regarding attitudes, the respondents generally hold positive attitudes toward open-burning regulations and responsible behaviour, with a high overall mean score ($M = 4.20$, $SD = 0.69$). This indicates strong support for management,

monitoring, and public awareness efforts. There was a broad consensus on the importance of regulation and education about the harmful effects of open burning ($M = 4.28$, $SD = 0.65$), but willingness to participate in workshops showed some variability ($M = 4.13$, $SD = 0.879$). In addition, attitudes toward procedural compliance, such as notifying authorities ($M = 4.09$, $SD = 0.72$) and following regulatory control ($M = 4.24$, $SD = 0.62$), were also favourable. The relatively uniform positive responses likely reflect the sample's demographic similarities. The overall findings indicate strong support for responsible practices and legal enforcement.

Other than that, the study found that respondents reported relatively positive self-perceptions of their practices ($M = 4.11$, $SD = 0.73$). The relatively high self-reported practice scores suggest that respondents generally perceived themselves as complying with safe burning practices. However, triangulation with interview and observational findings revealed inconsistencies between reported practices and on-site compliance with procedural and environmental requirements. Most respondents reported that they generally followed safety measures, such as avoiding burning during poor air quality or unfavourable weather ($M = 4.29$, $SD = 0.57$). Many respondents also expressed support for non-burning alternatives when feasible ($M = 4.08$, $SD = 0.61$). However, some variability exists in practices such as avoiding burning near residential areas ($M = 4.06$, $SD = 0.804$) and adopting alternative waste management methods ($M = 4.11$, $SD = 0.73$). While efficiency concerns sometimes lead to less desirable behaviours, the study found that overall self-reported compliance with safe burning techniques appeared relatively positive. The findings suggest relatively positive self-perceptions of compliance among respondents, although qualitative and observational findings indicate that on-site compliance remains partial.

Local Community's Perception of Farmers' KAP

Interview findings indicate that the community generally perceived farmers as having a good understanding of the requirements and risks associated with open burning. Most interviewees reported that farmers are aware of key practical conditions before burning, such as maintaining a safe distance from residential areas and considering weather conditions, including wind direction and speed. This suggests that farmers' understanding is primarily focused on immediate safety and harm prevention.

Farmers were also perceived to be aware of the environmental and health impacts of open burning, particularly respiratory effects on nearby residents. Despite this awareness, interviewees reported that open burning continues due to economic considerations and the long-standing use of burning as a traditional waste management practice. These findings suggest that

awareness alone does not necessarily translate into full procedural compliance with open-burning controls.

Interviewees further indicated that farmers' willingness to reduce open burning is constrained by practical and financial considerations. Although alternatives such as reusing or selling paddy straw are recognised, they are generally viewed as costly, labour-intensive, and impractical, making open burning the most efficient and affordable option. Attitudes towards the ban are therefore mixed. Support depends largely on clear guidelines and government assistance, particularly for small-scale farmers, while opposition is driven by economic constraints and established farming practices. Farmers were also reported to prefer education-based and targeted enforcement over punitive measures.

Finally, interviewees highlighted that open burning is a seasonal practice occurring mainly after the harvesting period. Although farmers generally consider weather conditions to minimise the spread of fire and smoke, adherence to prescribed timing requirements remains inconsistent and depends on harvesting schedules and straw conditions. Safety measures were also reported to be largely informal and based on experience.

Field Observation

Field observations indicate that open burning is neither frequent nor continuous within the study area. Across five site visits, only one instance of active burning was observed. However, the presence of ash residues and burn scars in several spots suggests that open burning still occurs periodically. The limited number of observed incidents may have been influenced by factors such as weather conditions, enforcement activities, or farmers' awareness of environmental regulations. During the observed incident, paddy straw was burned in an open field after harvesting. The proximity of the burning site to nearby roads and residential areas raised concerns regarding compliance with recommended buffer distances, as smoke exposure may affect both road users and residents. It potentially poses risks to traffic safety and respiratory health. Observations also indicated that environmental conditions, such as wind direction, may not have been fully considered prior to burning. Furthermore, limited fire safety precautions and the absence of warning signs suggested inconsistencies between on-site practices and regulatory requirements. The findings suggest that open burning in Sekinchan occurs only occasionally. Compliance with safety measures, smoke management, and buffer distance requirements remains partial.

