



Data-driven safety, quality and maintenance inspection management

A practical step in operating more efficiently

A paradoxes white paper



Who should read this?

If you work in labor-centric fields such as construction or engineering and are an owner, manager, executive, field inspection manager, field inspector, data collector, business analyst or any role that relies on safety, quality, or maintenance inspection data to make decisions, read on.

Executive summary

Safety, quality and maintenance inspections are a crucial component of projects in industries such as construction, engineering, facilities management, utilities, manufacturing, oil and gas, mining and quarrying, wholesale and distribution, warehousing, and others. These inspections originate with the goals of achieving safe work environments and producing quality work, but quickly widen to encompass customer satisfaction, company reputation, and profit margins. Prioritizing these inspections is an opportunity that holds massive gains. Ignoring them invites massive risks.

Organizations, from general contractors to specialty trades, make an effort to control safety, quality and maintenance. However, they face daily challenges implementing effective safety, quality and maintenance management programs that ensure projects are done safely, correctly, on time, and on budget.

The stakes are high from a quality standpoint: Performing jobs correctly significantly reduces rework and the steep costs associated with it. According to Navigant, in 2020, the global cost of rework in the construction industry alone was estimated to represent 5% of all construction costs, or \$625 billion worldwide.

This rework is often caused by poor decision making stemming from bad data and poor communication. A study by Autodesk and FMI showcased poor project data and miscommunication is responsible for 48% of all rework in the U.S.

“Poor quality work is much more than just the cost of rectifying the work. It has far-reaching consequences that many fail to see or recognize. Consequences that could destroy the company and leave employees without a job.” – Construction Management Consultant.

Beyond the rework costs due to poor quality, U.S. workplace accidents costs \$50 billion per year, according to the National Safety Council

Of course, along with any downside risks there co-exists upside gains. According to the study Safety Management in the Construction Industry 2021 by Dodge Data & Analytics, doing jobs safely enables firms to achieve numerous positive benefits including negotiating better insurance terms, improving their ability to bring in new work, better training workers, and reducing recordable injury rates..

Top Positive Impacts of Safety Programs (share of contractors who experienced a positive impact on each)

Dodge Data & Analytics, 2021



FM Sylvan provides industrial process pipe fabrication, HVAC and boiler, millwright and rigging, and other mechanical-contracting services to Fortune 500 companies across North America. Jim Metz, VP of Safety at the company, recently described negotiating with FM Sylvan’s insurance carrier for their annual renewal. *“They pepper you with questions, and if they aren’t happy with the answers you’re giving, your rates are going up,”* he said. *“But we demonstrated that we are continually developing our safety program by collecting and analyzing safety data. We said, ‘Here are our reports, and here is our safety program.’ I gave a few of them access to our digital inspection data and said, ‘Go look at it,’ and they loved it.”*

This report explores . . .

- The goals of safety, quality and maintenance inspections
- Why firms collect safety, quality and maintenance data
- Understanding the safety, quality and maintenance digital inspections landscape
- How safety, quality and maintenance data is being collected, the challenges encountered, and how it’s being used
- The benefits of digitizing safety, quality and maintenance inspection processes
- How to get started, or improve, your safety, quality and maintenance inspection processes and decision making

The goals of safety, quality and maintenance inspections

The main purposes of safety, quality and maintenance inspections are to keep people safe, equipment operational, and projects on track to protect lives, ensure profitability, and increase customer satisfaction.

Increasingly, using inspection data to make decisions is emerging as the centerpiece of these programs, and at the nucleus is the quality of field inspection data. We all know the adage “garbage in, garbage out.”

A 2020 study conducted by enterprise construction software provider AutoDesk, *Harnessing the Data Advantage in Construction*, reports on the role of data in the global construction industry, estimating the cost of bad data – defined as “inaccurate, incomplete, inconsistent, or untimely data” – is a staggering \$1.8 trillion due to poor decision making based on poor data.

