

Integrating 5S Practices into HACCP Food Safety Management: Evidence From a Malaysian Food Manufacturing

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ABSTRACT

This article examines how Sort, Set in Order, Shine, Standardise and Sustain (5S) may support Hazard Analysis and Critical Control Point (HACCP) management without being mistaken for technical food safety controls. It critically reinterprets a documented, qualitative-dominant case investigated at a Malaysian probiotic beverage manufacturing site in 2019. The original study reported questionnaires completed by 10 executive and laboratory supervisory employees, as well as semi-structured interviews with 2 executives. Its narrative described established HACCP-related routines alongside uneven 5S practice: Shine was relatively prominent, whereas Sustain was difficult to maintain. Communication, commitment and organisational reinforcement were recurring concerns. A document-based evidence audit identified an inconsistency between the original method's description of 15 5S questionnaire items and a 25-item instrument reproduced in its appendix; consequently, this article does not reconstruct unverified scores. The analysis separates the historical findings and original conceptual associations from a refined operational framework. In the proposed framework, 5S primarily supports good hygiene practices and prerequisite programmes and may indirectly assist employees in executing approved HACCP procedures. A six-stage managerial sequence is offered for future testing. The study does not establish causal effects on HACCP compliance or food safety outcomes.

Keywords: 5S; HACCP; food safety management; lean manufacturing; prerequisite programmes; workplace routines

INTRODUCTION

Food safety also requires technically justified control and execution during normal production. HACCP is a preventive approach to the identification, assessment and control of significant food safety hazards. The Codex General Principles of Food Hygiene differentiate good hygiene practices (GHPs) and supporting prerequisite programmes (PRPs) from additional hazard-specific control established by HACCP, where required (Food and Agriculture Organisation of the United Nations & World Health Organisation [FAO & WHO], 2023). Documenting a HACCP plan does not automatically mean that people always do what is approved or that the system has the desired effect. In Malaysia, the Ministry of Health also expects applicants to its HACCP certification arrangements to have documented HACCP and PRP/GMP systems consistent with the relevant Malaysian Standards (Ministry of Health Malaysia, 2026).

These arrangements are the context for the present discussion. They are not applied retrospectively to a factory examined in 2019. Research on Malaysian beverage manufacturers demonstrates that documented management arrangements should not be confused with control activities or microbiological evidence (Cheah et al., 2021). The management question is how to ensure approved food safety tasks remain clear, feasible, and consistently carried out on the production floor. 5S provides complementary workplace routines. Sort (Seiri) eliminates the unnecessary. Set in Order (Seiton) provides accessible locations for the approved items and equipment. Shine (Seiso) integrates cleaning with the handling of abnormal conditions. Standardise (Seiketsu) creates common instructions and visual standards. Sustain (Shitsuke) supports ongoing compliance.

In food manufacture, such practices may contribute to the conditions through which GHPs, PRPs and approved HACCP procedures operate. They do not replace hazard analysis, scientifically defensible critical limits, approved CCP monitoring and independent verification. Lean methods and HACCP have already been the subject of combined research. Cabrera et al. (2020) describe a food-industry project that combined several improvement tools, including 5S, with statistical process control and HACCP. Domínguez et al. (2021) set out an integrated Lean 6S-HACCP model in which food safety was one of a wider set of improvement priorities.

Syikilili et al. (2026) recently reviewed 65 studies of Lean Six Sigma-HACCP integration. These studies establish the problem of integration but do not settle a narrower interpretive question. When does 5S genuinely improve the conditions in which an approved HACCP task is carried out? When is a connection between them treated as evidence that the HACCP principle itself has been satisfied?

This article addresses that distinction by re-examining a documented case of Malaysian probiotic beverage manufacturing investigated in 2019 (Md Ramli, 2020). It retains the reported implementation patterns and barriers, reviews the study's original 5S-HACCP conceptual associations against current technical guidance, and develops a qualified managerial sequence. The contribution is an evidence-based explanation of operational support, not a new intervention or a claim that 5S caused better safety performance.

