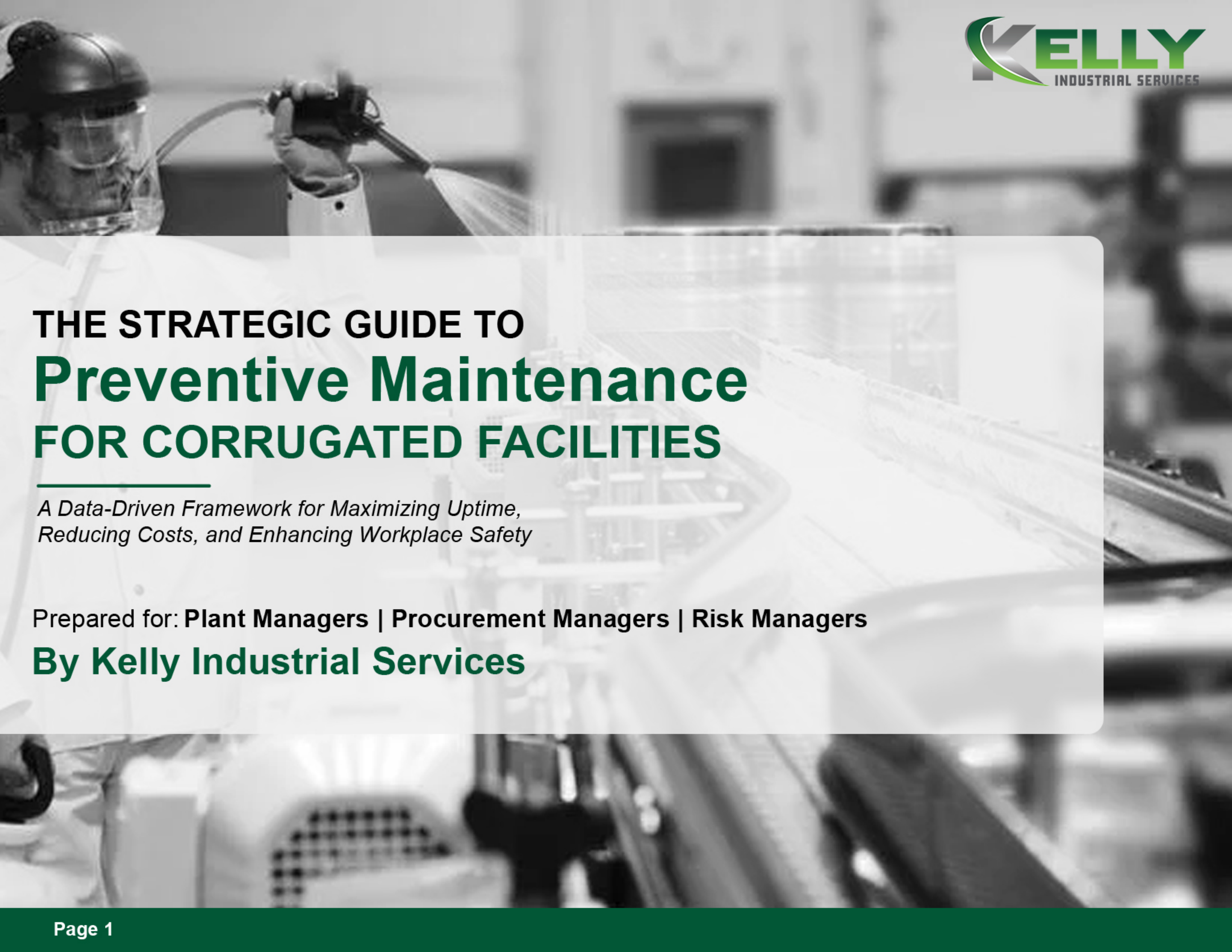


A background image showing a worker in full PPE (hard hat, safety glasses, and gloves) using a high-pressure spray gun on industrial equipment. The scene is in black and white, with a semi-transparent white box overlaid on the left side containing the title and other text.

