

## Evolved Supply Chain Outlook for Predictive Maintenance in the Cold Storage Supply Chain

We lay out a roadmap for IIoT and other Industry 4.0 technology adoption within an evolving supply chain.

### Pre-2021: Phase 1: Consolidation of Parts Distribution System—Efficiencies of Channel Compression

Manufacturers continue to develop company parts stores by buying independent distributors as they had been abandoned 20 years ago.

This is met by an opportunity for consolidation into OEM-agnostic parts and maintenance services as well.

There will be no going back this time because e-commerce structures are so efficient.

Boutique 3PL Services will evolve into SaaS offerings.

### 2022-??: Phase 2: Consolidation of Parts Distribution System—Expansion of Near-Time Decision Making

As Parts Distribution System consolidates and more sensors are added to assets, opportunities for smaller decision windows abound.

This is primarily due to larger economies of scale to deliver have higher and more precise significance of information. This is value leverage.

Due to the Cloud orientation, the bar is lowered for leveraging predictive analytics like failure forecasting and prevention.

Services for small and medium businesses as well as large ones will emerge and build a more robust ecosystem.

### 2023-??: Phase 3: Radical Cost Reduction of Failure Events—Multi-Part Failure Avoidance

The financial cost of forklift failure and maintenance events is heavily weighted towards labor time versus parts. Reduction of Failure saves lives and limbs and mitigates disability durations.

Our research shows that each event typically involves an estimated average of 3.3 mechanic hours plus 1 driver hour per event and \$48 in parts. One avoided event is worth \$800 Million annually for the forklift maintenance industry.

As the historical operational databases grow, just-in-time repair of forklifts services will emerge. Our research shows that we can today predict additional failures of specific parts within the next week after a single part failure event experience.

Thus, repairing those soon-to-fail parts will avoid the disruption of their failure on materials/goods/produce movement, as well as, more visits to the shop. Weekly and daily scheduling of repair activity will be greatly enhanced. Labor becomes much, much more healthy and productive!!

#### 2023: Phase 4: Consolidation of Parts Distribution System— Emergence of Real-Time Command and Control

By this time, the IoT adoption has risen out of the Valley of Disillusionment and crossed The Chasm of Adoption towards rapidly increasing use.

Tracking asset movements is now a reality. Air Traffic Control-like control centers will have multiple dashboards on all aspects of movement. Two-way communication from control center to asset is a reality.

Self-driving forklifts augment automated conveyor systems for the last 100 meters of materials/goods/produce movement.

#### 2024-??: Phase 5: Radical Cost Reduction of Failure Events— Optimization of Real-Time Workload Management

The Future of Movement Optimization can now be realized.

Intelligent surrogate agents, Digital Twins interact with control processes rendering the reality of Real-Time Command and Control of Logistics at an end-to-end macro level all the way down to the micro (roadways) and nano (warehouse floors) levels in the Supply Chain.