Furthering this point, a McKinsey study indicates that 33% of poor decisions are made as a result of bad data. When good data exists, it is often not available or easily accessible for quick decisions. Let’s dig deeper into the world of safety, quality and maintenance inspection data.

Why firms collect safety, quality and maintenance inspection data

Ultimately firms are collecting safety inspection data to protect workers, quality data to ensure the project is being done correctly, and maintenance data ensures safety and operational quality of infrastructure already in place. This assortment of inspection data is used to manage operations and inform decision making with the goal of achieving a variety of important outcomes.

Top reasons for collecting safety and quality data

Safety	Quality
<ul style="list-style-type: none">• Decrease injuries• Decrease insurance costs• Improve reputation/industry standing• Win new jobs• Acquire and retain staff• Comply with federal and local laws and regulations• Reduce work stoppages and related cost increases / time delays	<ul style="list-style-type: none">• Decrease rework costs• Reduce safety incidents• Reduce change orders• Reduce budget overruns• Accreditation
<ul style="list-style-type: none">• Keep projects on schedule and on budget• Improve decision-making quality and speed• Project profitability• Real-time visibility into assets and resources• Improved resource management and scheduling	

Understanding the field inspection landscape

Every inspection is a form of data collection. Each time an organization collects safety, quality and maintenance data it represents an opportunity to digitize the inspection process. A digitized inspection process is a more efficient means of collecting inspection data and automating the ensuing workflows and actions that need to occur as a result of what is learned through this information. This inspection automation quickly transforms an organization from “performing inspections” to efficiently taking actions on data. This results in improving team productivity, operating efficiency, and achieving organization wide improvements.

According to the U.S. Census and a Field Inspection Management 2021 study conducted by paradoxes, inc., it is estimated there are nearly 10.5 million people in safety, quality and maintenance inspection roles across the U.S.

	Construction	Engineering Services	Facilities Management	Utilities	Oil & Gas	Mining/ Quarrying	Warehousing	Wholesale/ Distribution	Manufacturing
Total entities (persons)	5,410,211	1,010,144	4,525,894	246,710	154,271	503,325	798,160	380,158	5,401,220
Total employees (persons)	11,391,000	4,799,464	13,314,065	636,775	1,112,764	3,523,295	5,168,510	701,895	12,559,800
Median # of data collectors	55	375	375	375	375	375	175	55	375
Median # of employees	175	875	875	875	1,750	875	1,750	875	1,750
% of data collectors	31%	29%	29%	20%	21%	43%	10%	6%	10%
# of data collectors	3,514,019	958,972	2,262,967	113,355	140,592	1,508,975	515,852	41,088	1,255,500

There are an average of 242 employees collecting information, performing inspections, and/or gathering data either from the field or onsite per organization. The median number of staff collecting inspection data is 175 employees. Of course, this varies by organization size.

Number of employees collecting data/performing inspections per organization

	Total	SMB	Mid-Market	Enterprise
Average	242	28	76	354
Median	175	5	55	375

Source: Field Inspection Management 2021, paradoxes, inc.