Three research questions guide the article: (RQ1) What pattern of 5S practice did the historical case describe? (RQ2) Which proposed relationships between 5S, PRPs and the execution of HACCP procedures are technically defensible? (RQ3) What do the reported implementation barriers suggest about the difference between establishing visible workplace improvements and maintaining them?

LITERATURE REVIEW AND ANALYTICAL FRAMEWORK

HACCP, prerequisite programmes and food safety management

The seven HACCP principles address hazard analysis; determination of CCPs; establishment of validated critical limits; establishment of monitoring procedures; establishment of corrective actions; validation and verification; and documentation and record-keeping (FAO & WHO, 2023). These functions are not interchangeable. For example, a label can help identify a controlled storage area, but cannot determine a CCP or justify a time-temperature limit. Likewise, a cleaning checklist usually documents a hygiene prerequisite rather than CCP monitoring unless the approved HACCP plan specifically defines the relevant critical point and monitoring procedure.

GHPs and PRPs provide the everyday conditions needed for food safety management, including facility hygiene, equipment, sanitation, staff competence, material handling, pest control and traceability. A review of HACCP in yoghurt production illustrates how controls depend on specific dairy-processing stages rather than generic housekeeping activities (Aslani et al., 2024). In Malaysian powdered-beverage manufacturing, Cheah et al. (2021) used diagnostic and microbial assessment approaches, illustrating that management-system documentation and operational performance require different types of evidence.

What previous integration studies establish and what they do not

The existing evidence addresses different levels of integration. Cabrera et al. (2020) examined a combined improvement intervention using lean tools, statistical process control, and HACCP; however, the outcomes of that combined approach do not allow isolation of the effect of 5S on HACCP execution. Domínguez et al. (2021) provided an integrative Lean 6S-HACCP framework that prioritises food safety by integrating lean practices and HACCP; however, the outcomes are adapted to food production. Syikilili et al. (2026) reviewed a much broader body of literature and identified repeated use of 5S, visual management, and documentation practices, as well as shortages of technical expertise and practical implementation guidance. Their synthesis supports further attention to implementation, but does not validate the particular workplace-to-HACCP links proposed in the present historical case.

Related work separates organisational conditions from technical controls. Maiberger and Sunmola (2023) identified food safety culture, inspection and verification, knowledge, regulation, and PRPs as recurring factors in the effectiveness of food safety management systems. Jespersen et al. (2017) found considerable variation in food safety culture evaluation models, highlighting the need to avoid treating easily visible practices as sufficient indicators of deeper organisational behaviour. In Malaysian food manufacturing, Azalanazllay et al. (2022) identified leadership, culture, process management and employee participation as relevant to Lean Six Sigma readiness. Readiness to introduce an initiative is not the same as evidence of its sustained operation.

Analytical proposition

The proposition above is therefore layered. First, each 5S practice may contribute to a condition that can be observed in the workplace: material organisation, cleaning and inspection, approved standard work and continuing reinforcement. Second, such conditions may support existing GHPs and PRPs of employees. Third, where an authorised connection exists with a HACCP procedure, routines may support execution without altering the hazard and control specification. Figure 1 presents this proposed pathway; its arrows are plausibly supportive rather than proven causes.

METHODOLOGY**Design and documentary evidence**

This article treats a documented, qualitatively dominant, single-site case as the basis for a critical reinterpretation. The field in 2019 was a Malaysian cultured-milk probiotic-beverage manufacturer that had reportedly established HACCP and introduced 5S in 2018. The original study was reported in a master's thesis (Md Ramli, 2020). The present article does not report new interviews with participants, inspection of completed questionnaires, factory observation or a new HACCP audit. Its evidence is the recorded methods and narrative findings of the earlier study, its aggregate figures and component tables, and its questionnaire and interview guide in the appendices. The set was read as a bounded historical record rather than as a fresh qualitative interview data set. Current Codex language, Malaysian public certification materials, and academic publications were consulted to anchor the concept where it was unclear, rather than to fill in as missing organisational evidence. It was a focused interpretive comparison rather than a systematic literature review or a new triangulation.

