AUGUST | 2020

PANDEMICS AND CONSTRUCTION PRODUCTIVITY: QUANTIFYING THE IMPACT

Commissioned by ELECTRI International. Conducted by Maxim Consulting Group and Marquette University.
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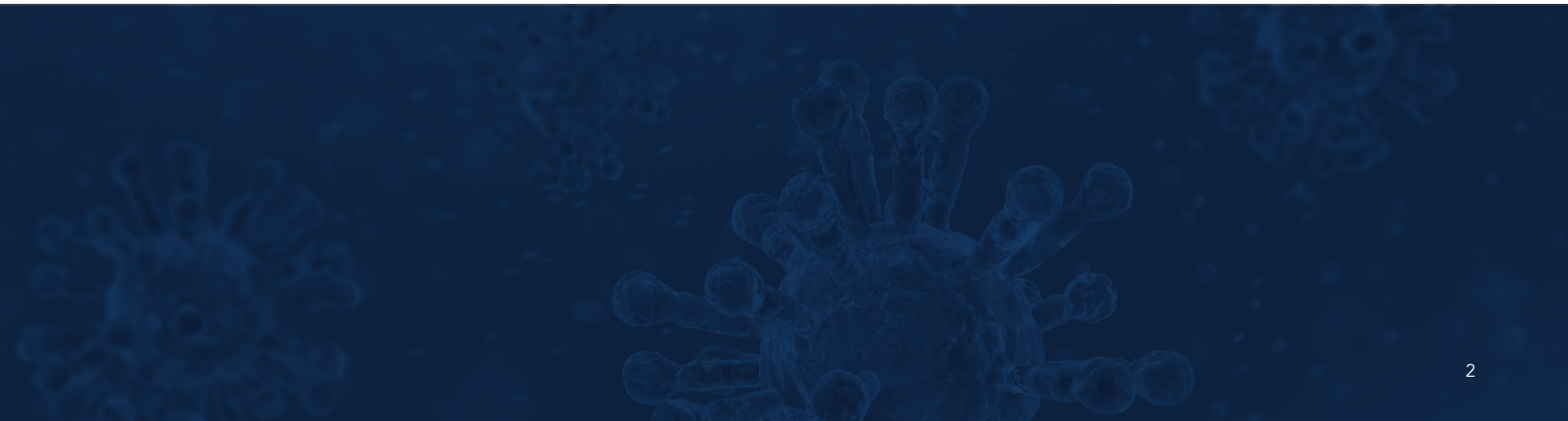
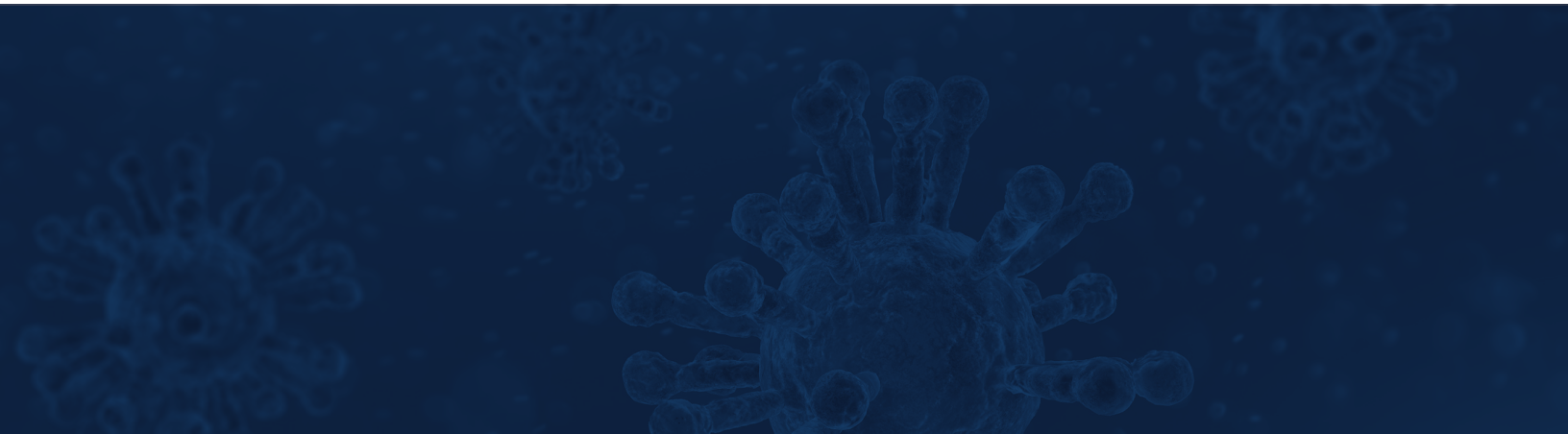
ELECTRI INTERNATIONAL
Research and Education for the Electrical Construction Industry

Contents





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Acknowledgements

Many individuals and their firms worked collaboratively and intensively to produce the data and recommendations for this study. ELECTRI International and the National Electrical Contractors Association acknowledge, with sincere appreciation, their dedication to the electrical construction industry.

- **TIM SPENO, CHAIR**
  E2E Summit
- **JOHN FRANTZ**
  Sidney Electric Company, Inc.
- **GREG GOSSETT**
  ERMCO, Inc.
- **KELLIE HOLLAND**
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- **DAN SHEA**
  Shea Electric & Communications LLC
- **BRIAN WILKERSON**
  ERMCO, Inc.
- **JOEY SHORTER**
  Atlanta Electrical Contractors Association
- **DAVID LONG**
  NECA
- **JOSH BONE**
  ELECTRI International
- **LAURA HOLMES**
  ELECTRI International

This ELECTRI International research project has been conducted under the auspices of the Research Center.

Center for RESEARCH

Executive Summary

Overview

A pandemic can have far reaching impacts on the U.S. economy. Companies in once successful industries across the United States have felt the immediate impact of the current pandemic in the most devastating ways. Since March 2020, many companies have come to a complete and total shutdown, displacing more than 25 million Americans from their jobs. Other industries, such as the healthcare and medical research fields, have seen excessive stress placed on them not only in terms of resources and equipment, but also on the personal lives of the professionals administering these services. These are truly unprecedented times that were unforeseen just six months ago.

The federal government has tried to do its part to care for the unemployed, the small businesses, and even some large industries that have been most noticeably impacted by the government-directed shutdowns and forced isolations of our population. The CARES Act has gone a long way to help start bridging the gap from today toward recovery. Yet, it is not enough and cannot be the end of the support provided to corporations across this country.

The essential operations that have been asked to remain working during this pandemic are caught in the middle ground and left out of these often-discussed areas of our society and business. These industries are traditionally known to provide food, basic human necessities or some service that our government has deemed critical to the well-being of our citizens. These are the operations that keep our economy moving in some way to help prevent a total collapse of our infrastructure.

The construction industry is one of those essential industries that has continued to deliver its services to both private owners and government agencies alike. It has done so while adapting to and adhering to a continuously-updated and changing set of recommendations from our health, state, and federal government officials. During this time of essential operation, our construction workers continue to receive their paychecks; contributions to union pension and health funds continue without drawdowns; and our building owners receive their buildings per the completion schedules for which they have asked. While these are all positives for the economy, the unintended consequence of being deemed essential and working under these new mandates has fallen directly at the feet of the corporations that employ this workforce.

Most of these construction companies work on fixed price contracts with limited (if any) financial relief per the terms of their owner agreements. So, the added costs and inefficiencies of being an essential business are directly taken from the corporate profits. Without financial aid from our government, this industry will also suffer from the impact of this pandemic, but it will look different from the early impact on the people and industries our legislative branch has tried to save thus far during the pandemic.

It could be months or, in some cases, a few years from the start of this pandemic until we see construction companies fail. It will happen because they have no clear channel for equitable adjustment and have been contractually mandated to continue operations. The new normal being created from pandemic-driven health and social modifications is being seen early in the construction industry. Congress should take note as to what the potential financial or profitability ripple looks like as we start to reopen America.

Construction sites are usually vibrant micro-communities that thrive on fast-paced teamwork and require the precision of large numbers of men and women working together in tight spaces. They all play their parts, working together to erect massive buildings. Nearly every activity on a job site takes more than one person to complete, so the rule of social distancing creates a nearly impossible challenge. Hundreds of men and women line up daily to have

their temperatures scanned prior to beginning work. To move to and from their work areas, they ride in elevators in one-third the capacity that they once did in order to create sufficient space from each other.

