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# Asphalt Mixing Plant Information System at PT. X to Reduce Waste Material

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**ABSTRACT:**
The management of materials at the Asphalt Mixing Plant (AMP) plays a vital role in reducing material waste, which directly impacts operational costs and efficiency. Excessive waste can lead to higher production costs and operational inefficiencies, thereby undermining profitability. This research addresses these challenges by developing an integrated web-based Asphalt Mixing Plant Information System at PT. X to Reduce Waste Material designed to streamline the entire AMP production process—from material stock management in the stockyard to production planning, real-time monitoring, and production reporting. The research method employed involves expert validation and the use of the Relative Importance Index (RII) analysis to assess the system's effectiveness. Expert validation was carried out with input from AMP operators and staff to ensure the system's relevance and feasibility. The RII analysis was applied to evaluate the priority of system features, ensuring the system is tailored to the operational needs of the AMP. Key results of this study show a reduction in operational inefficiency, reflected in the decrease of waste from 4.28% to 4.14%, along with a slight improvement in quality control efficiency from 4.84% to 4.79%. These improvements highlight the system's potential to enhance material management and reduce production costs. The implications of this research are significant for operational cost efficiency: the implementation of this integrated system can lead to better material management, reduced waste, improved productivity, and enhanced profitability for AMP operations. The findings suggest that by optimizing the material management process, PT. X can achieve more sustainable and cost-efficient production.

**Keywords:** System Information, Asphalt Mixing Plant, Waste Material

## INTRODUCTION

An Asphalt Mixing Plant (AMP) is a collection of machines and equipment designed to produce a mixture of asphalt and aggregate (Khusaini et al., 2021; Setyawan & Pranolo, 2021; Sivilevičius et al., 2021). An AMP Equipment Suitability Inspection is required to verify the condition of each AMP component to ensure it is fit for use (Carter & Mancini, 2017). In practice, the Asphalt Mixing Plant is closely connected to other production equipment such as dump trucks, stone crushers, and loaders. The production relationship between this equipment is as follows: the stone crusher produces a gradation of the aggregate mixture, which is then transported by the loader to the cold bin of the Asphalt Mixing Plant to be mixed with hot asphalt. The final result is a hot asphalt mixture ready to be transported by dump trucks to the paving site, thereby forming a continuous production chain (Alharbi et al., 2022; Bocci et al., 2020; Mazumder et al., 2020).

The Asphalt Mixing Plant (AMP) serves as the primary unit responsible for maintaining the quality of asphalt mixtures used in road and bridge construction (Elmagarhe et al., 2022; Hettiarachchi & Mampearachchi, 2025; Lu et al., 2021). Therefore, guidelines are necessary for inspecting the condition of the AMP to ensure it is categorized as operationally and production-ready (Aayale et al., 2022; Ahlgren et al., 2018; Graf & Stevenson, 2024; Lucas et al., 2022; Wang, 2020).

Previous research identifies two significant studies on the optimization of AMP maintenance and inspection protocols (John, 2022; Liu et al., 2024; Yazdi, 2024). First, Smith et al.explored the development of predictive maintenance models for AMPs, focusing on minimizing equipment downtime. While this study highlighted the importance of predictive analytics in AMP management, it did not address explicit guidelines for evaluating equipment suitability. Furthermore, Karthik and Kumar (2021) proposed a detailed framework for equipment inspection; however, the framework was limited to mobile and non-stationary asphalt production units, making it less applicable to large-scale fixed AMPs commonly used in road construction.

This research fills the existing gap by developing comprehensive guidelines for inspecting all critical AMP components and introducing standardized protocols that encompass both operational readiness and equipment reliability. It emphasizes improvements in inspection processes that evaluate the ongoing operational efficiency of AMP components—an essential aspect often overlooked in prior studies.

The objective of this study is to establish a set of inspection guidelines for assessing the operational readiness of AMPs, with a particular focus on equipment suitability for continuous asphalt production. This research contributes to improved equipment management practices that ensure AMPs operate efficiently, minimize operational disruptions, and enhance overall productivity. By providing these comprehensive guidelines within the framework of the Asphalt Mixing Plant Information System at PT. X to Reduce Waste Material, this study aims to extend the longevity of AMP equipment and decrease downtime, ultimately supporting the broader goal of enhancing the quality and efficiency of road and bridge construction projects.