Document-based analytical procedure

The reinterpretation proceeded through three transparent stages. First, the historical materials were examined for evidence regarding case context, sampling, instruments, reported HACCP activities, the 5S components, implementation barriers, and original conceptual associations. Recorded observations and participant-related interpretations were retained as historical findings, without newly invented interview quotations or numerical results. Second, statements in the methods chapter were checked against the reproduced questionnaire, figures and component tables to identify internal reporting discrepancies. Where administration, scoring or coding could not be verified, the uncertainty was retained rather than resolved by assumption.

Third, the original proposed associations between 5S and individual HACCP principles were compared with the technical separation between GHPs/PRPs and HACCP controls in FAO and WHO (2023). Each association was reconsidered in terms of (a) the workplace task 5S could plausibly support, (b) its main GHP/PRP relevance and (c) the HACCP function it could help staff execute, if specifically authorised. The resulting crosswalk and management sequence are the present article's analytical propositions. They were not implemented or validated at the case facility. Table 1 records the available evidence and its principal limitations.

Participants, instruments and reporting discrepancies

The original questionnaire was reportedly completed by ten purposively selected employees: two in executive management roles and eight in laboratory supervisory roles. The historical research also reports face-to-face, semi-structured interviews with two executives between 8 October and 16 November 2019, lasting approximately 20–35 minutes, with handwritten notes taken by the investigator. The documentation does not establish whether the interviewees were the same two executives who completed questionnaires; the groups are therefore reported separately rather than counted as 12 distinct participants (Md Ramli, 2020).

Four questionnaire sections are documented. Section A contained seven demographic questions; Section B contained seven HACCP questions; and Section D contained 19 items concerning conditions associated with 5S implementation. The questionnaire contains 25 numbered items, five for each 5S component. Descriptive conclusions are drawn only at the level stated in the historical research.

Table 1. Documentary evidence and limits of the reinterpretation

Source component	Recorded information	Interpretive limit
Case and participants	One 2019 site; 10 questionnaire respondents (2 executives; 8 laboratory supervisors).	Purposive, role-specific sample; no new site observation.
Interviews	Two executives, face-to-face, approximately 20–35 minutes, October–November 2019.	Overlap with questionnaire respondents is unknown; no transcripts are available.
Questionnaire	Sections A: 7; B: 7; C: 15 stated in methods / 25 reproduced; D: 19.	No verified administered version, coding key or completed forms.
Reported case outputs	Narrative results, aggregate graphs, component tables and original 5S–HACCP mapping.	Permits documentary comparison, not participant-level reanalysis.
Current analytical outputs	Evidence-qualified crosswalk and six-stage implementation proposal.	Conceptual propositions, not observed interventions or safety outcomes.

Confidentiality and ethical scope

The historical research describes organisational access, voluntary participation and a commitment to keep individual responses confidential for academic purposes (Md Ramli, 2020). The available report does not provide an institutional ethics approval identifier or establish permission for a later identifiable journal article. The present analysis collected no additional human-participant data, reports historical findings only in aggregate and omits the manufacturer's name, brands, specific location and distinctive certification details. Because the source study is cited for scholarly attribution, complete anonymity cannot be guaranteed; the present article does not imply the manufacturer's endorsement.

HISTORICAL CASE FINDINGS

Reported HACCP arrangements

In the 2019 case, the selected executive and laboratory supervisory employees described existing HACCP-related work in the production of cultured milk beverages. The historical account refers to recognition of physical, chemical and microbiological hazards; attention to material receipt and thermal processing; monitoring and documentation; corrective action; and periodic review (Md Ramli, 2020). The descriptions establish the reported management setting against which the 5S programme was later examined. They are not an independently reviewed HACCP plan, verified CCP records or measured microbiological performance.