THE STRATEGIC GUIDE TO **Preventive Maintenance** FOR CORRUGATED FACILITIES

*A Data-Driven Framework for Maximizing Uptime,
Reducing Costs, and Enhancing Workplace Safety*

Prepared for: **Plant Managers | Procurement Managers | Risk Managers**

By Kelly Industrial Services

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EXECUTIVE SUMMARY

The corrugated packaging industry operates in one of the most demanding manufacturing environments. With the global corrugated packaging market valued at \$233.8 billion in 2024 and projected to grow at 5% CAGR through 2034, facilities face unprecedented pressure to maximize output while controlling costs. This guide presents a comprehensive, data-driven framework for implementing preventive maintenance strategies that deliver measurable returns.

The business case for preventive maintenance has never been stronger. Research demonstrates that every dollar invested in preventive maintenance saves up to five dollars on unforeseen expenses. Organizations implementing comprehensive PM programs achieve 12%-18% cost savings over reactive maintenance approaches, while extending equipment lifespan by 20%-30%.

For plant managers seeking operational excellence, procurement managers optimizing total cost of ownership, and risk managers protecting against safety incidents and production losses, this guide provides the strategic framework and supporting evidence to transform maintenance from a cost center into a competitive advantage.

Key Statistics at a Glance

- **\$1.4 trillion in annual losses from unplanned downtime** among Fortune 500 companies (Siemens, 2024)
- **545% ROI over 20 years** from switching reactive to preventive maintenance (Jones Lang LaSalle)
- **120 fatalities and 50,000 injuries prevented annually** through proper lockout/tagout procedures (OSHA)
- **20%-30% extension in equipment lifespan** through proper preventive maintenance programs