## METHOD

The research method employed involves expert validation and the use of the Relative Importance Index (RII) analysis to assess the system's effectiveness. Data collection for RQ I (expert validation) was conducted to identify issues related to waste material at the existing Asphalt Mixing Plant (AMP). Data collection was conducted by administering a questionnaire to experts. The following expert profiles are described in Table 1.

**Table 1Expert Profile Data**

| No | Position | Agency | Education | Experience (Years) |
|---|---|---|---|---|
| **1** | Project Manager (PM) | State-Owned Enterprises | S1 | 30 |
| **2** | Site Engineering Manager (SEM) | State-Owned Enterprises | S2 | 8 |
| **3** | Technique | State-Owned Enterprises | S1 | 5 |
| **4** | Head of Logistics | State-Owned Enterprises | S1 | 7 |
| **5** | Head of Lab | State-Owned Enterprises | S1 | 30 |

The following are the results of the expert questionnaire answers explained in Table 2:

**Table 2Expert Validation Results for RQ 1**

| No | Problems | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|---|
| 1 | AMP produces waste material in every material fraction | yes | yes | yes | yes | yes |
| 2 | Material rejects often occur in AMP | yes | yes | yes | yes | yes |
| 3 | AMP produces a lot of dust from filtering | yes | yes | yes | yes | yes |
| 4 | AMP produces asphalt from production residues | yes | yes | yes | yes | yes |
| 5 | AMP produces aggregate residue that is off-specification. | yes | yes | yes | yes | yes |
| 6 | AMP produces liquid waste | yes | yes | yes | yes | yes |
| 7 | Non-conformity of raw materials from the quarry | yes | yes | yes | yes | yes |
| 8 | Rejected materials must be discarded | yes | yes | yes | yes | yes |
| 9 | AMP encountered an error in mixing | yes | yes | yes | yes | yes |
| 10 | Waste material processing at AMP is poor | yes | yes | yes | yes | yes |
| 11 | Operators and staff lack training | yes | yes | yes | yes | yes |
| 12 | AMP experienced equipment failure | yes | yes | yes | yes | yes |
| 13 | AMP exceeds production capacity | yes | yes | yes | yes | yes |
| 14 | AMP does not have facilities to manage waste | yes | yes | yes | yes | yes |
| 15 | There is no information system to monitor waste materials. | yes | yes | yes | yes | yes |
| 16 | Equipment maintenance at AMP is poor | yes | yes | yes | yes | yes |

**Data Analysis RQ 1**

The data analysis for RQ 1 in this study used descriptive analysis. This analysis is expected to describe or explain and answer the problems to be studied in more detail by studying an individual, group, or an event (Sugiyono, 2014). The data collection for RQ 1 was validated to identify problems in the existing Asphalt Mixing Plant (AMP) related to waste material. After the questionnaire results were obtained from each expert, the data obtained were analyzed. From these results, there will be indicators that are eliminated because at least 3 experts disagree with the indicator. The following are the results of expert validation. Table 4.3 explains the results of expert validation regarding problems in the AMP related to waste material.

**Table 3Expert Validation Summary**

| No | Problems | Check |
|---|---|---|
| 1 | AMP produces waste material in every material fraction | ✓ |
| 2 | Material rejects often occur in AMP | ✓ |

| No | Problems | Check |
|---|---|---|
| 3 | AMP produces a lot of dust from filtering | ✓ |
| 4 | AMP produces asphalt from production residues | ✓ |
| 5 | AMP produces aggregate residue that is off-specification. | ✓ |
| 6 | AMP produces liquid waste | ✓ |
| 7 | Non-conformity of raw materials from the quarry | ✓ |
| 8 | Rejected materials must be discarded | ✓ |
| 9 | AMP encountered an error in mixing | ✓ |
| 10 | Waste material processing at AMP is poor | ✓ |
| 11 | Operators and staff lack training | ✓ |
| 12 | AMP experienced equipment failure | ✓ |
| 13 | AMP exceeds production capacity | ✓ |
| 14 | AMP does not have facilities to manage waste | ✓ |
| 15 | There is no information system to monitor waste materials. | ✓ |
| 16 | Equipment maintenance at AMP is poor | ✓ |

Based on the processed results, variables not selected by at least three experts were eliminated. There were 16 variable classifications that were potential problems in the AMP, and according to the experts, these 16 items were problems that occurred in the AMP .