Reported implementation of the five 5S practices

The research had uneven reporting across the five parts. Shine was found to be relatively visible in the sanitation-intensive production environment. Sustain was found to be more difficult to sustain because participation continued to require employee commitment, communication, and management reinforcement. Sort, Set in Order, and Standardise were found in the reported clearing, identifying materials, organising equipment, and displaying procedures. Table 2 presents what the original account does not convert aggregated questionnaire graphs into unconfirmed dimension scores.

Table 2. Historical 5S implementation findings and their evidential boundaries

5S component	Historical case description	What cannot be inferred
Sort	Clearing unnecessary items and managing workplace materials were described.	No isolated effect on hazard analysis or measured safety outcome.
Set in Order	Assigned locations, retrieval and material identification featured in the account.	No evidence that location rules determined CCPs or critical limits.
Shine	Relatively prominent; discussed alongside routine cleaning needs.	No independently measured sanitation or microbial performance.
Standardise	Work instructions, visual displays and audit-related routines were described.	Presence of procedures does not confirm consistent adherence.
Sustain	Reported as difficult to maintain; linked in the case narrative to motivation and reinforcement.	No longitudinal assessment of adherence or causal link to safety outcomes.

Implementation concerns reported in the case

The case study categorised 5S concerns into employees, organisation, resources, top management, and training. Its interpretation emphasised communication, awareness, commitment, and resistance to change, with communication also highlighted in the executive interview account. Additionally, management time and resources, ongoing training, and coordination were noted (Md Ramli, 2020). These concerns are reported from the source rather than derived from a new thematic analysis of the interview transcripts.

Careful attention is required when interpreting the barrier questionnaire. Certain items assess the presence of supporting conditions, standard procedures, allocated responsibilities, or training, while others address demands and participation. An affirmative response does not necessarily indicate the existence of a barrier. Due to the lack of a confirmed coding direction and original responses, aggregate category totals cannot be treated as comparable barrier scores. Table 3 presents the identified themes without implying their relative magnitude or independent effect.

Table 3. Historical implementation concerns without an unverified ranking

Category	Concern documented in the case	Evidence qualification
Employees	Communication, awareness, commitment and resistance to change.	Prominent in the historical narrative; relative magnitude unverified.
Organisation	Coordination, policy support and workplace culture.	Documented contextual concerns; no separate effect estimated.
Resources	Time, expertise and financial or competing operational demands.	Item direction and coding cannot be reconstructed.
Top management	Decisions on time, budget and continuing oversight.	Enabling conditions discussed, not quantified causal determinants.
Training	Practical instruction and repeated reinforcement.	Presence of training is not inherently a barrier; item polarity matters.

ANALYTICAL SYNTHESIS AND DISCUSSION

Distinguishing historical findings, earlier associations and current propositions

Three levels of claim must remain separate. The first consists of the original study's descriptive findings: selected staff reported established HACCP-related activities, relatively visible Shine routines and difficulties maintaining Sustain. The second consists of the original investigators' suggested associations between specific 5S components and individual HACCP principles. These associations were interpretive mappings, not results of a measured 5S intervention. The third consists of the present article's reinterpretation: 5S is principally an operational support for GHPs/PRPs and may indirectly assist employees in carrying out HACCP tasks already specified by an approved food safety plan. This third level is proposed for subsequent testing; it is not additional historical evidence.

The earlier mapping associated Sort with Principles 1, 3 and 4; Set in Order with 2 and 3; Shine with 4; Standardise with 5, 6 and 7; and Sustain with 6 and 7 (Md Ramli, 2020). Figure 1 reframes these links as a pathway from discrete workplace routines to hygiene prerequisites and, conditionally, to execution of approved HACCP procedures. Table 4 sets out how the earlier associations are qualified by the present analysis.

The most important technical distinction concerns what 5S cannot establish. Removing unwanted materials may simplify hazard recognition, but does not set scientific critical limits. Labels and approved storage positions may help staff follow an existing CCP arrangement, but do not determine whether that CCP has been selected appropriately. Routine sanitation checks generally monitor a PRP; they count as HACCP Principle 4 monitoring only when the approved HACCP plan defines the relevant CCP and procedure (FAO & WHO, 2023). Similar boundaries apply to validation, verification, corrective action and records.



