Smart Manufacturing Integrating IIOT for High Pressure Washing

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ABSTRACT

High Pressure Washing (HPW) performance is crucial for maintaining plate quality. In the current process, it is difficult to detect delayed issues such as skipped steps, pressure fluctuations, or machine errors.

This paper discusses how we are leveraging digitalization and automation through the Industrial Internet of Things (IIoT) to ensure that key output variables (KOVs) in the plate cleaning process such as soap pressure, water rinse pressure, and air drying remain under control. This study uses the DMAIC methodology to systematically guide the improvement process.

Since implementing IIoT, there have been no skipped processes, and all abnormalities are captured through alarm systems. This allows technicians to immediately perform Out-of-Control Action Plans (OCAP) to address related issues.

To further address these challenges, we have integrated data analytics via IIoT, enabling engineers to gain actionable insights from big data and resolve problems more efficiently. Our flexible tools also enhance real-time equipment performance by supporting predictive maintenance.

1.0 INTRODUCTION

Washing-related defects were identified as a root cause of Out-of-Control (OOC) plate quality issues. Traditional methods, such as manual data entry and KPI monitoring are slow and prone to delays due to limited resources and the absence of standardized protocols in legacy tools. This manual approach hinders timely data analysis and issue resolution, increasing the risk to product quality and inventory levels. Figure 1 illustrates these related issues

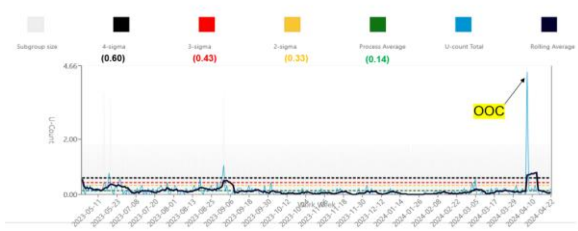


Figure 1 Sample KOV OOC chart

2.0 REVIEW OF RELATED WORKS

Not applicable

3.0 METHODOLOGY

3.1 Industrial Internet of Things (IIoT)

To address this, we developed an automated Industrial Internet of Things (IIoT) system designed to provide real-time visibility through intuitive dashboards and visualization tools, enabling informed decision-making. The system offers browser-based access to key equipment and process metrics, with archived data easily accessible for trend analysis. Real-time data from processes, equipment, and sensors are captured and stored in a unified database, allowing for global production visualization.

The system digitizes manufacturing processes by systematically detecting deviations in failure rate trends in real time, enabling prompt and appropriate responses to abnormalities.

3.2 Tool Connectivity Concept

As shown in Figure 2, IIoT connectivity utilizes a host PC and a server-based system, referred to as Factory Digital Transformation (FDT), for data transfer and automation. Data is collected from machine signals such as I/O, log files, and PLCs transferred via a network, and stored within the IIoT system infrastructure. This data is then used to build custom dashboards for monitoring and analysis.

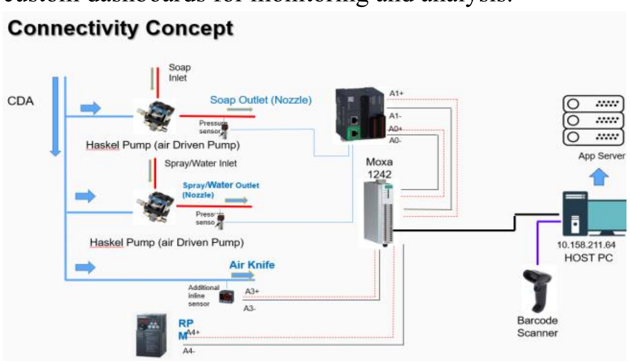


Figure 2 connectivity layout

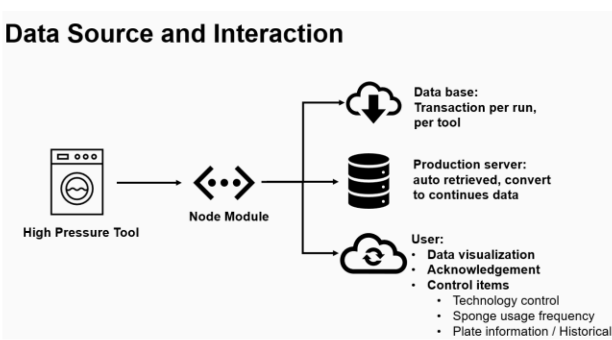


Figure 3 IIoT system data interaction

3.3 IIoT System Creation for KPVs

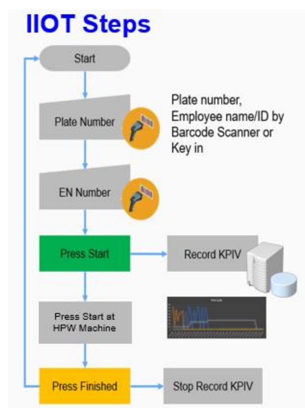
Before implementation, data was collected manually without clear criteria. By controlling Key Process Variables (KPVs) such as soap/rinse pressure, air knife pressure, table RPM, and cycle time, process consistency can be improved. To prevent skipped processes, we developed IIoT system to monitor both KPV behavior and machine parameters, triggering alarms when anomalies are detected. Figure 4 shows the control items.