This requirement takes up hours that used to be spent productively installing construction materials. Instead, these hours are now spent simply getting to the work area. Every activity is spaced at six-foot distances. Safety toolbox talks, stretch and flex programs, and daily meetings are all impacted as communication and coordination of activities has diminished at job sites. Each site has created its own version of shelter-in-place habits that have slowed down the industry to reduce the potential spread of this virus while continuing to work.

The findings of this study are based upon data collected from NECA members who represent some of the largest and most sophisticated contractors in the United States. The analysis and conclusions derived from the data set are intended to serve as a representation of the average impact on electrical contractors across the country. It should be noted that the research consultants performed a similar study for the sheet metal, HVAC and mechanical trades. The outcome of that study produced comparable results, as would be expected since the nature of the work impacts are very similar. Contractors may find variability in their own companies and find utility in conducting their own impact study. However, it would be difficult to recreate the same conditions that occurred globally and within the United States over the timeline of this study.

The construction industry thrives on challenge and innovation and will continually improve to deliver products safely to owners. In time, firms will adjust to this new normal and price the contracted work appropriately. However, in the near term, the industry's financial burden from the social restrictions placed on it may be so great that many companies will not survive to compete in the future.

Findings

Measurements of the impact of this pandemic suggest that construction productivity has been impacted by nearly 20%. **A rule of thumb for self-performing contractors is that a 10% impact on productivity results in a 100% impact on profitability.** Accordingly, contractors need to consider seriously the impact of this study on their profitability and seek equitable adjustments that adequately compensate them for the impact.

This study is divided into three distinct sections:

- Part I - Pandemic Mitigation Tracking specifically quantifies hours associated with preventative measures such as training, health screenings, cleaning and disinfecting, job site access, and administration - all instituted to minimize exposure.
- Part II - Productivity Benchmarking specifically quantifies the reduction in direct work productivity related to social distancing rules, staggered shifts, reduced crew sizes, increased personal protective equipment requirements, and related job site regulations.
- Part III - Business and Project Impacts specifically quantifies ancillary impacts experienced by most contractors who participated in this study.

The following section provides a description of each of the three distinct parts.

Part I - Pandemic Mitigation Tracking

Based on a random sampling of more than 92,000 labor hours, data collected to date suggest that **8.9% of labor hours is lost due to pandemic mitigation activities.** It is reasonable to expect that, if crews were not spending 8.9% of their available productive time working on pandemic mitigation, they would be putting work in place.

Contractors should prepare and submit change order requests to seek compensation for the impact of pandemic mitigation and prevention efforts instituted on their projects. Pandemic mitigation was never contemplated at the time of pricing a project and represents an unforeseen cost. Contained within this study is a change order calculator for contractors.

Part II - Productivity Benchmarking

The data indicate a 12.9% overall average productivity impact on Vertical Construction productivity as a result of the pandemic. It is important to note that this impact is additive to the 8.9% loss experienced as a result of mitigation tracking. Based on the current data, there are 62 minutes of lost productivity per day per employee's 8-hour work period.

While the study shows that the overall average impact on work productivity is 12.9%, Figure 8: Vertical Construction Productivity by Task Type Against Period, illustrates that certain task types clearly take a more significant impact to productivity. **The tasks that showed the greatest impact to work productivity, primarily due to close proximity of workers** were:

- **Overhead Rough In**
- **In Wall Rough In**
- **Trim**

The study clearly illustrates the need to file change orders to recover losses on out-of-scope work and losses in productivity. The current pandemic also demonstrates the necessity of implementing proper productivity controls. Contractors who are using accurate labor and productivity tracking systems are far better positioned to manage the crisis than those who are not. As a follow up to this study, the National Electrical Contractors Association (NECA) will conduct an outreach program to help educate contractors on "the how and why" of effective job cost-control systems.

Companies that have trended lower in productivity losses have established, organized, and trained their teams with new pandemic mitigation processes and procedures. Additionally, they have monitored and shifted work activities to accommodate required distance spacing between team members.

The average baseline productivity impact of:

12.9% (Productivity) + 8.9% (Mitigation) = 21.8% (Total Productivity Impact)

is substantial. Contractors should utilize this information to price an equitable adjustment properly employing both the Pandemic Change Order Calculator provided with this study and the study itself as backup verification for the impact.

Part III – Business and Project Impacts

To mitigate the impact of a pandemic on their field and project management staff, companies should focus on three specific areas:

1. Jobsite Impacts
   - Additional cleaning and the greater number of safety (PPE) requirements.
   - Distracted workers discussing the news.
   - Access issues (limited workers, temperature testing, single access).
2. Project Management Impacts
   - Less project review (fewer PM visits/ less rigorous monthly review meetings).
   - Additional time to track cost impacts (documenting pre-pandemic impacts on a project that would be a potential change order from post-pandemic impacts).
   - Time spent in project re-start planning.
3. Business Impacts
   - Project cancellations or projects delays.
   - Additional meetings: internally, with clients, with vendors, contingency planning, job re-start procedures.
   - Understanding rules and regulations issued by various governmental agencies.

Productivity Change Order Calculator and supplemental educational videos: https://electri.org/product/pandemics-and-construction-productivity-quantifying-the-impact/

Part I
Pandemic Mitigation Tracking

Objective

The objective of Pandemic Mitigation Tracking is to quantify lost productivity directly associated with jobsite pandemic mitigation requirements such as training, health screenings, cleaning and disinfecting, job site access and administration—all instituted to minimize exposure.

Data Collection and Methodology

To collect project hours on a daily basis, the consultants provided participants with an application for iOS and Android smartphones and tablets. A Microsoft Excel-based worksheet for participants with bulk daily time data offered an additional data collection option. Data collection began on April 15, 2020 and ended July 3, 2020.

A single data point for this research represents time reported to five standardized time codes, per project, per day. Standard definitions for each time code normalize the data across the range of participants in the sample. The time codes are:

- 100 - Total Hours Worked
- 200 - Hours lost to COVID Safety and Training
- 201 - Hours lost to COVID Distancing and Jobsite Access
- 202 - Hours lost to COVID Cleaning and Disinfecting
- 203 - Hours lost to COVID Administration.

Detailed definition of the types of activities per time code are included in Appendix A.

Definitions of activities for each time code category were drawn from:

- Local, state, and federal government guidelines for social distancing
- OSHA's *'Guidance on Preparing Workplaces for COVID-19'*
- OSHA's '*Interim Enforcement Response Plan for Coronavirus Disease 2019'*
- First-hand accounts provided by contractors.

Participants received instruction for using the data collection tools via a combination of methods:

- Webinar (live and recorded)
- PDF Instruction Manual
- Instructions and FAQ embedded in both data collection tools
- Direct access to the research project's consultants via phone, text or email for technical support and answers to their specific questions.

Each day, the research team reviewed sample size and geographic coverage using a heat map linked to the sample data set.

The analysis of the collected data centers around a single question: *Is it reasonable to expect that, on average, the percent of labor hours a contractor loses on jobsite pandemic mitigation requirements are hours not available to produce work at estimated rates of production and/or rates of production as defined in resources such as NECA's Manual of Labor Units 2019-2020?*

Sample Set

As shown in **Figure 1**, the sample data collected were geographically distributed across the United States and Ontario, Canada, and contained many major markets.

Figure 2 shows the "heat map" distribution and relative number of samples from each geographic location.

Figure 3 provides a table depicting the breakdown of hours collected and tasks coded to mitigation- related activities.