Figure 1. Proposed pathway from 5S routines to prerequisite-programme support and indirect HACCP execution. The model has not been empirically tested.

Table 4. Qualified reinterpretation of the original 5S–HACCP conceptual associations

5S (earlier proposed principles)	Primary GHP/PRP support	Boundary for HACCP procedures
Sort (1, 3, 4)	Remove unnecessary materials; maintain approved segregation and quarantine locations.	Can help identify conditions but neither establishes critical limits nor replaces CCP monitoring.
Set in Order (2, 3)	Locate, identify and segregate approved materials and equipment.	May assist use of existing CCP arrangements; cannot determine CCPs or validate limits.

Shine (4)	Follow approved cleaning procedures; inspect for visible abnormalities and report any deviations.	Normally PRP monitoring; HACCP Principle 4 only when specifically defined in the approved plan.
Standardise (5, 6, 7)	Use approved instructions, visual standards, responsibilities and records.	Supports execution; technical corrective action, validation, verification and record rules remain HACCP-specific.
Sustain (6, 7)	Maintain competence, training, audit follow-up and routine documentation.	Can reinforce scheduled verification and record-keeping; does not independently demonstrate effectiveness.

Note. Principle associations reproduce the historical proposal described by Md Ramli (2020). The PRP distinctions and technical qualifications are the present authors' interpretation, informed by FAO and WHO (2023).

Why the Shine–Sustain contrast matters

The contrast with Shine has a plausible organisational explanation, but the evidence does not establish a causal mechanism. In a cultured-milk beverage factory, cleaning is close to routine production and hygiene requirements. Visible dirt, inappropriate materials, and poor work areas can call for action. Visibility may be why Shine was prominent in the original employees' accounts. Sustain is another matter. Its effect is felt after a workplace has been organised and cleaned, when production pressure can compete with audits, refresher training, and improvement activities.

The difference can be expressed as task performance relative to the persistence of practice. A completed cleaning task proves that something was carried out, but does not prove that the approved approach was followed, that departures were reported, that the records were correct, or that corrective action was taken. Sustain is concerned with the organisational conditions that will enable such routines to be preserved. It should not be read as employee willpower. The accounts of communication problems, managerial time allocation, and repeated training in the case indicate that opportunities to sustain practice can be influenced by management systems and responsibility arrangements.

This reading is consistent with broader findings without assuming they were measured in this case. Maiberger and Sunmola (2023) list culture, verification, knowledge, and PRPs as factors affecting the effectiveness of food safety management systems; Azalanzazllay et al. (2022) list organisational readiness conditions for introducing Lean Six Sigma; and Jespersen et al. (2017) warn against measuring food safety culture with a single approach. They justify the distinction between visible workplace order and reliable ongoing performance. None proves that changing Sustain would have changed this facility's food safety results. Alternative explanations can still be made. The purposive group comprised mainly of laboratory-supervisory staff, whose duties may have made sanitation and monitoring more visible than less observable improvement activities, and the study is cross-sectional, with no independent audit or longitudinal observation available. The Shine-Sustain contrast should therefore be considered as a focused hypothesis to be tested, not as a general hierarchy of 5S levels.

Contribution relative to existing Lean–HACCP literature

The analytical value of this case does not lie in claiming that 5S and HACCP can be combined for the first time. Integrated approaches and broader reviews already exist (Cabrera et al., 2020; Domínguez et al., 2021; Syikilili et al., 2026). Its narrower contribution is an explicit boundary between three different objects that integration studies can conflate: the workplace routine introduced by a lean method, the GHP/PRP activity it may support, and the technical HACCP requirement that remains independently defined. The historical case also illustrates why the existence of a visible routine and its continuity over time may merit separate evaluation.

