# Independent research reveals the power of IWS:

Yale, MIT and LSE confirm its positive impact on operational performance.

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P&G

Operational excellence is an ongoing goal for most manufacturers. But successfully achieving it, let alone sustaining it, can be elusive. Procter & Gamble is a notable exception. Its Integrated Work System (IWS) has been at the core of the consumer product giant's operational excellence and a key driver of the company's superior financial performance over decades.

IWS clearly has delivered benefits for P&G. Can it do so for other companies? **According to an independent team of researchers from MIT, Yale and the LSE**, the answer is a resounding "yes." This research team found that IWS deployed across two different consumer goods manufacturers delivered a wide range of measurable operational benefits that could translate into a potential revenue uplift of as much as $480 million — using the same production equipment.

In this paper, we explore in more detail what IWS is, how it works and the benefits the research team found it could generate.

## IWS drives significant, sustainable performance improvements

At its essence, IWS is a holistic, company-wide and integrated system that encompasses work processes, human capabilities, tools, methods, operational and technical standards and enabling technologies — all focused on achieving a clear organizational objective: *harnessing 100% employee engagement to continuously drive toward zero loss*. Combined, this creates the IWS culture and a workplace where continuous improvement is the driving force, and the ultimate objective is to deliver superior products and value to P&G's consumers and customers.

IWS has enabled sustainable performance improvement over decades of change; it's been at the heart of how P&G runs its production facilities for more than 30 years. IWS is used at all P&G sites worldwide, regardless of the processes they operate or products they produce, and across the end-to-end supply chain. With IWS at its core, P&G has driven continuous improvements across key cost, cash, people, customer service and sustainability metrics, helping to make P&G one of the most valuable and profitable companies of all time. Even more impressive, the company has done this through changes in CEOs, manufacturing leaders at all levels, organizational structure, market shifts and shocks and disruptive technology trends — in an industry that's notoriously prone to swings in consumer tastes and requires continuous innovation.

## Employee ownership is key

A core tenet of IWS is the concept of employee ownership, which empowers employees to solve problems independently. Take, for instance, machine operators on the shop floor. Instead of asking operators to simply push buttons on a machine, the IWS program trains workers to manage every aspect of a machine:

- Operators seek to understand the issues they encounter and make the right decisions to solve the problems because it's their machine and process.
- As a result, operators aren't calling their supervisors multiple times a day asking for help with a problem, or waiting for maintenance or engineering staff to repair it. They're fixing it themselves.
- Such self-sufficiency was especially vital to P&G's ability to continue production during COVID-19 restrictions that kept non-essential employees at home. It didn't matter to line operators; they were fully capable of managing things on their own.

IWS has been a major factor in P&G's success. But does it work in settings outside of P&G, and if so, what is its impact? Those are the questions we sought to answer with a team from the Supply Chain Research Alliance, a collaboration of researchers at Yale, MIT and the London School of Economics. This team's ongoing efforts reveal that IWS is not only highly effective in other manufacturing settings besides P&G's, but also generates significant, measurable financial benefits. Over seven years of studying IWS deployment across many lines at various plants in two large food and beverage manufacturers, the research team found IWS on average contributed to a potential revenue boost of $240 million to $480 million.

## Operator ownership: a critical element of IWS

As mentioned, a core element of IWS is encouraging employees to take ownership of their work — to find, highlight and solve work process and equipment losses to improve reliability, reduce costs and elevate productivity.

On the shop floor, this approach results in highly involved operating teams with the autonomy and capability to independently run, maintain and improve their equipment and work processes. This is a direct contrast to a traditional manufacturing environment, in which shop floor workers are simply operators of machinery, executing numerous repetitive tasks and relying on others to resolve issues such as equipment breakdowns or malfunctions. This is typically someone who doesn't even operate the machine, such as those from an engineering or maintenance team.