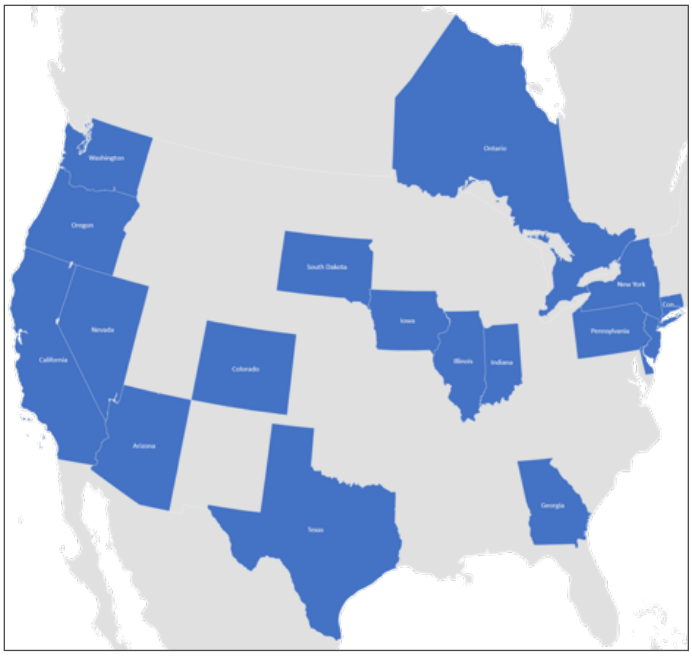


Figure 1 – State distribution of mitigation data

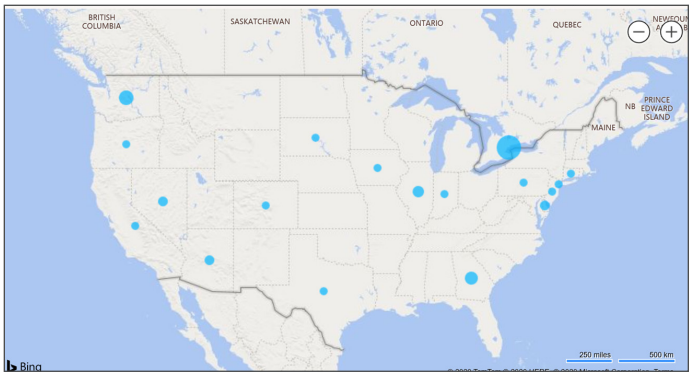


Figure 2 – Concentration heatmap of sample set data areas

	Total Hours	% of Total Hours	% of Mitigation Hours
Total Hours Available	92,390		
Mitigation Safety & Training	1.759	1.9%	21.2%
Mitigation Distancing & Access Rules	3,642	3,9%	43.9%
Mitigation Cleaning & Disinfecting	2,259	2.4%	27.2%
Mitigation Administration	642	0.7%	7.7%
Total Mitigation Hours	**8.302**	**8.9%**	**100.0%**

Figure 3 – Hours by task code for mitigation activities

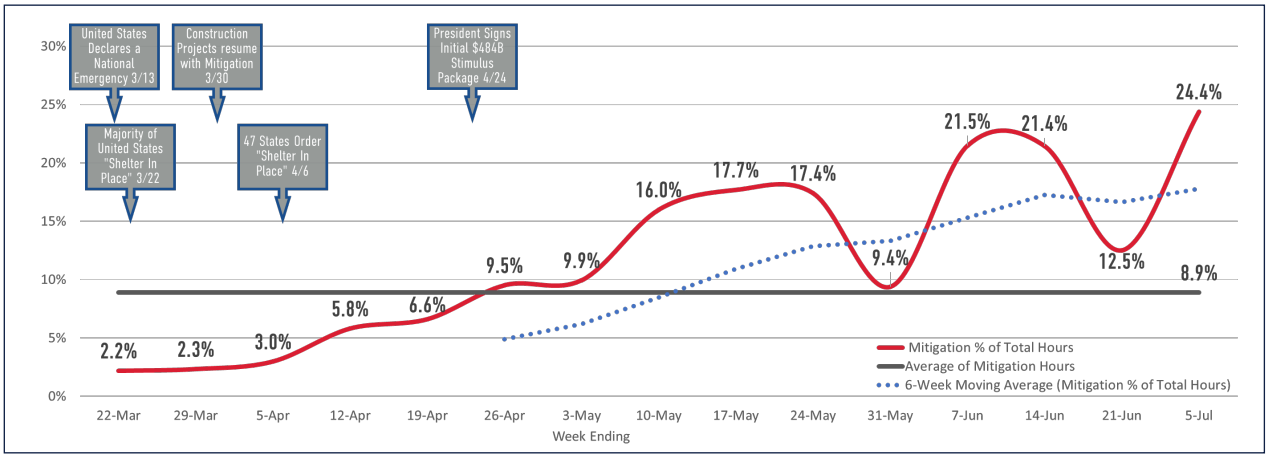


Figure 4 *– Mitigation hours as a percent of total hours by week*

Figure 4 provides a chart showing mitigation hours as a percentage of the total hours worked during each weekly period.

Summary Findings

On average, electrical contractors experience a daily 8.9% loss of production due to pandemic mitigation activities. Over 71% of the loss is due to the combined effects of distancing, access, cleaning and disinfecting activities. During an active pandemic, these are activities that crews manage throughout each day.

The next 21% of the loss is due to pandemic-specific safety and training meetings, toolbox talks, orientations, medical screenings, personal protective equipment fitting and training, etc. that occur on a more periodic basis.

The final 8% of lost time occurs due to pandemic-related administration such as additional paperwork, managing suspected cases and additional work coordination due to increased complexity in managing workflow. These activities are typically managed via onsite supervision.

In general, contractors should not be required to itemize the overall 8.9% mitigation loss into sub-categories since all categories require management on active projects during a pandemic. Federal distancing guidelines, OSHA requirements, and the resulting general contractor and subcontractor safety plans apply to most projects, regardless of region or type. For example, the following existing standards are referenced by OSHA as applicable in times of pandemic and apply to all projects across the country:

- 29 CFR § 1904, Recording and Reporting Occupational Injuries and Illness
- 29 CFR § 1910.132, General Requirements - Personal Protective Equipment
- 29 CFR § 1910.133, Eye and Face Protection
- 29 CFR § 1910.134, Respiratory Protection
- 29 CFR § 1910.141, Sanitation
- 29 CFR § 1910.145, Specification for Accident Prevention Signs and Tags
- 29 CFR § 1910.1020, Access to Employee Exposure and Medical Records
- Section 5(a)(1), General Duty Clause of the OSH Act

It is possible that local, state, owner-driven, or contractor-specific mitigation requirements could affect the degree and complexity required to comply with mitigation requirements. In such cases, contractors should use the 8.9% loss as a baseline from which modifications specific to their situation are made. Factors to consider are provided in the "Roadmap" section that follows.

Is the situation improving with time? It is too early to tell. It is reasonable to expect that the early uncertainty surrounding the necessity and degree of mitigation requirements will ease as the specific disease is better understood and enforcement agencies more clearly define requirements. It is also reasonable to expect that contractors will improve their ability to cope with mitigation requirements as time goes on, provided they know what to expect. Until then, to assess the degree of impact they will experience, contractors should consider several factors that will modify the current average including:

- GC/CM/Owner Site-Specific Safety Plans
- GC/CM Site Logistics Plans
- Quality of Work Coordination
- Local, state, or other modifiers to Federal Guidelines

With the number of hours and projects sampled, 8.9% is a solid calculation of the current average loss experienced daily by contractors across the country with a margin of error of ±3%.

Roadmap

Contractors should utilize the average loss in productivity in the following scenarios:

- Use the average provided (and the calculator provided as backup) to prepare change orders requesting relief for the time lost due to managing pandemic mitigation requirements.
- Use the average provided as a multiplier on an active project to forecast financial projections, schedule impact, and resource availability.
- Use the average provided as a multiplier both for estimating projects that will require pandemic mitigation factors as projects re-open and for future projects, assuming prolonged mitigation requirements.

Factors that should be considered as modifications to the baseline average include but are not limited to:

- Detailed knowledge of federal, OSHA, and CDC applicable guidelines and directives.
- Local and state modifiers or additions to federal, OSHA, and CDC guidelines and directives.
- Availability and clarity of owner, GC/CM project-specific safety plans.
- Project-specific characteristics that influence social distancing and logistics.
- Relationships with the GC/CM.

It should be noted that some traditional methods of schedule acceleration, such as additional manpower or overtime, are either not possible due to the nature of pandemic mitigation guidelines and directives or will compound the effects of activities such as waiting for access to work areas or gaining access to trailers for medical screenings, to name a few.

Contractors should look to their local NECA Chapters for news and information regarding additional training and education as well as updates to the data provided.

