Data Analytics in Construction Safety

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Agenda

1. Review and Comparison
2. Case Study
3. Construction Safety under Covid

Review And Comparison

- Wearable Sensors
- Predictive Analytics
- Virtual Reality

Review and Comparison

Fatal Construction injuries:

- Roughly 20% of workers deaths in the United States are in Construction, but construction workers make up only 6% of the U.S. labor force.
- A total of 1,008 construction workers died on the job in 2020.
- 0.1% of construction workers suffer a fatal injury, which is the third highest rate of any industry.

Non-Fatal Construction Injuries:

- Each year, 1.1% of construction workers suffer an injury serious enough that they miss work.
- The construction industry accounts for 6% of all injuries that result in lost days of work.
- Injury and illness rates in construction were 24% higher than they were across all industries on average in 2020.
- In 2020, there were 174,100 cases of injuries in the construction sector.

BigRentz, Inc. “Bigrentz.” *BigRentz*, 9 Mar. 2022, https://www.bigrentz.com/blog/construction-safety-statistics#fatal.

Review and Comparison

Wearable Sensors

Predictive Analytics

Virtual Reality

Review and Comparison

	How it works
Wearable Sensors	Measuring: Kinematic Movements, Cardiac Activity, Skin Response, Muscle Engagement, Eye Movements, and Brain Activity
Predictive Analytics	Analyze the collecting data, Rank the list of projects from most to least likely, and Use dashboards to show results such as high, medium or low.
Virtual Reality	Simulating PPE Training in Virtual Reality, Choosing a VR Platform, Sourcing Our 3D Assets, Lighting Up The VR Environment, Creating The Instructional Board, Adding Sound Effects To VR Objects, Overcoming Challenges with VR Objects

Quatela, Dave. “Home.” VisionThree, https://visionthree.com/.

Gattie, Tim. “Predictive-Based Safety: Reshaping Construction Insurance.” Newmetrix, 23 Mar. 2021, https://www.newmetrix.com/ai-in-construction-blog/pbs-reshaping-landscape-of-insuring-construction-projects.

Journal of construction engineering and management, 11/1/2019, ISSN: 0733-9364, Volume 145, Issue 11, p. 3119007 Professional safety, 4/1/2020, ISSN: 0099-0027, Volume 65, Issue 4, p. 16

Review and Comparison

	How it helps
Wearable Sensors	Prevent Musculoskeletal disorders, Prevent Falls, Assess Physical Workload and Fatigue, Evaluate Hazard-Recognition Abilities, Monitor Workers' Mental Status
Predictive Analytics	With predictions and prescriptions in hand, project teams are able to focus in on the details of their safety program that require attention (high, medium, and low).
Virtual Reality	Virtual reality simulations remove the risk of damaging equipment or causing injuries. With virtual reality apps, both new employees and experienced employees can learn how to use equipment and maintain safety and security protocols as they evolve. Virtual Reality can reduce the need for costly equipment and improve training accessibility.

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PASC.https://www.pasc.edu.in/wp-content/uploads/2020/08/Academic-Calender-20-21.pdf.

Sustainability Report. 29 Dec. 2020, https://s24.q4cdn.com/913789668/files/doc_downloads/sustainability-reports/2022/SustainabilityReport2021.pdf.

Review and Comparison

	Limitations
Wearable Sensors	• Signal Artifacts and Noise in Field Measurements When Using Wearable Sensors. • Variable Standards in Assessing Personal Safety and Health Risks • Uncertainty about the Return on Investment
Predictive Analytics	• Data collected from different sources could vary in quality and format • The data could be incomplete • The uncertainty of ROI • Differences between predictive results and report values • Outputs may have high degree of variability
Virtual Reality	• Lacks robust data and empirical evidence from actual users' attitude to use VR technology • Abundant rendering and animating in VR training, making trainees confused and distracted. • Participants cannot move freely in the virtual environment, which reduce the realism of the immersive experience.