SECTION 1: DOWNTIME COSTS

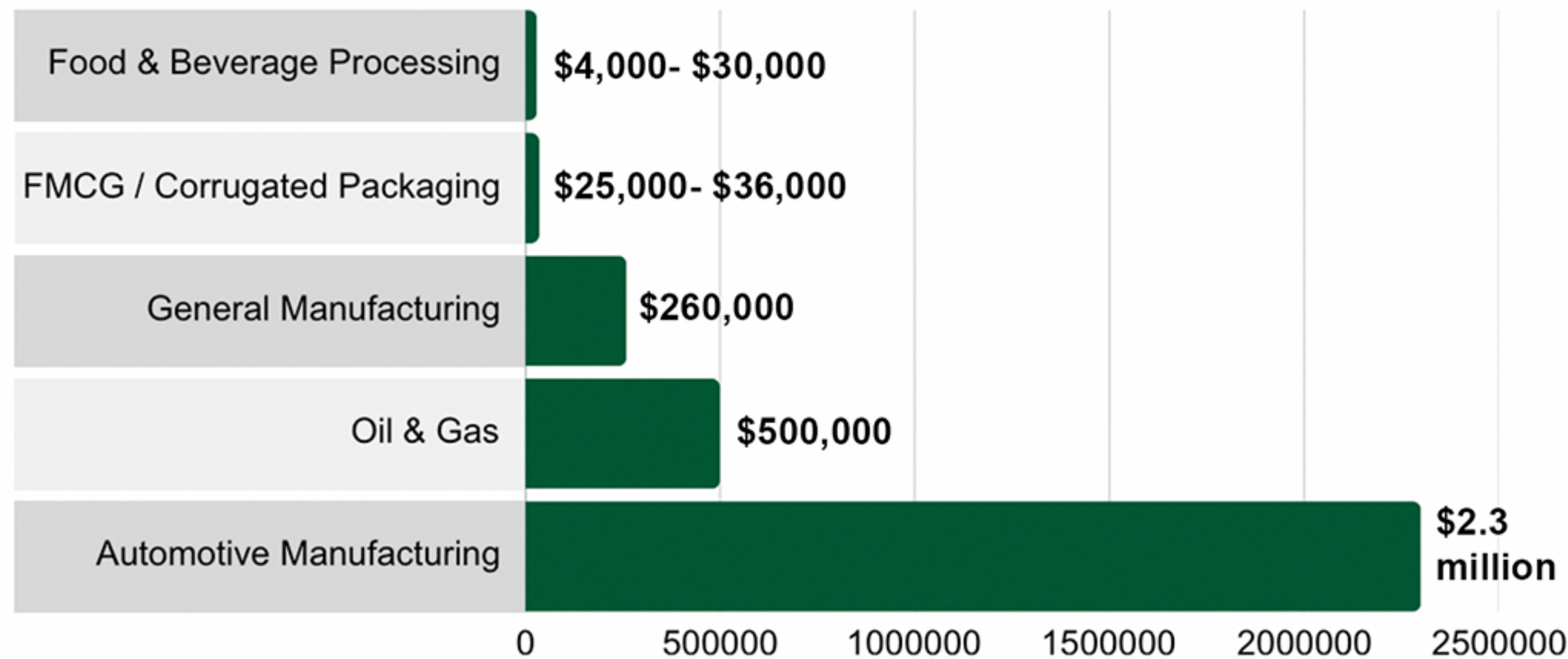
Understanding the Financial Impact

Unplanned downtime represents one of the most significant threats to manufacturing profitability.

Unscheduled downtime now costs the world's 500 biggest companies

\$1.4 trillion annually – *OR* – **11% of their yearly revenues**

Downtime Cost Comparison by Industry



Source: Siemens True Cost of Downtime Report, 2024; MaintainX Survey, 2024

The Hidden Multiplier Effect

When operations stop, the real damage starts— downtime triggers ripple effects that drive costs far beyond the initial disruption.

Reactive Maintenance

- **3-5x cost**
- Unplanned downtime
- Emergency Labor

Preventive Maintenance

- Controlled costs
- Planned shutdowns
- Extended equipment life

Recovery times have
increased by

32 minutes

due to skilled labor shortages
and supply chain complexities.

The average manufacturing
facility experiences

25

**downtime
incidents per month.**

SECTION 2: PROFIT IN PM

Quantified Cost Savings

The financial returns from preventive maintenance are substantial and well-documented.

