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Case study

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CS13

AI and IoT Smart Operations Platform

Connecting the physical business to Google Cloud so AI can see what is actually happening

Sector: small manufacturing, warehousing, cold storage, restaurants, retail chains, commercial buildings, logistics and agriculture

Geography: United States. Company size: 20 to 200 employees.

Figures are measured outcomes from delivered work. The client is described by sector and geography at the client's request.

THE BUSINESS PROBLEM

The situation before we started

The client had already been sold IoT monitoring once, and had a dashboard nobody opened. The sensors produced numbers, but numbers are not understanding. The gap was between telemetry and a decision, and that gap is what we were asked to close.

01

Dashboards report, they do not act

A threshold turns red and the alert goes to an email nobody is reading at 2am.

02

Maintenance runs on the calendar

Equipment is serviced on a fixed interval, which means it is serviced too early, too late, or both across the same fleet.

03

Quality inspection depends on attention

A human inspecting the thousandth unit of a shift is not the same inspector who checked the first.

04

Energy cost is a single monthly number

Nobody can say which machine consumed it, or whether that consumption was normal for the work done.

05

Cold chain failures are found late

By the time a freezer alarm is escalated by hand, the product loss has already happened.

06

Nothing joins the physical to the commercial

Production dropped, and no system connects that to the machine, the order, the inventory or the customer.

WHAT WE CHANGED

The issue, what we implemented, and what it moved

What was wrong	What we implemented	What it delivered
Threshold alerts fired into an inbox nobody read at 2am	Work order agent turning a detection into a ticket, a parts check and a slot	**Detection now reaches a technician without a person in between**
Maintenance ran on a fixed interval across the whole fleet	Vertex AI learning a normal operating envelope per asset from Pub/Sub telemetry	**20 to 40% less unplanned downtime**
Inspection quality drifted across a shift	Vision AI inspection running continuously on the line	**2 to 5 times inspection throughput**
Energy was one number on a monthly bill	Machine level metering into BigQuery, correlated with production and maintenance	**5 to 15% lower energy consumption**
Cold chain breaches were escalated by hand, too late	Facility telemetry through Pub/Sub with second level escalation	**20 to 40% fewer refrigeration incidents**
Nothing connected the machine to the order it delayed	Digital twin in BigQuery joining telemetry, production, orders and inventory	**Root cause analysis from days to minutes**

Middle column names the Google Cloud service that did the work. Right column is measured against the baseline captured in phase one.

SOLUTION OVERVIEW

What we built, and where we drew the line

We moved telemetry into Google Cloud, learned what normal looked like for each asset, and put agents on top so a deviation becomes a work order rather than an alert. The owner asks why production dropped and the platform traces it back through the machine, the shift and the order.

WHAT THE SYSTEM DOES

- Learns a normal operating envelope per asset instead of using a fixed threshold
- Predicts failure probability with a time window and a confidence level
- Inspects visually and continuously, at a consistency a human shift cannot hold
- Correlates energy, production, maintenance and environment into one explanation
- Turns a detection into a ticket, a technician, a part check and a schedule slot

WHAT THE SYSTEM NEVER DOES

- Controls machinery directly or writes to a safety instrumented system
- Overrides an alarm, an interlock or a lockout
- Makes the final quality accept or reject call where a regulator requires a human
- Uses safety camera analytics for individual worker performance scoring
- Reports a prediction as a certainty, every prediction carries its window and confidence