As the Supply Chain Research Alliance team found, operator ownership of machines and lines changes the game. The team closely studied production lines in the two companies' plants before and after the rollout of IWS, and the results are eye-opening.

### Before IWS: Unplanned downtime significantly erodes output

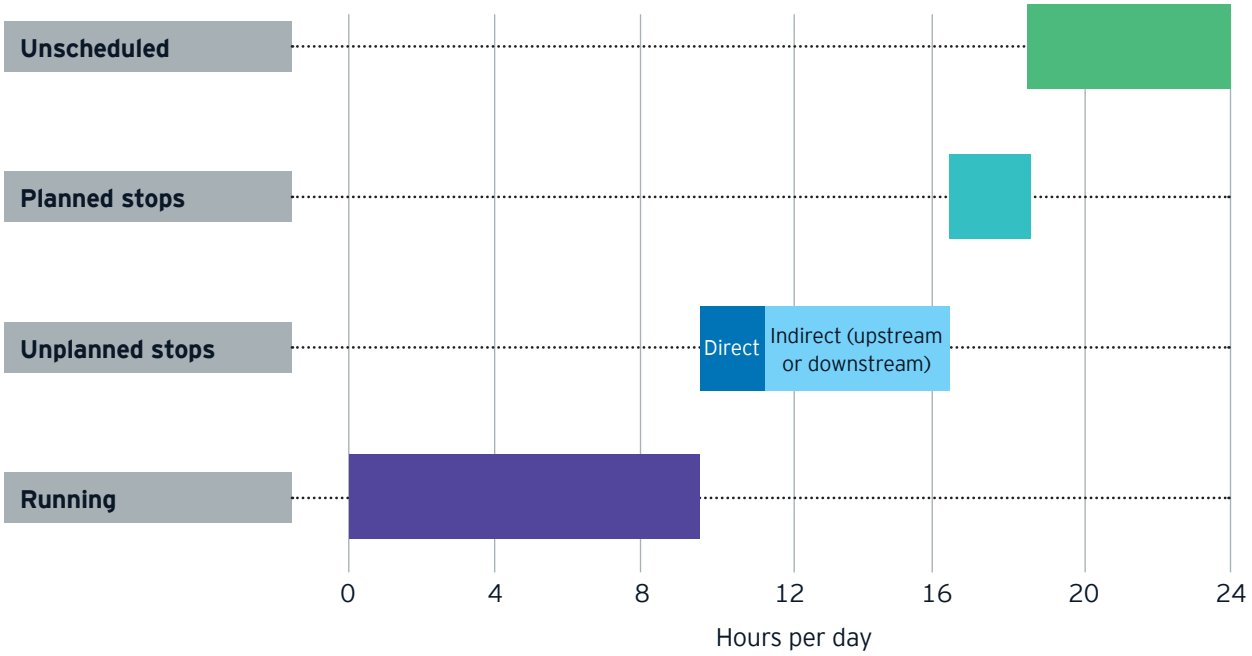
**Before IWS:**

- Production workers were responsible simply for operating machines during their shift and reporting breakdowns as they happened.
- A separate maintenance team handled repairs associated with breakdowns and cleaned all the lines (albeit infrequently).
- Proactive maintenance was infrequent, and machine records that tracked the reasons for stops were not systematically analyzed.

As a result, machine performance suffered. For example, the research found that on a typical day, a machine lost seven hours to unplanned downtime, seriously eroding its output. As shown in Figure 1, the machine was running for just under 10 hours a day despite being scheduled to run for more than 18 hours, with unplanned stops (either its own or related to other machines) consuming about six of those lost hours.