Productivity Change Order Calculator and supplemental educational videos:
https://electri.org/product/pandemics-and-construction-productivity-quantifying-the-impact/

Part II
Productivity Benchmarking

Objective

The aim of the Productivity Benchmarking had three elements:

1. Measure electrical contractor companies' pre- and post-pandemic direct work productivity
2. Measure the impacted tasks by market segment, project/job type and geographic area
3. Provide analysis, summary findings, and a roadmap to operationalize the results

To achieve this objective, the research consultants established a model to normalize data and provide a consistent and structured manner in which to collect and analyze the productivity data. More specifically, the consultant team:

- Documented specific tasks designed by an ELECTRI-designated Task Force. This enabled collection of percent completed and hours for common tasks across companies by market segment
- Constructed a formalized data gathering process from multiple electrical contracting companies across the US
- Defined specific critical dates that impacted contractor productivity (i.e. – Shelter-in-place orders)
- Measured, tracked, mapped and analyzed the data provided by contractors
- Built analytics models to generate insights into data and then summarized the results
- Utilized a double-blind methodology to ensure confidentiality with only the project leader (Maxim Consulting) knowing which contractor's data are aggregated in the results
- Provided contractors who participated in the study an individualized profile of their results versus the national numbers to assist them further with their quantification

Data Collection and Methodology

The Collection Process

The data collection process involved the generation of large amounts of data from contractors who provided the information using a formalized template.

For each data point, the project consultants collected the following information from contractors:

- Market Segment
- Project ID
- Project/Job Name
- Project/Job Type
- Location City
- Location State
- Contact Person
- Contact Person Phone
- Week Start Date
- Week Date
- Task Code
- Percent Complete
- Hours
- Week of Data Collection

Contractors received a specific selection of options for the Project/Job Type based on the federal government's establishment of essential projects:

- Chemical
- Commercial Facilities
- Communications
- Critical Manufacturing
- Dams

- Defense Industrial Base
- Emergency Services
- Energy
- Financial Services
- Food and Agriculture
- Government Facilities
- Healthcare and Public Health
- Information Technology
- Nuclear Reactors, Materials, and Waste
- Transportation Systems
- Water and Wastewater Systems
- Other (in any instance in which a specific state had a departure from the federal list)

Contractors received specific selection options for the Market Segment:

- Vertical Construction (high rise, mid-rise, commercial, healthcare, etc.)
- Horizontal Construction (traffic signalization, streets and bridges, agriculture, etc.)
- Line Construction (power transmission and distribution, substations, etc.)
- Systems only Construction (i.e. – fire alarm, low voltage, etc.)
- Maintenance (facility maintenance, etc.)

Data were normalized by providing contractors with the specific definition for the Task Codes associated with each Market Segment:

Market Segment	Task Code	Definition
Vertical	Underground	Utility and Communication Conduits, Site Lighting, Pole Bases, Trenching, Utility Transformer Pad, Ductbank, Secondary Feeder Conduits to Service, Vaults.
Vertical	In Slab	Branch Distribution Raceways (power, lighting, equipment), BAS Raceways, Feeder/Power Distribution Raceways. Life Safety & Communication Raceways, if acceptable.
Vertical	Overhead Rough In	Power, Lighting, and Equipment Raceways, Life Safety Raceways, Communications Raceways, BAS Raceways, Feeder Raceways if Not in Slab, Branch Home Runs.
Vertical	In Wall Rough In	The "In The Wall" Portion of the Raceway That Needs to Be Concealed in a Wall for Switches, Receptacles, Communication, Life Safety, BAS Devices, any Miscellaneous Equipment That Needs a Wall Rough In.
Vertical	Wire Pulling	Wire & Cable Installations for all Systems Below Slab or Overhead. Feeder Wire, Branch Power, Branch Lighting and Equipment Wire, Life Safety, Communications, and BAS Cabling.
Vertical	Trim	Light Fixture Installation, Power and Lighting Device Installation, Life Safety, Communication, and BAS Device Installation.
Vertical	Electric & Equipment Rooms	Switchboards, Panelboards, Electrical Switching Devices, VFD's, Mechanical Equipment Connections (HVAC, Plumbing, Process, etc.)
Horizontal	Traffic Signals	Below Grade Work, Set Poles & Equipment, Wiring.
Horizontal	Street Lighting	Below Grade Work, Set Poles & Luminaires, Wiring.
Horizontal	Interconnect	Below Grade Work, Below Grade Wiring, Overhead Work (if applicable).
Line Construction	Mobilization/ Demobilization	Mobilization/Demobilization of equipment, tooling and manpower to project. Includes warehouse support, trucking, on-boarding and establishment of laydown/office areas.

Market Segment	Task Code	Definition
Line Construction	Drilling/Pole Setting	Drilling of pole holes including caisson foundations, setting of wood/steel poles, plump/backfill of pole, torqueing of bolts on steel monopoles.
Line Construction	Framing	All framing of the poles including cross arms, insulators, attachment plates, grounding, riser material, equipment (cutouts, reclosers, transformers, cap banks, switches, etc.).
Line Construction	Anchors/Guys	Installation of anchor types and associated guying between the pole and anchor.
Line Construction	Wire Stringing	All tasks involved with the installation of wire including pulling ropes, pulling wire, clipping in and dead ending wire, and splicing.
Line Construction	Transfers	Moving wire or equipment from old pole to new pole (typical for distribution work)
Line Construction	Removals	Removal of any poles, framing, anchors/guys, wire, etc.
Systems	General Pathways	When included in our SOW this details cable tray (outside of TR's), sleeves, cable supports, etc.
Systems	ER/TR Buildout	Telecommunication room buildout includes ladder tray, racks, cabinets, patch panels, fiber panels, UPS/PDU's, and grounding associated with ER/TR's.
Systems	Horizontal Cabling	Includes category cabling to work area outlets. Depending on scope this can also include other systems type cable. Depending on project size the technical systems (AV, sound masking, paging, fire alarm, nurse call, etc.) would constitute a separate cost code.
Systems	Backbone Cabling	Includes copper, fiber, and coax type backbone cable between main ER and all associated TR's.
Systems	Horizontal Cable Termination & Testing	Includes terminating and testing both headend and station end cabling. This also can be broken out by floor, area, etc. depending on project size with separate cost codes for each. Also includes face plates and labeling.
Systems	Backbone Cable Termination & Testing	Includes termination and testing of all backbone cabling. This also can be broken out by floor, area, etc. depending on project size. Also includes patch panel labeling.
Maintenance	UPS Maintenance	Mobilize/Demobilize, Facility Check-in Process, OEM Operational Testing, Battery Access/Inspections, Load Bank Testing, Test Reports Data Gathering, OEM Supply Chain Scheduling.
Maintenance	Batteries Maintenance	Mobilize/Demobilize, Facility Check-in Process, Valve Regulated Battery Testing, Flooded Cell Battery Testing, Torque and Tighten Connections, OEM Supply Chain Scheduling.
Maintenance	Generator Maintenance	Mobilize/Demobilize, Facility Check-in Process, OEM Operational Testing, Load Bank Testing, Fuel Polishing, OEM Supply Chain Scheduling.

Sample Set

The data collected for Vertical Construction were normalized into seven distinct task types:

- Underground
- In Slab
- Overhead Rough In
- In Wall Rough In
- Wire Pulling
- Trim
- Electric and Equipment Rooms

As shown in **Figure 5,** the sample data collected were geographically distributed across the country and contained many major markets.

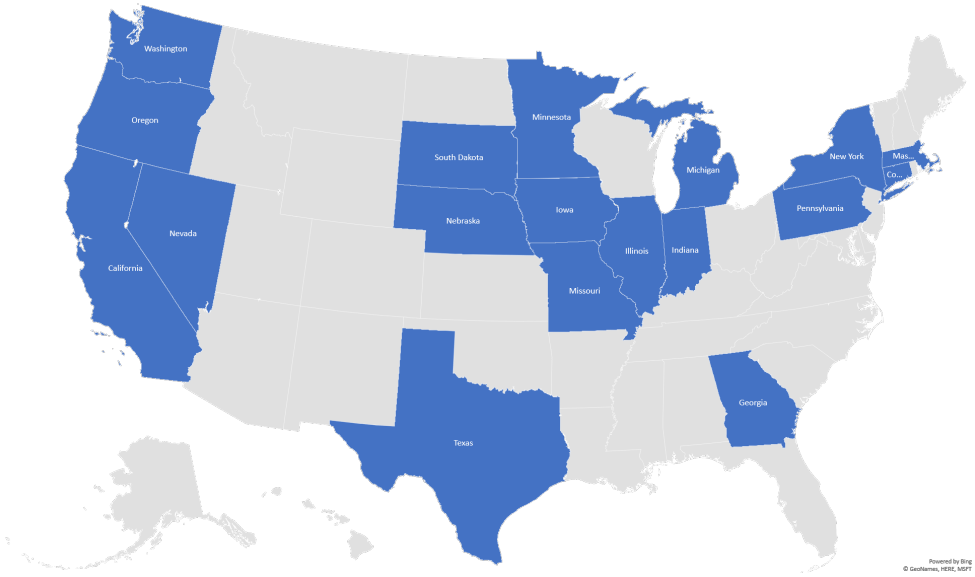


Figure 5 *– State distribution of productivity data*

Figure 6 shows the "heat map" distribution and relative number of samples from each geographic location. The largest data samples were collected from California, Illinois, Michigan, Nevada, Pennsylvania, and Washington.

