Hazardous Substance Prevalence and Cadre Resilience in Tanjungsari's Community-Based Safe Food Market Program, Cilacap

Agnes Dwi Safarina [a,1*]

[a] The Indonesian Food and Drug Authority, Jl. Percetakan Negara No. 23, Jakarta Pusat 10560, Indonesia
[1] agnes.safarina@pom.go.id*
**corresponding author*

ARTICLE INFO

Article history
Received:
March 26, 2026

Revised:
July 02, 2026

Accepted:
July 16, 2026

DOI:
https://doi.org/10.54384/eruditio.v5i2.254

ABSTRACT / ABSTRAK

Food safety issues in traditional markets remain a systemic challenge due to the illegal use of hazardous chemicals such as formaldehyde and textile dyes, particularly in coastal areas with extensive seafood distribution chains. This study aims to analyze the trends in hazardous substance prevalence and evaluate the effectiveness of the Community-Based Safe Food Market Program (PPABK) in Cilacap Regency, focusing on Tanjungsari Market. The methodology employed is a descriptive-analytical study design with a community intervention approach conducted from May to July 2025. Primary data were collected through incidental sampling (n=39) and tested using PPPOMN-verified rapid test kits. Research findings revealed a high pre-intervention prevalence of hazardous substances in the Cilacap region at 40.6%. During the intervention process, a detection paradox occurred, where prevalence increased from 16.7% to 40.0% due to the enhanced capacity of cadres in performing targeted sampling. However, in the final monitoring and evaluation phase, the prevalence significantly dropped to 0%. The study concludes that strengthening the resilience of market cadres as internal supervisors effectively changes trader behavior and creates independent oversight. The proposed policy recommendation is the replication of the PPABK model in other traditional markets, supported by the integration of local government budgets to ensure the sustainable availability of independent testing facilities.

Permasalahan keamanan pangan di pasar tradisional masih dihadapkan pada tantangan sistemik terkait penyalahgunaan bahan kimia berbahaya seperti formalin, boraks, dan pewarna tekstil, khususnya pada wilayah pesisir dengan rantai distribusi hasil laut yang panjang. Penelitian ini bertujuan untuk menganalisis tren prevalensi bahan berbahaya dan mengevaluasi efektivitas Program Pasar Pangan Aman Berbasis Komunitas (PPABK) di Kabupaten Cilacap, dengan lokus utama di Pasar Tanjungsari. Metodologi yang digunakan adalah desain studi deskriptif analitis dengan pendekatan intervensi komunitas pada periode Mei hingga Juli 2025. Data primer diperoleh melalui sampling insidental (n=39) dan pengujian menggunakan rapid test kit yang telah terverifikasi oleh Pusat Pengembangan Pengujian Obat dan Makanan Nasional (PPPOMN). Temuan penelitian menunjukkan bahwa data pra-intervensi mencatat prevalensi bahan berbahaya yang tinggi sebesar 40,6% di wilayah Cilacap. Selama proses intervensi, terjadi fenomena *detection paradox* di mana prevalensi meningkat dari 16,7% menjadi 40,0% akibat peningkatan kapasitas kader dalam melakukan *targeted sampling*. Namun, pada tahap monitoring dan evaluasi akhir, prevalensi menurun drastis hingga mencapai 0%. Penelitian menyimpulkan bahwa penguatan resiliensi kader pasar sebagai pengawas internal efektif dalam mengubah perilaku

pedagang dan menciptakan kemandirian pengawasan. Rekomendasi kebijakan yang diusulkan adalah replikasi model PPABK di pasar tradisional lainnya dengan dukungan integrasi anggaran daerah untuk ketersediaan sarana pengujian mandiri secara berkelanjutan.

Keywords: Food Safety, Hazardous Substances, PPABK, Traditional Market, Cilacap
Kata Kunci: Keamanan Pangan, Bahan Berbahaya, PPABK, Pasar Tradisional, Cilacap

1. Introduction

Food safety assurance is both an absolute prerequisite and a fundamental foundation for achieving optimal and sustainable public health. Safe food is not merely defined as a commodity free from accidental physical, biological, and chemical contamination, but must also be protected from the misuse of hazardous chemicals prohibited in both production and distribution processes. This is in line with the mandate of Law No. 18 of 2012 on Food, which affirms that the state bears a constitutional responsibility to ensure the availability of safe, high-quality, and nutritionally balanced food for all segments of society without exception. Failures in the food safety oversight system not only pose risks to individual health but also have the potential to degrade the quality of the nation's human resources in the long term.

