

Rapid Measurement of Labor Efficiency with Automated Excel Dashboards in High-Mix Manufacturing Lines

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Abstract:

Companies that make a lot of different things in a short amount of time often have trouble assessing labor efficiency across production lines in a precise and consistent way. Calculations done by supervisors are usually done by hand, take a long time, and are not always accurate. This makes it hard for leaders to see what is going on and slows down decision-making. This paper presents a case study showing the design, implementation, and impact of an automated Excel-based dashboard designed to rapidly monitor Direct Labor (DL) efficiency in an outdoor power equipment manufacturing facility that manufactures outdoor power equipment. The deployed system coordinated labor efficiency projections across five assembly lines and cut the time it took to report from 20 to 30 minutes per line to about 2 to 3 minutes for the whole facility. The results show that reporting is more consistent, accurate, and visible to leaders, which shows how useful low-cost digital solutions can be for improving operational excellence through data.

Keywords: Manufacturing Performance Measurement, Operational Excellence, Digital Transformation in Manufacturing, Digital performance dashboards, Lean Manufacturing, Labor efficiency and performance, Automated Excel dashboard, operational excellence, Enterprise Resource Planning (ERP) and Advanced Manufacturing Execution Systems (MES).

1. INTRODUCTION

Labor efficiency is a key measure of how well a production system works, and it has a direct effect on cost, throughput, and competitiveness. Measuring labor efficiency is especially hard in high-mix production settings since SKUs change often, standard times vary, and reporting processes aren't always the same (Groover, 2020). As companies work more and more on lean manufacturing and digital transformation projects, it becomes more important to have accurate ways to monitor labor efficiency in order to cut down on waste and keep getting better (Womack & Jones, 2003).

Enterprise Resource Planning (ERP) and Advanced Manufacturing Execution Systems (MES) are two types of software that can collect and analyze data in one place. But a lot of businesses still use manual or semi-manual methods because they are too expensive, too hard to set up, or their old systems don't work with new ones (Parmenter, 2015). This makes it hard to see how well things are doing, which can slow down decision-making and make operations less responsive.

This study aims to bridge the gap between manual labor efficiency reporting and fully integrated digital systems by showcasing that a structured, Excel-based automation methodology may provide swift, precise, and uniform evaluation of labor efficiency. The research employs a real-world industry case study to offer practical insights into cost-effective digital transformation in manufacturing operations.

The goal of this article is to write about the challenge, the system architecture, the implementation approach, and the performance impact of an automated DL efficiency dashboard. It will also look at its effects on management and operations.

2. LITERATURE REVIEW

2.1 Measuring Labor Efficiency and Performance

Performance measurement systems are essential for making manufacturing competitive. Neely, Gregory, and Platts (2005) emphasize that performance measures must be standardized, measurable, and in line with the organization's plan. Labor efficiency indicators help businesses figure out how productive their workers are, find problems, and make decisions about how to use their resources. Kaplan and Norton (1996) also emphasize the need to combine operational measurements with strategic performance measurement frameworks to help make balanced decisions.

Research on lean manufacturing repeatedly finds that labor efficiency is a major sign of waste and process stability (Liker, 2004). Standardized work and time study procedures are the basis for creating reliable labor standards (Barnes, 1980). Ohno (1988) says that standardized work helps businesses stabilize their processes and set a baseline for ongoing improvement. Without standardized measurement frameworks, companies frequently have inconsistencies in reporting methods that undermine metric dependability.

2.2 The Importance of Time Study and Standardization in Manufacturing Analytics

For a long time, people have known that time study methods are important for setting performance benchmarks and labor norms. Niebel and Freivalds (2009) say that accurate time studies help businesses figure out how much productivity they can expect and make better plans for their workers. Maynard (2001) further says that standardized labor measurements make it possible to compare performance across different production lines and facilities in a consistent way.

By adding time study data to digital performance dashboards, companies may get more accurate measurements and cut down on the work that needs to be done by hand. Empirical investigations demonstrate that automated standard retrieval minimizes calculation errors and facilitates data-driven continuous improvement programs.

