

Effectiveness of the Community-Based Safe Food Market Program (PPABK) in Improving Traders' Knowledge and Reducing the Detection of Hazardous Substances in Food at Nambangan Market, Surabaya, Indonesia

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ABSTRACT

The PPABK is a community empowerment initiative aimed at improving knowledge and strengthening food safety surveillance in traditional markets. This study aimed to evaluate the effectiveness of PPABK implementation by the BBPOM Surabaya at Nambangan Market, Surabaya, based on changes in participants' knowledge and hazardous substance surveillance results during the 2023–2025 period. The study employed a quantitative evaluative approach by analyzing pre-test and post-test scores from 10 participants using the Wilcoxon signed-rank test, along with a descriptive analysis of testing results for borax, formalin, Rhodamine B, and Methanil Yellow. The findings revealed an increase in the mean knowledge score from 68.00 to 80.00, with a statistically significant difference ($Z = -2.807$; $p = 0.005$). The percentage of non-compliant test results decreased from 52.29% during the initial surveillance phase in 2023 to 5.66% following the intervention, with no non-compliant results detected in the examinations conducted in 2024 and 2025. The evaluation findings indicate that PPABK was effective in improving the knowledge of technical training participants, accompanied by positive developments in food safety surveillance, as reflected in the declining detection of hazardous substances in the tested food samples. These findings provide evidence of program achievements in knowledge improvement and surveillance outcomes, while emphasizing the importance of continuous guidance, strengthening personnel capacity, and engaging market communities in maintaining food safety..

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1. INTRODUCTION

Food safety is an essential aspect of public health protection, as food that fails to meet safety requirements may pose biological, chemical, and physical hazards [1]. This issue

is particularly relevant in traditional markets, where producers, distributors, traders, and consumers interact through daily trading activities. One persistent concern is the illegal use of chemical substances prohibited in food, such as borax, formalin, Rhodamine B, and

Methanil Yellow. These substances may be misused to extend shelf life, modify texture, or enhance the appearance of food products. [2] reported the detection of hazardous substances in food products examined during surveillance activities in Indonesia. These findings indicate that food safety surveillance should extend beyond product testing to include education and community participation throughout the food supply chain, from producers to end consumers.

Improving knowledge through education and training is one approach to strengthening food safety practices. However, increased knowledge does not necessarily lead to consistent behavioral changes. [3] explained that the relationships among food safety knowledge, attitudes, and practices are not always consistent. [4] also demonstrated that training generally improves participants' knowledge, whereas changes in practices are influenced by additional factors, including environmental support and workplace conditions. These findings suggest that education should be complemented by continuous guidance and surveillance to facilitate the application of knowledge in daily activities. In traditional markets, the involvement of market managers, market personnel, and traders is particularly important because they are directly engaged in food distribution and are well positioned to identify and report products suspected of failing to meet food safety requirements.

To strengthen food safety surveillance, Indonesian Food and Drug Authority (*Badan Pengawas Obat dan Makanan*; BPOM) developed the Community-Based Safe Food Market Program (*Pasar Pangan Aman Berbasis Komunitas*; PPABK). This program integrates advocacy, technical training, food safety education, food sampling, hazardous substance testing, and monitoring and evaluation to improve the knowledge and capacity of market communities to support food safety surveillance. This approach is consistent with BPOM's program implementation guidelines, which emphasize market community empowerment, cross-sectoral collaboration, and local government support to ensure

program sustainability [5]. [6] in a study of PPABK implementation at Tanjungsari Market in Cilacap Regency, demonstrated that improvements in market personnel's capacity to conduct risk-based sampling may be accompanied by changes in hazardous substance detection patterns. The proportion of non-compliant test results initially increased during certain surveillance stages before declining, with no positive results detected during the final monitoring phase. These developments indicate that program evaluation should not rely solely on the number of findings recorded within a single period but should also consider surveillance capacity and changes in testing outcomes over time.

Nambangan Market, located in Kenjeran District, Surabaya, was selected as one of the PPABK implementation sites in 2023. According to the 2023 market profile issued by Surabaya City Office of Cooperatives, Small and Medium Enterprises, and Trade (*Dinas Koperasi Usaha Kecil dan Menengah dan Perdagangan Kota Surabaya*; Dinkopumdag), Nambangan Market comprises 424 stalls or business units and serves approximately 600 visitors daily. PPABK implementation at this market was coordinated by Surabaya Regional Office of the Indonesian Food and Drug Authority (*Balai Besar Pengawas Obat dan Makanan di Surabaya*; BBPOM Surabaya) in collaboration with the Surabaya City Government through Dinkopumdag and the market community, including market managers, market personnel, traders, trader associations, and market visitors or consumers. Program activities began with advocacy and market surveys, followed by technical training for market personnel, food safety education, sampling and testing of food products suspected of containing hazardous substances, and monitoring and evaluation. During implementation, BBPOM Surabaya provided technical guidance, strengthened personnel capacity to identify high-risk food products, and supplied rapid test kits to support food safety surveillance within the market. These activities formed part of broader efforts to strengthen the market

community's capacity to participate in food safety surveillance.

Food safety surveillance at Nambangan Market was further strengthened through innovations developed through interinstitutional collaboration. One such innovation is the Food Safety Monitoring Post, a facility that provides testing services for food products suspected of containing hazardous substances and free consultation services for traders and market visitors. This facility was developed through collaboration between PPABK and the Safe Fresh Food Market Program (*Pasar Pangan Segar Aman*; PAS Aman), which is supported by National Food Agency (*Badan Pangan Nasional*; BAPANAS) through the Surabaya City Office of Food Security and Agriculture. In addition, an Internal Control System (ICS) Team was established under PAS Aman to support fresh food surveillance, involving market personnel who also participated in PPABK activities. Accordingly, the Food Safety Monitoring Post serves as a market-level innovation supporting food testing and food safety consultations, while the ICS Team operates as part of fresh food surveillance under PAS Aman. Both mechanisms contribute to food safety surveillance at Nambangan Market through coordination with PPABK activities implemented by BBPOM Surabaya. Local government support is also reflected in the replication of food safety education activities across six other markets in Surabaya in 2023 through Dinkopumdag. These initiatives demonstrate efforts to strengthen surveillance through personnel capacity development, the provision of supporting facilities, and cross-sectoral collaboration.

Previous studies have examined knowledge improvement through food safety education and training. [4] demonstrated that food safety training contributes to improvements in participants' knowledge, although changes in behavior and food safety practices do not necessarily occur simultaneously. Similarly, [7] showed that participatory food safety education can improve community understanding of food safety risks and contamination prevention.

Meanwhile, [3] explained that improvements in knowledge are not always accompanied by the consistent implementation of food safety practices.

Nevertheless, evaluations that integrate changes in participants' knowledge with trends in hazardous substance testing results across multiple surveillance periods remain limited, particularly in the implementation of PPABK in Indonesian traditional markets. Pre-test and post-test assessments can describe changes in knowledge following training; however, these measurements alone are insufficient to explain subsequent developments in food safety surveillance outcomes. Therefore, this study aims to analyze changes in the knowledge of technical training participants before and after PPABK intervention by BBPOM Surabaya and to evaluate trends in testing results for borax, formalin, Rhodamine B, and Methanil Yellow at Nambangan Market during the 2023–2025 period. These two indicators are analyzed separately because they involve different units of analysis. Consequently, this study does not seek to establish a direct causal relationship between improvements in knowledge and reductions in hazardous substance detection. The findings are expected to provide useful considerations for BPOM, local governments, and market management in strengthening technical guidance, food safety surveillance, and the sustainability of community-based food safety programs.