1.1. Food Safety Dynamics and the Urgency of Consumer Protection

Food safety oversight in Indonesia continues to face complex challenges, particularly regarding the ongoing detection of the misuse of hazardous chemicals such as formalin and borax, as well as non-food synthetic dyes like Rhodamine B and Metanil Yellow (Arisanti et al., 2018). This issue has long been a concern in food safety studies, given that these substances are prohibited from being used as food ingredients or food additives under PerBPOM No. 22/2023 on Prohibited Ingredients in Processed Foods and Substances Prohibited for Use as Food Additives due to their potential to cause serious health impacts. This situation not only reflects weak regulatory compliance among some business operators but also highlights a gap between knowledge and awareness and actual practices in the field. In many cases, the misuse of these hazardous substances is driven by short-term economic considerations, such as extending product shelf life, minimizing spoilage losses, and enhancing the visual appeal of food products to make them more competitive, particularly in traditional markets.

On the other hand, consumers are often in a vulnerable position when making decisions about food safety due to limited information about a product's risks. The FAO and WHO (2016) emphasize the importance of effective food risk communication to enable consumers to make informed decisions based on adequate information. Furthermore, the WHO (2022) affirms that food safety is a shared responsibility requiring the involvement of all stakeholders, including empowered consumers, so that the public is not merely a recipient of protection but also plays an active role in ensuring food safety.

Various studies have shown that chronic exposure to hazardous chemicals can cause serious health effects. Formalin, for example, is toxic and has been classified as a carcinogen that can increase the risk of cancer and cause damage to the respiratory system and vital organs. Borax is known to have toxic effects on the digestive system and kidneys, while synthetic dyes such as Rhodamine B and Metanil Yellow have the potential to damage the

liver and are mutagenic (Saparinto & Hidayati, 2006; Mahdi, 2013). These impacts are generally cumulative and not immediately apparent, so they often go unnoticed by the public.

Therefore, strengthening the food safety oversight system is imperative. These efforts include not only increasing the intensity of oversight and law enforcement but also strengthening cross-sectoral coordination, enhancing the capacity of testing laboratories, and utilizing technology for the early detection of hazardous substances.

1.2. Regional Characteristics and Monitoring Challenges

Within the working area of the Banyumas Regional Office of the Indonesian Food and Drug Authority (POM), Cilacap Regency presents food safety oversight challenges that are not only technically complex but are also significantly influenced by the socioeconomic conditions of coastal communities. Cilacap Regency is one of the major fishing hubs on the southern coast of Java, with a relatively large volume of fishery products marketed through Fish Auctions (TPI) based on data from the 2023 Statistics on Marine Fisheries Sold at TPI in Cilacap Regency (Cilacap Regency BPS, 2024). The high level of fishery product distribution activity necessitates the implementation of an adequate cold chain system. The FAO (2023) emphasizes that consistently maintaining low temperatures throughout handling, storage, and distribution is critical to preserving the quality and safety of fishery products. Disruptions in the cold chain can accelerate spoilage, reduce product shelf life, and increase the risk of quality degradation during distribution.

These conditions create opportunities for the misuse of hazardous substances, such as formalin, which is illegally used to extend the shelf life and maintain the appearance of fishery products. Various studies indicate that these practices are driven by a combination of economic factors, weak regulatory compliance, limited knowledge among business operators, and high market demand for fresh-looking products (Kaur et al., 2024; Mehta et al., 2024). Therefore, efforts to ensure food safety cannot rely solely on oversight and regulatory enforcement but must also be supported by education and increased awareness among business operators and the public as part of a sustainable preventive approach.

To date, food safety oversight has largely been carried out through inspections, audits, and regulatory enforcement by the relevant authorities. Although this approach is important for ensuring compliance with food safety requirements, Yiannas (2009) emphasizes that the success of food risk management is determined not only by systems, procedures, and regulations, but also by individual behavior and the food safety culture that develops within organizations and throughout the food supply chain. In line with this, the WHO (2022) advocates strengthening food safety systems that are more preventive, risk-management-oriented, and involve various stakeholders, as food safety is a shared responsibility. Therefore, food safety oversight must be supported by efforts to empower the public and businesses to build a sustainable food safety culture.