12%-18%

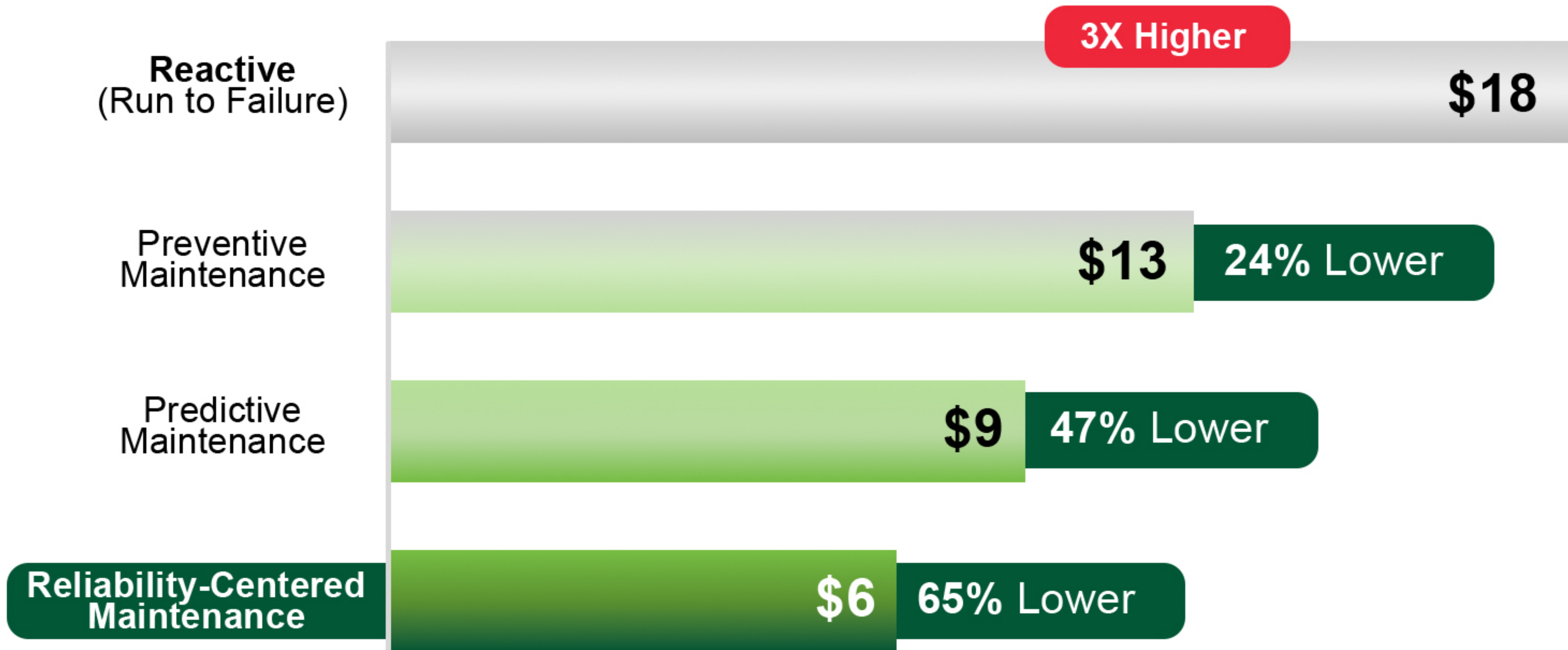
cost savings can be achieved through preventive maintenance programs compared to reactive maintenance approaches, according to the U.S. Department of Energy.

545%

long-term ROI was calculated over a 20-year period for preventive maintenance in a landmark Jones Lang LaSalle study.

This extraordinary return stems from the compound effect of reduced repair costs, extended equipment life, avoided emergency situations, and improved operational efficiency.

Maintenance Cost Comparison by Approach



Source: US Department of Energy, Federal Energy Management Program

Extended Equipment Life

Equipment maintained with comprehensive preventive programs routinely operates **20-30 years or more**, while poorly maintained equipment often fails within 5-10 years. For capital-intensive corrugated facilities, this lifespan extension translates directly to improved asset utilization and delayed capital expenditure requirements.

20%-30%
longer equipment
lifespan

20%-40%
increase in
machine life

30%-50%
reductions in
machine downtime

Energy Efficiency Gains

The U.S. Department of Energy reports that comprehensive operations and maintenance programs can save 5% to 20% on energy bills without significant capital investment. Preventive maintenance lowers energy consumption of machines by 10%-20% through optimized equipment performance, proper lubrication, and maintained efficiency standards.

Operations and maintenance energy savings measures cost approximately 20 times less and achieve roughly the same energy savings as retrofit measures. For energy-intensive corrugated operations running hot plates, preheaters, and continuous production lines, these efficiency gains represent substantial operational savings.

SECTION 3: SAFETY IMPERATIVES

The Human Cost of Inadequate Maintenance

Workplace safety and preventive maintenance are inextricably linked.

5,283

workers suffered fatal work injuries in 2023.

Up to
30%

of all manufacturing deaths are related to maintenance activities.

2.5
million

non-fatal workplace injuries and illnesses were recorded by private industry employers in 2024.

Lockout/Tagout: A Critical Control Point



Control of Hazardous Energy (lockout/tagout) ranked as the **third** most cited OSHA standard in fiscal year 2024, with 2,655 violations recorded.



58.8%

of fatal hazardous energy incidents involved cases where lockout procedures were not even attempted.

24

workdays of lost time are required on average for workers injured in hazardous energy incidents.



Every year, OSHA estimates that proper lockout/tagout procedures prevent approx.