2.3 Digital Dashboards and Data Visualization in Manufacturing

Digital dashboards have been found to improve operational visibility and speed up decision-making by turning raw production data into useful information (Few, 2013). Visual management technologies let industrial leaders quickly find performance problems and take steps to fix them (Shingo, 1989). Tufte (2001) says that a good way to show numbers visually makes them easier to understand and lessens the mental strain of making decisions.

More and more companies are using manufacturing analytics dashboards to bring operational KPIs together into one reporting platform. Yigitbasioglu and Velcu's (2012) research shows that dashboards make it much easier for leaders to keep an eye on things and hold people accountable for their work.

2.4 Technology for Decision Support Based on Spreadsheets

Due to their flexibility and ease of use, spreadsheet-based decision support tools are still commonly utilized in manufacturing. Panko (2015) says that spreadsheets may be very useful for analysis if they are set up with consistent formulas and validation steps. Grossman and Ozluk (2004) also say that spreadsheet models can be cheaper than enterprise analytics solutions if they are created and kept up to date correctly.

Even though people are worried about mistakes in spreadsheets, research shows that formal design frameworks, automated calculations, and standardized templates greatly lower the chance of mistakes and make decisions more reliable.

2.5 Affordable Digital Transformation in Manufacturing

Digital transformation in manufacturing does not necessitate the adoption of enterprise-scale systems. Adopting new technologies in small steps, such as automated spreadsheets and localized analytics tools, can greatly improve the maturity of performance assessment (Westerman, Bonnet, & McAfee, 2014). Kane et al.

(2015) emphasize that changing a culture to make decisions based on data often starts with localized digital tools that show measurable operational benefits.

Research on Industry 4.0 is starting to talk more about the necessity of intermediate digital transformation stages. These are when businesses use hybrid solutions that combine manual reporting systems with automated analytical tools. These kinds of strategies let companies slowly build up their digital skills while keeping their financial risk low (Schwab, 2017).

There is a lot of interest in digital manufacturing tools, but there isn't much scientific writing that goes into detail about how to use spreadsheet-based labor efficiency dashboards in high-mix manufacturing settings. This work helps to fill this gap in research.

3. METHODOLOGY

3.1 Context for Manufacturing

The research took place in a facility that makes outdoor power tools. The enterprise had five mass-production assembly lines that worked one shift each day. They made about 10,200 pieces a day from a mix of about 127 SKUs. There were between 14 and 58 operators on each line, which made it hard to deploy workers and report on them.

The facility works in a high-mix, medium-to-high volume assembly setting where products are often changed and the amount of workers needed changes.

3.2 Problem Statement

Before the intervention, supervisors used informal, non-standardized ways to figure out how efficient DL was on their own. Each supervisor used their own way of calculating, which caused different results across lines. It took about 20 to 30 minutes a day to figure out how efficient a single line was, especially when it was making more than one SKU.

Some of the biggest problems were: - Different ways of calculating - A lot of room for mistakes - Not enough trend analysis - Less trust in performance measures from executives - Not enough real-time visibility into performance

These problems made it take longer for managers to make decisions and made it harder for engineers to check the data.

3.3 The structure of the system and the data inputs

The suggested fix was an automatic Excel-based dashboard that would bring all of the DL efficiency calculations together and make them all the same. The data sources were: - The standard headcount from SKU-level time studies - The actual production output from daily production reports - The actual labor headcount from line leaders

Data inputs were gathered from standardized production reporting systems, which made sure that they were all the same and cut down on manual variability.

3.4 The Logic Behind Calculating Efficiency

In order to determine direct labor efficiency, a comparison was made between actual labor hours and standard labor hours. Standard labor hours were figured out by multiplying time study standards by actual production output. Actual labor hours were figured out by adding up the number of workers and the length of their shifts.

The following equations were used to figure the DL Efficiency:

Standard Hours required to complete work order = (Number of unit produced/Standard units per hour) x standard headcount.

Actual Hours took to complete work order = Number of working hours x Actual headcount.