1.3. Implementation of the PPABK and Innovations in Supervisory Resilience Analysis

As a concrete step toward strengthening a more participatory food safety oversight system, the implementation of the Community-Based Safe Food Market Program (PPABK) in Cilacap Regency focuses not only on technical interventions but also on transforming the oversight ecosystem at the grassroots level. Implementing this program in strategic locations, such as markets, is a relevant entry point, given that markets are food distribution hubs with high transaction volumes and involve various actors in the food supply chain. Through this

approach, markets are no longer merely objects of oversight but active participants in ensuring food safety.

The PPABK program is designed to position market cadres as key actors in self-regulation. Market cadres typically come from market management and merchant associations and have received training on identifying hazardous substances, using simple testing kits, and communicating risks to fellow merchants and consumers. This role is highly strategic because the cadres have close social ties and a contextual understanding of market dynamics, enabling them to take a more persuasive approach than formal oversight by regulators. This community-based approach has proven effective in increasing business compliance by leveraging social norms and collective control (Grace, 2015).

The success of the PPABK's implementation also depends heavily on cross-sectoral collaboration, particularly between the Indonesian Food and Drug Authority (BPOM), local governments, and market operators. Local governments play a role in supporting policies and facilitating infrastructure, while the BPOM provides technical assistance, training, and periodic supervision. This collaboration creates a more adaptive and sustainable oversight ecosystem, in which interventions do not stop at awareness-raising but continue through ongoing guidance and evaluation.

The novelty of this study lies in its analysis of the resilience of market cadres in performing their self-monitoring functions, particularly under resource constraints. Resilience, in this context, is understood not only as the ability to persevere but also to adapt and continue to carry out monitoring functions effectively despite constraints such as budget limitations, a lack of laboratory facilities, and fluctuations in cadre participation. This perspective is important because most previous studies have focused primarily on program outcomes (e.g., reductions in the detection of hazardous substances) but have not extensively examined the internal processes that enable program sustainability at the community level.

1.4. Significance and Objectives of the Analysis of Trends in the Prevalence of Hazardous Substances

Until now, evaluations of food safety programs have often been short-term in nature and focused on immediate monitoring results, such as positive findings of hazardous substances within a specific period. However, to understand the actual impact of an intervention, a trend-based analysis is needed that can illustrate changes in prevalence over time. This approach allows researchers and policymakers to assess whether implemented interventions consistently reduce the misuse of hazardous substances (Green & Kreuter, 2005). Therefore, this study aims to: (1) analyze trends in the detection of hazardous substances in food sold at traditional markets in Cilacap Regency during the 2021–2024 period; and (2) evaluate the effectiveness of the Community-Based Safe Food Market Program (PPABK), specifically at Tanjungsari Market in Cilacap Regency.

An analysis of trends in the prevalence of hazardous substances under the Community-Based Safe Food Market Program (PPABK) in 2025 serves as a crucial tool for measuring the program's success more objectively. By comparing data before and after the intervention, this study can identify patterns of change—whether reduction, stagnation, or potential resurgence in the misuse of hazardous substances. This information is crucial in determining whether the program has been effective or still requires strategic adjustments. Additionally, trend analysis can help identify contextual factors that influence the program's success, such as levels of community participation, institutional support, and vendors' socioeconomic conditions (Grace, 2015).

From a policy perspective, the findings of this study are expected to serve as a strategic reference for local governments and the Indonesian Food and Drug Authority (BPOM) in formulating measures to strengthen and replicate similar programs in other regions, particularly in traditional markets with comparable characteristics. An evidence-based approach is crucial in public decision-making, particularly regarding food safety issues that directly impact public health. With valid and measurable trend data, the resulting policies are not only normative but also adaptable to on-the-ground conditions (World Health Organization, 2015).