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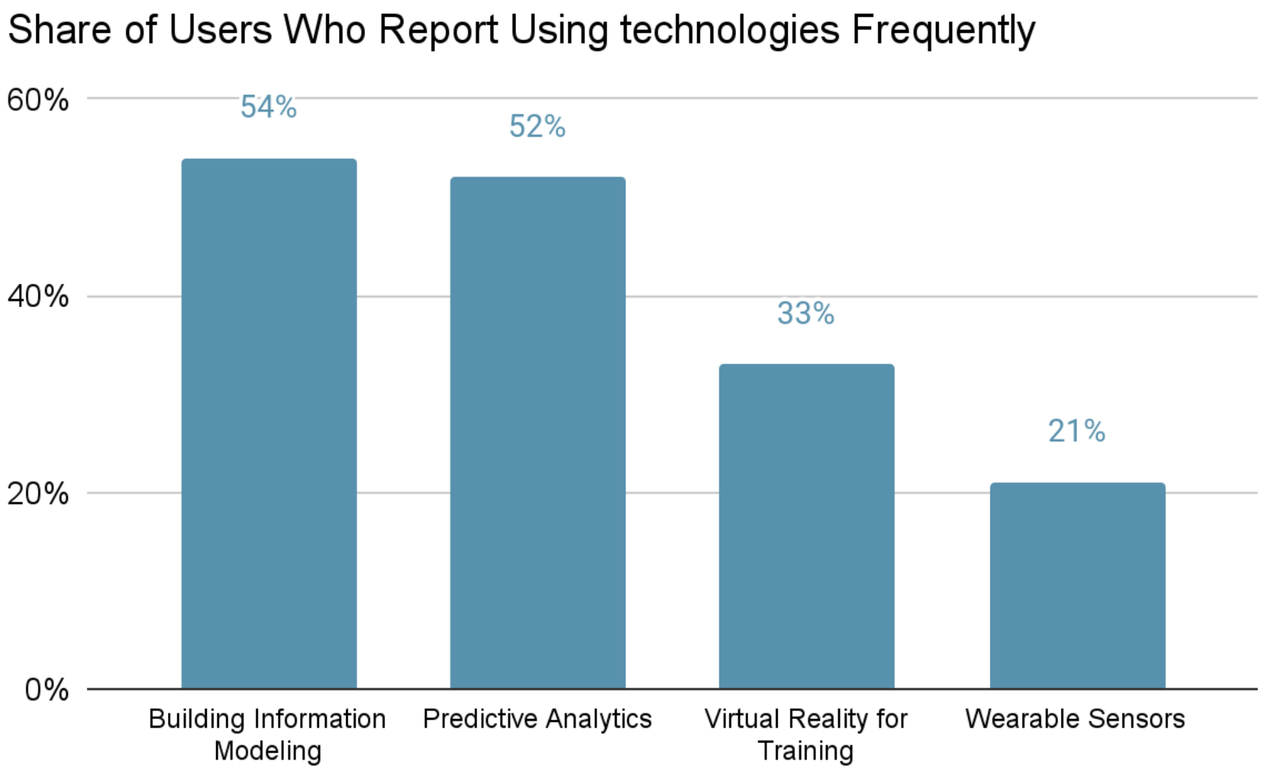
"Learning Made Easy." Dummies, https://www.dummies.com/article/technology/information-technology/ai/machine-learning/the-limitations-of-the-data-in-predictive-analytics-153988.
Gattie, Tim. "Why Safety Software Fails." Newmetrix, 23 Jan. 2021 https://www.newmetrix.com/ai-in-construction-blog/why-safety-software-fails.