2. LITERATURE REVIEW

2.1 Food Safety and the Risks of Hazardous Substances in Traditional Markets

Food safety is an important aspect of public health protection, as food that fails to meet safety requirements may pose health risks arising from biological, chemical, or physical hazards. Food safety surveillance should be conducted comprehensively throughout the supply chain, from production and distribution to the point at which food reaches the final consumer. Traditional markets require particular attention because

various food products from producers and distributors are sold directly to the public [8]. One persistent concern is the misuse of chemical substances prohibited for use in food, such as borax, formalin, Rhodamine B, and Methanil Yellow [9]. Borax and formalin may be illegally used to modify food texture or extend shelf life, while Rhodamine B and Methanil Yellow may be used to produce more visually appealing colors. [2], [10] demonstrated the continued relevance of testing for these substances in food safety surveillance. Therefore, surveillance efforts should include product testing, trader education, communication regarding hazardous substance risks, and follow-up actions for food products that fail to meet safety requirements.

Rapid testing is one method that can be used to identify the suspected presence of hazardous substances in food under field conditions [11]. [6] in a study of PPABK implementation at Tanjungsari Market in Cilacap Regency, discussed the use of rapid tests for borax, formalin, Rhodamine B, and Methanil Yellow to support risk-based food testing and the involvement of market personnel in surveillance activities. However, rapid testing provides qualitative screening results and therefore requires appropriate procedures, the correct use of reagents according to the manufacturer's instructions, and personnel with adequate technical competence. The interpretation of results should also consider sampling methods and the number of tests conducted for each parameter. When samples are selected based on risk, the percentage of non-compliant test results represents the proportion of non-compliance among the tests performed rather than the prevalence of hazardous substances in all food products circulating within the market. Accordingly, food safety surveillance in traditional markets requires competent personnel, adequate testing facilities, effective communication with traders, and market

community participation to ensure that testing and follow-up activities can be sustained.

2.2 *PPABK as an Approach to Community Empowerment and Food Safety Surveillance*

PPABK was implemented at Nambangan Market, Surabaya, by BBPOM Surabaya in 2023 to improve the knowledge, skills, and independence of market communities in conducting food safety surveillance. As the implementing institution, BBPOM Surabaya conducted advocacy, coordination with the local government, technical training, food safety education, sampling, hazardous substance testing, and monitoring and evaluation. BBPOM Surabaya also provided technical guidance on identifying high-risk food products and using rapid test kits to detect borax, formalin, Rhodamine B, and Methanil Yellow. These activities aimed to strengthen the capacity of market personnel to conduct preliminary examinations and support sustainable food safety surveillance.

PPABK implementation by BBPOM Surabaya was supported through collaboration with the Surabaya City Government, market management, and the trading community. This support was reflected in the establishment of the Food Safety Monitoring Post, an innovation at Nambangan Market that provides preliminary testing and food safety consultation services. In addition, some market personnel were involved in the ICS Team under PAS Aman to support fresh food surveillance. Both mechanisms complement PPABK implementation, although they were not established entirely by BBPOM Surabaya. Consistent with [6], who emphasized the importance of personnel competence in risk-based sampling, the evaluation of PPABK at Nambangan Market should consider both improvements in participants' knowledge and trends in food testing results during the 2023–2025 period.

2.3 Food Safety Knowledge, Behavior, and Culture

Knowledge is an important indicator in evaluating food safety education because it enables individuals to recognize risks, understand food safety requirements, and identify appropriate preventive measures. Knowledge can be improved through education, technical guidance, training, and direct experience in surveillance activities. [4] demonstrated that food safety training generally has a positive effect on participants' knowledge, although changes in behavior and food safety practices do not necessarily occur simultaneously. Pre-test and post-test assessments can be used to evaluate changes in knowledge following educational activities, but they are insufficient to establish whether these changes are sustained over time or lead to improvements in behavior [12]. [7] also showed that participatory food safety education can improve public understanding of the risks and prevention of *Salmonella* sp. contamination. Nevertheless, [3] explained that increased knowledge is not always followed by the consistent implementation of food safety practices. This knowledge-practice gap indicates that the effectiveness of food safety education should be interpreted cautiously and supported by conditions that enable participants to apply their acquired knowledge.

Food safety behavior is influenced not only by knowledge but also by individuals' capabilities, motivation, and environmental support. [13] explained that these three aspects contribute to shaping food safety behavior, while [14] emphasized the importance of leadership, communication, commitment, and management systems in establishing a food safety culture. [14] further highlighted that risk awareness must be accompanied by shared responsibility to ensure the consistent implementation of

food safety practices. In traditional markets, applying these principles requires the involvement of market management, market personnel, traders, and local government support. This is relevant to PPABK implementation by BBPOM Surabaya, which combines knowledge improvement through technical training with strengthened surveillance capacity. The establishment of the Food Safety Monitoring Post and the involvement of market personnel in the ICS Team under PAS Aman also provide institutional support for surveillance activities at Nambangan Market. However, this study did not directly measure changes in food safety behavior or culture. These concepts were used as a theoretical foundation to explain the importance of facilities, coordination, and continuous surveillance in complementing improvements in participants' knowledge.

2.4 Program Sustainability and Food Safety Surveillance Outcomes

The sustainability of food safety programs depends not only on successful educational activities but also on the capacity to maintain guidance and surveillance after BBPOM Surabaya's intervention has concluded. Improvements in knowledge need to be supported by personnel competence, the availability of testing facilities, and the commitment of market management and local government. [12] explained that pre-intervention and post-intervention measurements have limitations in assessing the sustainability of outcomes without follow-up observations. [15] also emphasized the importance of knowledge retention, behavioral implementation, and environmental support in evaluating food safety education. The sustainability of PPABK at Nambangan Market can be observed through routine food surveillance and testing activities. [6] demonstrated that testing outcomes may change as personnel improve their ability to

conduct risk-based sampling. However, changes in the percentage of non-compliant test results must be interpreted by considering the number of tests, types of food products, and testing parameters, as risk-based samples do not represent all food products circulating within the market.

In implementing PPABK at Nambangan Market, the sustainability of surveillance activities was supported by guidance provided by BBPOM Surabaya and collaboration with the Surabaya City Government and market management. According to the 2023 Nambangan Market Profile, this support included the provision of rapid test kits, the development of the Food Safety Monitoring Post as a facility for preliminary testing and consultation, and the involvement of market personnel in the ICS Team under PAS Aman. The evaluation of PPABK at Nambangan Market was based on two indicators: changes in the knowledge of technical training participants in 2023 and trends in testing results for borax, formalin, Rhodamine B, and Methanil Yellow during the 2023–2025 period. These indicators provide complementary information on training and surveillance outcomes but do not demonstrate that improvements in knowledge directly caused a reduction in hazardous substance detection. Therefore, program sustainability should be understood in terms of the continuity of surveillance activities, testing outcomes among the examined samples, and the availability of institutional and operational support

that enables surveillance to be maintained over time.