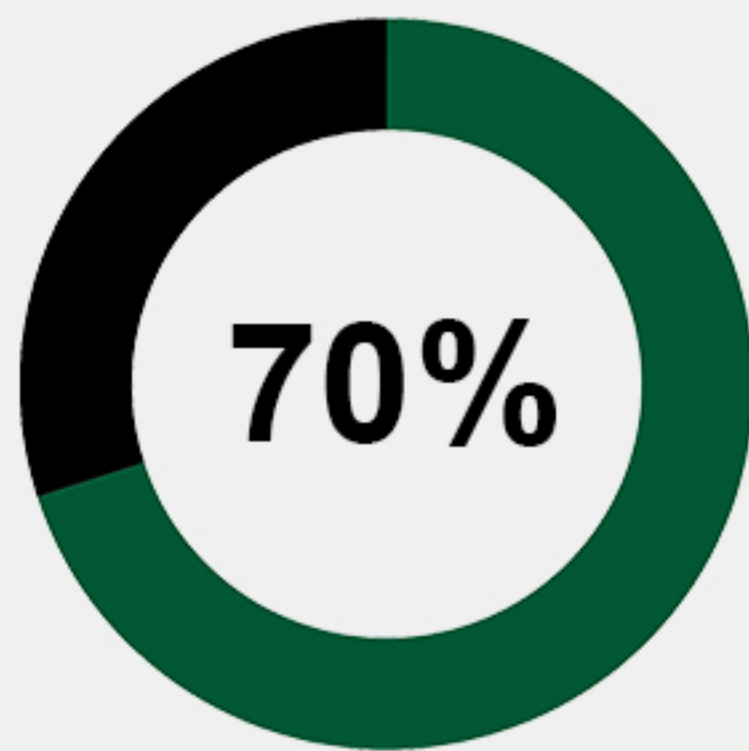
120 **&** **50k**
FATALITIES INJURIES

Combustible Dust Hazards

Corrugated facilities face specific risks from combustible dust accumulation. The U.S. Chemical Safety and Hazard Investigation Board identified 281 combustible dust incidents between 1980 and 2005, leading to 119 deaths, 718 injuries, and extensive facility damage. Paper, pulp, and wood dust are specifically identified as explosion hazards requiring vigilant housekeeping and dust control measures.

OSHA conducted 2,553 combustible dust inspections between 2013 and 2017, identifying 3,389 violations. Proper facility-wide cleaning, particularly of rafters, overhead structures, and equipment surfaces, is essential for eliminating dust accumulation that could trigger devastating secondary explosions.

Safety Impact of Preventive Maintenance



of maintenance technicians believe preventative maintenance improves safety.



14%

reduction in safety, health, and environmental risks through predictive maintenance (PwC).



25%

fewer safety incidents reported by companies practicing preventive maintenance.

SECTION 4: CORRUGATED OPS

Industry Context and Growth

5% CAGR

through 2034

building on the corrugated packaging market valued at **\$233.8 billion** in 2024.

\$49.97 Billion

North American Market by 2031

driven by accelerating e-commerce, plastic replacement initiatives, and sustained food and beverage reliance.

With more than **1,000** corrugated manufacturing units operating in the U.S. and **over 50%** of corrugated boxes made from recycled content, the industry faces constant pressure to maximize production efficiency while meeting increasingly stringent quality and sustainability standards.

Unique Maintenance Challenges

Corrugated production presents distinct maintenance challenges that demand specialized attention. Machines run hot, fast, and continuously. Adhesive mist, starch, dust, and fibers accumulate rapidly on equipment surfaces. Heat cycles and vibration accelerate wear on critical components. Even minor buildup on hot plates, preheaters, and rollers can degrade product quality and reduce line speeds.