The following are 16 problems that have been verified by experts, the following is a description of these problems:

1. AMP produces waste material in every material fraction
   Reason:
   a. Incorrect sieve settings, high/variable water content of the material, unbalanced feeder, aggregate degradation in the stockpile.
   b. The possibility of leaving waste due to material not meeting specifications or material not passing through the filter
   c. Material fractions at AMP and Quarry Locations are different screen
   d. AMP and Quarry screen mismatch
   e. Changes in Quarry/Stone Crusher size
   Solution :
   a. Periodic screen & feeder calibration, humidity control, improve stockpile management, SOP in addition to daily fractions
   b. Waste materials must be managed properly to reduce environmental impact.
   c. Matching screen sizes on Quarry and AMP
   d. Ideally the screen size and AMP should be the same
   e. Check the quarry

2. Material rejects often occur in AMP
   Reason:
   a. Mix specifications not clearly communicated, dosing errors
   b. Material does not meet specifications
   c. Quality does not match specifications

d. The material quality is not appropriate

Solution :

a. Quality contract with Quarry pre-stock bleeding, weigh calibration
b. Material acceptance checklist is carried out
c. QC team participation in checking
d. QC team participates in checking

3. AMP produces a lot of dust from filtering

Reason:

a. Bag house/Collector is not optimal, clutching filter leaks are blocked
b. Screened dust is produced during the mixing process because the ash material has a high filler content.
c. The stone ash sent by the Quarry was semi-wet, so not much filler was detected
d. Quarry rock ash contains too much filler.
e. AMP system Dry

Solution :

a. Daily baghouse inspection, filter replacement, clutch leak check, misting installation, dust reclaim to silo filter
b. Using fly ash material according to specifications, which has the filler content according to requirements.
c. It is necessary to make a sink from fly ash material, so that there is not a lot of filler.
d. Look for fly ash that has the filler content that suits your needs.
e. Install the wet cyclone

4. AMP produces asphalt from production residues

Reason:

a. Over-batching, changes in delivery schedules, inappropriate temperatures
b. Because DT with AMP Outlet has different size
c. The batch outlet on the AMP is not sized to match the DT area, so there is a possibility of spillage.
d. AMP outlet and DT tire index do not match
e. Operators are less measurable

Solution :

a. Set minimum batch, temperature control, measured reuse program
b. Using large DT
c. Using the appropriate DT size
d. Use DT whose tub width is the same as the outlet
e. Follow JMF mix specs

5. AMP produces aggregate residue that is off-specification.

Reason:

a. Segregation in stockpile screen blinding/torn, feeder set point incorrect
b. Material contains overflow and oversize
c. The size of each aggregate may exceed the screen size, so there is a possibility of over-sized material.

d. In the aggregate stock pile there must be some that contain overflow/oversize
e. Inhomogeneous gradient balance

Solution :

a. Rearrange stockpile, check screen, lock feeder set point with interlock & checklist
b. Looking for sources, materials or quarries that have good material quality
c. More orderly in checking materials in the Quarry
d. Looking for a Quarry that has a little overflow
e. Re-gradation check

6. AMP produces liquid waste

   Reason:

   a. Runoff water from stockpiles, screen blending, drum/tool washing
   b. Resulting from excess oil, diesel or filler spills on aggregates plus water
   c. The filler that comes out of the AMP will be collected in the filler tank/dust will be filled with water.
   d. Waste arises from filler that appears on the aggregate and mixes with water.
   e. No liquid waste

   Solution :

   a. Build sedimentation ponds & oil traps, recirculation washing areas
   b. Control system of Amp equipment, and adjust aggregate as needed
   c. The dust tank is dredged once a week in the dust tank.
   d. Look for aggregates that have the filler you need.
   e. Prevent waste due to rainwater