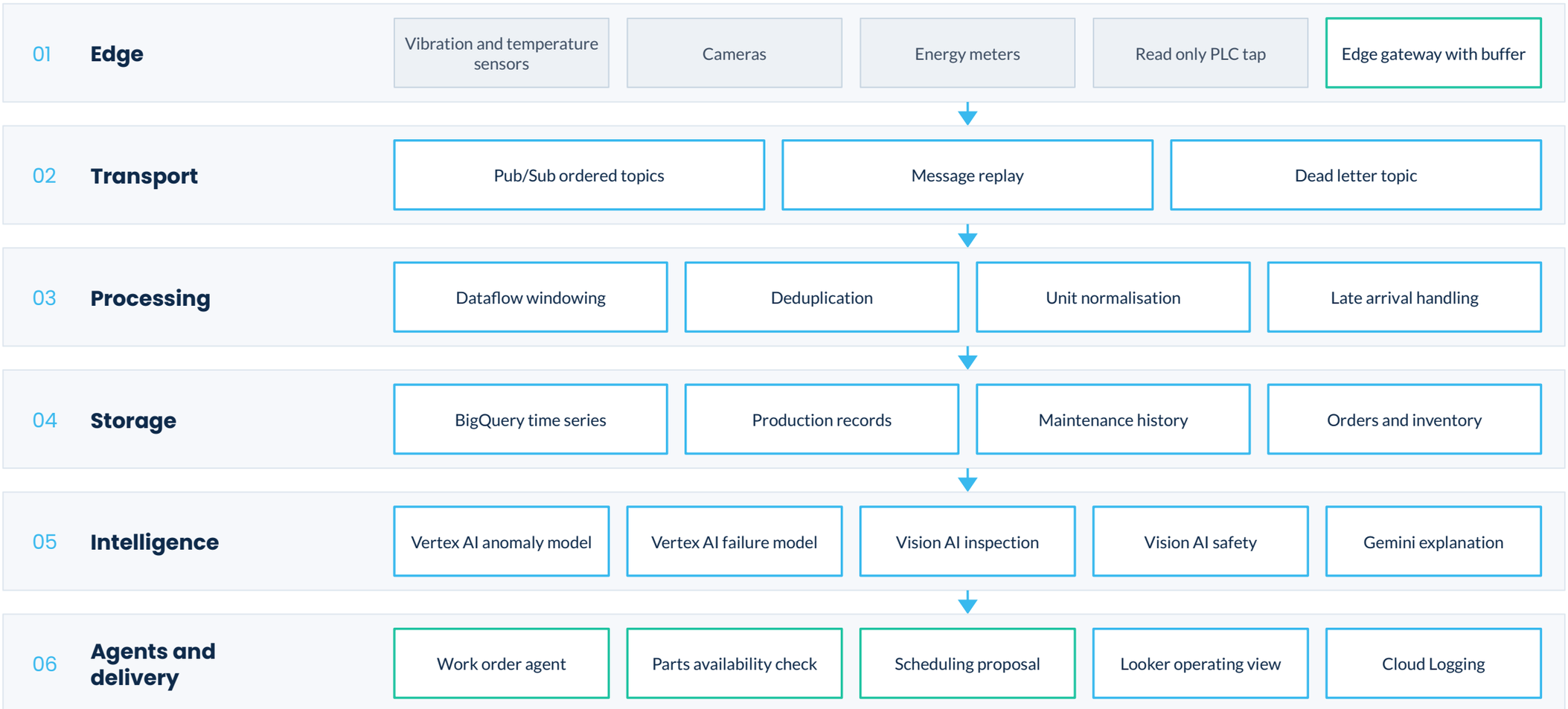
ARCHITECTURE

How the platform is put together

01	**Edge**	Machines, sensors, cameras, vehicles and meters feed a gateway that buffers locally when the link drops
02	**Transport**	Pub/Sub carries telemetry and events with ordering and replay, so nothing is lost during an outage
03	**Processing**	Dataflow handles windowing, deduplication, unit normalisation and late arriving data
04	**Storage**	BigQuery holds the time series alongside production, maintenance, inventory and order data in one place
05	**Intelligence**	Vertex AI carries anomaly, failure and forecast models. Vision AI carries inspection and safety detection
06	**Agents and delivery**	Gemini explains what happened in plain English, agents raise the work, and Looker holds the operating view

Google Cloud services used Pub/Sub · Dataflow · BigQuery · Vertex AI · Gemini · Agent Platform · Vision AI · Cloud Run · Looker · Maps Platform

The components and how they connect



RUNTIME DATA FLOW

What happens when a machine drifts out of its envelope

01

Sense

Vibration, current and temperature stream from the asset at fixed intervals.