Triangulation of Findings and Discussion

The study's findings from surveys, interviews, and structured observations collectively indicate that open burning in Sekinchan is an occasional but

intentional activity. It is shaped by both regulatory awareness and socio-cultural practices. Survey results show that farmers have a high level of knowledge of the prohibition on open burning under the EQA and the permitted exemptions for small-scale agricultural burning. They express positive attitudes towards regulatory compliance in principle when supported by government awareness programs. However, self-reported practices were generally positive, although interview and observational findings suggest that on-site compliance with procedural requirements and environmental safeguards remains inconsistent. Economic considerations, time constraints, and cultural norms were identified as major barriers. Interviews with residents corroborate these findings, highlighting that while farmers generally understand the legal framework, enforcement challenges and the perceived convenience of burning contribute to the continued practice of open burning.

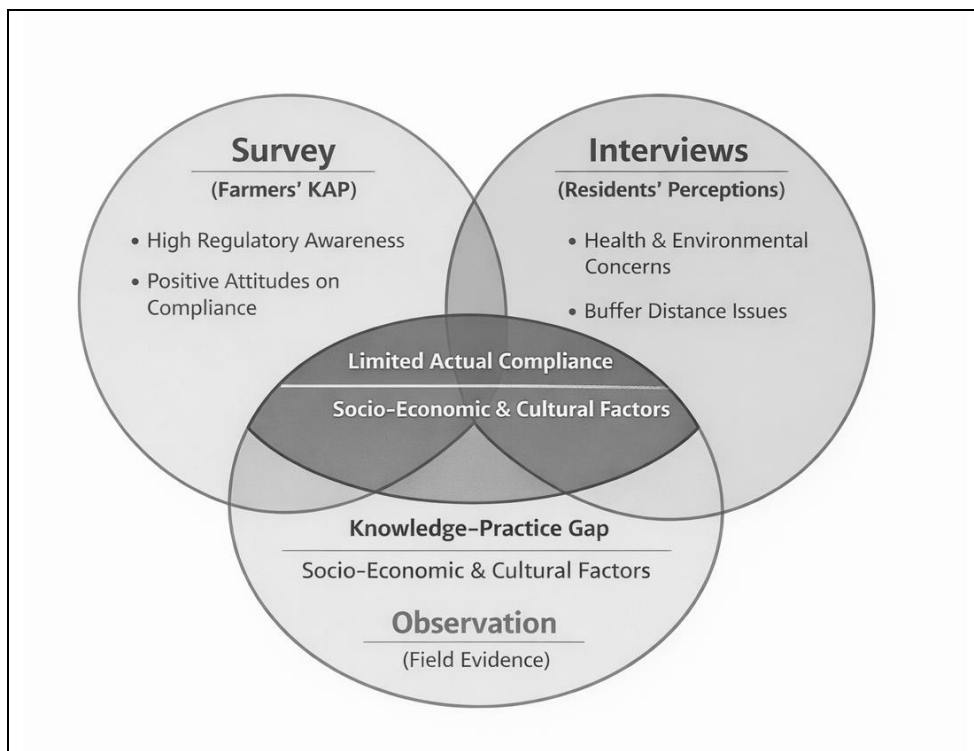


Figure 1: Triangulation of Findings on Open Burning in Sekinchan, Selangor

Interviewees also emphasised health and environmental concerns, particularly regarding exposure to smoke and proximity to residential areas. The proximity of burning activities to residential areas also increases the risk of fire

spread. Structured observations complement these perspectives. The observations revealed that open burning is infrequent but strategically timed, often after harvest periods. Some disregard for recommended buffer distances, wind conditions, and fire safety measures was also noticed. Together, the three methods indicate a gap between regulatory awareness and consistent procedural compliance. While regulatory awareness is relatively high, adherence to procedural, safety, and environmental precautions is inconsistent. This reflects the complex interplay of socio-economic, cultural, and environmental factors influencing open-burning practices.