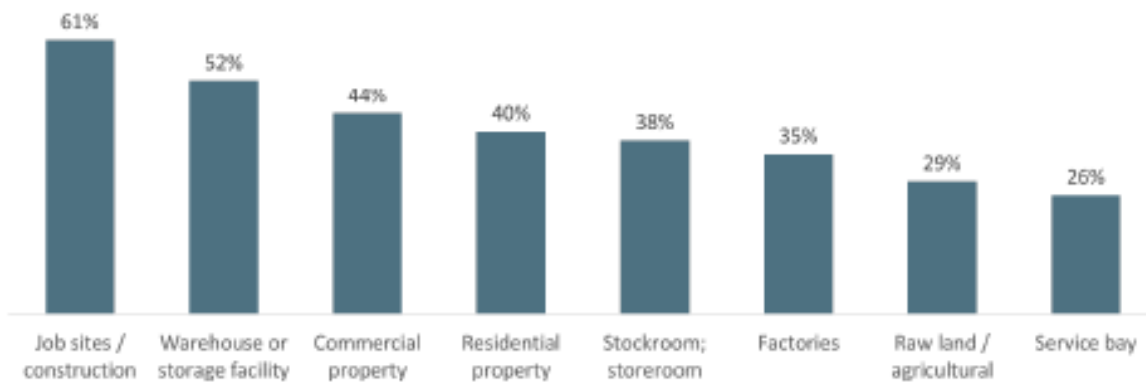
Across the aforementioned industries, a typical company is collecting inspection data across an average of 28 locations simultaneously spanning job sites, warehouses, commercial and residential properties, stockrooms, factories, raw land, service bays, and other locations.

Number of concurrent field sites from which data is collected

	Total	SMB	Mid-Market	Enterprise
Average	37	12	30	43
Median	17	3	7	17

Source: Field Inspection Management 2021, paradoxes, inc.

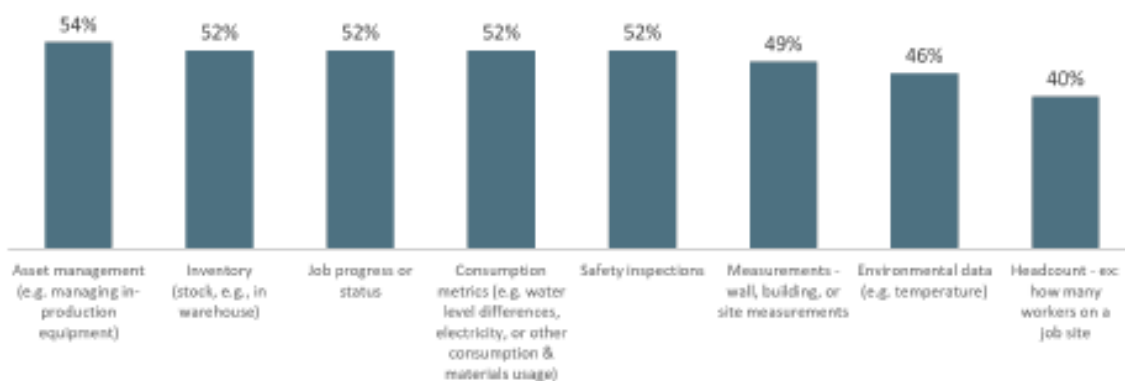
Job Locations Where Data is Collected



What types of locations best describes where field data is being collected for your organization? (n303)
Source: Field Inspection Management 2021, paradoxes, inc.

On average, a typical inspector visits 4.3 sites per day to collect a variety of data including asset data, inventory, job progress information, consumption metrics, safety inspections, measurement, environmental, and staff on site.

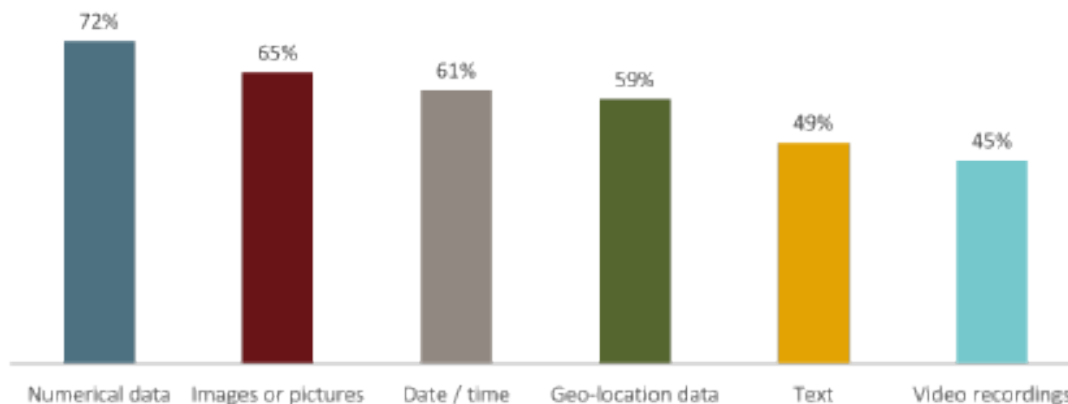
Categories of Data Being Collected in the Field