The findings of this study are expected to strengthen a healthy market ecosystem that not only meets standards of cleanliness and comfort but also ensures the safety of food in circulation. With a sustained decline in the prevalence of hazardous substances, the risk of public exposure to toxic and carcinogenic substances can be minimized. In the long term, this will contribute to improved public health and strengthen public confidence in the food safety oversight system. Therefore, this study is not only academically relevant but also has a tangible impact in supporting consumer protection and sustainable public health development.

2. Methods

2.1. Analysis of Trends in the Misuse of Hazardous Substances in Food at Traditional Markets in Cilacap Regency

The trend analysis was conducted using data from food safety monitoring conducted by the Banyumas POM Office at traditional markets in Cilacap Regency during March–April 2025. The analyzed data included the number of samples tested and the number of samples identified as containing hazardous substances such as formalin, borax, Rhodamine B, and Metanil Yellow. This analysis aimed to describe the patterns of hazardous substance findings in traditional markets in Cilacap Regency as a basis for determining food safety intervention strategies.

The prevalence rate of hazardous substances is calculated as the proportion of positive samples to the total number of samples tested and is expressed as a percentage (Tenny & Hoffman, 2023). The prevalence rate is calculated using the formula:

$$P = \frac{\sum S_+}{\sum S_t} \times 100\%$$

where P is the prevalence, $\sum S_+$ is the number of positive samples for hazardous substances, and $\sum S_t$ is the total number of samples tested.

2.2. Evaluation of the Effectiveness of the Community-Based Safe Food Market Program (PPABK)

2.2.1. Research Location

Based on the results of monitoring analyses and advocacy efforts with the Cilacap Regency Government, Tanjungsari Market was designated as the intervention site (pilot project) for the Community-Based Safe Food Market Program (PPABK). The location was selected through purposive sampling, taking into account the results of pre-intervention monitoring conducted in March–April 2025, which still revealed samples that did not meet

standards (TMS), as well as the local government's commitment to supporting the program's sustainable implementation. The intervention focuses on Tanjungsari Market to develop a safe-food market model by empowering internal cadres.

2.2.2. Research Subject

The intervention subjects consisted of 20 people who participated in the Technical Guidance (Bimtek) program, including market managers (from Tanjungsari, Saliwangi, and Pelemgading Markets), the administrative staff of Tanjungsari Market, and members of the Tanjungsari Market vendors' association. From this group, four core members were selected—comprising one market manager, two market administrators, and one chairperson of the Tanjungsari Market association—to carry out ongoing self-monitoring functions.

2.2.3. Intervention Stages

The intervention was carried out in three phases, namely: (1) Technical Guidance and Outreach to the Market Community on May 14, 2025; (2) Food Safety Outreach to 15 non-association vendors on June 24, 2025; and (3) Food Safety Oversight and Monitoring and Evaluation (M&E) on July 14, 2025. The success of the intervention was measured through pre- and post-tests during the technical guidance phase to assess knowledge gains, as well as through an analysis of trends in the decline in the prevalence of hazardous substances via food sampling activities.

2.2.4. Sample Collection and Testing

Sampling was conducted on an ad hoc basis during market operating hours, specifically from 9:00 a.m. to 12:00 p.m. Western Indonesian Time. Sample inclusion criteria were based on specific physical indicators of suspicion (striking color or rubbery texture), trends in findings from other regions, and commodities in high demand in the market. A total of 39 samples were tested across the three intervention phases: 12 during the Technical Training phase, 15 during the Outreach phase, and 12 during the Monitoring and Evaluation phase.

Testing was conducted on four key hazardous substance parameters using rapid test kits verified by the National Center for Drug and Food Testing Development (PPPOMN) according to the following protocols: Rhodamine B (PPPOMN-PV-01-RB-2020; detection limit 1 ppm); Formalin (PPPOMN-PV-02-F-2020; detection limit 0.1–2 ppm); Metanil Yellow (PPPOMN-PV-03-MY-2020; detection limit 1 ppm); and Borax (PPPOMN-PV-04-B-2020; detection limit 50 ppm).

Technically, testing follows a specific protocol for each parameter, in which the sample is first ground, dissolved in distilled water, and reacted with a reagent. Results are determined visually by comparing the solution's color change with the color standards provided in the test kit instructions.

2.2.5. Data Analysis

The research data were analyzed descriptively to evaluate the effectiveness of the Community-Based Safe Food Market Program (PPABK). The evaluation was conducted using two indicators: changes in the prevalence of food found to contain hazardous substances and improvements in participants' knowledge.