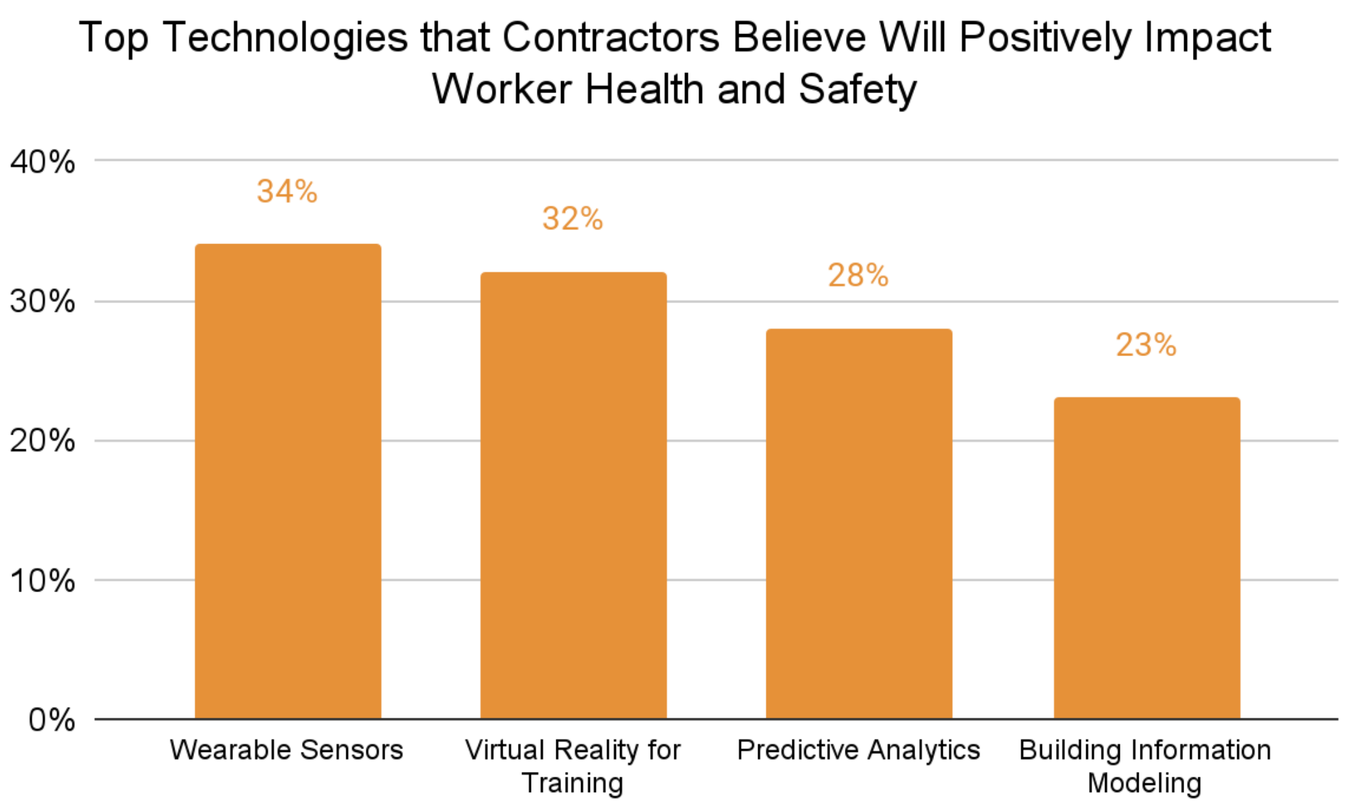
Review and Comparison



From the Dodge Data & Analytics Report in 2021, around 54% of contractors use BIM frequently, 52% of contractors often use Predictive Analytics, 33% of them use Virtual Reality for Training, and 21% of them use Wearable Sensors frequently.

Safety Management in the Construction Industry 2021. https://www.cpwr.com/wp-content/uploads/Dodge_SmartMarket_Report_2021.pdf.

Review and Comparison



This chart shows that even though the applications of Wearable sensors and Virtual Reality of Training are limited , they still share 34% and 32% respectively that contractors believe they will have positive impact on safety, 28% of contractors hold the opinion that Predictive analytics has significant impact on construction safety, and only 23% of them believe BIM will positively impact workers' health observably.