Q21 Thinking about the field data being collected at your organization today, what category or categories of data are you currently collecting? (N=303)
Source: Field Inspection Management 2021, paradoxes, inc.

The types of inspection data most commonly collected are numerical data, followed by images, date/time, geolocation, text and video recordings.

Format of Field Data Collected at Organizations Today



Q22 Thinking about the field data being collected at your organization today, what format of data are you currently collecting? (n303)
Source: Field Inspection Management 2021, paradoxes, inc.

For each instance of inspection data collected in the field, respondents to paradoxes, inc. 2021 Field Inspection Management study indicated they spend an average of 31 minutes collecting data for a typical inspection. This time spent does not vary by organization size, indicating this is a time-consuming process no matter the firm performing the inspection. For smaller firms with fewer resources, this has even more substantial resource implications, though no company wants to use its people inefficiently.

Time it takes to collect a typical instance of field inspection data

	Total	SMB	Mid-Market	Enterprise
Average	31	30	31	30
Median	16	16	16	16

Source: Field Inspection Management 2021, paradoxes, inc.

Multiply this amount of time by the number of inspectors and you can quickly see the time costs associated with inefficient and ineffective inspection processes.

Let’s perform a quick calculation. This research indicates there are an average of 242 inspectors working for a firm that collects inspection data. They perform inspections at an average of 4.3 sites per day. It takes an average of 31 minutes per inspection to collect that data. Let’s conservatively assume they are only collecting 1 instance of data per inspection site. This equates to 538 hours of data collection time per day which equates to 28% of each person’s day being occupied by collecting safety, quality and maintenance inspection data.

Other studies indicate between 40% and 50% of staff time is dedicated to collecting, managing, and analyzing project data.

242 (data collectors) x 4.3 (sites visited to collect data per day) x 1 (data collection incident per site) x 31 (minutes to collect data per incident) = 538 hours per day x \$30 per hour (estimated average wage) = \$967,758 per day in inspection and data collection costs.

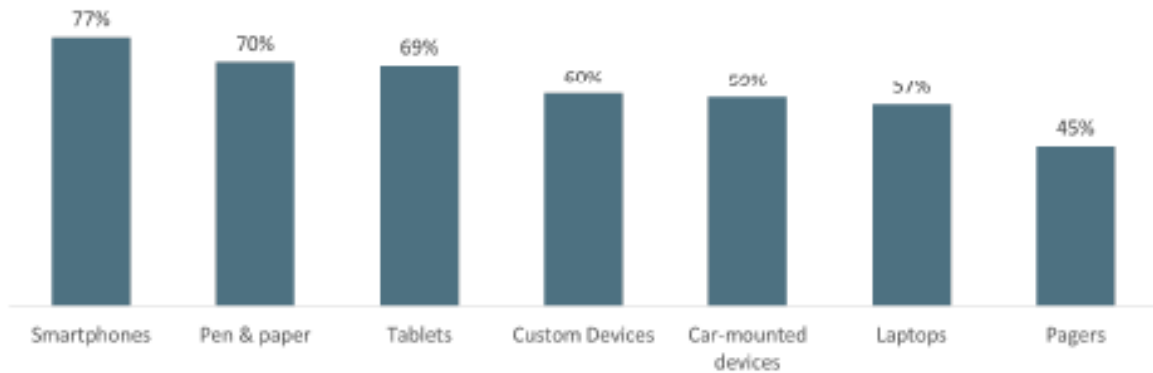
From this analysis, one can clearly see the large cost savings available by shifting from cumbersome manual inspection processes to streamlined and automated digital inspections. And this does not even count the time savings gained from more efficiently sharing the data, managing teams based on the data, and increased operational insights from making the data available to more people in real-time.