**Figure 1: On a typical day, seven hours were lost to unplanned downtime**

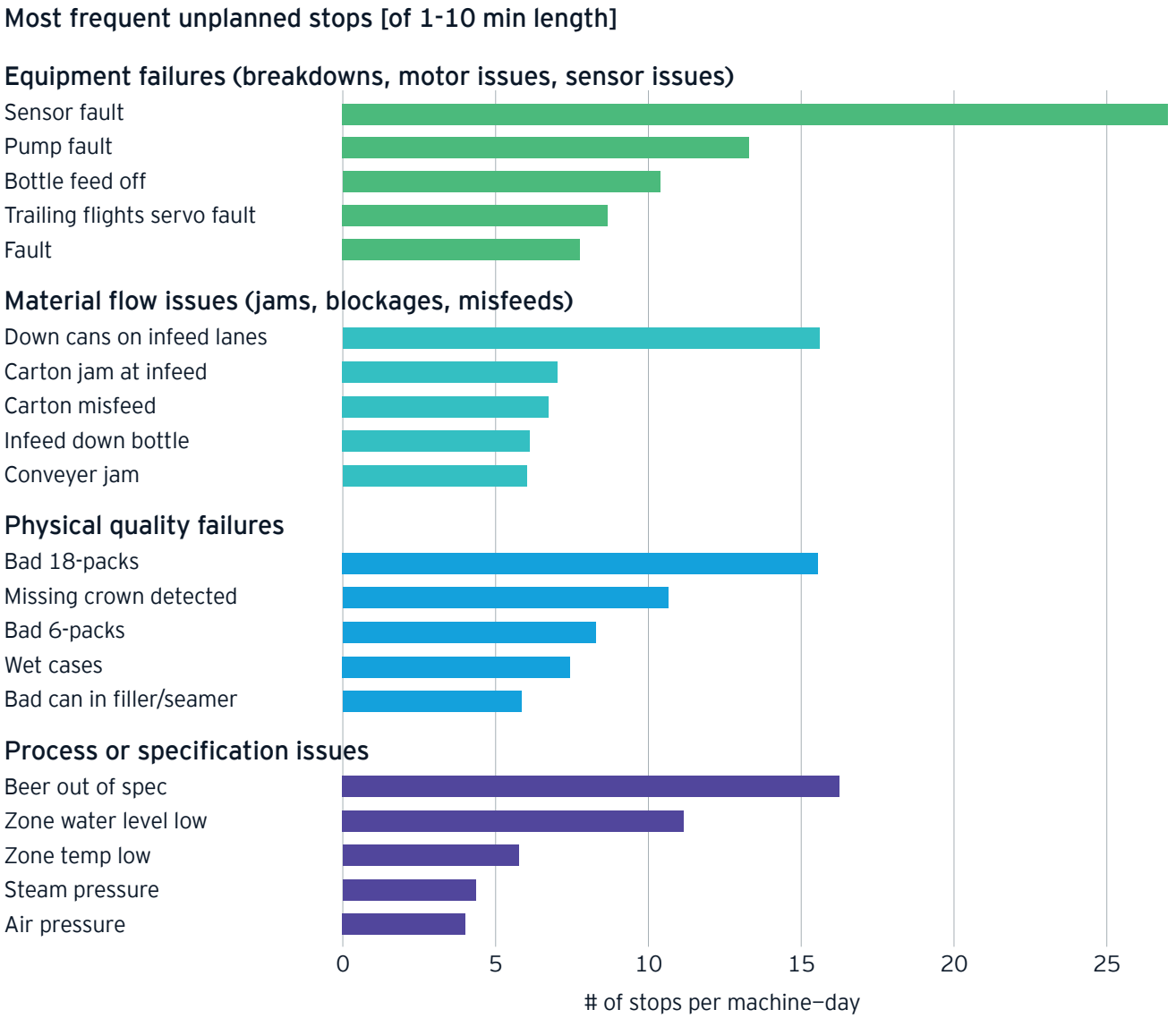
Machine status in average 24-hour period




Notes: The data come from pre-IWS machine-level stop records of the largest firm in the sample. Stops are aggregated to the shift level, averaged over all shifts, and rescaled to a representative 24-hour period. Upstream stops are recorded as "starved" by machines, and downstream stops are recorded as "blocked." Workers do not initiate unplanned stops within a machine. Planned stops (both maintenance and changeovers) are initiated by workers. Unscheduled stops are holidays, weekends and shifts with no demand.