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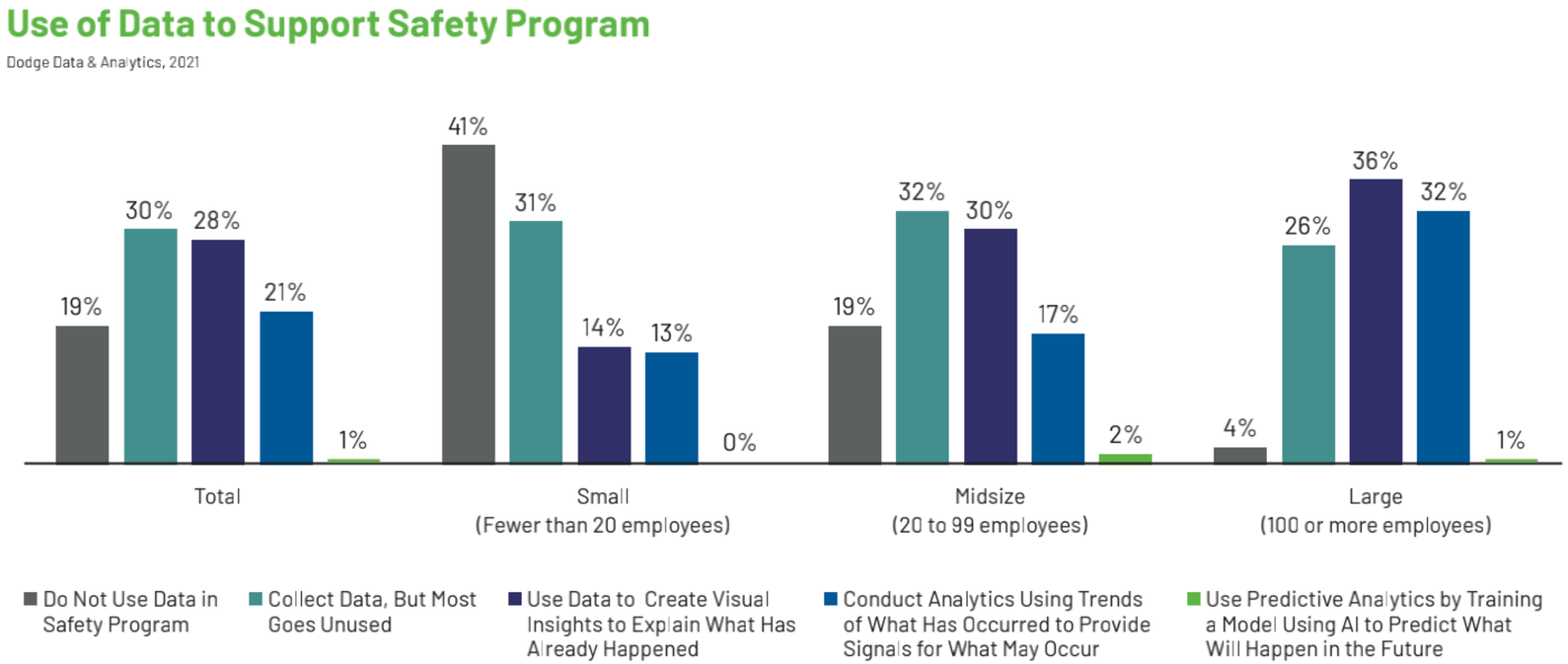
Review and Comparison



Safety Management in the Construction Industry 2021. https://www.cpwr.com/wp-content/uploads/Dodge_SmartMarket_Report_2021.pdf.

From this chart, it can be seen that large companies are more mature to analyze data, and are more likely to use data to create visual insights to explain what has already happened and provide signals to what may occur.

Our Comments & Thoughts

Each type of methods to improve construction safety has certain limitations, but some thoughts and recommendations can be come up with:

- Combining these methods with smartphones can make these applications more popular and widely used.
- Try to train more specialized data analysts in the field of construction safety.
- The public and private sectors should invest more in companies that produce hardware of these applications.
- Try to develop more efficient procedures to simplify the process of data analysis.
- Put forward a more accurate system, so that the equipment can better resist the interference of the surrounding environment.
- Design wearable sensors with higher comfort in appearance.
- Train workers to understand the theories of these applications, and promise them to protect their privacy so that they better know these technology and sincerely accept them.
- Small companies with less budget should consider to apply more economical methods to improve construction safety.