Further, this also does not account for the savings from improved data quality resulting from digitizing inspection processes. According to the Autodesk study, 50 percent of respondents indicated 20% to 50% of their data collected is bad due to inaccurate/incorrect data (data collected with right intent but errors occurred along the way), missing data, or wrong data (data that cannot be used for its intended purpose – e.g. collected progress data for 3 people but 5 were working on the task).

How safety, quality and maintenance inspection data is being collected, the challenges encountered, and how it's being used

Most organizations are collecting safety, quality and maintenance inspection data both online and offline through a variety of methods including smartphones, pen and paper, tablets, custom devices, car-mounted devices, laptops and pagers. The top three ways of collecting data in the field are smartphones, pen and paper and tablets. A massive 70% of respondents indicate they still collect some data using pen and paper.

Technology Employees Have Access to for Collecting Data in the Field



Q16: Indicate which technologies employees have access to while collecting data in the field (n303).
Source: Field Inspection Management 2021, paradoxes, inc.

There are numerous challenges in managing field inspection programs and managing field teams composed of inspectors with differing experience levels simultaneously located over numerous sites.

The top five obstacles organizations face in efficiently collecting field inspection data and managing these teams are the complexity, file size, volume of data, difficulty training the staff in data collection, and too many steps to collect the data. Other challenges include staff turnover, spotty internet access, format of data (e.g. images, scans), lack of access to the data (e.g. locating serial number), and fragility of devices.

Obstacles organizations face to efficiently collecting field inspection data	% of respondents
Complexity of data collection	37%
File size of data (e.g. images, video)	37%
Volume of data collection	35%
Training staff in data collection is difficult	31%
There are too many steps in data collection	28%
Staff turnover is high	28%
Spotty internet access	27%
Format of data (e.g. images, scans, text)	25%
Access to the data (e.g. locating serial number)	25%
Fragility / dependability of devices	24%

Q37 Please select the top 3 obstacles your organization encounters today related to workers efficiently collecting information in the field or onsite (e.g., performing inspections) (n303)
Source: Field Inspection Management 2021, paradoxes, inc.

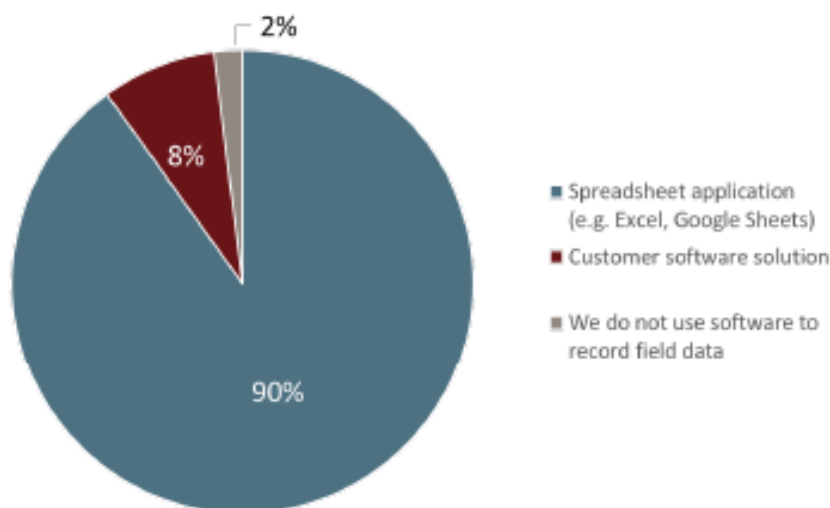
“The top issue we face in collecting data is incomplete forms. Forms are filled out via pen and paper, information is not always complete or accurate.” – Mid-market project manager