Figure 7 shows productivity contrasted against external events. The researchers observed productivity reactions to specific external events and a general improvement trend with negative productivity impact from March 29th through May 3rd.

While the study shows that the overall average impact on work productivity is 12.9%, **Figure 8** illustrates that certain task types clearly take a more significant impact to productivity. **The tasks that showed the greatest impact to work productivity, primarily due to close proximity of workers** were:

- **Overhead Rough In**
- **In Wall Rough In**
- **Trim**

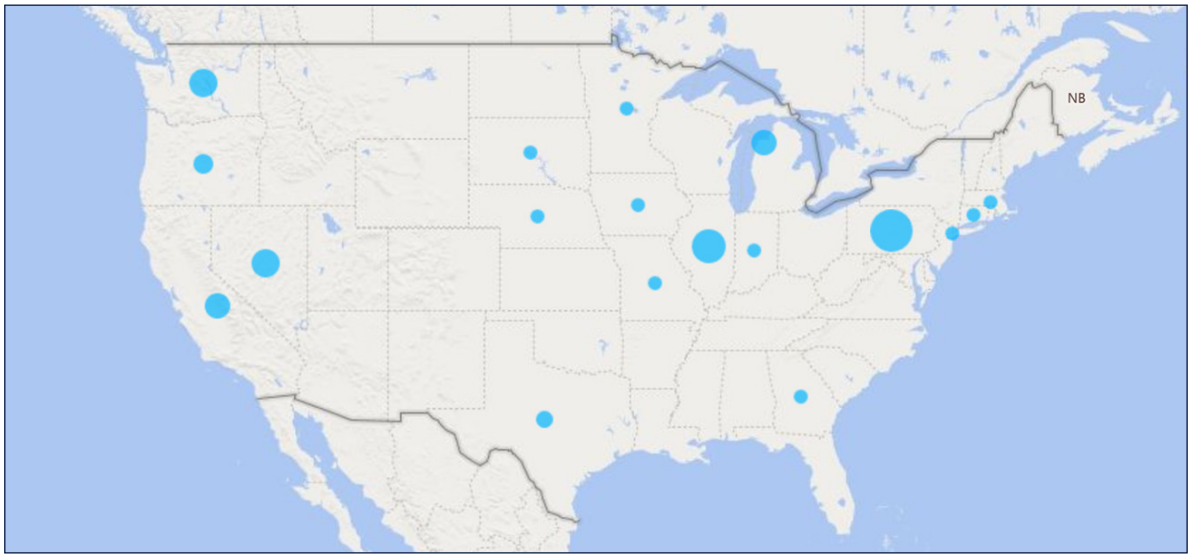


Figure 6 – *Concentration heatmap of sample set data areas of United States*

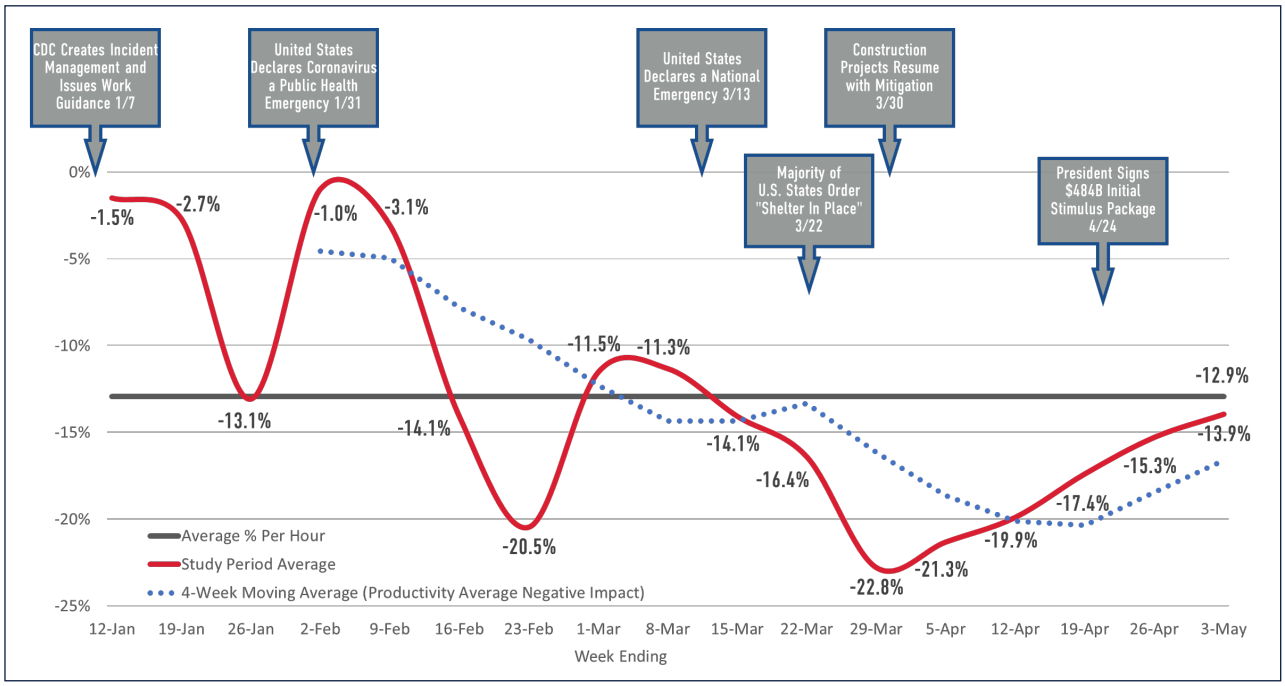


Figure 7 – *Vertical construction productivity against events*

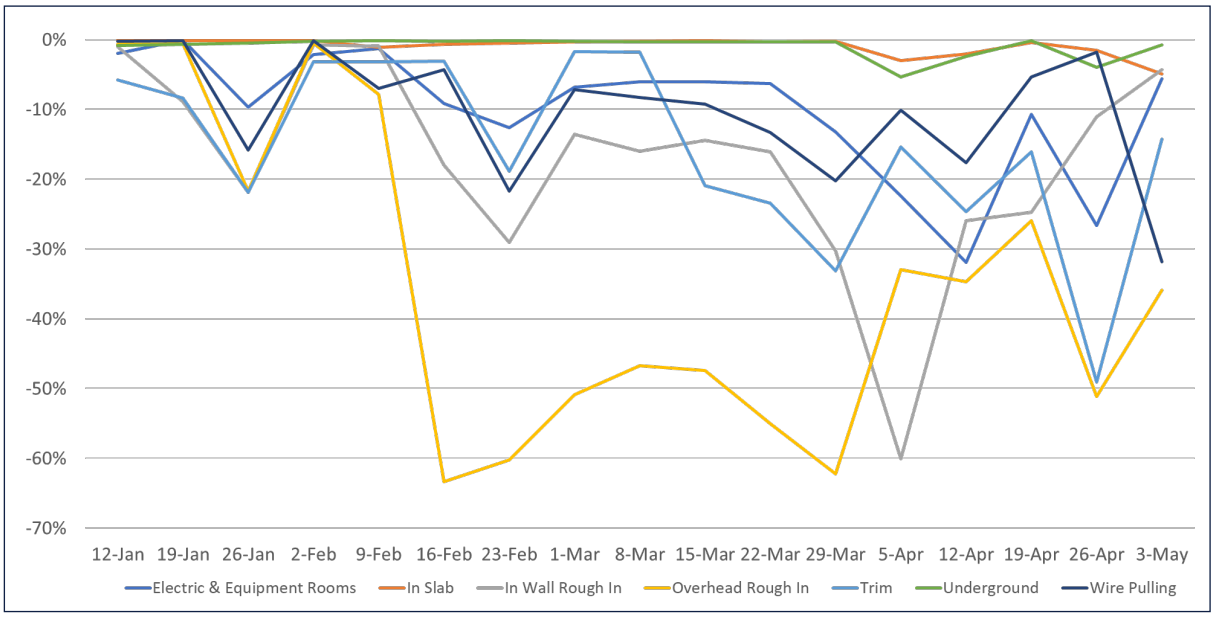


***Figure 8** – Vertical construction productivity by task type against period*

Summary Findings

This study indicates a 12.9% overall average pandemic impact on Vertical Construction productivity. Based on the current data, the result is 62 minutes of lost productivity per day per employee 8-hour work period. This is in addition to the daily 8.9% loss of production due to pandemic mitigation activities, creating a total productivity loss of 21.8%. This means, on average, there is a total productivity loss of 105 minutes per day per employee's 8-hour work period.