Data from food sample testing were analyzed quantitatively to calculate the prevalence of hazardous substances at each stage of the intervention using the following formula:

$$P = \frac{\sum S_+}{\sum S_t} \times 100\%$$

where P is the prevalence, $\sum S_+$ is the number of positive samples for hazardous substances, and $\sum S_t$ is the total number of samples tested during each intervention period.

The increase in participants' knowledge in the Technical Guidance (Bimtek) was analyzed by comparing pre- and post-test scores administered before and after the activity. The results of the analysis are presented in the form of average scores, percentage increases, and the distribution of participants' levels of understanding of the food safety material presented.

Next, descriptive analysis was used to compare the prevalence of hazardous substances across the various stages of the intervention to assess the program's effectiveness in reducing their incidence at Tanjungsari Market.

3. Results and Discussion

3.1. Trends in the Detection of Hazardous Substances in Food

Preliminary monitoring results for the period from March to April 2025 indicate that food safety issues in Cilacap Regency remain at an alarming level, with a prevalence of hazardous substances at 40.6% of the total 59 samples tested. These findings indicate that nearly half of the food products circulating in traditional markets may still contain hazardous substances, reflecting systemic vulnerabilities in the food distribution chain. The distribution of these findings varies across market locations, as presented in Table 1, which serves as a preliminary map of the issues in the study area.

Table 1. Comparison of The Location Matrix with Hazardous Materials Findings

Location	Samples Tested (n)	Non-compliant Sample	Types of Hazardous Material Findings				Prevalence (%)
			Borax	Formalin	Rhodamin B	Metanil Yellow	
Pasar Sampang	13	8	3	2	3	0	61,5
Pasar Kemojing	4	2	0	2	0	0	50
Pasar Nusawungu	6	3	0	1	2	0	50
Pasar Gede	2	1	-	1	0	-	50
Pasar Sidodadi	17	6	0	3	2	1	35,3
Pasar Kroya	11	3	0	2	1	0	27,2
Pasar Tanjungsari	6	1	0	0	1	-	16,7
Total	59	24	3	11	9	1	40,6

When analyzed by food type, all formalin detections in this study were found in fishery products, specifically 7 samples of anchovies and 4 samples of dried squid. These findings indicate that fishery products remain the food group most vulnerable to formalin misuse in Cilacap Regency. From a geographic perspective, this situation is closely linked to Cilacap Regency's characteristics as a coastal area with high levels of fishing activity and seafood distribution. Fishery products are perishable and therefore require prompt and proper post-

harvest handling to maintain their quality. However, in practice, the limited availability of cold chain facilities at the traditional vendor level may lead some business operators to misuse formalin as a quick fix to extend product shelf life. In addition to formalin, the misuse of borax has been found in "obat gendar," Rhodamine B in "kerupuk cantir," and Metanil Yellow in yellow tofu, indicating that the misuse of hazardous substances continues to occur across various food categories with the aim of preserving specific physical characteristics, such as product texture or color.

This phenomenon has been widely reported, with formalin still being misused in fishery products to maintain a fresh appearance and prevent spoilage during distribution, particularly in developing countries with limited infrastructure (Mehta et al., 2024; Kaur et al., 2024). Thus, the high levels of formalin detected in several markets in Cilacap Regency not only reflect regulatory violations but also indicate structural pressures within the food distribution system in coastal areas.

In addition to geographical factors, the high prevalence of hazardous substances in several traditional markets—such as Sampang Market (61.5%), Kemojing Market (50%), Nusawungu Market (50%), and Gede Market (50%)—indicates that the misuse of hazardous substances still occurs in markets across Cilacap Regency. These findings suggest that some food business operators still view the use of formalin and synthetic dyes such as Rhodamine B and Metanil Yellow as an alternative to maintain product characteristics, both in terms of shelf life and visual appearance. This situation highlights the need for interventions that focus not only on regulatory enforcement but also on raising awareness and changing the behavior of food business operators.