2.5 Conceptual Framework

The conceptual framework of this study positions PPABK as a food safety capacity-building and surveillance program implemented by BBPOM Surabaya through technical training, food safety education, sampling, rapid testing, and monitoring and evaluation. [3] explained that improvements in knowledge do not necessarily lead to changes in practice, while [13] emphasized the importance of capability, motivation, and environmental support in implementing food safety practices. At Nambangan Market, such support is reflected in the Food Safety Monitoring Post and the involvement of market personnel in the ICS Team under PAS Aman. This study evaluates PPABK using two indicators: changes in participants' knowledge based on pre-test and post-test scores, and trends in hazardous substance testing results based on the percentage of non-compliant tests during 2023–2025. These indicators are analyzed separately because they involve different units of analysis, while the Food Safety Monitoring Post and the ICS Team are positioned as supporting mechanisms for surveillance rather than variables subjected to statistical testing. Accordingly, this conceptual framework is used to evaluate PPABK implementation outcomes without inferring a direct causal relationship between improvements in knowledge and reductions in hazardous substance detection.

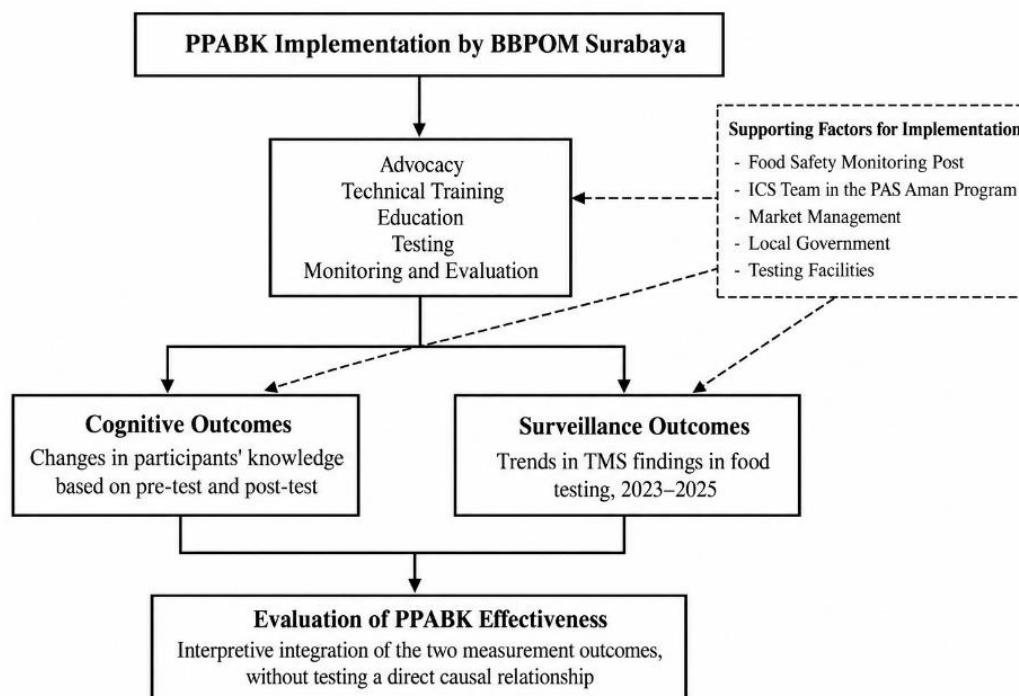


Figure 1. Conceptual Framework of the Study

3. METHODS

3.1 Research Design

This study employed a quantitative approach using a descriptive evaluative design and paired comparative analysis to assess the effectiveness of PPABK at Nambangan Market, Surabaya. The quantitative approach enables systematic measurement and analysis of program outcomes based on numerical data [16]. The evaluation focused on two primary indicators: changes in technical training participants' knowledge, measured using pre-test and post-test scores from the same individuals, and trends in food safety surveillance outcomes based on hazardous substance testing conducted during the 2023–2025 period. This study was retrospective in nature, as it utilized previously documented program data. Changes in knowledge were analyzed using a paired statistical test, whereas trends in food testing outcomes were examined descriptively across surveillance periods. The two indicators were analyzed separately because they involved different units of analysis and were subsequently interpreted together

to evaluate PPABK implementation outcomes without inferring a direct causal relationship between improvements in knowledge and reductions in hazardous substance detection.

3.2 Study Location and Context

The study was conducted at Nambangan Market, located in Kenjeran District, Surabaya, East Java, Indonesia. Nambangan Market is a traditional public market owned by the Surabaya City Government and managed by Dinkopumdag. According to the 2023 Nambangan Market Profile, the market comprises 424 stalls or business units and serves approximately 600 visitors daily.

Nambangan Market was selected because it was one of the implementation sites for PPABK conducted by BBPOM Surabaya in 2023. In addition, documentation was available in the form of technical training participants' assessment scores, food sample testing reports, and follow-up surveillance reports extending through 2025.

Program implementation was supported by the Food Safety Monitoring

Post, an innovation introduced at the market, and the involvement of market personnel in the ICS Team under PAS Aman. These supporting mechanisms formed part of the institutional context relevant to understanding the sustainability of food safety surveillance at Nambangan Market.

3.3 PPABK Program Intervention

The intervention evaluated in this study was PPABK implemented by BBPOM Surabaya in 2023. According to the 2023 Nambangan Market Profile, program activities included advocacy and cross-sectoral coordination, market surveys, technical training for market management personnel, food safety education, food sampling, hazardous substance testing, and monitoring and evaluation by Dinkopumdag. BBPOM Surabaya provided technical guidance and strengthened the technical capacity of market personnel, particularly in identifying high-risk food products, understanding sampling procedures, and using rapid test kits. BBPOM Surabaya also supplied testing equipment to support the detection of hazardous substances in food products circulating within the market.

PPABK implementation was further supported by the PAS Aman, a market-level innovation providing preliminary testing and food safety consultation services for traders and market visitors. In addition, market personnel who participated in PPABK were also involved in the ICS Team under PAS Aman to support coordination in fresh food surveillance. These facilities and institutional mechanisms were considered supporting elements of surveillance activities rather than intervention components whose effects were assessed independently. PPABK implementation outcomes were evaluated using two indicators: changes in participants' knowledge scores before and after technical training and trends in hazardous substance testing results during the 2023–2025 period.

3.4 Population, Sample, and Data Sources

This study utilized two datasets corresponding to the evaluation indicators. The first dataset consisted of pre-test and post-test scores from market management personnel who participated in technical training in 2023. All participants with complete paired scores were included through total sampling, resulting in a sample of 10 participants for analyzing changes in knowledge before and after the intervention. The second dataset comprised secondary data obtained from food sampling and hazardous substance testing reports at Nambangan Market during the 2023–2025 period. These records included surveillance periods, food product types, testing parameters, and classifications of results as compliant (*Memenuhi Syarat*; MS) or non-compliant (*Tidak Memenuhi Syarat*; TMS). The parameters analyzed were borax, formalin, Rhodamine B, and Methanil Yellow. The unit of analysis for food safety surveillance was the individual parameter test result, as a single food sample could be tested for more than one parameter; therefore, the total number of tests did not necessarily correspond to the number of food samples. The two datasets were analyzed separately because they involved different units of analysis and there was no individual-level linkage between technical training participants and the food samples examined.