Roadmap

Companies that have trended lower in productivity losses have established, organized, and trained their teams with new pandemic mitigation processes and procedures. Additionally, they have monitored and shifted work activities to accommodate required distance spacing between team members.

The baseline productivity impact of 12.9% (Productivity) + 8.9% (Mitigation) = 21.8% is substantial. Contractors should utilize this information to price an equitable adjustment properly employing both the Pandemic Change Order Calculator provided with this study and the study itself as backup verification for the impact.

Productivity Change Order Calculator and supplemental educational videos:
https://electri.org/product/pandemics-and-construction-productivity-quantifying-the-impact/

Part III
Business Impact of a Pandemic

The current pandemic has had a dramatic impact on the productivity of field and office personnel in the electrical contracting industry. Over the past few months, this impact on project acquisition, pre-fabrication, the available pipeline of projects, project execution both for the field and project management, and the interactions and payment cycle of clients have created dramatic changes.

Objective

The research for this portion of the project called upon representatives from all segments of the EC industry, both line and commercial. Data collection relied on discussion groups, case studies, and an industry Flash Survey to untangle and characterize objectively the relationship between productivity and this pandemic. The objective was to develop of a set of best practices and identify necessary education and training that would enable electrical contractors to better manage their projects and businesses and mitigate the impact of a pandemic on their field and project management staff.

Data Collection and Methodology

Using discussion groups, case studies and an industry survey, as noted above, the researcher collected anecdotal data on the impacts the pandemic has had on electrical contractors beyond those impacts on their labor productivity. The four discussion groups and ten case studies focused on the ways electrical contractors were able to adapt their business practices working remotely, allow for social distancing in the workplace, and identify new ways of interacting with suppliers and clients working from home.

The survey focused on gathering data that pertain to impacts on the jobsite, project management, overall business operations, and other items identified by the participants themselves. Participants indicated the impacts in each of these four areas as High, Medium, Low or No impact. This format allowed the researcher to quantify the relative magnitude of the impact within each area.

As discovered in the discussion groups and case studies, impacts varied dramatically, based on the type of construction. Contractors mentioned that large HealthCare projects managed by National CM/GC firms seemed to be the most impacted. For some smaller work involving a crew of one, contractors actually reported improved productivity. In some instances, contractors used the absence of workers in client facilities to increase their sell-additional-work volume. This approach helped ECs take care of projects that, during normal times, clients might not have had the time or access to start.

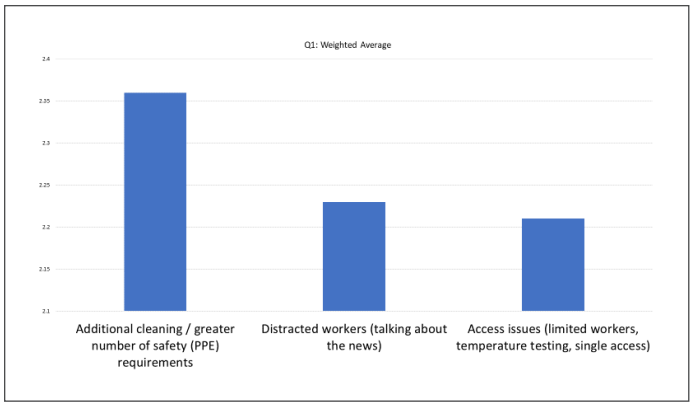
Contractors identified their top three impacts using this scale:

3 = High Impact
It has resulted in significant financial harm to your business
2 = Medium Impact
It has resulted in some financial loss to your business
1 = Low Impact
It has not impacted your financials in a meaningful way
0 = No Impact
Absolutely no impact on your financials.

Jobsite Impacts

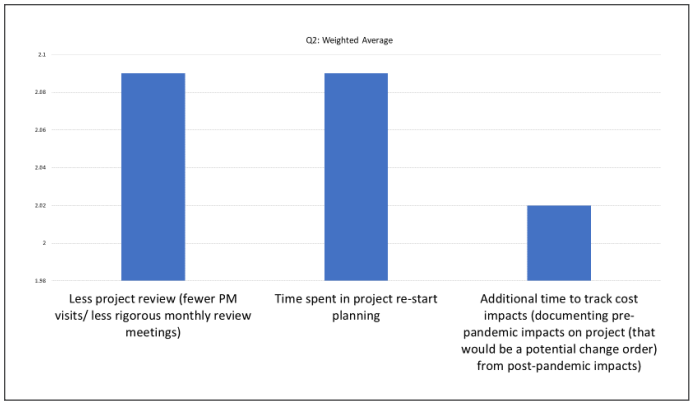
Contractors reported their three most significant jobsite impacts were **additional cleaning and the greater number of safety (PPE) requirements.** On this point, 89% of the participating contractors

indicated this had a High or Medium financial impact, with an average of 2.32. The second highest impact was from **distracted workers discussing the news** with 80% of the contractors stating this had a High or Medium financial impact, with an average of 2.26. Note: this topic had the highest number of contractors selecting this as High impact at 44%) The third highest impact area was **Access issues (limited workers, temperature testing, single access),** coming in at 83% of contractors indicating this had a High or Medium financial impact, with an average of 2.23.



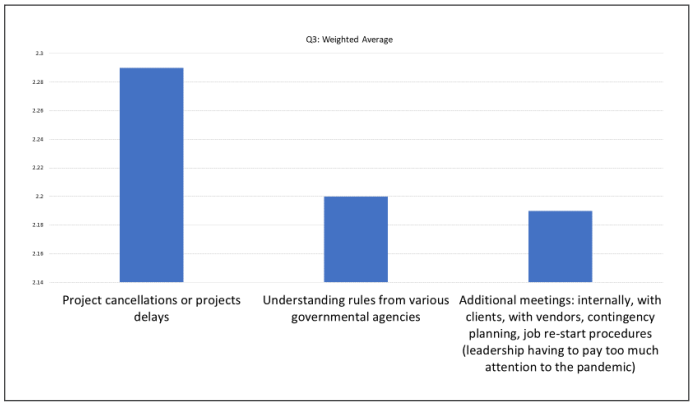
Project Management Impacts

Contractors reported their three most significant project management impacts were **less project review (fewer PM visits/less rigorous monthly review meetings).** For this factor, 73% of the contractors indicated a High or Medium financial impact, with an average of 2.15. The second highest impact was from **additional time to track cost impacts (documenting pre-pandemic impacts on a project (that would be a potential change order) from post-pandemic impacts).** Here, 75% of the contractors rated this as a High or Medium (selected by 2/3 of the contractors) financial impact, with an average of 2.04. The third highest impact area at 71% was **time spent in project re-start planning.** Contractors indicated this had a High or Medium financial impact, also with an average of 2.04.



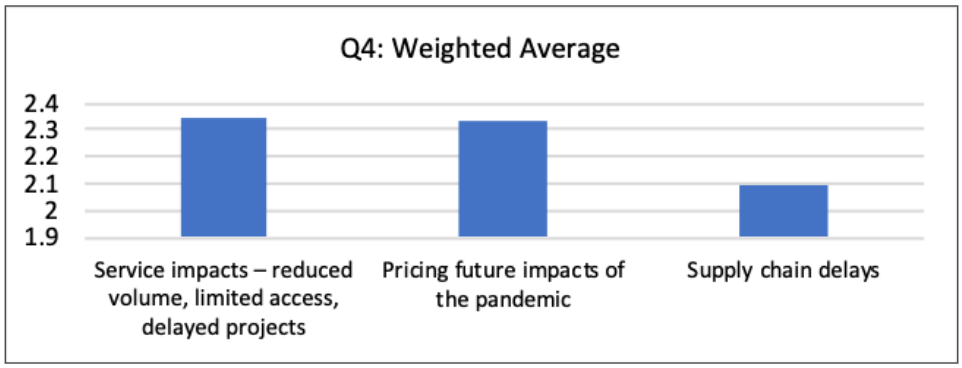
Business Impacts

Contractors noted their three most significant business impacts were **project cancellations or project delays.** For this topic, 86% of the contractors reported a High or Medium financial impact. This particular impact also had the highest overall average of any item in the survey at 2.34. The second highest impact concerned **additional meetings: internally, with clients, with vendors, contingency planning, job re-start procedures (leaders having to pay too much attention to the pandemic).** For this, 82% of the contractors indicated a High or Medium financial impact, with an average of 2.22. The third highest impact area was **understanding rules from various governmental agencies,** with 76% of contractors noting this had a High or Medium financial impact, also with an average of 2.18.