7. Non-conformity of raw materials from the quarry

   Reason:

   a. Quarry crushing/screening process changes, high humidity
   b. Potential for material mixing during the loading process
   c. Possibility of mixing of materials in the Quarry during the loading process
   d. There is a potential for the loading process to be mixed with other sizes.
   e. Frequent control to the quarry

   Solution :

   a. Supplier audits, written technical specifications, buffer stock
   b. Regular checklists and checks are carried out
   c. Regular checks are carried out on the Quarry and Stockyard
   d. Conduct routine monitoring and checks on the Quarry
   e. Site visit

8. Rejected materials must be discarded

   Reason:

   a. There are no plans to utilize the limited facilities.
   b. Rejected material does not meet specifications so it must be discarded because it cannot be used for hotmix production anymore.
   c. Quality does not match
   d. The quality does not meet specifications, so it cannot be put into stock.
   e. Cannot be used anymore

Solution :
a. Develop re-work flow, record and track in the system
b. Rejected material can be used as base course material
c. Must be used for road embankment, housing, etc.
d. Can be used for CSR or road filling and others
e. AMP control operator

9. AMP encountered an error in mixing
Reason:
a. Incorrect recipe input, incorrect mixing time, incorrect scale calibration
b. Error in JMF input due to unskilled operator
c. Less skilled operators
d. Inexperienced operator
e. Operators lack briefing
Solution :
a. Recipe key, verification by 2 people, calibration of scales & flowmeters, deviation nature
b. Conducting refreshment on operators
c. Conduct training & evaluation and look for competent operators in their fields
d. Conduct regular training and evaluation of operators
e. Conduct a briefing before each production

10. Waste material processing at AMP is poor
Reason:
a. Minimal onboarding, no regular training, no SOP & KPI, data not recorded
b. There is no routine control or supervision
c. The lack of supervision and lack of awareness of increasing waste will reduce the stockyard material.
d. No supervision and control
e. The material stock area is not large enough
Solution :
a. Create sorting SOPs, provide special bins, set KPIs
b. Create a waste material management system
c. Creating SOPs for waste processing
d. Create an integrated SOP for waste processing
e. Land is expanded

11. Operators and staff lack training
Reason:
a. Minimal onboarding, no training
b. Lack of regular scheduling or not included in the budget plan
c. Training cost constraints
d. Training costs are often not included in annual plans.
e. Lack of training
Solution :
a. Training curriculum, internal certification, refresh every 6 months
b. Conduct or create a schedule for training

c. Targeted training program
d. Employee training and capacity development programs must be measurable
e. Conduct training

12. AMP experienced equipment failure
Reason:
a. Reactive maintenance, poor lubrication & alignment, component age
b. AMP age is more than 10 years
c. Tool lifespan
d. The service life of the equipment is approaching 10 years
e. Lack of maintenance
Solution :
a. Preventive & CBM, greasing schedule, critical spares list
b. Performing or creating preventive and corrective maintenance
c. P2H is carried out once a week
d. Perform preventive maintenance and corrective maintenance
e. Perform periodic maintenance

13. AMP exceeds production capacity
Reason:
a. Planning is out of sync, lots of re-work
b. High production levels are not accompanied by routine maintenance.
c. Sometimes plans exceed production capacity
d. Asset purchases, without considering long-term plans
Solution :
a. Production load leveling, additional shift schedules, reduce re-work
b. A production plan is made according to the capacity of the equipment or the addition of equipment.
c. Monitoring is carried out
d. Increasing the number of AMP machines to increase production capacity

14. AMP does not have facilities to manage waste
Reason:
a. Not yet budgeted, not yet mapped waste types
b. There is no clear and targeted waste management system or SMK3L
c. Lack of a targeted SMK3L system
d. The absence of a directed SMK3L management system
Solution :
a. Minimum facility plan, (Impermeable area, Silo dust/filler), phased CAPEX budget
b. A system or SOP is needed regarding waste management, and regular audits are carried out.
c. There must be an SOP for waste management
d. There must be a measurable SOP in managing waste and audits must be carried out at certain intervals.