3.5 Variables and Operational Definitions

The effectiveness of PPABK was evaluated using two primary indicators: participants' knowledge levels and food safety surveillance outcomes. Knowledge levels were measured based on changes in technical training participants' pre-test and post-test scores, with positive differences indicating improved knowledge, zero differences indicating no change, and negative differences indicating decreased scores. Meanwhile, food safety surveillance outcomes were assessed using rapid tests for four hazardous substances: borax,

formalin, Rhodamine B, and Methanil Yellow. Test results were classified as MS or TMS according to the surveillance reports and were subsequently used to evaluate trends in hazardous substance detection throughout the study period. The percentage of TMS results was calculated using the following formula:

$$TMS(\%) = \frac{N_{TMS}}{N_{tested}} \times 100$$

Where:

(N_{TMS}) = Number of parameter test results classified as non-compliant.

(N_{tested}) = Total number of hazardous substance parameter tests conducted during the period analyzed.

The percentage of TMS results was calculated using the total number of parameter tests as the denominator because a single food sample could undergo more than one type of testing. This percentage was used as an indicator of surveillance outcomes among the samples examined and was not interpreted as the prevalence of hazardous substances in all food products circulating at Nambangan Market.

3.6 Data Collection Techniques

Data were collected through testing and document review. The test data were obtained from records of pre-test and post-test scores of participants attending technical training on hazardous substance surveillance conducted in 2023. Both measurements were obtained from the same participants and were therefore treated as paired data to evaluate changes in

knowledge before and after technical training [17].

Document review was conducted by examining the 2023 Nambangan Market Profile and food sampling and hazardous substance testing reports covering the 2023–2025 period. The information collected included surveillance periods, food product types, hazardous substance parameters, the number of tests performed, and the classification of results as MS or TMS. All data were subsequently organized according to the study indicators and surveillance periods to support descriptive analysis, statistical testing of differences in knowledge scores, and evaluation of trends in food safety surveillance outcomes.

3.7 Food Sampling and Hazardous Substance Testing Procedures

Food samples were selected purposively based on risk considerations (*risk-based sampling*), prioritizing products exhibiting characteristics or indications suggesting the potential presence of hazardous substances. Sample selection criteria included unusual coloration, abnormal texture, shelf-life characteristics inconsistent with the nature of the product, and previous findings involving similar food commodities.

This approach was intended to support the early detection of potentially hazardous food products rather than to obtain a random sample representative of all food products circulating within the market. Qualitative testing was conducted for four parameters: borax, formalin, Methanil Yellow, and Rhodamine B.

Table 1. Characteristics and Testing of Hazardous Substances in Food

Parameter	Characteristics	Testing Method	Interpretation of Results
Borax	A non-food chemical substance that may be illegally used to increase food elasticity or crispness.	Rapid test for borax.	Identification of the suspected presence of borax according to the test kit instructions.
Formalin	A formaldehyde-containing substance that may be illegally used as a food preservative.	Rapid test for formalin.	Identification of the suspected presence of formalin based on reactions with testing reagents.

Parameter	Characteristics	Testing Method	Interpretation of Results
Methanil Yellow	A synthetic non-food dye that may be illegally used to produce a bright yellow color in food products.	Rapid test for Methanil Yellow.	Identification of the suspected presence of Methanil Yellow according to the test kit instructions.
Rhodamine B	A synthetic non-food dye that may be illegally used to produce a bright red color in food products.	Rapid test for Rhodamine B.	Identification of the suspected presence of Rhodamine B according to the test kit instructions.

Source: PPABK testing documentation at Nambangan Market for the 2023–2025 period, compiled based on the testing parameters recorded in the reports.

Rapid testing was used as a qualitative screening method to identify the suspected presence of hazardous substances in food samples rather than to determine their concentrations quantitatively. Test results were classified as MS or TMS according to the testing reports used as the study's data sources. Because this study relied on secondary data and did not conduct additional testing, the interpretation of results was limited to the hazardous substance parameters examined and the documented testing methods and outcomes. Accordingly, positive rapid test results were treated as preliminary indications of the presence of hazardous substances and did not replace confirmatory testing when required.

3.8 Data Analysis Techniques

Participants' knowledge was analyzed using descriptive statistics and paired comparison tests. Descriptive statistics included the number of participants, minimum and maximum scores, mean, median, standard deviation, and differences between pre-test and post-test scores. The normality of score differences was assessed using the Shapiro–Wilk test to determine the appropriate statistical method [18]. When the distribution of score differences did not meet the assumption of normality, changes in knowledge were analyzed using the Wilcoxon signed-rank test at a significance level of 0.05. The null hypothesis (H_0) stated that there was no difference in knowledge scores before and after PPABK technical training, whereas the alternative hypothesis (H_1) stated that there was a

difference between the two measurements. A p-value below 0.05 was used as the criterion for rejecting H_0 . The interpretation also considered the direction of score changes and the number of participants whose scores increased, decreased, or remained unchanged.

Food safety surveillance data were analyzed descriptively according to the examination periods during 2023–2025, including the number of food samples, the number of parameter tests performed, and the number and percentage of MS and TMS results. Trends in surveillance outcomes were evaluated by comparing the proportion of TMS results during the 2023 intervention stages with those recorded during post-intervention examinations in 2024–2025, based on the dates documented in the surveillance reports. Differences in the number of tests and the composition of testing parameters across periods were considered because sampling was conducted using a risk-based approach. Consequently, the percentage of TMS results could not be used to estimate the prevalence of hazardous substances in all food products circulating at Nambangan Market. The findings from the knowledge assessment and food safety surveillance were subsequently integrated through interpretive analysis as two complementary indicators of PPABK evaluation. No direct causal relationship was inferred because the two datasets involved different units of analysis and the study did not include a control group. The findings were

presented in statistical tables, paired comparison test results, and graphs illustrating surveillance trends.

4. RESULTS AND DISCUSSION

4.1 *Overview of Nambangan Market and PPABK Implementation*

Nambangan Market is a traditional public market owned by the Surabaya City Government, located in Kenjeran District, Surabaya, East Java, Indonesia, and managed by Dinkopumdag. According to the 2023 Nambangan Market Profile, the market comprises 424 stalls or business units offering various commodities and serves approximately 600 visitors daily. In 2023, Nambangan Market became one of the implementation sites for PPABK, conducted by BBPOM Surabaya in collaboration with the local government and market community. Program activities included advocacy and cross-sectoral coordination, market surveys, technical training for market management personnel, food safety education, food sampling and testing, and monitoring and evaluation. BBPOM Surabaya provided technical guidance, strengthened the capacity of market personnel to identify high-risk food products, and supplied rapid test kits to support food safety surveillance within the market.