Economic motives are the dominant factor driving this practice. Vendors tend to choose inexpensive and practical preservation methods over safer but more costly storage technologies. Studies show that the misuse of formalin in food remains widespread due to its cost-effectiveness, a lack of oversight, and low awareness among business operators of the associated health risks (Haetami et al., 2024; Martini et al., 2025). This indicates that food safety issues are not merely technical but are also closely linked to micro-level economic behavior and business culture.

3.2. Resilience of Cadres in the Community-Based Safe Food Market Program (PPABK)

Tanjungsari Market, which was selected as the intervention site (pilot project), did not have the highest prevalence rate—16.7%. This selection was based on strategic considerations, namely the level of institutional readiness and the potential for success of community-based programs. Tanjungsari Market has a more organized management structure, an active merchants' association, and openness to capacity-building programs. In public health intervention approaches, selecting locations with a high level of readiness often yields more optimal and sustainable outcomes. Such locations enable the development of community health workers as agents of change who can independently conduct community-level monitoring. This approach is also considered more effective for replication in other markets.

As a next step, an intervention strategy is needed that focuses not only on enforcement but also on community empowerment and behavioral change among business operators. These findings serve as an important foundation for analyzing the dynamics of the intervention in the next phase, including the phenomenon of increased detection (the

detection paradox) and the role of community volunteers in improving the accuracy of monitoring.

3.2.1. Intervention Dynamics and Prevalence Fluctuations

The implementation of community-based food safety interventions at Tanjungsari Market revealed interesting dynamics, particularly fluctuations in the prevalence of hazardous substances across the stages of the activities. In general, the prevalence of hazardous substances increased from 16.7% during the Technical Guidance (Bimtek) phase to 40.0% during the outreach phase, as shown in Table 2. This increase could be interpreted as a deterioration in food safety conditions at the market. However, in the context of this study, this phenomenon reflects the "detection paradox"—that is, an increase in detection rates due to improved detection capacity, rather than an actual increase in the incidence of hazardous substances.

Table 2. Changes in the Prevalence of Hazardous Substances Found During the PPABK Intervention Phases at Tanjungsari Market

Stages (Date)	Sample Size	Samples Tested Positive for Formalin	Samples Tested Positive for Borax	Samples Tested Positive for Rhodamine B / Metanil Yellow	Total Prevalence
Technical Guidance and Outreach for Market Communities (May 14, 2025)	12	1	0	1	16,7%
Food Safety Awareness Campaign for the Market Community (June 24, 2025)	15	3	0	3	40,0%
Food Safety Oversight and Monitoring and Evaluation (Monev) (July 14, 2025)	12	0	0	0	0,0%

In the early stages, sampling was still relatively random (random sampling), so the likelihood of finding samples that actually contained hazardous substances was still limited. However, after volunteers received training and gained an understanding of the physical characteristics of suspicious food—such as striking colors, unusual textures, or excessively long shelf lives—the sampling strategy shifted to a more targeted approach (targeted sampling). This increased the probability of detecting positive samples. This aligns with findings in the literature that an increase in detection capacity through training and education is often followed by a rise in detection rates during the early phases of an intervention—a trend that does not reflect an increased risk but rather an increase in the sensitivity of the surveillance system (Mehta et al., 2024; Kaur et al., 2024). Thus, a spike in prevalence during the awareness-raising phase can actually be interpreted as an early indicator of the program's success in improving detection capabilities at the community level.

3.2.2. Resilience of Cadres and Program Sustainability

The success of the community-based food safety intervention at Tanjungsari Market is reflected not only in reducing the prevalence of hazardous substances to 0% in the final stage, but also in the development of resilience among the cadres, who are key actors in sustaining behavioral change and enhancing knowledge. This resilience is demonstrated by the cadres' increased knowledge of testing procedures and the dangers of chemical misuse, their improved ability to identify non-compliant food products through targeted sampling, and the establishment of community-based self-monitoring, which has contributed to increased compliance among vendors (Table 3). Resilience in this context is understood not only as the ability to endure but also as the cadres' adaptive capacity to perform independent monitoring functions despite various constraints, particularly in terms of resources and budgetary support.

Table 3. Indicators of Cadre Resilience and Changes in Vendor Compliance Before and After the Intervention.