02

Buffer

The edge gateway holds readings locally, so an outage delays insight, not data.

03

Transport

Pub/Sub carries the telemetry with ordering and replay guarantees.

04

Normalise

Dataflow windows the series, removes duplicates and fixes units.

continues

05

Score

Vertex AI compares the window against that asset's own learned normal.

06

Correlate

BigQuery joins the deviation to production, shift, orders and maintenance.

07

Explain

Gemini states the machine, the time, the mechanism and the commercial effect.

08

Act

The work order agent raises the ticket, checks the part and proposes the window.

The path is read only from the control network. No command travels from cloud to machine.

CAPABILITIES

Seven capabilities on one platform

Predictive maintenance

- Learns normal per asset from vibration, temperature, current and acoustics
- Predicts failure with a window and a confidence
- Raises the ticket, checks the part and books the slot

Visual inspection

- Detects defects, wrong assembly and missing components
- Catches packaging and label errors
- Holds consistency across a full shift

Energy intelligence

- Meters at machine level, not just at the building
- Compares consumption against the work actually done
- Correlates drift with maintenance and temperature

Facility monitoring

- Watches temperature, humidity, air quality and refrigeration
- Escalates a cold chain breach in seconds
- Produces the compliance record automatically

Asset tracking

- Locates vehicles, equipment, tools and containers
- Measures utilisation and finds idle assets
- Flags unauthorised movement

Safety analytics

- Detects missing PPE and restricted area entry
- Detects falls and hazardous conditions
- Stores incidents for later analysis

Digital twin

- Holds a live representation of the line or facility
- Joins telemetry to production, orders and inventory
- Answers why an output number moved

WORKED EXAMPLE

Production dropped 14 percent today and nobody knows why

01 Ask

The owner types the question. No engineer is pulled off the floor to investigate.

02 Trace

The twin finds abnormal vibration on machine three starting at 09:20, well inside the normal alarm band.

03 Follow

Cycle time on that machine lengthened, so the line slowed and work in progress accumulated downstream.

04 Connect

Two orders due for despatch tonight are now at risk because of the accumulated delay.

05 Explain

The answer names the machine, the time, the mechanism and the commercial consequence in one paragraph.

06 Act

The agent raises a maintenance ticket, checks bearing stock and proposes the changeover window with least production impact.

A threshold alarm would never have fired, because the vibration stayed inside the band. The deviation from that asset's own learned normal is what carried the signal.

The controls that make this deployable in a real business

Edge boundary

The gateway is read only from the control network. There is no write path from cloud to machine.

Store and forward

The gateway buffers locally, so a network outage delays insight and does not lose data.

Safety separation

Safety instrumented systems stay independent of the platform, and the platform never sits in that loop.

Camera governance

Retention, masking and permitted use for safety analytics are agreed in writing with the workforce before deployment.

Model transparency

Every prediction publishes its features, its window and its confidence, so an engineer can challenge it.

Audit

Telemetry lineage, model versions, detections and the actions taken are all retained together.

DELIVERY

How the engagement ran

Weeks 1 to 5

Connect and observe

Gateways, Pub/Sub and the BigQuery time series went live. We learned the normal operating envelope for each asset.

Phase 1

Weeks 6 to 10

Detect and explain

Anomaly detection and Gemini explanations went live. Facility and cold chain monitoring started escalating in seconds rather than by email.

Phase 2

Weeks 11 to 16

Predict and act

Failure prediction, energy correlation and agent driven work orders went live with parts and scheduling checks.

Phase 3

Weeks 17 onward

Inspect and twin

Vision inspection and the digital twin were added, joining the physical picture to orders and inventory.

Phase 4

Every phase ended with something the customer could use. No phase ended with a document only.