Main Step	Main Step	Sub-Steps
Clean	Soap	Soap + Sponge
Rinse	Water Rinse	Rinse + Sponge
	Water Rinse	Rinse
Dry	Spin+Air Knife	Spin+Air Knife

Figure 4 Washing control items

3.4 Fool-Proofing Process

To prevent skipped steps, the system verifies the plate's history to ensure completion of the HPW process. Figure 5 shows plate tracking.



Real-time feedback will be provided if a plate is processed with an issue, including IIoT alarms that are visible to operators

Figure 5 Sequence: How to Use IIoT

3.5 IIoT Utilization

IIoT allows for tool utilization and performance monitoring. This data helps optimize corrective actions and prevent abnormalities in downstream processes. Figures 6 IIoT application

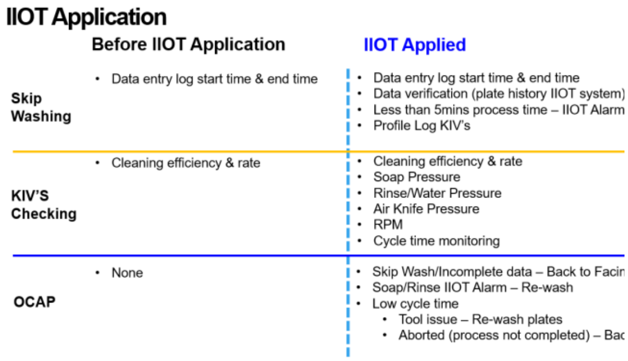


Figure 6 IIoT application advantages

3.6 Alarm Notifications for OOC

The IIoT system includes intelligent alarms for deviations such as low cycle time or hit rate. Custom email notifications are sent to assigned personnel for immediate action.

i. Soap Hit rate below set limits
ii. Rinse Hit rate below set limits
iii. Low Cycle time below set limits
iv. Sponge replacement alarm above set limits

4.0 RESULTS AND DISCUSSION

After implementing the IIoT system, process and High-Pressure Washing (HPW) machine KPIs enabled early detection of abnormalities, leading to a 20% improvement in OEE. This allowed for faster response and prompt corrective actions. These successful use cases also demonstrate how IIoT helps prevent plate quality issues such as skipped HPW washing, aborted processes, or tool operation under poor conditions (e.g., low pressure or abnormal RPM).

Figure 7 IIot application effectiveness

Figure 8 IIoT sample KPV's output

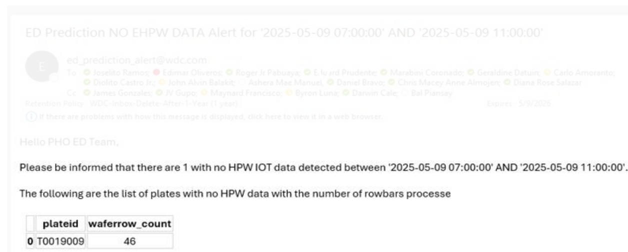


Figure 9 sample of plate with issue

5.0 CONCLUSION

The application of IIoT has proven effective for data-driven monitoring and control of HPW operations, resulting in a 20% improvement in OEE. Its direct connection to tooling enables rapid issue detection, allowing technician to address anomalies promptly and reduce production costs. It also helps prevent and capture issues such as skipped HPW washing, aborted processes, or tool operation under poor conditions (e.g., low pressure or abnormal RPM).

6.0 RECOMMENDATION

To further enhance IIoT adoption:

Data Visualization: Provide real-time dashboards for operator alerts and KPIs.

IoT Integration: Expand sensor usage for improved monitoring and maintenance.

Automation: Increase automated data gathering to reduce manual errors.

Continuous Improvement: Encourage innovation and feedback-driven enhancements.

Creating an agile, responsive, and efficient Factory Digital Transformation (FDT) ensures competitiveness in today's fast-paced manufacturing environment.

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8.0 REFERENCES

Not applicable

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Hesusa Krisani Cardona: 5 years work experience at Western Digital Corp and is engaged at Engineering System, with experience in Equipment Maintenance, Process Engineering and Currently handling tool automation under System Engineering.

10. APPENDIX

None