Evaluation Components	Pre-intervention	Post-intervention	Description of Changes
Cader Knowledge	Low (Score <60)	High (Score >90)	Understanding Testing Procedures and the Hazards of Chemicals
Sampling Capabilities	Random	Targeted	Able to identify the physical characteristics of TMS food
Merchant Compliance	Low	High (0% findings)	A community-based self-monitoring system has been established

One of the key findings of this study is the strategic role of four core leaders—the market director, two market managers, and the association chairperson—in performing internal oversight functions. Unlike conventional oversight approaches, which are external and periodic, these leaders, as part of the market community, benefit from close social ties and high-intensity interaction with vendors. These key members not only serve as testers but also as agents of change with social legitimacy, enabling them to establish stronger social control mechanisms compared to interventions by external parties (Martini et al., 2025). In addition to enabling more flexible and sustainable oversight without relying on official inspection schedules, this model is also aligned with the community-based food safety approach, in which the community is not merely the object of oversight but also plays an active role in ensuring food safety in its environment (Mehta et al., 2024).

Although this program faces budget constraints, particularly in providing laboratory testing facilities, the community health workers have still been able to carry out their surveillance functions by making optimal use of rapid test kits. This demonstrates a high level of adaptability, as the community health workers can adjust their surveillance methods to the available resources. Their resilience is also supported by collaboration with local governments, which provide operational support, albeit on a limited scale. This support is critical to ensuring the program's sustainability, particularly in providing testing supplies and facilitating activities. Recent studies indicate that the sustainability of community-based programs is strongly influenced by a combination of local capacity and institutional support

(Kaur et al., 2024). Thus, the resilience of community health workers in this study is not merely individual but also the result of interactions between internal factors (knowledge, skills, motivation) and external factors (policy support and resources).

The reduction in the prevalence of hazardous substances to 0% during the Monitoring and Evaluation (Monev) phase serves as a key indicator of changes in vendors' behavior. Unlike external oversight, which is temporary, the presence of community volunteers as internal monitors creates the perception that monitoring can occur more frequently. This encourages vendors to exercise greater caution when using food additives or when accepting food suppliers, as the risk of detection increases. Furthermore, firsthand experience with test results from the previous stage reinforces vendors' awareness of the dangers of misusing hazardous chemicals in food. This behavioral change aligns with the theory that a combination of increased knowledge, empirical experience, and social pressure can drive more sustainable behavioral change (Haetami et al., 2024). In other words, this intervention not only changes what vendors know but also how they act in their daily practices.

The results of this study indicate that a community-based approach has great potential to serve as a model for sustainable food safety oversight. However, to ensure long-term sustainability, the support system must be strengthened in both policy and funding. Integrating market cadres into the formal oversight system—for example, through regular training programs or performance-based incentives—can help maintain their motivation and consistency in fulfilling their roles. Furthermore, replicating this model in other markets requires consideration of community readiness, as was done in selecting Tanjungsari Market as the pilot project.

As a next step, future research should explore the long-term sustainability of changes in vendors' behavior and assess the effectiveness of this model in regions with different characteristics. Thus, the contribution of this study is not only locally scoped but can also serve as a reference for the broader development of community-based food safety policies.

4. Conclusion

The study results show that in the initial stage, the prevalence of hazardous substances remained relatively high at 40.6%, indicating systemic vulnerabilities in the food distribution chain, particularly in coastal areas where seafood is distributed over long distances. Interventions carried out through the empowerment of market cadres revealed an interesting dynamic, in which the prevalence increased from 16.7% to 40.0% during the awareness-raising phase. This finding indicates the presence of the "detection paradox"—an increase in detection rates caused by the enhanced capacity of cadres to detect contaminants through a targeted sampling approach. In the final monitoring and evaluation phase, the prevalence of hazardous substances dropped to 0%, indicating a short-term change in vendors' behavior in response to the intervention.

An analysis of the resilience of market cadres as internal monitors in ensuring the sustainability of food safety programs shows that cadres drawn from within the market have proven capable of performing their monitoring functions more effectively through social control mechanisms, improved technical literacy, and adaptability within resource constraints. Furthermore, interventions based on hands-on experience—such as on-site rapid test kit testing—have increased awareness among business operators and significantly

reduced the number of non-compliant samples, thereby promoting greater compliance with food safety standards.