This boundary makes the framework usable without turning it into an unsupported claim of effectiveness. A manager can trace an approved food safety activity to its operational support need, specify the associated 5S action and then assess both implementation fidelity and independent safety outcomes. Transferability depends on the product, process, and maturity of existing PRPs and workforce roles. No assumption is made that the same Shine–Sustain pattern would recur in other food manufacturers

MANAGERIAL IMPLICATIONS AND FUTURE EVALUATION

A six-stage implementation sequence follows from the technical distinction above. Its starting point is an approved HACCP/PRP requirement or a documented operational weakness; generic housekeeping targets are not a substitute for identifying the relevant food safety task. The sequence in Table 5 is proposed for prospective application and evaluation and was not tested in the historical factory.

Table 5. Proposed six-stage integration sequence for future testing

Stage	Proposed management action	Evaluation boundary
1. Diagnose	Review approved HACCP plans, PRP/GHP procedures, audit findings and recurring deviations.	Identify a documented support need; do not infer risk from appearance alone.
2. Sort	Remove unnecessary items using approved disposition and segregation procedures.	Check segregation compliance; do not revise hazard analysis informally.
3. Set in Order	Specify approved locations, labels, routes and access to necessary equipment.	Assess retrieval and identification; CCP selection and limits remain technical decisions.
4. Shine	Combine authorised cleaning with inspection and a defined escalation process for abnormalities.	Assess PRP completion and cleaning effectiveness using approved methods.
5. Standardise	Document work methods, responsibilities, visual cues and relevant record formats.	Audit task adherence while preserving formal validation and verification.
6. Sustain and review	Schedule competency refreshers, audits, feedback, corrective-action follow-up and management review.	Assess persistence over time and measure relevant food safety outcomes separately.

A future evaluation could measure fidelity through the completion of approved cleaning schedules, documented CCP monitoring, audit observations, corrective action closure, and staff competency records. Environmental or product microbiology results and verified non-conformities, where appropriate, should be examined as separate outcome measures. A prospective, preferably multi-site design with repeated observations would be needed to test whether the proposed sequence improves control reliability beyond employees' perceptions or a 5S housekeeping score.

LIMITATIONS

The underlying investigation concerned one manufacturer and a small purposive group consisting of executive management and laboratory supervisory employees; it does not represent the full workforce or the Malaysian food industry. Its 2019 observations cannot establish the current organisational practice. The present analysis had access to the documented research, including narrative results and reproduced instruments, but not completed participant forms, original interview records, company audit files or independently measured product-safety outcomes. Its source checks are documentary comparisons, not renewed statistical or thematic analysis. The conceptual crosswalk and managerial sequence remain untested proposals. These limits constrain the strength of the conclusions but make clear which evidence a future prospective study would need to collect.

CONCLUSION

The documented Malaysian case illustrates a gap between visible workplace activity and the continued reinforcement needed to maintain it. Its historical account describes established HACCP-related routines among selected respondents, relatively prominent Shine practices and difficulties with Sustain, communication and organisational support. These findings are descriptive, not current assessments of the facility or evidence of improved food safety outcomes.

The article's analytical contribution is to delimit the role of 5S in food safety management. Sorting, organisation, cleaning, standard work and reinforcement can support approved GHPs and PRPs and may indirectly help staff execute HACCP procedures. They do not determine hazards, set critical limits or independently verify control effectiveness. The qualified crosswalk and proposed implementation sequence provide testable management propositions rather than conclusions of a completed intervention.

DECLARATIONS

Ethics and consent. The earlier investigation reported organisational access, voluntary participation, and confidentiality for individual responses; however, the available documentation does not provide an institutional ethics approval reference. No new human-participant data were collected for this article. The company and participants are not named in this manuscript.

Data availability. The current analysis uses the documented historical research and the published sources cited below. Completed questionnaires, verbatim interview transcripts, original company audit records, and independent microbiological results were not available for reanalysis; no new participant-level dataset is reported.

Prior dissemination and originality. The historical empirical work was documented in Md Ramli (2020), which is cited in this article. The present paper contributes a critically qualified documentary reinterpretation and a proposed operational framework. It should not be represented as a newly collected or independently reanalysed empirical dataset.

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