

Article

Drug Use: Impact, Rules, Regulations and Mitigation Practices in the Construction Industry in the U.S

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Abstract: Abusing intoxicating substances such as alcohol and drugs in the construction industry poses a serious threat to the safety of workers. It is a pervasive problem that often results in fatal accidents and other relevant risks. This paper aimed to investigate the impacts of substance abuse at job sites, the perception of industry professionals about the issue, and the current practices of the industry. The objective was to compare the perception of the industry to the findings of the background study conducted in this area. To achieve this goal, the authors conducted a survey to analyze (1) the difference in perception between onsite and administrative teams regarding the issue of onsite substance abuse, (2) comparing possibilities of occurrence of diverse impacts of substance abuse as per the industry perspective, and (3) effectiveness of the available mitigation practices according to industry professionals. The results show that (1) there is a significant difference in perception regarding the existence and the seriousness of the problem of substance abuse in the construction companies between the onsite and the administrative teams, (2) though fatal accidents are the worst possible impact, loss in productivity is considered as the most common impact, and (3) drug-testing is not considered as the best mitigation practice by construction professionals. It was concluded that there is a need for education on the seriousness of drug abuse as well as extensive research for developing more efficient mitigation systems.

Keywords: construction industry; drug-testing; substance-abuse; intoxication; impact

1. Introduction

The construction industry is one of the most hazardous industries that alone accounted for 21.1% of worker fatalities in the year 2018 [1]. Construction work demands focus and teamwork. In such a work environment, it becomes even more important to eliminate the use of intoxicating substances such as illicit drugs and alcohol, not only for the safety of oneself but also for the safety of coworkers. The workers in the construction industry could be exposed to substantial risk due to coworkers indulging in substance abuse, as each employee has to depend on the competence of the entire team to work safely [2]. Substance abuse is common in all industries, but the risks are higher in the construction industry as workers perform many more life-threatening jobs daily that include working at a height, using dangerous tools, and moving heavy equipment around the job site [2]. Losing focus even for a split second is enough to cause a fatal accident.

According to the Occupational Safety and Health Administration, substance abuse is the inherent reason for 65% of all work-related accidents [3]. Construction workers use intoxicating substances not only for recreation but also to cope with the strenuous nature of construction work [4,5]. Workers involved in heavy-duty and high-risk areas such as a masonry section, concreting section, etc., are mostly

prone to fatigue and physical stress. They are often prescribed opioids by healthcare professionals for pain relief. Opioids being an addictive substance can be dangerous. If overused, it can lead to withdrawal symptoms making it difficult to quit. According to the Center of Construction Research and Training (CPWR) data report, there has been a nine times increase in unintentional overdose fatalities due to opioids in 2018 since 2011, whereas, the average of all industries for the same is only four times [6]. The use of illicit opioids during a lifetime was also the highest in the construction industry during 2011–2014, with an average of 21% workers, though this calculation was only based on workers who self-reported [6]. Thus, it is essential to address the drug problem to reduce the number of impaired workers on the construction site.

The most common drug other than opioids that is rampantly used in the workplace is marijuana. Currently, recreational marijuana is legal in 12 states and medical marijuana is legal in more than 30 states in the U.S. [7]. Recently, Canada also has legalized marijuana and the Coca-Cola Company has been expanding its business model toward cannabis-infused drinks. With increasing legal weed and intoxicated workers, the construction industry requires preparing for a rapid regulatory change, looking for innovative ways to prevent severe accidents and losses, and seeking out employees who abuse alcohol and drugs. Figure 1 below shows the legality of cannabis in the U.S.