Overall, this study shows that a community-based monitoring approach is not only effective in reducing the prevalence of hazardous substances, but also has the potential to create a sustainable monitoring system through local capacity building. Therefore, this intervention model can be replicated in other traditional markets, taking into account the level of community readiness and institutional support as key factors for success.

Acknowledgments

The author would like to express appreciation to the Cilacap Regency Government and the management of Tanjungsari Market for their support and assistance in implementing the intervention activities and collecting data for this study. Thanks are also extended to all market volunteers and vendors who actively participated, enabling this study to be carried out successfully and contributing to the strengthening of the community-based food safety system.

References

Arisanti, R. R., Indriani, C., & Wilopo, S. A. (2018). Kontribusi agen dan faktor penyebab kejadian luar biasa keracunan pangan di Indonesia: Kajian sistematis (Contribution of agents and factors causing foodborne outbreak in Indonesia: A systematic review). *Berita Kedokteran Masyarakat*, 34(3), 99–106. https://doi.org/10.22146/bkm.33852

Badan Pusat Statistik Kabupaten Cilacap. (2024). *Statistik Perikanan Laut yang Dijual di Tempat Pelelangan Ikan Cilacap 2023* (Katalog: 5402004.3301). Cilacap: BPS Kabupaten Cilacap.

Food and Agriculture Organization of the United Nations. (2023). Cold storage. Retrieved on 13 Juny 2026, from https://www.fao.org/flw-in-fish-value-chains/value-chain/processing-storage/cold-storage/en/

Food and Agriculture Organization of the United Nations, & World Health Organization. (2016). *Risk communication applied to food safety handbook*. Rome: Food and Agriculture Organization of the United Nations & World Health Organization.

Grace, D. (2015). Food safety in low and middle incom countries. *International Journal of Environmental Research and Public Health*, 12(9), 10490–10507. https://doi.org/10.3390/ijerph120910490

Green, L. W., & Kreuter, M. W. (2005). *Health Program Planning: An Educational and Ecological Approach* (4th ed.). New York: McGraw-Hill.

Haetami, K., Karlina, L., & Junianto, J. (2024). Formalin content test in samples of salted fish and fresh fish sold in traditional markets. *PharmaCine: Journal of Pharmacy, Medical and Health Science*, 5(1), 48–54. https://doi.org/10.35706/pc.v5i1.11339

Kaur, G., Tripathy, S., & Rout, S. (2024). Formalin adulteration in fish: A state-of-the-art review on its prevalence, detection advancements, and affordable device innovations.

Trends in Food Science & Technology, 153, 104708. https://doi.org/10.1016/j.tifs.2024.104708

Mahdi, C. (2013). Formalin, borax and rhodamine quick detection instruments discovered by researcher and education staff of Brawijaya University produced by Biochem Laboratory. *VOK@SINDO: Jurnal Ilmu-Ilmu Terapan dan Hasil Karya Nyata*, 1(1), 1–6.

Martini, M., Fauzi, M., & Nuryanto, N. (2025). Detection of formalin, borax, and pathogenic bacteria in processed meat-based foods and their implications for antimicrobial resistance (AMR). *BIO Web of Conferences*, 193, 00073. https://doi.org/10.1051/bioconf/202519300073

Mehta, N. K., Vaishnav, A., & Priyadarshini, M. B. (2024). Formaldehyde contamination in seafood industry: An update on detection methods and legislations. *Environmental Science and Pollution Research,* 31, 54381-54401. https://doi.org/10.1007/s11356-024-34792-8

Republik Indonesia. (2012). *Undang-Undang Republik Indonesia Nomor 18 Tahun 2012 tentang Pangan*. Jakarta: Sekretariat Negara

Saparinto, C., & Hidayati, D. (2006). *Bahan Tambahan Pangan*. Yogyakarta: Kanisius.

Tenny, S., & Hoffman, M. R. (2023). Prevalence. In *StatPearls*. Treasure Island, FL: StatPearls Publishing.

World Health Organization. (2015). *WHO estimates of the global burden of foodborne diseases*. Geneva: World Health Organization.

World Health Organization. (2022). *WHO global strategy for food safety 2022–2030: Towards stronger food safety systems and global cooperation*. Geneva: World Health Organization.

Yiannas, F. (2009). *Food Safety Culture: Creating A Behavior-based Food Safety Management System*. New York: Springer.