The research also discovered that most unplanned stops originating at a particular machine were only a few seconds long and the most repetitive stops were due to a jam, blockage or misfeed (Figure 2). These stops don't require maintenance's attention but were highly disruptive and a significant drag on machine productivity. Happening so frequently, stops consumed much of an operator's attention, to the point at which they couldn't even step away from the machine, much less take the time to try to understand what could be done to prevent the stops, because they were continually fighting fires.

**Figure 2: Top reasons for short unplanned stops**




Notes: The data come from machine-level stop records of the largest firm in the sample. The research team uses a large language model (LLM) to classify all unplanned stop reasons into groups (equipment failure, material flow issue, physical quality issue, or process/specification issue). The team then ranks all stop reasons by their frequency (i.e., the number of times that a stop reason appears on a given day) and retain the top five most frequent stops within each group.

## After IWS, operator ownership takes root in 16 weeks

IWS was rolled out into this environment via a 16-week effort called Run-to-Target (RTT). This primarily involves eliminating losses by improving and consistently applying operational and technical standards; building capability, from operating teams to top leadership; and creating a culture and workplace where continuous improvement and a relentless pursuit of zero losses are the driving forces.

After IWS was introduced, operators had new duties:

- Not just running the machine, but carefully and consistently logging stops and reasons for them
- Identifying how to prevent those stops from happening again
- Proactively and regularly lubricating, cleaning and inspecting machines to keep them running as smoothly as possible

According to the research, three key elements marked this shift: organizational changes, data collection and review by production workers, and new practices focused on proactive maintenance and innovation.

1. **Organizational change:** Within a shift, each production worker assumed ownership of one machine, with a line leadership triad appointed from existing workers: a line lead (production worker), a maintenance lead (production worker) and a process engineer (skilled engineer). The line lead runs a 30-minute daily direction-setting meeting to plan changeovers, gather input and collectively decide the shift plan for the day.
2. **Data collection and review by production workers:** All the potential reasons for machine stops received a worker code, which workers could access on a tablet to record why a stop happened. The full team regularly reviews these reasons, captured in a loss tree (Figure 3) and identifies short and frequent stops.