Case Study

- Wearable Sensors
- Predictive Analytics
- Virtual Reality

Wearable Sensors- T2S & Eurovia Vinci

The Challenge	T2S is a French manufacturer of high-visibility products and PPE, and a garment partner of Wearable Technologies. Eurovia is a construction company. In this project, the two companies worked together to reduce the risk of collision between workers and equipment on construction sites for Eurovia Vinci.
The Solution	• Eurovia Vinci adopted our smart garment solution, together with a compatible Proximity Warning System (PWS) to set a safe distance between workers and moving machinery on a motorway site. The worker was equipped with a smart garment featuring vibration as well as eleven LEDs, visible at 400 metres, which would flash simultaneously if the proximity warning was activated. • At the same time, the drivers of the vehicles were alerted to the proximity of the workers via a light and sound box in the cabin. This was fixed by magnet and operated wirelessly with a rechargeable battery. Outside, a light and sound beacon also signalled the machines. • The system was set up to detect proximity within a 360 degree radius and up to ten metres in distance and has become a major factor in reducing the risks of vehicle and worker collisions on hazardous sites.
The outcome	The device has been well accepted by its users and has demonstrated its effectiveness. With the Eleksen system, the fact that the two parties are alerted makes it possible to climb up a notch in terms of shared vigilance.

Eurovia Vinci(2021). Wearable Technologies Case Study. Case Study - Wearable Technologies

Takeaways

- The smart vests are common Wearable Sensing Devices(WSD) used on construction projects and can be accepted by most workers.
- The smart vests can react to potentially dangerous conditions immediately. In this project, LEDs will flash when the worker get too closer to the equipments.
- Using WSD can effectively reduce the construction injuries.

Eurovia Vinci(2021). Wearable Technologies Case Study. Case Study - Wearable Technologies

Predictive Analytics- Predictive Solutions Corporation

The Challenge	Predictive Solutions Corporation aims to save lives by predicting workplace injuries
The Solution	● Its software solutions help track, trend and analyze safety related data. ● They employ proprietary models that predict the likelihood, frequency and location of workplace injuries using its customers' safety observation data. ● Predictive solutions delivers consulting services that drive culture and process change within organizations to create sustainable safety processes that reduce injuries.
The outcome	With more than 100 million observations and nearly 40,000 reported incidents from more than 15.000 worksites around the world, Predictive Solutions has emerged as an industry leader in predicting injuries and evidence provides that workplace injuries can be really predicted.

Predictive Solutions(2012)."Predictive Analytics in Workplace Safety".

Takeaways

- More inspections predict a safer worksite to make sure your program rewards high levels of inspections
- Can include as many people as possible in your safety inspection program, have more non-safety than safety people in your program
- Allow the construction company ti fixing the unsafe observations before they cause incidents

Virtural Reality- Safety Training

Background Information	In Hong Kong, one large-scale construction company has set up its VR training in a factory building.
The Solution	In two-dimensional VR, users are immersed in a construction site environment with a simulated two-minute real-life cartoon through VR Cartoon, where they walk around construction sites. Other three-dimensional VR simulated the “fall from height” situation.
The Outcome	One of the research assistants said that he was frightened by the simulated “fall from height” VR clips. To a certain extent, that can allow learners, especially those with shadow experience, to have a deeper memory of the fall from height, leading to better safety awareness and, eventually, safety prevention.

R.Y.M Li.(2018). An Economic Analysis on Automated Construction Safety.

Takeaways

- Virtual Reality(VR) can help with construction safety by simulates real world situations
- The project manager can apply VR to safety training, construction process simulation, building structure simulation and so on
- VR can efficiently eliminate safety problems from both workers and unsafe working conditions

Construction Safety under Covid

- **Understand the Risk**
- **Implement Safety Measures**
- **Practices Instituted on Jobsites**

Understand the Risk

- Close Proximity: working close to others
- Longer Exposure: spending more time with potentially infected people
- Crowded Places: having more people in a space
- Closed Spaces: indoor spaces with less fresh air (working indoors is riskier than working outdoors)
- Forceful Exhalation: activities that cause people to breathe more deeply, such as physically demanding work, speaking loudly and singing