According to program evaluation documentation, the market's assessment score increased from 63.33%, categorized as Fair, to 96.7%, categorized as Good, in 2023. These improvements included organizing trading zones according to commodity types, providing running water in areas selling fresh animal products, implementing pest control measures, installing additional covered waste bins, and improving drainage systems. These developments reflect efforts by market management and the local government to establish a more organized trading environment that supports hygiene and sanitation practices. In addition to

infrastructure improvements, strengthening personnel capacity through technical training and food safety education formed part of broader efforts to improve the market community's ability to conduct food safety surveillance.

PPABK implementation was also supported by the PAS Aman, an innovation at Nambangan Market developed through collaboration with PAS Aman. The facility operates under the supervision of Dinkopumdag, while PAS Aman is supported by BAPANAS through the Surabaya City Office of Food Security and Agriculture. The Monitoring Post provides preliminary testing services for food products suspected of containing hazardous substances and offers free food safety consultations to traders and the public. Trained market personnel conduct screening tests for borax, formalin, Rhodamine B, and Methanil Yellow, while pesticide testing falls within the scope of fresh plant-based food surveillance. In addition to the Monitoring Post, an ICS Team was established under PAS Aman to support surveillance of fresh plant- and animal-based food products. The involvement of market personnel in both PPABK and the ICS Team facilitates coordination between processed and fresh food surveillance activities, although the two programs have different scopes and institutional responsibilities.

The progress achieved through program implementation also received national recognition. On June 21, 2024, Nambangan Market was awarded second place at the national level in the Western Region category of the PPABK Competition organized by BPOM. The award was presented at the BPOM RI Merah Putih Building during the 2024 *Gerakan Masyarakat Hidup Sehat Sadar Pangan Aman* (Healthy Living and Safe Food Awareness Movement; Germas SAPA) workshop. According to competition documentation, the

assessment involved several stages, beginning with portfolio submissions and interview selection, followed by on-site verification of the leading nominees before the three highest-ranking markets were selected. Nambangan Market's achievement represents recognition of the commitment demonstrated by market management, the trading community, the local government, and BBPOM Surabaya in developing community-based food safety surveillance. This achievement also highlights the importance of technical guidance, community participation, innovation, and cross-sectoral coordination in supporting program implementation.

Support for the sustainability of food safety surveillance at Nambangan Market is reflected in the provision of testing equipment, improvements in personnel capacity, the development of surveillance facilities, and collaboration between BBPOM Surabaya and the local government. This commitment was further demonstrated through the replication of food safety education activities by Nambangan Market personnel in six other markets across Surabaya in 2023: Gunung Anyar Market, Dukuh Menanggal Market, Kutisari Market, Jambangan Market, Penjaringansari Tourism Market, and Keputih Harmoni Tourism Market. These replication activities demonstrate efforts to expand food safety information dissemination and encourage market community participation in surveillance.

The establishment of the Food Safety Monitoring Post and the involvement of market personnel in the ICS Team also indicate the availability of operational and institutional support for market-level surveillance. However, this study did not independently assess the effects of these two mechanisms. Therefore, PPABK effectiveness was evaluated using two primary indicators: changes in the knowledge of technical training participants and trends in hazardous substance testing results during the 2023–2025 period. These indicators were used to describe capacity-building and surveillance outcomes without inferring a direct causal relationship.

4.2 Effectiveness of PPABK in Improving Knowledge

a. Descriptive Statistics of Pre-test and Post-test Scores

The evaluation of knowledge improvement was based on pre-test and post-test results from 10 participants who attended technical training on hazardous substance surveillance conducted by BBPOM Surabaya in 2023. Both measurements were obtained from the same participants and were therefore treated as paired data. Descriptive statistics were used to characterize participants' knowledge levels before and after the training, including minimum and maximum scores, mean, standard deviation, median, and score changes.

Table 2. Descriptive Statistics of Knowledge Scores Before and After the Intervention

Variable	N	Minimum	Maksimum	Mean	Standar Deviation	Median
Pre-test	10	50,00	90,00	68,00	13,17	65,00
Post-test	10	70,00	100,00	80,00	9,43	80,00
Score Improvement	10	0,00	30,00	+12,00	7,89	+10,00

Source: Pre-test and post-test score records from the 2023 technical training, processed in 2026.

Based on Table 2, the mean knowledge score increased from 68.00 before technical

training to 80.00 after the training, representing an average improvement of 12.00 points.

The median score also increased from 65.00 to 80.00. The minimum score increased from 50.00 to 70.00, while the maximum score rose from 90.00 to 100.00. In addition, the standard deviation decreased from 13.17 to 9.43, indicating that the variability in participants' knowledge scores was lower after the training than before the intervention. Descriptively, these findings indicate an improvement in participants' knowledge following PPABK technical training.

These findings are consistent with [7], who demonstrated that participatory food safety education can improve community knowledge regarding food safety risks and the prevention of foodborne hazards. In the context of PPABK

implementation at Nambangan Market, the increase in knowledge scores reflects a positive outcome of the technical training conducted by BBPOM Surabaya, particularly in improving participants' understanding of food safety and hazardous substance surveillance.

b. Normality Test Results

Normality testing was conducted to determine the appropriate statistical method for analyzing differences in knowledge scores before and after the intervention. The Shapiro–Wilk test was applied because the data were obtained from 10 participants and the analysis focused on score differences derived from paired measurements.

Table 3. Shapiro–Wilk Normality Test Results

Variable	Shapiro–Wilk Statistic	df	P-value	Interpretation
Pre-test	0.858	10	0.073	No evidence of a significant deviation from normality
Post-test	0.841	10	0.045	Does not meet the normality assumption
Score difference	0.751	10	0.004	Does not meet the normality assumption

Source: Research data, processed in 2026.

Based on Table 3, the Shapiro–Wilk test results showed p-values of 0.073 for the pre-test, 0.045 for the post-test, and 0.004 for the score differences. The p-value for the score differences, which was below 0.05, indicated a statistically significant deviation from the normal distribution. In paired comparisons of mean scores, the normality assumption concerns the distribution of differences between the two measurements rather than the distributions of the individual datasets. Therefore, based on the

distributional characteristics of the score differences, the analysis proceeded using the Wilcoxon signed-rank test as a nonparametric method to evaluate changes in participants' knowledge.

c. Differences in Knowledge Scores Before and After the Intervention

The Wilcoxon signed-rank test was performed to determine whether there was a statistically significant difference between pre-test and post-test knowledge scores. The analysis included 10 paired scores from

participants who attended PPABK technical training.

Table 4. Wilcoxon Signed-Rank Test Results

Category	N	Mean Rank	Sum of Ranks
Negative ranks	0	0,00	0,00
Positive ranks	9	5,00	45,00
Ties	1	–	–
Total	10	–	–
Statistic Test	Nilai		
Z	-2,807		
Asymp. Sig. (2-tailed)	0,005		

Source: Research data, processed in 2026.

Based on Table 4, nine participants demonstrated an increase in knowledge scores, one participant showed no change, and none experienced a decrease. The Wilcoxon signed-rank test yielded a Z-value of -2.807 with a significance level of $p = 0.005$. Since the p-value was below 0.05, the null hypothesis stating that there was no difference in knowledge scores before and after technical training was rejected. Thus, participants demonstrated a statistically significant improvement in knowledge following PPABK technical training.