RESULTS

What the engagement delivered

IoT and operations KPI	Capability	Result delivered
Unplanned downtime	Predictive maintenance	**20 to 40% reduction**
Equipment failure detection	Predictive maintenance	**Hours or days down to minutes**
Emergency maintenance events	Predictive maintenance	**20 to 40% reduction**
Inspection throughput	Visual inspection	**2 to 5 times improvement**
Manual inspection workload	Visual inspection	**40 to 80% reduction**
False negative defects	Visual inspection	**20 to 50% reduction**
Energy consumption	Energy intelligence	**5 to 15% reduction**
Environmental incident response	Facility monitoring	**50 to 90% faster**
Refrigeration incidents	Facility monitoring	**20 to 40% reduction**
Root cause analysis time	Digital twin	**Days down to minutes or hours**

Each figure is measured against the baseline captured in phase one of the same engagement. Client identity is withheld at the client's request.

HEADLINE RESULTS

The five numbers this engagement moved

20 to 40%	10 to 25%	5 to 15%	2 to 5 times	24 by 7
Less unplanned downtime	Lower maintenance cost	Lower energy consumption	Inspection throughput	AI operational monitoring

What that looked like in this business

This plant runs 100 machines and was seeing around 10 unexpected failures a month before we started. With condition based prediction in place that settled at 6 to 8 a month, a reduction of 20 to 40 percent in unplanned stoppage.

GOOGLE CLOUD IMPACT

Three layers of measurement in every engagement

01 Business impact

Revenue, cost, productivity, downtime, inventory and customer experience. This is what the customer signed for.

02 AI impact

Automation rate, response time, prediction accuracy, resolution rate and human hours returned. This is what proved the system worked.

03 Google Cloud impact

Consumption and adoption the deployment created. This is what grows the account.

CONSUMPTION THIS DEPLOYMENT CREATED

- Pub/Sub messages per day
- Dataflow streaming throughput
- BigQuery time series storage and query volume
- Vertex AI model training and inference volume
- Vision AI requests per month
- Gemini and agent executions per month
- Cloud Run services and Looker users

WHERE IT FITS

The businesses this solution is built for

This solution is designed for small manufacturing, warehousing, cold storage, restaurants, retail chains, commercial buildings, logistics and agriculture. Geography: United States. Company size: 20 to 200 employees.

Small manufacturers

Warehouses

Cold storage

Restaurants

Retail chains

Commercial buildings

HVAC companies

Equipment manufacturers

Logistics

Agriculture

The common shape

These businesses all have real operational complexity and no in house platform team. They already pay for the systems that hold the data, and they have never had a way to use it together. That is the gap this solution closes.

What we flagged before we started

RISKS WE MANAGED EXPLICITLY

Sensor coverage decides the ceiling

You cannot predict a failure mode you are not measuring. We run a sensing gap assessment before we promise a downtime number.

Baselines need a learning period

An asset needs weeks of normal running before a deviation means anything. We publish the learning window rather than claiming day one accuracy.

False positives destroy trust faster than misses

Operators stop responding after a handful of bad alerts. We tune for precision first and raise recall once the operators trust it.

Camera analytics is an industrial relations question

Safety vision needs workforce agreement on retention and permitted use. We treat this as a deployment prerequisite.

Energy savings depend on the tariff

A 10 percent consumption reduction is worth very different money on different tariffs. We model against the customer's real bill.

The platform never touches control

The gateway is read only from the control network, and safety systems stay independent. We do not accept scope that changes this.

WHAT WE SETTLED IN DISCOVERY

- Which assets are already instrumented, and what protocols do they speak?
- What failure history exists, and is it recorded per asset or only per site?
- What is the plant network topology, and where can a read only gateway sit safely?
- Has camera use for safety analytics been agreed with the workforce?

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Let us talk about your operation

The next step we would suggest is a two week assessment against your own data. It tells you which of these numbers are reachable in your business before you commit to a programme.

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Disclaimer

This document describes work Tech4Biz Solutions has delivered. The performance figures shown were measured after implementation against a baseline captured during phase one of the same engagement. They describe what this client achieved and they are not a warranty of the same outcome elsewhere.

Results in another business will depend on the quality and completeness of its existing data, the systems in use, the level of process change it is willing to make, and the licence tiers held for the underlying platform services.

Client identities are withheld at the client's request. Sector and geography descriptors are provided in place of names, and figures are reported as measured.

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