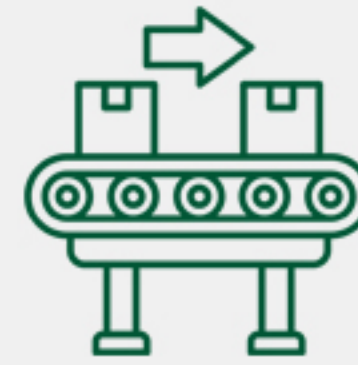
Glue systems are particularly notorious sources of downtime. Starch systems that are not properly cleaned and maintained cause cascading problems throughout the production line, leading to clogging, streaking, misfeeds, and inconsistent product quality.

Critical Equipment Areas Requiring PM Focus



Hot Plates and Preheaters

Heat transfer efficiency directly impacts production quality.



Stackers and Conveyors

Product handling affects throughput and quality.



Glue Machines and Applicators

Adhesive consistency determines bond strength.



Control Boxes and Drive Systems

Electrical reliability underpins all operations.



Rollers and Bearings

Alignment and lubrication affect line speed stability.



Steam Systems

Proper trap maintenance and steam quality impact adhesive performance.



Slitter-Scorers

Precision cutting requires clean, properly maintained blades.

CHAPTER 5: BUILD A PM PROGRAM

The Five Pillars of Effective PM

High-performing corrugated facilities share common traits in their maintenance programs. Rather than relying on guesswork, heroic last-minute repairs, or accepting that "good enough for today" is acceptable, they focus on proactive care across five critical areas.



1 Equipment Cleaning

Equipment cleaning is the foundation of corrugated preventive maintenance. Machines that accumulate starch, adhesives, dust, and fibers quickly lose efficiency, build heat, and develop alignment problems. Industrial-grade cleaning that removes adhesive mist, starch, carbon, and hardened buildup restores equipment performance and makes all other PM tasks more effective.