These results indicate that PPABK technical training achieved positive outcomes in improving participants' knowledge. The mean increase of 12.00 points, accompanied by improvements in nine out of ten participants, demonstrates an enhanced understanding of food safety and hazardous substance surveillance following the training. This finding is consistent with [3], who explained that knowledge is an essential component of food safety practices, although improvements in knowledge do not necessarily lead to consistent changes in actual practices.

Overall, the evaluation demonstrated that PPABK technical training produced positive and measurable outcomes in participants' knowledge. This achievement represents one indicator of the successful implementation of capacity-building activities conducted by BBPOM Surabaya at Nambangan Market. To provide a more comprehensive assessment of program implementation outcomes, the evaluation was further complemented by an analysis of trends in hazardous substance testing results during the 2023–2025 period.

4.3 Trends in Hazardous Substance Detection in Food

a. Food Safety Surveillance During Phase 1 in 2023

Food safety surveillance at Nambangan Market was conducted through sampling and rapid testing for four hazardous substances: borax, formalin, Rhodamine B, and Methanil Yellow. The initial surveillance phase in 2023 was intended to provide an overview of the food products selected for examination before the implementation of subsequent PPABK interventions.

According to the study records, 95 food samples were

examined for one or more hazardous substance parameters during Phase 1 in 2023. Since each sample could be tested for more than one parameter, the number of parameter tests did not necessarily correspond to the

number of individual food samples. The records indicated that 36 tests were conducted for borax, 56 for formalin, 10 for Rhodamine B, and seven for Methanil Yellow, resulting in a total of 109 parameter tests.

Table 5. Hazardous Substance Testing Results During Phase 1 in 2023

Parameter	Number of Tests	TMS	TMS Percentage
Borax	36	23	63.9%
Formalin	56	27	48.2%
Rhodamine B	10	6	60.0%
Methanil Yellow	7	1	14.3%
Total Parameter Tests	109	57	52.29%

Source: Nambangan Market Phase 1 testing records for 2023, processed in 2026.

Based on Table 5, the Phase 1 testing results revealed TMS findings across all four hazardous substance parameters examined. The highest percentage of TMS results was observed for borax at 63.9%, followed by Rhodamine B at 60.0%, formalin at 48.2%, and Methanil Yellow at 14.3%. Overall, 57 TMS results were recorded out of 109 parameter tests, representing 52.29%. These findings indicate that hazardous substances were still detected in several food samples examined during the initial phase of PPABK surveillance at Nambangan Market. Differences in percentages across parameters should be considered, as the numbers of tests conducted for Rhodamine B and Methanil Yellow were relatively smaller than those for borax and formalin.

Although the percentage of TMS results during Phase 1 was relatively high, the figure of 52.29% cannot be interpreted as the prevalence of hazardous substances in all

food products circulating at Nambangan Market. Food samples were selected based on risk considerations rather than random sampling; therefore, the testing results reflect only the characteristics of the samples and parameters examined. Accordingly, the Phase 1 findings were used to establish an initial overview of food safety surveillance outcomes and served as a basis for comparison with subsequent examinations to evaluate the progress of PPABK implementation by BBPOM Surabaya.

b. Food Safety Surveillance Following the 2023 Intervention

Following a series of capacity-building and training activities for the market community, food safety surveillance continued through Phase 2 sampling and testing in 2023. According to the study records, this phase involved 95 food samples and 106 parameter tests, comprising 29 tests for borax, 67 for formalin, six for Rhodamine B, and four for Methanil Yellow.

Table 6. Hazardous Substance Testing Results During Phase 2 in 2023

Parameter	Number of Tests	TMS	TMS Percentage
Borax	29	2	6.9%
Formalin	67	1	1.5%
Rhodamine B	6	3	50.0%
Methanil Yellow	4	0	0.0%
Total Parameter Tests	106	6	5.66%

Source: Nambangan Market Phase 2 testing records for 2023, processed in 2026.

Based on Table 6, the Phase 2 testing results showed a decrease in the percentage of TMS results for most parameters compared with Phase 1. The percentage of TMS results for borax decreased from 63.9% to 6.9%, while that for formalin declined from 48.2% to 1.5%. No TMS results were detected among the four tests conducted for Methanil Yellow. Meanwhile, the percentage of TMS results for Rhodamine B remained at 50.0%, with three TMS results out of six tests. The Rhodamine B findings should be interpreted cautiously because of the relatively small number of tests performed. Overall, the percentage of TMS results decreased from 52.29% in Phase 1 to 5.66% in Phase 2, representing a reduction of 46.63 percentage points. These changes indicate an improvement in surveillance outcomes among the food samples examined during PPABK implementation at Nambangan Market.

The decrease in the percentage of TMS results occurred during PPABK implementation by BBPOM Surabaya, which included technical training, food safety education, sampling, hazardous substance testing, technical guidance, and follow-up actions based on surveillance findings. These activities supported improvements in market personnel's capacity to identify

high-risk food products and conduct food safety examinations. However, the decrease in the percentage of TMS results cannot be directly attributed to the PPABK intervention because the study did not include a control group and samples were selected using a risk-based approach. Furthermore, differences in the number and composition of tests across surveillance periods should be considered when interpreting the findings. Therefore, these changes are more appropriately understood as positive developments in surveillance outcomes among the examined samples rather than evidence of a direct causal relationship between program implementation and reduced hazardous substance detection.

4.4 Consistency of Food Safety Surveillance Outcomes During 2023–2025

Following the main PPABK intervention in 2023, food safety surveillance activities at Nambangan Market continued through food monitoring and testing involving market personnel. These follow-up surveillance activities provided information on changes in testing outcomes after the technical guidance and capacity-building activities conducted by BBPOM Surabaya.

According to the testing reports, independent surveillance activities designated as Phase 3 (Market-Initiated Independent Surveillance) were conducted on

January 26–28, 2024. During these activities, 30 food samples were examined through a total of 35 parameter tests, comprising seven tests for borax, 18 for formalin, eight for Rhodamine B, and two for Methanil Yellow. All test results were classified as MS, with no TMS results detected among the samples and parameters examined.

Further surveillance activities were documented in 2025, involving the

examination of 45 food samples. Testing was conducted during June–July 2025, comprising 24 tests for borax, 21 for formalin, 13 for Rhodamine B, and 10 for Methanil Yellow, resulting in a total of 68 parameter tests. According to the testing records, the percentage of TMS results was 0% across all parameters examined.

Table 7. Trends in Food Safety Surveillance Outcomes at Nambangan Market During 2023–2025

Period	Surveillance Characteristics	Number of Parameter Tests	TMS	TMS Percentage
2023 Phase 1	Initial surveillance	109	57	52.29%
2023 Phase 2	Post-intervention surveillance	106	6	5.66%
January 2024 (Phase 3)	Market-initiated independent surveillance	35	0	0.00%
June–July 2025	Follow-up surveillance	68	0	0.00%

Source: Nambangan Market testing records for 2023, independent surveillance reports from January 2024, and testing reports from June–July 2025, processed in 2026.