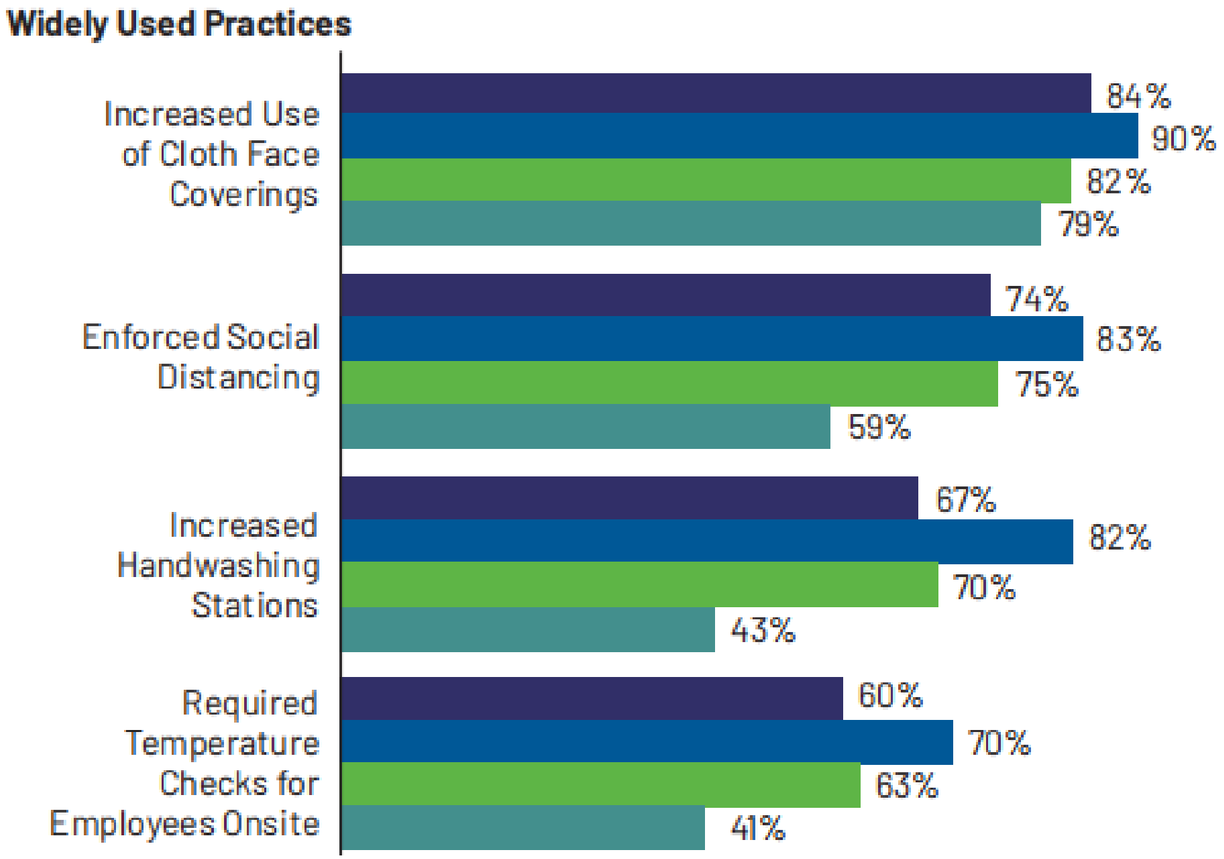
Construction Site Health and safety during COVID-19. ontario.ca. (n.d.). Retrieved April 6, 2022, from https://www.ontario.ca/page/construction-site-health-and-safety-during-covid-19

Implement Safety Measures

- screening helps to keep people who may be infectious out of the workplace
- good ventilation and wearing masks can help reduce the amount of virus in an indoor space
- maintaining physical distance reduces the chance of being exposed to respiratory droplets of all sizes
- personal protective equipment (PPE) can help protect the wearer from exposure to the virus and may be required when other control measures cannot be consistently maintained

/author/christine-Serlin. (2021, January 8). *NAHB urges covid-19 safety reminders for construction sites*. Builder. Retrieved April 6, 2022, from https://www.builderonline.com/building/safety-healthfulness/nahb-urges-covid-19-safety-reminders-for-construction-sites_o

Practices Instituted on Jobsites



- Increased use of cloth face coverings is the most widely adopted practice, used by most contractors (84%) with no major differences in use by company size or type. This is part of a larger focus across the US on using face coverings to control spread of the virus.
- About three quarters (74%) also enforce social distancing. This practice is significantly more widely adopted by large companies than by small ones, with midsize ones falling somewhere in between.
- Increased handwashing stations have been put in place by about two thirds (67 %) of contractors. However, fewer than half of small companies (43%) use these, compared with the majority of midsize (70%) and large (82%) ones.
- 60% of contractors also require temperature checks for employees onsite, but again, this is a common practice among midsize (63%) and large (70%) companies, but less common with small ones (41%).