Other Impacts

Contractors reported their top two most significant other impacts were **pricing future impacts of the pandemic** with 84% of the contractors indicating these had a High or Medium financial impact and an overall average of 2.34. Following closely was **service impacts – reduced volume, limited access, delayed projects** with 83% of the contractors indicating these had a High or Medium financial impact and an overall average of 2.33. The third highest impact area was **supply chain delays**, with 78% of contractors noting this had a High or Medium financial impact and an average of 2.09.



Operationalizing the Findings with Best Practices

Following the analysis of the interviews and case studies, these best practices are offered to help electrical contractors better manage a future pandemic. The argument can also be made that these are best practices for the EC industry – with or without a pandemic environment.

1. Follow notice requirements detailed in your contract. Do not give away your rights by not following the contract.
2. Rely on NECA for current information. Identify and assign one person (or more) in your organization to keep up with changes that may be announced several times per day.
3. Include the cost of a pandemic in any quotation for future work. This would apply to both changes in field productivity and the cost of meeting pandemic requirements such as limited access, health documentation, temperature screening, etc.
4. Understand and ensure that fair Force Majeure and delay clauses are included in your contract. Some contractors reported contracts specifically identifying this pandemic as a known item, thereby excluding known items from any possible Force Majeure clauses
5. Track accounts receivable and follow-up quickly. Due to the nature and timing of this research initiative, many participating contractors had not yet experienced significant slowdowns in their accounts payable. They attributed that fact to the short horizon they are experiencing thus far during this pandemic. Most thought those financial impacts would be felt 60 to 90 days after a billing cycle had been completed.
6. Manage the firm's cash and learn whether there are governmental program changes that allow the company

to borrow or defer payments. To "hoard" or keep cash, contractors reported the need to understand what programs can help with cash flow and how to use the firm's bank to negotiate better line-of-credit terms.

7. Small contractors, especially, must make sure to find the time to work "on" the business rather than just "in" the business. Many small business owners indicated that, after working in the field all day, it was difficult to keep up with rapidly changing information.
8. Ensure the company's technology is sufficient to support remote work. Some contractors reported forced investment in technologies rather than planned investment. In those situations, they noted that cost inefficiencies occurred due to the need to purchase quickly, whether the item was communication technology/bandwidth or large numbers of laptops. For the longer term, some contractors are planning for a more robust system to manage payroll, purchasing, and job costs.
9. Encourage diversification within market segments. Contractors who seemed most impacted were those heavily reliant on a single market segment that itself was significantly impacted. For example, in this pandemic, the automotive, hospitality, and retail markets all experienced a much bigger negative impact than other market segments.
10. Keep an appropriate stock of PPE equipment. For some electrical contractors, the purchasing manager spent the entire day for multiple weeks trying to locate needed PPE. Anticipate future changes and requirements (face shields, cleaning solutions, etc.) with which companies may be forced to comply.

Appendix A

Pandemic Mitigation Tracking Data Collection Definitions & Tools

Figure 9 *– Pandemic mitigation app data collection tool*

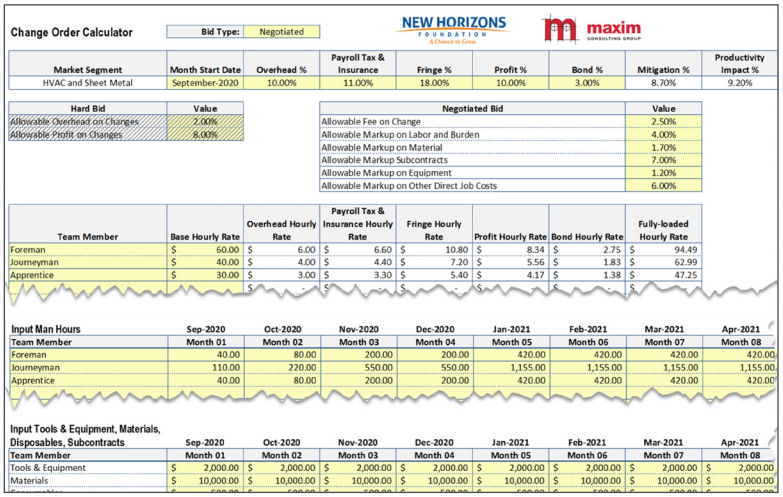
Cost Code Definitions		
Cost Code	**Cost Code Name**	**Example activities in Cost Code**
100	Total Crew Hours Worked	Sum of all labor hours worked on your project for the day.
200	COVID Safety & Training	Any/all forms of time lost due to COVID-specific safety huddles, orientations, respirator training & fitting, equipment handling, air flow equipment maintenance, sneeze shielding, etc.
201	COVID Distancing & Access Rules	Any/all forms of time lost due to site logistics, waiting to access work areas, waiting on medical screening, extra distance walking to lunch tents, additional coordination or reworking due to inaccessible work areas, etc.
202	COVID Cleaning & Disinfecting	Any/ all forms of time lost due to COVID-related cleaning, disinfecting, personal hygiene, filter management, disposal, etc.
203	COVID Administration	Any/ all forms of time lost due to COVID-related administration, paperwork, management of suspect or positive cases, additional work coordination meetings, etc.

Figure 10 *– Pandemic mitigation app activity definitions*

Appendix B

Productivity Change Order Calculator

Change Order Calculator Input



Change Order Calculator — Bid Type: Negotiated

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Market Segment	Month Start Date	Overhead %	Payroll Tax & Insurance	Fringe %	Profit %	Bond %	Mitigation %	Productivity Impact %
HVAC and Sheet Metal	September-2020	10.00%	11.00%	18.00%	10.00%	3.00%	8.70%	9.20%

Hard Bid	Value
Allowable Overhead on Changes	2.00%
Allowable Profit on Changes	8.00%

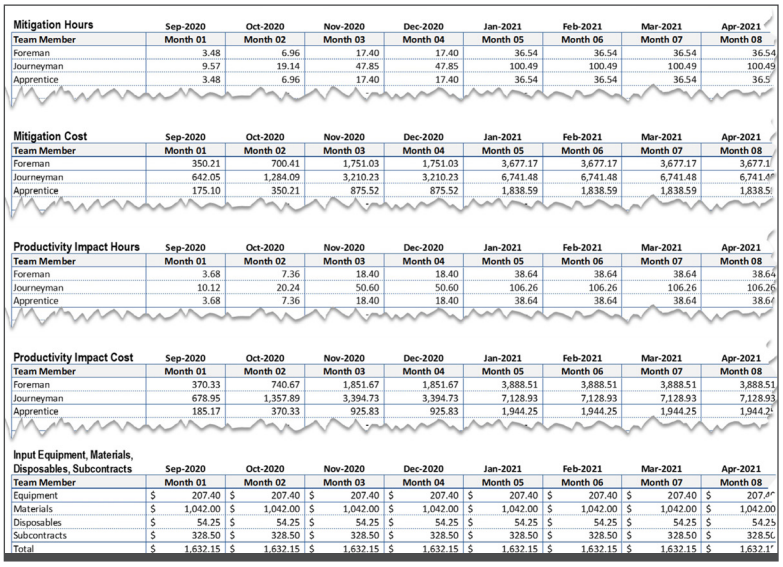
Negotiated Bid	Value
Allowable Fee on Change	2.50%
Allowable Markup on Labor and Burden	4.00%
Allowable Markup on Material	1.70%
Allowable Markup Subcontracts	7.00%
Allowable Markup on Equipment	1.20%
Allowable Markup on Other Direct Job Costs	6.00%