“Just managing the info, keeping track of it and storing it... and when the job ends, you hope the log doesn’t get thrown in a dumpster somewhere. It’s an enormous task.” – Enterprise VP of Safety

According to the Autodesk study, respondents indicated each of these present moderate challenges in working with their organization’s project data:

- Data from one source cannot easily be combined with another source (siloes data)
- Data is incomplete and missing aspects that would make it more usable
- Data is not easily accessible
- There is too much data to know how to use it effectively
- Errors raise suspicion about that data and its usefulness

In terms of where safety and quality inspection information is being stored once collected, 90 percent store their data in a spreadsheet.



Q27 What kind of software are you using to record the field data collected in your organization? (n303)
Source: Field Inspection Management 2021, paradoxes, inc.

The biggest needs firms have with workers performing inspections, collecting information, and gathering field data are saving time/accelerating data entry, simplifying the tools and workflow used, ability to customize data entry, real-time visibility of inspector locations and on-demand rescheduling, enabling easier/faster data analysis, and better data capture solutions.

Other needs include reducing data error rates, data security, communication between teams, monitoring safety policies, reducing data re-entry, and offline capabilities. Addressing any of these needs will result in improvements in inspection program efficiency and data collection accuracy.

Needs in organization today with workers collecting information, performing inspections, and/or gathering data	% of respondents
Saving time / speeding data entry	31%
Simplifying tools and workflow	28%
Customizable data entry	28%
Real-time visibility of assets & on-the-fly rescheduling	28%
Enabling easier/faster data analysis	27%
Better data capture technology solutions	27%
Reducing data errors	23%
Data security (including team login)	23%
Communication between teams	22%
Monitoring safety policies	21%
Reducing checking or rekeying data	19%
Offline capabilities	17%
Saving money	4%

Q38 Please select the top 3 needs in your organization today with workers collecting information, performing inspections, and/or gathering data (n303)

Source: Field Inspection Management 2021, paradoxes, inc.

Once the inspection data is collected, firms focus on analyzing the data to make actionable and impactful decisions. In doing so, they face key challenges including data accuracy, changing data analysis needs, and lack of standard reporting templates.

Obstacles organizations face analyzing the field data they collect	% of respondents
Data accuracy (from rekeying, or mistakes or omissions in-field, etc.)	37%
Data analysis needs change constantly	35%
The quality of data collected is poor	29%
Lack of standardized reporting templates	27%
The data structure is inconsistent	26%
The data does not align or trend well (e.g. does not match across time and location)	24%
Data is not stored/aggregated in a single data base	23%
The data visualizations are hard to work with	22%
It is hard to access the data	20%
It is hard to understand the data that is collected	20%
I do not have access to tools to aid with the data analysis that I need to do	18%
Language / translation	17%

Q39 Please select the top 3 obstacles your organization faces analyzing the field data you collect. (N=303)

Source: Field Inspection Management 2021, paradoxes, inc.

The benefits of digitizing safety, quality and maintenance inspection processes

Increasingly, using data to make safety, quality and maintenance decisions is on the rise and will continue to grow in importance across industries. Firms that digitize their safety, quality and maintenance processes will gain a competitive advantage and achieve widespread organizational improvements.

Digitizing field inspection processes will help organizations achieve many of the efficiency outcomes they seek including:

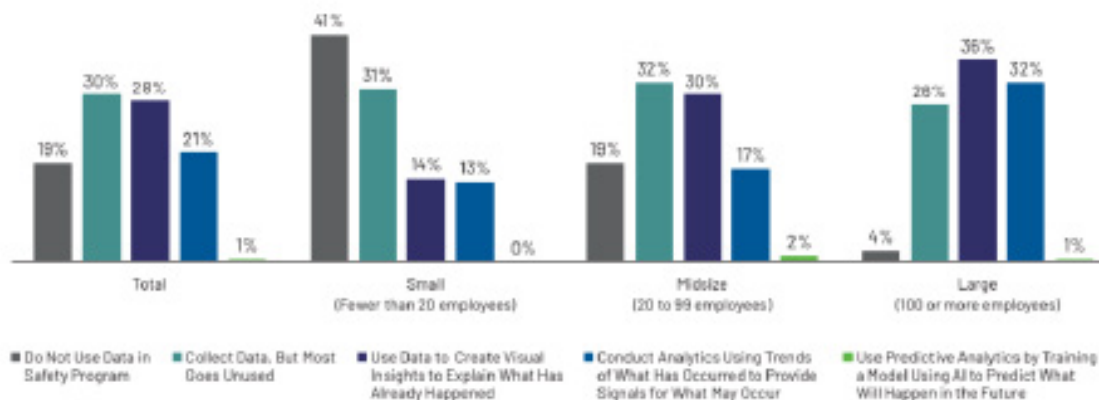
- **Saving time** by simplifying the process of collecting the data, making data more accessible across the organization, customizing the types of data collected and enabling faster data analysis
- **Improving data accuracy** by reducing error rates and combining data from disparate sources
- **Making better decisions** by improving communication between teams, providing real-time visibility of team locations, and accelerating on-demand scheduling and resourcing decisions
- **Reducing costs** caused by schedule delays, rework, injuries and poor decision making

At the same time, these industries are at the beginning of transforming manual inspection processes to digital and becoming more data-driven in their safety, quality and maintenance decision making. As indicated below, only 30% of firms say they collect safety data but most goes unused, only 28% create visual insights from the data to explain what already occurred, only 1 in 5 use data about what has occurred to forecast what may occur, and a tiny 1% are using Artificial intelligence (AI) to predict what will happen on their job sites in the future.

The time is now to commit to digitizing your safety, quality and maintenance field inspection processes to get and stay ahead of competitors, and achieve many of the efficiency gains being highlighted here.

Use of Data to Support Safety Program

Dodge Data & Analytics, 2021



How to get started, or improve, your inspection processes and decision making

There are several steps an organization can take to start or improve their inspection processes and decision making:

1. Create safety, quality and maintenance Key Performance Indicators (KPIs) to guide what data you collect, how you use it, and how you measure inspector performance
2. Digitize field inspection processes and checklists
3. Benchmark how long it takes to perform inspections and then adopt an easy-to-use Field Inspection Management solution to shorten data collection times and improve data accuracy
4. Leverage the Field Inspection Management solution to:
 - Improve decision making by leveraging safety, quality and maintenance inspection data
 - Increase team productivity by automating inspection processes
 - Foster operational excellence with performance management dashboards and end-to-end inspection visibility

What to look for in a Field Inspection Management solution

Evaluating solutions

What to look for:

- High engagement and adoption
- Customizable
- Shareable data
- Affordable
- Real-Time accesibility
- Security and privacy
- Scalable

Fulcrum's Field Inspection Management with Intelligent Team Automation may be a good fit for you

Shifting your manual inspection processes to a digital solution, such as Fulcrum's, provides three key benefits:

Digitize inspection processes

Effective platforms empower your teams with easy-to-use, customizable digital checklists and apps that define accurate procedures and deliver fast time to value. Deployable on all mobile devices in real time, these ensure the consistent and rigorous inspection processes that are necessary for overall safety, quality and maintenance management success. By definition, these records employ richer quality issue reporting content through the use of digital media including images, videos and audio recordings. More effective solutions also add location intelligence to the mix through automatic geotagging of inspection activities and records, and extend issue reporting to external contributors beyond just the inspection team.

"The task list (in the Fulcrum Field Inspection Management solution) forces employees to be organized with their tasks... and provides control with the list they have in front of them." – Mid-market Construction Firm, Project Manager

And when every stakeholder involved in safety and quality – inspectors, project and program managers, remediation scheduling teams – can access a single digital repository of uniform, reliable and context-rich data in real-time, the dreaded information gap and costly time delays are eliminated.