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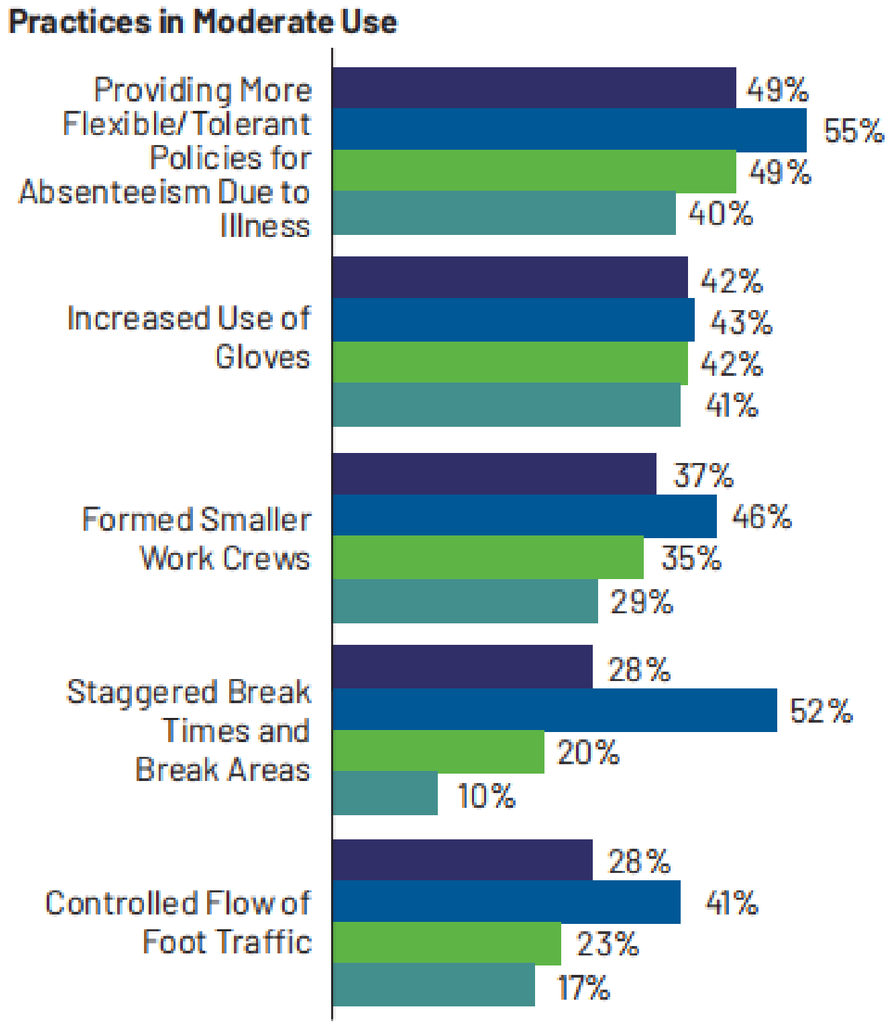
Practices Instituted on Jobsites



- Nearly half (49%) of contractors instituted more flexible/tolerant policies for absenteeism due to illness. The tight schedules in construction can lead to a focus on attendance regardless of illness that can leave other workers vulnerable to becoming sick. This is a big change to the culture of many construction sites, and an influential practice for improving the overall health of the workforce.
- One of the few practices with no meaningful differences in adoption between small, midsize or large companies is the increased use of gloves.
- Forming smaller work crews is another means to manage social distancing onsite and to avoid wide exposure of workers to a potential carrier of the virus.