Based on Table 7, food safety surveillance outcomes at Nambangan Market showed positive developments during the 2023–2025 period. The percentage of TMS results decreased from 52.29% in Phase 1 of 2023 to 5.66% in Phase 2, representing a reduction of 46.63 percentage points. During independent surveillance in January 2024, all 35 parameter tests were classified as MS. Similar findings were recorded during follow-up examinations in June–July 2025, when all 68 parameter tests were also classified as MS. These developments indicate that the reduction in the proportion of TMS results observed in 2023 was followed by the absence of TMS results among the samples examined during the subsequent two surveillance periods. Furthermore, the implementation of independent surveillance in January 2024 demonstrated the active

involvement of market personnel in continuing food safety testing activities after the main PPABK intervention conducted by BBPOM Surabaya.

Changes in surveillance outcomes should be interpreted by considering the characteristics of the examinations conducted during each period. Food samples were selected purposively based on risk considerations, with differences in the number of tests and the composition of testing parameters across periods. Testing was also limited to four hazardous substances: borax, formalin, Rhodamine B, and Methanil Yellow. Therefore, the percentage of TMS results represents the proportion of non-compliant test results among the samples examined rather than the prevalence of hazardous substances in all food products circulating at Nambangan Market. Nevertheless,

the observed trends provide valuable evaluative information regarding the condition of food samples targeted for surveillance and the continuity of testing activities following the main intervention.

Overall, surveillance outcomes during 2023–2025 demonstrated positive achievements, including a reduction in the proportion of TMS results among the tests conducted and the continuation of food safety surveillance activities at the market level. PPABK implementation by BBPOM Surabaya was supported by technical guidance, the involvement of market personnel, and coordination with the local government. The Food Safety

Monitoring Post and the participation of market personnel in the ICS Team under PAS Aman also provided operational and institutional support for surveillance activities. These findings indicate that strengthening community capacity and institutional support are important aspects of maintaining sustainable food safety surveillance. However, given the evaluative design employed in this study, the reduction in the proportion of TMS results is interpreted as a positive development in surveillance outcomes accompanying program implementation rather than evidence of a direct effect of PPABK on reducing hazardous substance detection.

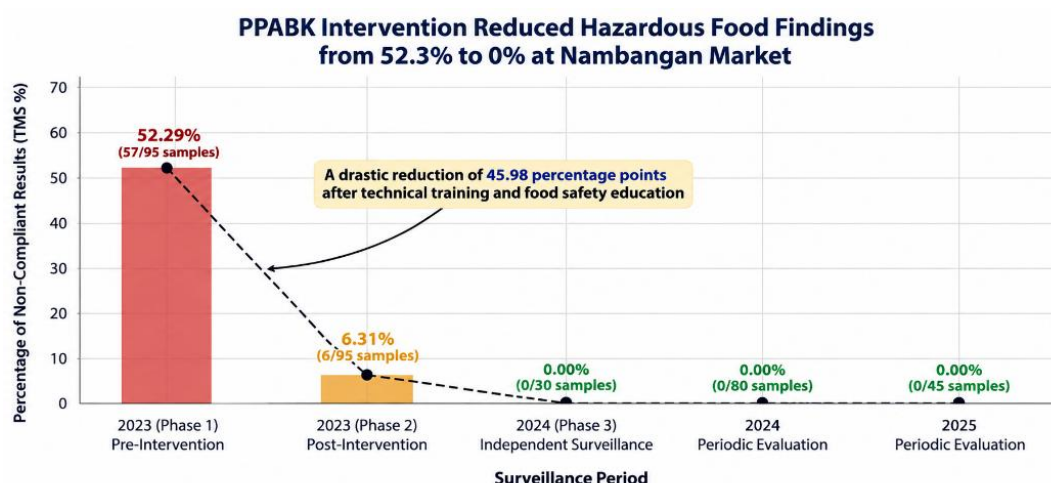


Figure 2. Trends in the Percentage of TMS Results in Food Safety Testing at Nambangan Market During 2023–2025

4.5 Discussion

a. Independent Food Safety Surveillance

PPABK implementation by BBPOM Surabaya at Nambangan Market in 2023 demonstrated positive developments in two evaluation indicators. The mean knowledge score of technical training participants increased from 68.00 to 80.00, with a statistically significant difference ($Z = -2.807$; $p = 0.005$). Meanwhile, the percentage of TMS results

decreased from 52.29% in Phase 1 of 2023 to 5.66% in Phase 2. No TMS results were detected among the samples tested during independent surveillance in January 2024 or follow-up examinations in June–July 2025. These developments indicate that improvements in participants' knowledge occurred alongside positive changes in surveillance outcomes, although the two indicators involved different units of analysis.

As the implementing institution of PPABK, BBPOM Surabaya conducted capacity-building activities, technical training, food safety education, food sampling, and hazardous substance testing. These activities aimed to strengthen market personnel's capacity to identify high-risk food products and support independent surveillance. [4] explained that food safety training generally improves knowledge, whereas changes in practice are influenced by environmental conditions and implementation support. This finding is consistent with [3], who demonstrated that increased knowledge does not necessarily lead to consistent changes in practice. Therefore, the involvement of market personnel in independent surveillance activities in January 2024 provides evidence that food safety testing continued after the main intervention by BBPOM Surabaya. However, it does not establish that improved knowledge directly caused the reduction in TMS results.

b. Strengthening Community Capacity as a Mechanism for Program Sustainability

Strengthening the capacity of market communities is one of the primary objectives of PPABK implemented by BBPOM Surabaya. Through technical training and food safety education, BBPOM Surabaya provided guidance on identifying high-risk food products, sampling procedures, the use of rapid test kits, and food safety surveillance procedures. These activities aimed to improve the capacity of market management personnel

to participate in food testing and surveillance after the main intervention had concluded. [13] explained that food safety behavior is influenced by capability, motivation, and environmental support, while [14] emphasized the importance of leadership, communication, commitment, and management systems in developing a food safety culture.

The findings of this study are consistent with [6], who examined PPABK implementation at Tanjungsari Market in Cilacap Regency, particularly regarding the importance of personnel competence in risk-based sampling and hazardous substance testing. At Nambangan Market, capacity-building activities conducted by BBPOM Surabaya were supported by the provision of testing equipment, the establishment of the Food Safety Monitoring Post, and the participation of market personnel in independent surveillance. Local government support was also demonstrated through the replication of food safety education activities in six other markets across Surabaya in 2023. These findings indicate that sustaining surveillance activities requires technical guidance from BBPOM Surabaya alongside operational and institutional support from the local government and market management.

c. The Role of the ICS Team and Market Community Education

Food safety surveillance at Nambangan Market was also supported by the ICS Team established under PAS Aman. According to the 2023

Nambangan Market Profile, the team involved market personnel in the surveillance of fresh plant- and animal-based food products. Some personnel involved in the ICS Team also participated in PPABK activities conducted by BBPOM Surabaya. This involvement supported coordination between fresh food surveillance under PAS Aman and hazardous substance surveillance under PPABK. Thus, the ICS Team formed part of the surveillance mechanism within PAS Aman rather than an organizational structure established directly by BBPOM Surabaya through PPABK.