The findings show that farmers continue open burning not because they lack knowledge but due to structural and financial limitations. Respondents demonstrated good knowledge and positive attitudes towards environmental protection, consistent with Ariffin and Wan Yacoob (2017). However, this awareness does not always translate into compliance. The gap between regulatory awareness and actual compliance suggests that knowledge alone is insufficient to change behaviour when practical constraints and external influences remain significant. Similarly, Akahoshi et al. (2024) found that institutional and social barriers hinder the implementation of crop-residue burning control policies, indicating that regulatory measures alone are insufficient to reduce open burning practices.

Economic barriers were identified as the primary factor sustaining open burning. Although respondents expressed a willingness to adopt alternatives, such as straw commercialisation and decomposing agents, these options were perceived as costly and labour-intensive. This finding is consistent with Rosmiza et al. (2019), who reported that open burning remains the cheapest and fastest method of land preparation for paddy farmers in Malaysia. Likewise, Mustafa et al. (2017) argued that a complete ban is impractical without institutional and financial support. The present findings further show that logistical constraints, limited access to straw markets, and the economic vulnerability of small-scale paddy farmers continue to impede the adoption of alternative residue-management practices (Asli & Rahman, 2023).

Apart from that, the knowledge-practice gap identified in this study appears to be influenced by local cultural factors. Such factors include the normalisation of open burning within the farming community, long-standing agricultural traditions, and peer influence among farmers. They contribute to the farmer's persistence in burning practices despite awareness of regulatory restrictions and environmental impacts. MARDI (2019) reported similar observations on paddy residue waste management in Selangor. The findings of this study also align with earlier research by Na Talang et al. (2024) and Erbaugh et al. (2024). Both studies showed that cultural traditions and long-established

farming practices continue to influence farmers' decisions to engage in open burning despite awareness of its environmental impacts.

In terms of regulatory strategies, the findings corroborate Mustafa et al. (2017) assessment of the EQA which imposes significant penalties but faces practical enforcement challenges. As indicated by survey results and interview input, there is a greater community preference for educational programs and awareness-based initiatives over punitive actions. Additionally, the study confirms earlier findings that open burning in Malaysia is perpetuated by economic realities rather than ignorance (Ariffin & Wan Yacoob, 2017; Rosmiza et al., 2019; Mustafa et al, 2017). Integrated solutions that incorporate financial incentives, accessible alternatives, and context-sensitive enforcement are needed to close the gap between farmers' knowledge and practice. A strict ban is unlikely to result in long-term compliance without support systems.

From a planning perspective, the findings support the designation of appropriate agricultural buffer zones between paddy fields and residential areas, the establishment of community-based monitoring mechanisms, and the provision of centralised paddy-residue collection or processing facilities. Integrating these measures into local land-use planning would reduce conflicts between agricultural production and environmental protection.

CONCLUSION

This study highlights the complex dynamics of open burning in Sekinchan, Selangor. It demonstrates that farmers generally have a high level of knowledge of the legal prohibition under the EQA and the provisions governing permitted controlled burning for small-scale agriculture. Nevertheless, compliance with procedural and environmental requirements remains inconsistent. Triangulation of survey, interview, and observational data revealed a persistent gap between regulatory awareness and on-site compliance, influenced by socio-economic constraints, cultural norms, and environmental factors such as the proximity of paddy fields to residential areas. Field observations further showed that open burning occurs infrequently but deliberately after the harvesting season to clear agricultural residues, with only partial adherence to safety procedures and smoke management requirements. Residents' perceptions also highlighted concerns regarding health impacts and enforcement challenges.

The findings highlight the need for more integrated and context-sensitive environmental governance strategies to address open burning. These include targeted awareness programmes, practical alternatives to burning, and improved enforcement measures that take local socio-cultural realities into account. Addressing these factors is essential to bridge the gap between regulatory knowledge and actual compliance, thereby supporting sustainable

crop-residue management and environmental protection in Malaysia's rice-growing regions.

From a planning perspective, the findings support policy measures such as subsidies for straw-management technologies, cooperative straw markets, farmer training programmes, and strengthened monitoring during the harvesting season. They also highlight the importance of integrating agricultural buffer zones, community-based monitoring mechanisms, and paddy-residue collection or processing facilities into local land-use planning and environmental governance frameworks. Such integrated measures would help reduce conflicts between agricultural production and environmental protection while promoting long-term compliance with open-burning regulations.

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