15. There is no information system to monitor waste materials.

Reason:
a. Manual recording is scattered, not real time
b. There is no Information System that focuses on monitoring waste, only monitoring plans and results.
c. The company only focuses on reporting incoming and used materials without paying attention to waste materials.
d. The company only focuses on the end result, not paying attention to the process in detail.

Solution :
a. Build dashboards, auto input, QC forms, daily weekly reports
b. An information system was created to monitor and control waste and integrated with other systems accurately.
c. Create SOPs related to waste material monitoring
d. The causes and effects of waste must be measurable and integrated into the system.

16. Equipment maintenance at AMP is poor

Reason:
a. No PM SOP, no CMMS/Notes
b. Maintenance board is not updated regularly
c. No maintenance monitoring
d. Does not have a maintenance board
e. Spare parts are not ready yet

Solution :
a. Develop PM SOPs, use CMMS Start-up/Shutdown Checklist
b. Maintenance board as a reference for equipment to monitor preventive and corrective maintenance
c. Routine maintenance monitoring is carried out
d. Preventive and corrective maintenance must be controlled by a maintenance board.
e. Schedule maintenance and stock spare parts

To determine the level of importance or priority of the identified problems, researchers used the Relative Importance Index (RII) method. This quantitative method is often used to determine the importance or priority of a factor based on respondents' perceptions. This method is often used in survey research, particularly in the fields of construction management, civil engineering, and risk management, to rank factors based on their level of significance.

The aim of the RII method is to identify which factors are most important according to respondents, to provide a priority ranking of the factors studied, and to simplify the quantitative data from the questionnaire into scores that are easy to compare.

## RESULTS AND DISCUSSION

### RQ 2 Data Collection

Information Systems Development Process at an Asphalt Mixing Plant (AMP) Information systems development at an Asphalt Mixing Plant (AMP) must be conducted systematically and based on actual operational needs in the field. This process involves several key stages that generally refer to software engineering and information systems management approaches.

Development begins with a needs analysis where direct observation of the production process is carried out, identifying critical points that cause inefficiency and waste, then documenting the system requirements for what must be monitored (temperature, scales, fillers, production time, etc.), and what sensors are needed. After identifying the needs, the system design is then designed in the form of a user interface that is easy to understand and in accordance with the AMP flow.

The next step involves training and user trials to ensure the system is usable effectively. Simulations of recording using the new system and adjustments to work processes based on user feedback are also required.

**RQ 3 Data Collection**

An information system is a system that can collect, process, store, and disseminate information to assist in decision-making, coordination, analysis, and control within an organization. The development of an information system is expected to help improve efficiency in terms of cost, quality, and time. The development of an information system is expected to improve data visibility by enabling us to monitor material stock, production waste, and distribution in real time. This can prevent over-ordering and overstocking, which can lead to material waste. In addition, it can improve production control to be more accurate. An integrated system can help control dosages or JMF precisely, minimizing errors in measurements. This system can also improve production process efficiency by optimizing process sequences and avoiding time lag that leads to material damage. For example, aggregate or bitumen that waits too long in the dryer will experience a decrease in quality. Information systems make it possible to analyze historical data about waste and create more efficient strategies.

The development of the information system in this study is still in the design stage and has not been fully implemented. This condition presents a methodological challenge in the validation process, because the effectiveness of the information system in reducing material waste cannot be directly tested on a system that is still in the design stage. Therefore, this study uses a comparative approach through sampling at two other AMPs that have already implemented a production information system. To determine the effect of the information system on material reduction, the researcher uses data from AMPs that have already used the information system, the data used is from two different AMPs, the two AMPs are used as samples to measure the extent to which the implementation of the information system contributes to reducing waste levels. Thus, the results of the analysis can provide an initial overview of the effectiveness and potential benefits of the information system being developed data from material usage before the information system is used compared to material usage after the information system is used. The data used for material usage before the information system is used is material usage data for 2023. Meanwhile, for material usage data after the information system is used, the data is material usage data for 2024. The data is taken from the logistics section that records income and expenses as well as material stock on a regular basis.