A successful digital platform provides a comprehensive view across all project stakeholders by consolidating a wide range of safety, quality and maintenance specifications and SOPs with inspection data, issues and resolution. And because geographic information systems (GIS) is a powerful and reliable tool in the construction toolbox, platforms that also leverage the power of existing GIS systems with automatic geotagging capabilities further uplevels logistical and resource planning value.

Provide intelligent automation for inspection teams

To produce valuable safety, quality and maintenance impact, a solid digital inspection management platform allows for automation to be built directly into the inspection process, connecting teams in real time.

For example, a QA manager can set up a workflow to automatically notify the remediation team, in real time, of an issue uncovered by the field inspector with a newly poured foundation. Early notification enables them to halt further work, depending on criticality, and allow for remediation instead of advancing the build on a faulty foundation that will fail final project approval. Upon resolution, a similar automated notification to the inspection team will prompt an expedited follow-up inspection in order streamline the approval process for work to resume.

Platforms enabling team automation and workflows empower you to create and assign quality inspection tasks, report issues, and track their resolution, marked by high-level progress visibility. More advanced platforms will furnish out-of-the-box tools for light configuration of automated workflows to get users started quickly and easily. However, beware of solutions requiring intervention of programming or IT teams to set up and implement these workflows – they are often less effective, ultimately decreasing adoption success and significantly increasing the time to realized value.

“We have a standard template on our programs as it became very repetitive... now it’s standardized for all supers and goes very quick.” Mid-market Construction Firm Production Manager

Platforms promoting intelligent team automation keep safety, quality and maintenance teams in constant communication with each other, letting you streamline tasks, avoid missing deadlines or milestones, while still reducing rework down the line – all told, ensuring high-quality end-to-end inspections, regardless of scope, for a more unified and improved safety and quality posture.

“It’s very user friendly ... looking at the user interface you know exactly what’s required to make the submission.” – Enterprise Construction Company Engineer



Deliver data-driven reporting and analytics

Finally, going digital with your inspection programs gives you unfettered access to consolidated safety, quality and maintenance data and reporting organization-wide. Not only will you be driving greater efficiencies addressing uncovered issues, but you will also be empowered to drive constant improvement with your inspection processes by aggregating data and insights at and across projects.

“It’s valuable to see how many tasks we’ve closed in the last week, and what percentage of our tasks are done. When we see employees are only getting through 20% of their tasks in a week, we can adjust the schedule to stay on track of the work... usually we are managing thousands of tasks at a time.” – Mid-market Construction Contractor Construction Manager

Data is useless unless it’s the right data in the right hands. When evaluating a Field Inspection Management platform, not only does it need to guarantee electronic delivery of performance dashboards and reports to appropriate teams, but it also needs to enable data to be easily shareable across teams, and across GIS, enterprise management, and business intelligence tools.

“Sometimes we have something simple that needs to get done by the end of the week that anyone can do... a solution like this provides us a list so the guys can go and do it without me having to assign it... like a project punch list.” Enterprise Construction Company Project Manager

About this study

This study utilized a combination of primary research and secondary studies:

- 2021 Field Inspection Management Study, Qualitative & Quantitative n303, Paradoxes, Inc.
- www.paradoxesinc.com
- Fulcrum Focus Groups (August 2021, Paradoxes, Inc.)
- Fulcrum FIM Product Demo In-depth-interviews (February 2022, Paradoxes, Inc.)
- US Census data (2018)
- Smart Management in the Construction Industry 2021, Dodge Data & Analytics / The Blue Book Network
- www.construction.com/toolkit/reports
- Harnessing the Data Advantage in Construction: Why adoption a data strategy can bring firms a competitive advantage.
- www.construction.autodesk.com