**Figure 3: Sample loss tree with operator comments**

| Category | Stops/Wk | DT Min/Wk | % PR Loss | MTBF | MTTR | Comments |
|---|---|---|---|---|---|---|
| UPDT | 93 | 459 | 6.70% | 45.79 | 4.9 | |
| Downtime | | | | | | |
| Micro Stoppage | 27.6 | 26.0 | 0.4% | 154.0 | 0.9 | |
| Tube Jam | 6.2 | 25.7 | 0.4% | 685.3 | 4.1 | |
| Scales | 6.0 | 47.5 | 0.7% | 708.2 | 7.9 | Weigh heads/ Blown fuses on cone |
| Case erector | 5.2 | 13.1 | 0.2% | 817.1 | 2.5 | |
| Raw Material (ex pH) | 4.2 | 9.3 | 0.1% | 1,011.7 | 2.2 | |
| Idle | 4.0 | 22.7 | 0.3% | 1,062.3 | 5.7 | |
| Powder Dispenser | 4.0 | 16.9 | 0.2% | 1,062.3 | 4.2 | |
| Foreign Material | 4.0 | 44.7 | 0.7% | 1,062.3 | 11.2 | Blue Plastic/ Drains backedup |
| Waiting for [REDACTED MATERIAL] - Prep Room | 3.6 | 13.3 | 0.2% | 1,180.3 | 3.7 | |
| Knife Issues | 2.8 | 29.5 | 0.4% | 1,517.5 | 10.5 | |
| Waiting for [REDACTED MATERIAL] - 640 cutter | 2.4 | 15.6 | 0.2% | 1,770.4 | 6.5 | |
| Waiting for [REDACTED MATERIAL] - warehouse | 2.2 | 18.4 | 0.3% | 1,931.4 | 8.4 | |
| Weights | 1.6 | 5.4 | 0.1% | 2,655.6 | 3.3 | |
| Markem | 1.6 | 41.6 | 0.6% | 2,655.6 | 26.0 | Server Issue |
| Labour | 1.6 | 3.1 | 0.0% | 2,655.6 | 1.9 | |
| Clean up Inter-batch | 1.4 | 12.8 | 0.2% | 3,035.0 | 9.1 | |
| Dirty Dies | 1.4 | 7.9 | 0.1% | 3,035.0 | 5.6 | |
| Shredder | 1.4 | 2.9 | 0.0% | 3,035.0 | 2.1 | |
| Bagger | 1.2 | 23.4 | 0.3% | 3,540.9 | 19.5 | |
| Dicer Jam | 1.2 | 9.8 | 0.1% | 3,540.9 | 8.2 | |
| Defective Packaging (Box/Film) | 1.2 | 1.8 | 0.0% | 3,540.9 | 1.5 | |
| Grids/Broken Wire | 1.2 | 4.9 | 0.1% | 3,540.9 | 4.1 | |
| Taper | 1.2 | 1.8 | 0.0% | 3,540.9 | 1.5 | |
| Leaker - | 0.8 | 6.5 | 0.1% | 5,311.3 | 8.2 | |
| Miscellaneous | 0.8 | 6.4 | 0.1% | 5,311.3 | 7.9 | |
| Bizerba | 0.6 | 1.5 | 0.0% | 7,081.7 | 2.6 | |
| [REDACTED MATERIAL] Allocations | 0.6 | 16.0 | 0.2% | 7,081.7 | 26.6 | |
| Upright Conveyor | 0.4 | 15.7 | 0.2% | 10,622.6 | 39.2 | |
| Ishida | 0.4 | 0.8 | 0.0% | 10,622.6 | 2.1 | |
| Cutter | 0.4 | 2.3 | 0.0% | 10,622.6 | 5.9 | |
| Misaligned | 0.4 | 0.9 | 0.0% | 10,622.6 | 2.2 | |
| [REDACTED MATERIAL] in the seal | 0.4 | 1.1 | 0.0% | 10,622.6 | 2.8 | |
| Zipper/Film Issues | 0.4 | 4.6 | 0.1% | 10,622.6 | 11.4 | |
| Material Shortage ([REDACTED MATERIAL]) | 0.2 | 3.2 | 0.0% | 21,245.2 | 16.0 | |
| Inconsistent Die Heat | 0.2 | 2.3 | 0.0% | 21,245.2 | 11.4 | |

Notes: Screenshot of a loss tree constructed by machine operators for a weekly direction-setting meeting. The first column shows the reasons for unplanned downtime. The second and third columns give the number and duration of stops for each reason. The fourth column (PR Loss) represents a version of percentage unplanned downtime that is incorporated into process reliability (OEE) calculations. MTBF = mean time between failures (# of stops or running time). MTTR = mean time to recover, or average stop length (in minutes).