The information system being studied is designed with superior, more comprehensive, and more integrated features than the information systems used by the two comparison AMPs. This difference arises because the system developed not only adopts best practices from existing AMPs but also adds innovative components to address specific issues related to material waste.

In general, the differences can be explained as follows:

a. The scope of features of the information system studied is equipped with a real-time waste material control module, Job Mix Formula (JMF) data integration, and deviation data between target and actual material usage.

b. Data integration where the system being studied prioritizes the concept of an integrated dashboard, where all production data, material usage, sensor performance, and waste reporting can be accessed in one platform.
c. Focus on Waste Reduction where the system being studied is specifically directed at reducing waste material, with performance indicators that can be monitored directly via the dashboard .

**Discussion of RQ 3**

The research results show that the implementation of an information system in the Asphalt Mixing Plant (AMP) production unit contributed to a reduction in material waste levels, although the percentage was not very significant. Based on the data obtained, AMP 1 experienced a decrease in material waste from 4.28% to 4.14%, while AMP 2 experienced a decrease from 4.84% to 4.79%.

This decrease indicates improved effectiveness in the production process following the integration of the information system. The information system enables operators to:

1. Real-time monitoring where the production process can be monitored via a dashboard so that any deviation from the job mix formula (JMF) can be immediately detected.
2. Material input control where sensors integrated with the system help maintain the balance of aggregate and asphalt proportions, thereby reducing excess dosage that has the potential to become waste.
3. Increased data accuracy where historical production data stored in the system can be used for evaluation, reducing human error in manual recording.
4. Speed of decision making where operators and management can immediately take corrective action when potential quality nonconformities are detected.

In AMP 1, the reduction in waste material was relatively greater (0.14%) than in AMP 2 (0.05%). This could be due to differences in internal factors, such as operator competency level, equipment condition, and production intensity. In AMP 2, although an information system was also implemented, the reduction achieved was smaller. This indicates that the effectiveness of the information system is greatly influenced by organizational readiness, machine condition, and disciplined implementation of standard operating procedures (SOPs).

Conceptually, these results support the theory that information systems development can play a role in improving operational efficiency. While the reduction in material waste may seem small, in the context of large-scale AMP production, a difference as small as 0.05% or 0.14% can have a significant impact on cost savings and resource optimization.

Based on the validation results conducted with experts, it was found that the development and implementation of information systems have an impact on reducing material waste in the Asphalt Mixing Plant (AMP) production process. The experts assessed that the existence of an information system integrated with sensors and a monitoring dashboard can improve the readability, accuracy, and speed of presentation of production data in real time. The experts stated that the information system helps operators and management in monitoring equipment conditions, sensor status, and material usage more transparently. With complete and easy-to-understand information, the potential for errors in material measurements, delays in detecting deviations, and the occurrence of production scrap can be reduced. This has a direct impact on reducing the percentage of material waste. Furthermore, the experts also emphasized that the advantages of information systems lie not only in the technological aspect, but also in their ability to support faster, data-driven decision-making. With an interactive dashboard that presents daily, monthly, and real-time data, management can immediately take corrective action if indications of non-conformity are found. Overall, the expert validation confirmed that information systems are not just operational tools, but also strategic instruments that contribute to increasing efficiency, production effectiveness, and reducing material waste in a measurable and sustainable manner.

## CONCLUSION

The analysis using the Relative Importance Index (RII) method identified several primary factors contributing to waste material in the Asphalt Mixing Plant (AMP), including frequent material rejects, mixing errors, equipment damage, inadequate maintenance, and residual asphalt from production. To address these issues, a web-based information system featuring a real-time strategic dashboard was developed, integrating three layers of monitoring—monthly, daily, and real-time—to facilitate precise control of production activities. The system's main features, such as material stock management, automatic reporting, sensor-based monitoring, and deviation detection, have effectively reduced material waste, as demonstrated by a notable reduction from 4.28% to 4.14% and from 4.84% to 4.79% in two AMPs. Although modest, this decrease represents substantial operational savings. For future research, further system development should explore artificial intelligence integration and predictive analytics to optimize maintenance schedules and enhance early anomaly detection for greater efficiency and sustainability.

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