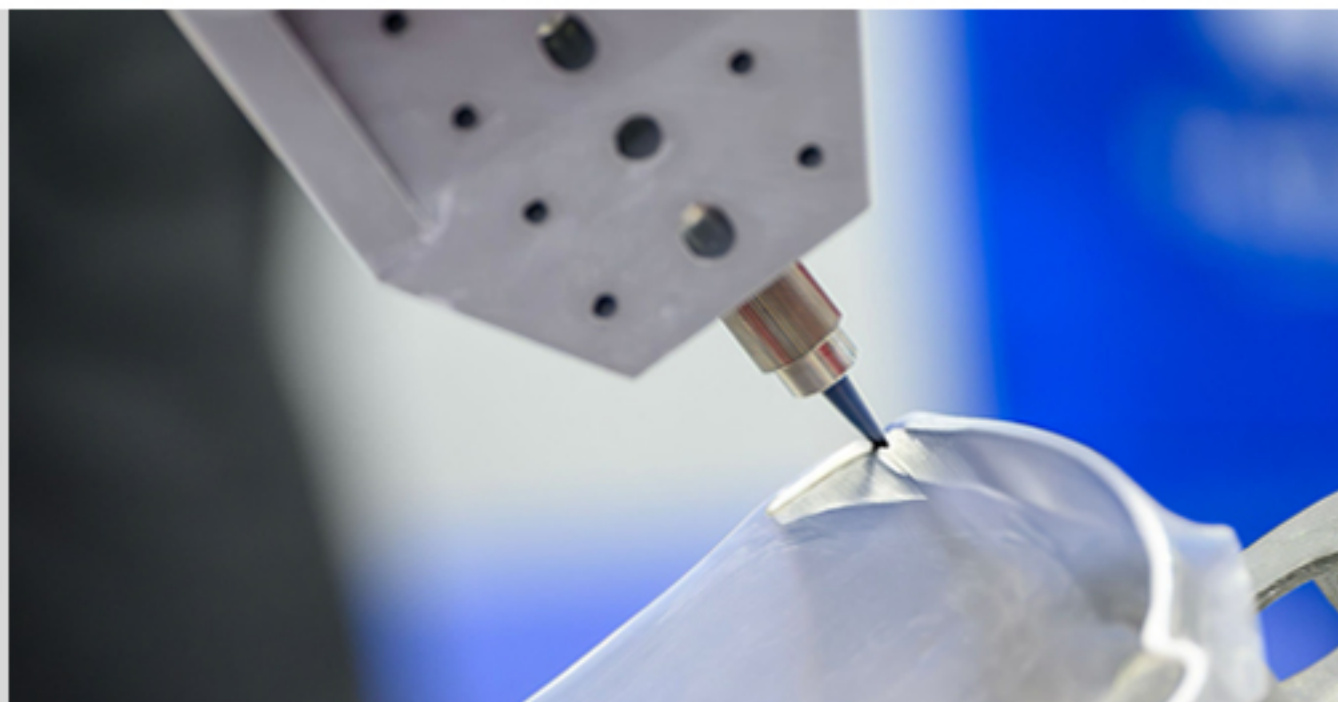
2 Predictive and Visual Inspections

Clean equipment transforms visual inspections from guesswork into genuine diagnostic tools. Effective inspection programs encompass glue pattern monitoring, roller condition checks, alignment and tension reviews, leak detection vibration analysis, temperature monitoring, and air-flow pathway assessments. When equipment is properly cleaned, small issues become visible long before they evolve into breakdowns.



3 Mechanical Maintenance and Lubrication

Heat, friction, and vibration are constant forces in corrugated environments. Poor lubrication causes more equipment failures than any other single factor. Comprehensive lubrication management programs that include proper lubricant selection, contamination control, and regular analysis are essential. Regular oil analysis can detect wear particles, contamination, and lubricant degradation before they cause damage.



4 Adhesive and Starch System Care

Glue systems are notorious sources of downtime in corrugated operations. Strong PM practices include cleaning glue pans and rollers, ensuring proper moisture and temperature balance, removing cured adhesive buildup, conducting steam system checks, managing starch consistency, and clearing applicators. A clean, predictable adhesive system keeps product quality consistent and reduces clogging, streaking, and misfeeds.



5 Facility-Wide Cleaning

Dust, fibers, and airborne debris settle everywhere and eventually fall into product, controls, or mechanical components. Critical facility cleaning includes rafter and overhead dust removal, wall and structural cleaning, pit and airflow system cleaning, glue room maintenance, and attention to mezzanines, platforms, and catwalks. This reduces fire hazards, contamination risks, and unexpected shutdowns, especially during audits and inspections.

CHAPTER 6: A PM RHYTHM

High-performing corrugated plants follow established maintenance rhythms that balance operational demands with equipment care requirements.

The following framework provides a structured approach to preventive maintenance scheduling.

Daily	Weekly	Monthly	Quarterly	Annually
Equipment wipe downs ✓	Lubrication ✓	Targeted equipment cleaning ✓	Deep cleaning ✓	Shutdown cleaning ✓
Adhesive and moisture checks ✓	Tension and alignment checks ✓	Facility walkthroughs ✓	Full-line inspection ✓	Roof and structural review ✓
Roller observation ✓	Cleaning of key touchpoints ✓	Pit checks ✓	Glue system cleaning ✓	Component inspection ✓
Visual inspections ✓	Contamination monitoring ✓	Air system reviews ✓	Structural debris removal ✓	Facility-wide restoration ✓
Operator safety checks ✓	Belt inspections ✓	Motor temperature monitoring ✓	Vibration analysis ✓	OEM-level assessments ✓

Addressing Common PM Program Failures

Most corrugated plants do not struggle because they lack knowledge. They struggle because they lack manpower, time, specialized cleaning equipment, shutdown support, consistent scheduling, proper surface preparation, and defined standards.



20%-30%

of organizations follow a comprehensive preventive maintenance schedule, indicating significant room for improvement across the industry.