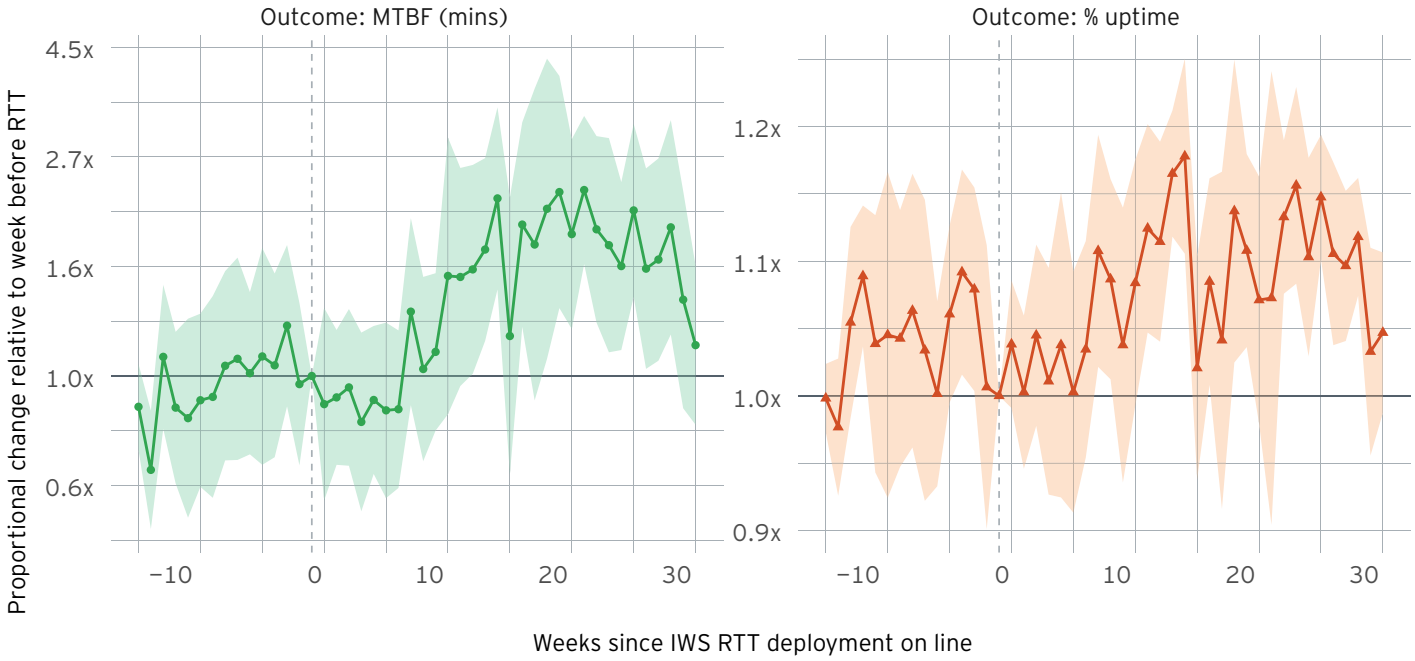
3 **New practices focused on proactive maintenance and innovation:** Operating teams were assigned responsibility for cleaning, inspecting and lubricating (CIL) machines regularly, as well as standardizing the machine's settings (i.e., "centerlining"). They were also put in charge of defect handling — identifying current defective parts —and using recent stops data to pinpoint parts that may fail in the future. Together, the team developed a procedure for defining and solving deeper issues that could lead to future stops and losses.

## The uptime and productivity benefits and multi-million-dollar impact

The impact of the change was a dramatic reduction in downtime and improvement in productivity across both companies studied.

Following the rollout of IWS, the research team documented a rapid decrease in machine downtime, largely due to a significant reduction in unplanned stops. This was achieved through an increase in the mean time between failures (MTBF) and an improvement in percentage uptime (100% minus percentage unplanned downtime) after removing untargeted stop reasons. Figure 4 illustrates this substantial improvement in productivity for one of the companies studied.