The ICS Team provided institutional support for surveillance coordination and food safety communication within the market. Market personnel who regularly interact with traders have opportunities to communicate information about high-risk food products and support follow-up actions based on testing results. [14] explained that food safety culture requires communication, leadership, and organizational support, while [13] emphasized the importance of an environment that facilitates food safety practices. In the context of Nambangan Market, technical guidance from BBPOM Surabaya and the involvement of market personnel in the ICS Team represent complementary activities operating within their respective program responsibilities. However, this study did not independently assess the effect of the ICS Team on changes in TMS results.

d. The Food Safety Monitoring Post as a Market Surveillance Innovation

The Food Safety Monitoring Post is an innovation at Nambangan Market that supports food safety surveillance by providing preliminary testing and consultation services for traders and the public. According to the 2023 Nambangan Market Profile, the facility was developed through collaboration between PPABK, implemented by BBPOM Surabaya, and PAS Aman, supported by BAPANAS through the local government. The Monitoring Post provides free testing services during designated service hours, involving market personnel who have received relevant training. Testing covers borax, formalin, Rhodamine B, and Methanil Yellow, while pesticide residue surveillance falls within the scope of PAS Aman.

BBPOM Surabaya supported the operation of the Food Safety Monitoring Post through technical guidance, improvements in market personnel competence, and the provision of rapid test kits. Meanwhile, the local government and market management supported the provision of facilities and the implementation of surveillance activities within the market. This division of responsibilities reflects collaboration between regulatory institutions and market management in supporting food safety testing. However, sustaining the Monitoring Post requires competent personnel, adequate supplies of testing equipment and reagents, systematic

recording of test results, and clear follow-up procedures. As this study did not independently assess the effects of the Monitoring Post, its role was considered operational support rather than a direct cause of the reduction in TMS percentages.

4.6 Program Sustainability and Trends in Surveillance Outcomes During 2023–2025

The sustainability of PPABK should be assessed by examining whether surveillance activities continued after the main intervention conducted by BBPOM Surabaya in 2023. [12] explained that pre-intervention and post-intervention measurements have limitations in assessing long-term outcomes without follow-up observations. In this study, knowledge improvement was evaluated using technical training data from 2023, while surveillance trends were examined using testing reports covering the 2023–2025 period. The percentage of TMS results decreased from 52.29% in Phase 1 to 5.66% in Phase 2 of 2023. Subsequently, no TMS results were detected among the 35 parameter tests conducted on 30 food samples during independent surveillance in January 2024 or among the 68 parameter tests conducted on 45 samples during June–July 2025. These findings indicate that food safety testing activities continued to be documented after the main intervention.

The continuity of surveillance activities was supported by improvements in personnel capacity through technical guidance from BBPOM Surabaya, the development of the Food Safety Monitoring Post, the involvement of market personnel in the ICS Team under PAS Aman, and collaboration with the local government. Nevertheless, the absence of TMS results in 2024 and 2025 does not indicate that all food products at Nambangan Market were free from hazardous substances. Sampling was conducted using a risk-based approach,

and the number and composition of testing parameters varied across surveillance periods. Therefore, these surveillance trends should be interpreted as findings related to the examined samples rather than evidence of a reduction in the prevalence of hazardous substances across all food products circulating within the market.

4.7 Theoretical Contributions

The contribution of this study lies in the use of two indicators to evaluate PPABK implementation by BBPOM Surabaya: changes in technical training participants' knowledge and trends in hazardous substance surveillance outcomes. This approach complements the evaluation of educational outcomes by incorporating food testing data from multiple surveillance periods. [3] explained that improvements in knowledge do not necessarily lead to changes in food safety practices, highlighting the need for additional indicators to provide a more comprehensive understanding of intervention outcomes. At Nambangan Market, improvements in participants' knowledge occurred alongside positive trends in testing results and institutional surveillance support through the Food Safety Monitoring Post and the involvement of market personnel in the ICS Team. Nevertheless, this study did not test causal relationships between the two indicators or independently assess the effects of individual institutional support mechanisms. Accordingly, the study contributes to an evaluative approach to PPABK that integrates the outcomes of capacity-building activities conducted by BBPOM Surabaya with trends in food safety surveillance results.

4.8 Practical Implications

The findings provide practical considerations for BBPOM Surabaya, the Surabaya City Government, and Nambangan Market management in strengthening PPABK implementation. As the institution responsible for implementing the program, BBPOM

Surabaya should maintain technical guidance, training, and surveillance assistance to improve market personnel's competence in identifying high-risk food products, collecting samples, and using rapid test kits according to established procedures. The local government and market management should support the maintenance of the Food Safety Monitoring Post, the availability of testing equipment, the documentation of test results, and follow-up mechanisms for food products suspected of failing to meet safety requirements. The involvement of market personnel in the ICS Team under PAS Aman can also be utilized to strengthen coordination between fresh and processed food surveillance activities in accordance with the responsibilities of the respective institutions. In addition, continuous trader education and risk communication are necessary to ensure that surveillance extends beyond testing to include appropriate preventive and corrective actions.

4.9 Study Limitations

This study has several limitations. The knowledge evaluation involved only 10 technical training participants; therefore, the findings cannot be generalized to the entire Nambangan Market community. Measurements were conducted before and after the intervention without a control group or subsequent knowledge assessments. Consequently, changes in knowledge scores cannot be attributed entirely to the technical training conducted by BBPOM Surabaya, nor can their long-term retention be established. In addition, food samples were selected using a risk-based approach; therefore, the percentage of TMS results reflects only the outcomes of the examined samples. Differences in the number and composition of parameter tests across periods should also be considered, particularly for Rhodamine B in Phase 2, which showed a TMS rate of 50.0% based on six tests. The study relied on

secondary data from qualitative rapid screening tests without independently conducting confirmatory testing. Furthermore, knowledge and surveillance data involved different units of analysis, preventing direct examination of causal relationships between the two indicators. This study also did not independently evaluate the effects of the Food Safety Monitoring Post or the ICS Team. Future research should therefore consider measuring actual surveillance practices, periodically evaluating personnel competence, and adopting more rigorous research designs to assess the sustainability of program outcomes.

5. CONCLUSION

This study demonstrated that PPABK implementation by BBPOM Surabaya at Nambangan Market was associated with improvements in technical training participants' knowledge and positive developments in food safety surveillance outcomes during the 2023–2025 period. The mean knowledge score of 10 participants increased from 68.00 to 80.00, with a statistically significant difference ($Z = -2.807$; $p = 0.005$). Meanwhile, the percentage of TMS results decreased from 52.29% in Phase 1 of 2023 to 5.66% in Phase 2. No TMS results were detected among the samples examined during independent surveillance in January 2024 or follow-up testing in June–July 2025. These findings indicate positive developments in participants' knowledge and food safety surveillance outcomes but do not establish a direct causal relationship between the two indicators.

PPABK implementation by BBPOM Surabaya was supported through collaboration with the Surabaya City Government. Capacity-building activities, technical training, food safety education, and surveillance conducted by BBPOM Surabaya were further supported by the Food Safety Monitoring Post as an innovation at Nambangan Market and the involvement of market personnel in the ICS Team under PAS Aman. Both mechanisms supported market-

level surveillance according to their respective functions. However, the testing results reflect only the conditions of the examined samples and parameters rather than the safety of all food products circulating within the market. Therefore, sustaining PPABK requires

periodic technical guidance, adequate testing facilities, consistent documentation and follow-up of testing results, and coordination among BBPOM Surabaya, the local government, market management, and the trading community.

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