The Biggest Gaps Include:

- PM tasks skipped during peak production due to production pressures
- Build-up hiding early warning signs that would be visible on clean equipment
- Incomplete shutdowns leaving tasks unfinished when shutdown windows are short
- Insufficient labor for deep cleaning as internal teams focus on repairs
- Adhesive and starch problems compounding over time without intervention
- Knowledge concentrated in a few senior techs, with turnover erasing tribal knowledge

CHAPTER 7: IMPLEMENTATION

Building the Business Case

Presenting a compelling business case for preventive maintenance investment requires quantifying both current losses and projected savings. Begin by documenting existing costs including unplanned downtime incidents, emergency repair expenses, overtime labor, expedited parts procurement, scrap and rework rates, and energy consumption patterns.

Apply Industry Benchmarks to Project Savings

12%-18% reduction in overall maintenance costs.

20%-30% extension in equipment life.

30%-50% reduction in unplanned downtime

25% reduction in safety incidents

For a mid-sized corrugated facility, these improvements can translate to hundreds of thousands of dollars in annual savings.

Technology Integration

Computerized Maintenance Management Systems (CMMS) enable work order management, spare parts inventory optimization, asset tracking, and integration with predictive maintenance approaches.

Organizations embracing these technologies achieve additional 8%-12% savings over preventive maintenance alone, with some achieving ROI ratios of 10:1 to 30:1 within 12-18 months of implementation.

35%

improvement in preventive maintenance scheduling is achieved with CMMS.

52%

of manufacturing organizations now utilize a CMMS to streamline and document maintenance activities.

26.5%

annual growth is projected to push the predictive maintenance market to \$70.73 billion by 2032.

Leveraging External Expertise

Resource allocation requires balancing what internal teams can handle versus when outside expertise is needed. Training internal staff for everyday maintenance while bringing in specialists for advanced techniques requiring specialized equipment or extensive training optimizes both capability and cost-effectiveness.

Industrial cleaning specialists provide deep equipment cleaning, shutdown and outage support, and facility-wide maintenance that internal teams rarely have time to complete. These services directly fill gaps in manpower, specialized cleaning equipment, and expertise while allowing internal maintenance teams to focus on their core competencies.

CONCLUSION: THE COMPETITIVE ADVANTAGE OF PM EXCELLENCE

Corrugated facilities that prioritize preventive maintenance consistently outperform those that do not. They experience more uptime, fewer emergency incidents, stronger productivity, safer working conditions, and lower total cost of ownership. In an industry where margins are tight and customer expectations continue to rise, operational excellence through effective maintenance is no longer optional.

The evidence is clear: every dollar invested in preventive maintenance returns five dollars in avoided costs. Organizations implementing comprehensive PM programs achieve 545% ROI over the long term while extending equipment life by decades rather than years. Worker safety improves, regulatory compliance strengthens, and production quality becomes more consistent.

Preventive maintenance is not a solo effort. It requires commitment across the organization, from leadership buy-in to frontline execution. It benefits from external partnerships that bring specialized expertise, equipment, and capacity to complement internal capabilities. And it demands consistent discipline in following established rhythms rather than allowing production pressures to defer essential care.

For plant managers, procurement managers, and risk managers seeking to optimize their operations, the path forward is clear. Invest in preventive maintenance. Partner with specialists who understand corrugated production environments. Build systems and schedules that institutionalize best practices. The returns will compound year after year in reduced costs, extended equipment life, improved safety, and enhanced competitive position.

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ABOUT KELLY INDUSTRIAL SERVICES

Kelly Industrial Services supports corrugated facilities nationwide with specialized maintenance services designed for the unique demands of corrugated production environments.

Our Services Include:

- Industrial equipment cleaning for hot plates, preheaters, rollers, and frames
- Glue and starch system cleaning and restoration
- Shutdown and outage support with trained, in-house technicians
- Facility-wide specialty cleaning including rafters, structural steel, and pits
- Fast mobilization and reliable performance for scheduled and emergency support

Our teams are fully staffed, fully trained, and never subcontracted. We specialize in the work internal maintenance crews rarely have time to complete, ensuring your entire facility maintains the high operational standards that drive competitive performance.

Ready to Transform Your Maintenance Program?

Contact Kelly Industrial Services to discuss how we can support your facility's preventive maintenance goals.