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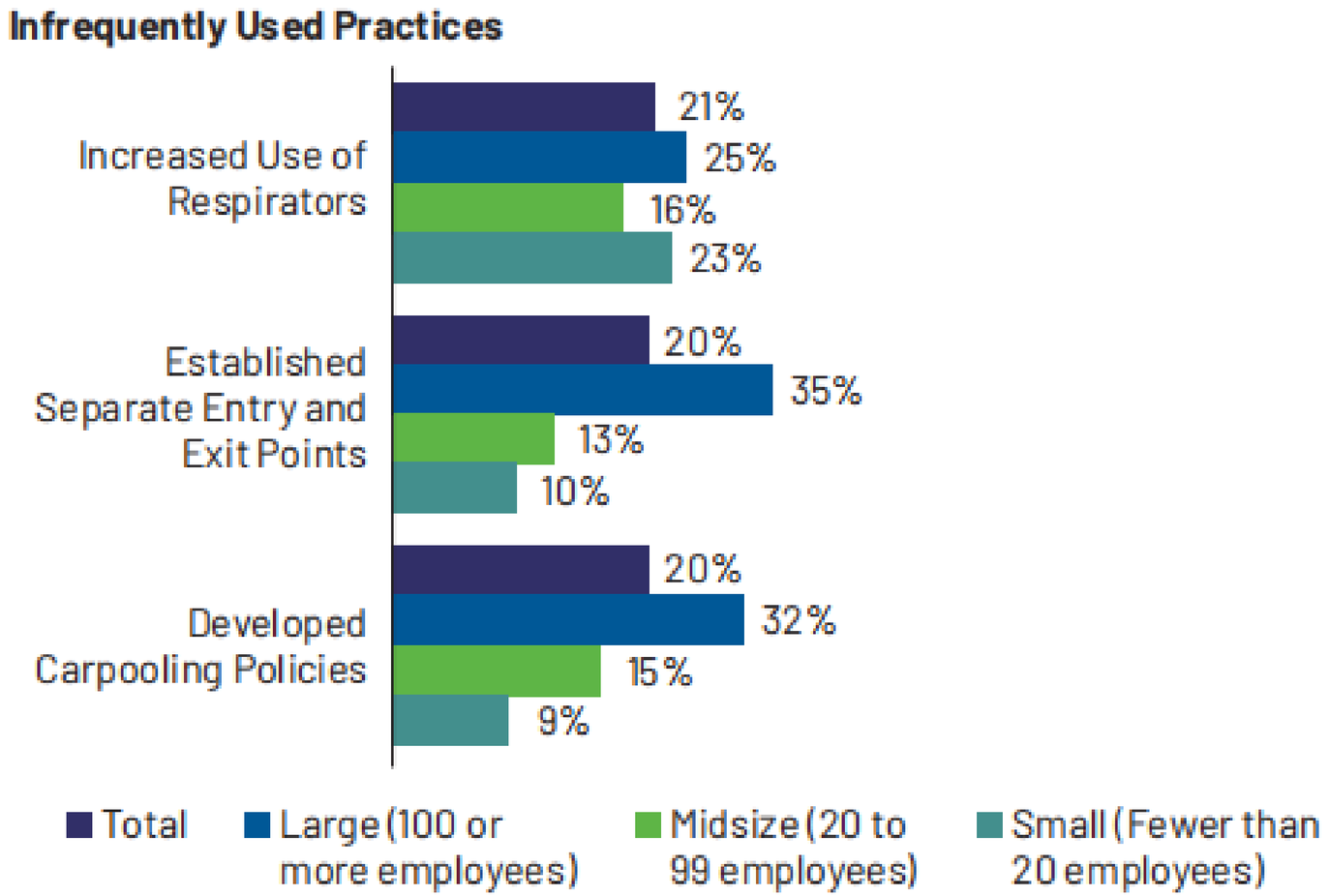

- Carpooling policies are more widely used by specialty trade contractors (26%) than by general contractors (14%). This is the only practice with a difference by type of company. Not surprisingly, it is also more widely used by large companies than by smaller ones.
- Significantly more large contractors (35%) have established separate entry and exit points than did midsize (13%) or small (10%) companies.

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Thank you!