**Figure 4: IWS rapidly and significantly increases time between stops and overall machine uptime**

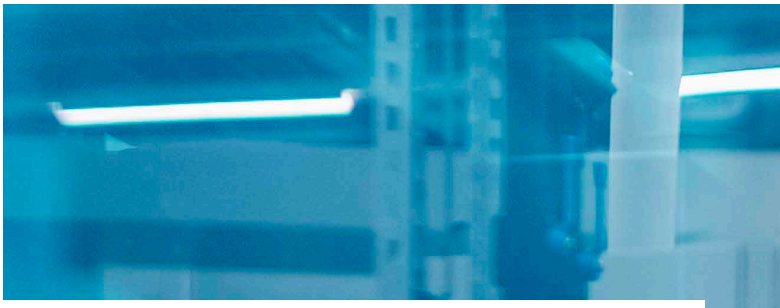



Notes: Plots show proportional changes (technically log changes) in machine-level MTBF (left panel) and percentage uptime (right panel) relative to the week before RTT rollout, along with shaded 90% confidence intervals. Each week is a separate estimate. A proportional change of 1.0x means no effect. Effects come from difference-in-difference event-study regressions around the RTT deployment date, with trends in stops for all other machines *within the same plant*, over the same period, serving as controls. Raw data comes from machine-level stops in the largest plant, aggregated to the machine, week and shift level.

After accounting for spillover benefits (fewer starved and blocked machines elsewhere on the line), this, in turn, translated into a 25% increase in overall equipment effectiveness (OEE), which the research tied directly to $240 million to $480 million more revenue generated from the same machines and lines, all things being equal. This figure is based on the increase (approximately 24 million gallons from a baseline of 96 million gallons of product) in the number of units produced because of greater OEE, multiplied by the per-unit industry benchmark price.

The biggest driver of this improvement was a 50% reduction in unplanned machine downtime, primarily resulting from the frequent stops of less than 10 minutes that are extremely disruptive to the productivity of not only the machine in question but also other machines that sit upstream and downstream along the production line.

A significant factor behind this is the fact that the new tablets and reason codes enabled workers to more precisely and consistently track these short stops and the reasons they were occurring — the critical first step in minimizing or eliminating them. Importantly, by dramatically reducing these stops, operators also have more time to proactively maintain the machines while they're running and think about ways to improve the process to prevent stops in the future.



## Conclusion

The research thus far clearly reveals that making workers responsible for one machine, its associated data and its maintenance tasks — in this case, via P&G's IWS — has a measurable, significant and positive impact on operational and financial performance. In the study, two separate global food and beverage manufacturers implemented IWS across their machines and plants and both companies experienced a significant increase in their machines' productivity as well as a corresponding boost in potential revenue. This doesn't include the improvement in the return they're getting on those capital investments, which, perhaps, could enable them to delay future such investments.

That's not the end of the research. The Supply Chain Research Alliance team is continuing to add companies from other industries to its study and gathering additional data on IWS's impact. In terms of the latter, the team is using HR data to determine which types of workers stay, which types leave and which types thrive in "machine manager" roles. Anecdotal evidence gathered thus far indicates the response from workers has been very positive. They're enthusiastic about being empowered to switch from a reactive role to a proactive one where they can be much more engaged in the factory's production and overall performance.

The research team also is looking at how IWS could impact absenteeism — i.e., if employees are more enthusiastic about their work and satisfied with their jobs, will they be less likely to call off? Combined with the preceding, this could suggest IWS can help retain and unlock greater value from existing workers in a very tight labor market where required skills and people are in short supply.

Finally, the team also is investigating the impact of IWS on innovation itself by reviewing the logs of improvements workers have made to various processes on the production line, which are extensively documented in one of the two companies involved in the study. This effort could help identify how IWS helps companies not only incrementally improve what they're already doing but also uncover new ways of working that could exponentially boost performance and impact.

The results of the research clearly show that for manufacturers of all kinds, IWS could deliver significant benefits, as illustrated by the experience of the companies studied.

Scan the QR code to learn more about how other companies can deploy IWS to achieve operational excellence through the EY-P&G Alliance.

We'll have more insights to come as the research team continues to expand and deepen its study and we encourage other companies to join. Those interested in participating to see firsthand how IWS can improve their operational and financial performance should contact morgan.malone@ey.com or craig.lyjak@ey.com.

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