DL Efficiency = (Standard Hours required to complete work order / Actual Hours took to complete work order) x 100

This common formula made it possible to compare the efficiency of all manufacturing lines and SKUs in a consistent way.

3.5 Excel Automation Tools

The dashboard used a number of Excel automation features, such as: - Pivot tables to group data by line, SKU, and day - Advanced lookup functions (VLOOKUP,XLOOKUP, INDEX-MATCH) - Templates for automatic calculations - Conditional formatting and graphical visualizations

To make the system easier to use and less complicated to maintain, macros and VBA were left out on purpose.

4. STRATEGIC APPROACH TO IMPLEMENTATION

The initiative started because leaders were worried about how accurate the KPIs were and how quickly they were reported. The project also fit with goals for continuous improvement that were centered on making operational analytics more consistent.

Development was completed independently over a period of approximately three months. The first test of the pilot version used only a small amount of data from one production line. After testing and making changes over time, the dashboard was made available on all five production lines.

During the implementation, data accuracy was guaranteed through direct production floor observation and manual verification. To make sure that the system's outputs were correct, parallel calculations were done to compare them to existing reporting techniques.

4.1 Training and Managing Change

Production supervisors, production assistants, and engineering personnel participated in structured training sessions. Training was done in a week, and everyone was using the system fully within two weeks. At first, supervisors were resistant since they weren't used to the tools and didn't want to learn how to use them.

5. EVALUATION

5.1 Better Efficiency in Reporting

Before the change, five supervisors spent about 20 to 30 minutes each day making efficiency reports. With the automated dashboard, it only took one person about 2–3 minutes to report on the whole facility. This saved about 90 to 120 minutes of time per day.

5.2 Standardization and Precision

The dashboard cut down on mistakes in calculations by a lot and made sure that all lines used the same way to figure out efficiency. Standardized reporting made people more confident in performance indicators and made it easier for engineers to check their work.

5.3 Improvements in Operational Performance

The technology didn't immediately affect line balancing, but it did help make better staffing decisions and made it easier to start focused productivity enhancement projects. Engineering teams found performance gaps more quickly, which helped with attempts to make things better all the time.

5.4 Adoption by organizations and effects in culture

The dashboard is currently in active use and has been deployed across all five production lines. Standardized efficiency reporting across the entire facility enhanced communication between departments and made KPI governance stronger.

6. Discussion

This case study shows that using spreadsheets to automate tasks might be a good way to start a digital transformation. Technology made operations more open, made reporting processes more standard, and cut down on the time needed to prepare data.

The results back up lean management ideas that stress standardized work, visual management, and quick feedback loops (Liker, 2004). The interface made reporting easier, which let leaders focus on improving performance instead of checking data.

Also, the instance shows how important it is to adopt digital technology gradually. Companies can see quantifiable gains in their operations without having to spend money right away on enterprise-level digital technologies.

7. Restrictions

The solution has certain problems, even though it has some good points. The dashboard needs reliable input from production reports and time study criteria that are updated on a regular basis. As the number of SKUs and historical data grows, Excel's performance may suffer. The solution doesn't let you see things in real time or do advanced analytics like predictive modeling or optimization.

Also, the dashboard mostly talks about how well workers are doing their jobs, and it doesn't provide indicators for machine use or quality performance. These limits provide us chances to make the system better in the future.

8. Improvements in the Future

Some of the things that will be better in the future are: - ERP and MES integration for automatic data extraction - dashboards that show how efficient things are in real time - AI-based labor efficiency predictions - automated report transmission to leadership - performance dashboards that can be accessed on mobile devices

These improvements would make it much easier to make decisions based on data and cut down on the work involved in manual reporting.

9. Conclusion

This study shows that automated Excel dashboards are a useful and scalable way to quickly monitor labor efficiency in high-mix manufacturing settings. The solution improved accuracy, operational visibility, and decision-making efficacy by standardizing computations and cutting down on reporting time.

The instance shows how important low-cost digital transformation tools are for lean manufacturing and ongoing improvement efforts. Companies that want to improve their operational analytics skills might use spreadsheet automation as a step toward fully integrated digital manufacturing systems.

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