Team Member	Base Hourly Rate	Overhead Hourly Rate	Payroll Tax & Insurance Hourly Rate	Fringe Hourly Rate	Profit Hourly Rate	Bond Hourly Rate	Fully-loaded Hourly Rate
Foreman	$ 60.00	$ 6.00	$ 6.60	$ 10.80	$ 8.34	$ 2.75	$ 94.49
Journeyman	$ 40.00	$ 4.00	$ 4.40	$ 7.20	$ 5.56	$ 1.83	$ 62.99
Apprentice	$ 30.00	$ 3.00	$ 3.30	$ 5.40	$ 4.17	$ 1.38	$ 47.25
		$ -	$ -	$ -	$ -	$ -	$ -

Input Man Hours — Team Member	Sep-2020 Month 01	Oct-2020 Month 02	Nov-2020 Month 03	Dec-2020 Month 04	Jan-2021 Month 05	Feb-2021 Month 06	Mar-2021 Month 07	Apr-2021 Month 08
Foreman	40.00	80.00	200.00	200.00	420.00	420.00	420.00	420.00
Journeyman	110.00	220.00	550.00	550.00	1,155.00	1,155.00	1,155.00	1,155.00
Apprentice	40.00	80.00	200.00	200.00	420.00	420.00	420.00	420.00

Input Tools & Equipment, Materials, Disposables, Subcontracts — Team Member	Sep-2020 Month 01	Oct-2020 Month 02	Nov-2020 Month 03	Dec-2020 Month 04	Jan-2021 Month 05	Feb-2021 Month 06	Mar-2021 Month 07	Apr-2021 Month 08
Tools & Equipment	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00
Materials	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00

Change Order Calculator Detail



Mitigation Hours — Team Member	Sep-2020 Month 01	Oct-2020 Month 02	Nov-2020 Month 03	Dec-2020 Month 04	Jan-2021 Month 05	Feb-2021 Month 06	Mar-2021 Month 07	Apr-2021 Month 08
Foreman	3.48	6.96	17.40	17.40	36.54	36.54	36.54	36.54
Journeyman	9.57	19.14	47.85	47.85	100.49	100.49	100.49	100.49
Apprentice	3.48	6.96	17.40	17.40	36.54	36.54	36.54	36.5

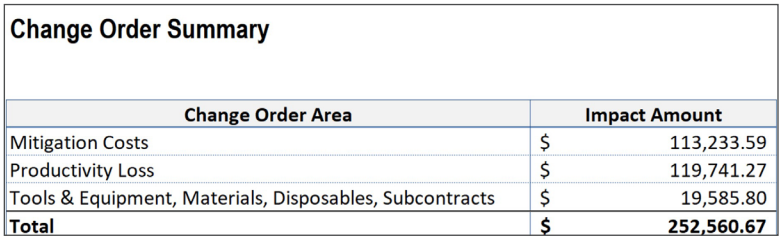
Mitigation Cost — Team Member	Sep-2020 Month 01	Oct-2020 Month 02	Nov-2020 Month 03	Dec-2020 Month 04	Jan-2021 Month 05	Feb-2021 Month 06	Mar-2021 Month 07	Apr-2021 Month 08
Foreman	350.21	700.41	1,751.03	1,751.03	3,677.17	3,677.17	3,677.17	3,677.1
Journeyman	642.05	1,284.09	3,210.23	3,210.23	6,741.48	6,741.48	6,741.48	6,741.4
Apprentice	175.10	350.21	875.52	875.52	1,838.59	1,838.59	1,838.59	1,838.5

Productivity Impact Hours — Team Member	Sep-2020 Month 01	Oct-2020 Month 02	Nov-2020 Month 03	Dec-2020 Month 04	Jan-2021 Month 05	Feb-2021 Month 06	Mar-2021 Month 07	Apr-2021 Month 08
Foreman	3.68	7.36	18.40	18.40	38.64	38.64	38.64	38.64
Journeyman	10.12	20.24	50.60	50.60	106.26	106.26	106.26	106.26
Apprentice	3.68	7.36	18.40	18.40	38.64	38.64	38.64	38.64

Productivity Impact Cost — Team Member	Sep-2020 Month 01	Oct-2020 Month 02	Nov-2020 Month 03	Dec-2020 Month 04	Jan-2021 Month 05	Feb-2021 Month 06	Mar-2021 Month 07	Apr-2021 Month 08
Foreman	370.33	740.67	1,851.67	1,851.67	3,888.51	3,888.51	3,888.51	3,888.51
Journeyman	678.95	1,357.89	3,394.73	3,394.73	7,128.93	7,128.93	7,128.93	7,128.93
Apprentice	185.17	370.33	925.83	925.83	1,944.25	1,944.25	1,944.25	1,944.2

Input Equipment, Materials, Disposables, Subcontracts — Team Member	Sep-2020 Month 01	Oct-2020 Month 02	Nov-2020 Month 03	Dec-2020 Month 04	Jan-2021 Month 05	Feb-2021 Month 06	Mar-2021 Month 07	Apr-2021 Month 08
Equipment	$ 207.40	$ 207.40	$ 207.40	$ 207.40	$ 207.40	$ 207.40	$ 207.40	$ 207.4
Materials	$ 1,042.00	$ 1,042.00	$ 1,042.00	$ 1,042.00	$ 1,042.00	$ 1,042.00	$ 1,042.00	$ 1,042.00
Disposables	$ 54.25	$ 54.25	$ 54.25	$ 54.25	$ 54.25	$ 54.25	$ 54.25	$ 54.25
Subcontracts	$ 328.50	$ 328.50	$ 328.50	$ 328.50	$ 328.50	$ 328.50	$ 328.50	$ 328.5
Total	$ 1,632.15	$ 1,632.15	$ 1,632.15	$ 1,632.15	$ 1,632.15	$ 1,632.15	$ 1,632.15	$ 1,632.1

Change Order Calculator Output



Change Order Summary

Change Order Area	Impact Amount
Mitigation Costs	$ 113,233.59
Productivity Loss	$ 119,741.27
Tools & Equipment, Materials, Disposables, Subcontracts	$ 19,585.80
Total	**$ 252,560.67**

Productivity Change Order Calculator and supplemental educational videos:
https://electri.org/product/pandemics-and-construction-productivity-quantifying-the-impact/

Appendix C

Double-Blind Productivity Benchmark Participant Survey

The research study utilized a double-blind methodology to observe pre- and post-pandemic construction productivity impacted by behavioral interventions. Blinding or masking refers to the withholding of information regarding treatment allocation from one or more research study participants. It is an essential methodological feature of studies that helps maximize the validity of the research results.

The Consulting Research Team

Michael McLin, Managing Director at Maxim Consulting Group, works with construction-related firms of all sizes to evaluate their business practices and assist with management challenges. His areas of specialization include organizational assessments, strategic planning, project execution, productivity improvement, prefabrication, peer groups, and training programs. McLin has consulted with some of the most sophisticated contractors in the U.S. and his industry experience includes some of the most complex construction projects undertaken across the country. He is adept at utilizing available tools and analysis to identify opportunities and challenges within an organization. In addition to his expertise in many facets of the construction world, McLin is a nationally-recognized public speaker and published author.

Dan Doyon, Director at Maxim Consulting, works with construction-related firms to solve complex business challenges that drive revenue and profitability. His broad experience in business process improvement across construction and related industries provides him with a unique perspective to identify and solve operational issues. His subject expertise includes organizational assessments, strategic business planning, financial planning and analysis, technology, organizational design and transition, productivity improvement, peer groups, and prefabrication system design. With his guidance and recommendations, companies have driven over $160 billion in top line sales growth and hundreds of millions in operational savings through improved processes.

Brian Lightner, Associate Director at Maxim Consulting, is responsible for client evaluation and implementation processes. His extensive work with construction firms, including the first ISO 9000 certified General Contractor in the U.S., has focused on process improvement initiatives. He is keenly aware of the challenges that contractors face, including in their field operations. Lightner's areas of expertise include project planning/scheduling/execution; field productivity assessments; project recovery; and process improvement/integration/standardization. His experience with both construction specialties and highly-successful general contractors allows him to execute many exemplary field operation and productivity studies.

Mark Federle, Associate Dean for Academic Affairs at Marquette University, is a licensed Professional Engineer and Certified Professional Constructor. Prior professional engagements include serving as Chief Information Officer for The Weitz Company (Des Moines) and as Professor-in-Charge of Iowa State University's Construction Engineering program. He was elected to the National Academy of Construction in 2018 and is a Fellow of ASCE. Since the mid-1990s, Federle has worked with ELECTRI International and NECA as a researcher and instructor and has published extensively on electrical contracting in ELECTRICAL CONTRACTOR magazine.

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Index Number # F3434