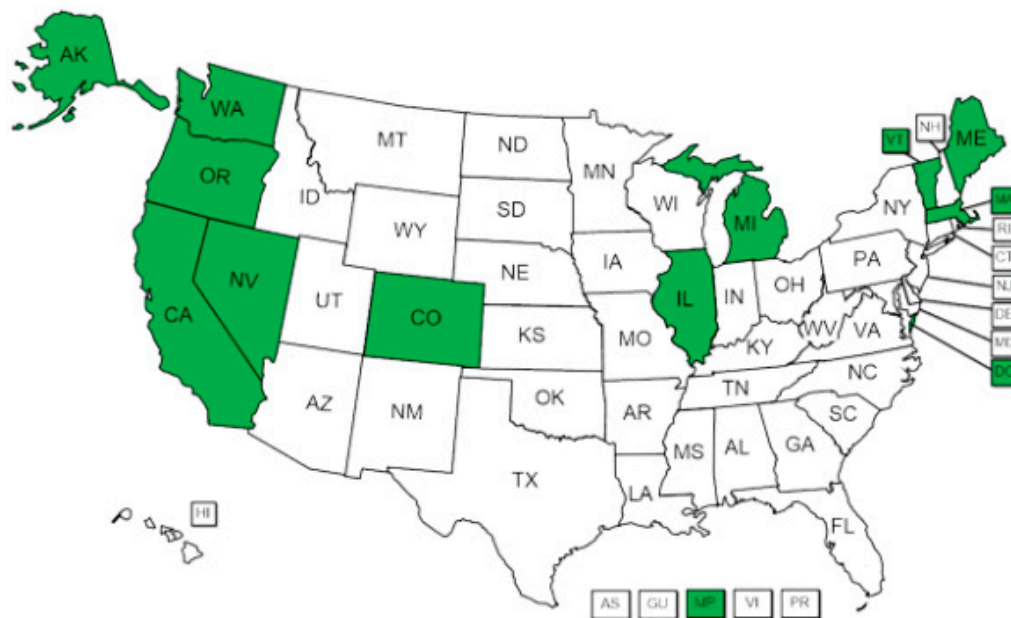


Figure 1. States that have legalized recreational marijuana in the United States. Reproduced from [7], NCSL: 2019.

The purpose of this study was to seek major knowledge gaps in the underlying risks of drug abuse in the construction industry that have not been identified in previous studies. These new findings can be crucial to the industry for obtaining a deeper understanding of the seriousness of the issue and how it can be mitigated. It can also provide adequate direction to future researchers for developing proactive systems for preventing substance abuse in the workplace.

2. Aims and Objectives

The construction industry has been constantly suffering from the risks of substance abuse, and the number of people involved in substance abuse has been the highest as compared to other industries. This shows that despite the constant battle to put a check on this issue, there has been little success. Therefore, there is a need to delve deep into the topic to investigate and identify what could be the possible reasons for the ever-increasing magnitude of this problem. In this regard, this paper aims to investigate the major impacts of substance abuse and the seriousness of the issue, the relevant state and

federal laws and regulations for restraining their use, and the current practices followed for mitigating substance abuse in the construction industry. The major objectives of this paper are listed below:

- To explore the relation between job positions and their subsequent understanding of the seriousness and risks of substance abuse at job-sites.
- To analyze and identify the most common impacts of substance abuse as per industry perspective.
- To analyze and compare the efficiency of the three majorly used practices for restraining workplace substance abuse as per the professionals working in the industry.

The study was focused on conducting a two-way investigation. First, through an analysis of relevant research works previously conducted and information gathered in this area, certain hypotheses were formulated. Second, a detailed survey was designed, that aimed to understand the perceptions regarding substance abuse in the industry, including the opinion of the industry professionals and experts on this matter. The goal was to find out whether the industry perceived things differently from what the information obtained from relevant background study suggested and make a preliminary list of possible reasons for such differences. The survey was solely based on the hypotheses that the authors deduced after reviewing similar studies conducted previously, information obtained from the background study, and having face-to-face informal conversations with construction professionals. The two-way investigation would help identify some of the underlying root causes regarding the ever-increasing magnitude of the problem and help understand the actual seriousness of the situation and awareness of the industry as a whole. Identifying the knowledge gaps would help in taking adequate actions in the right direction for improvement.

The survey conducted for this study was distributed to a total of 276 participants who are the members of the Louisiana State University Construction Industry Advisory Council (CIAC), out of which 27 participants responded. Ethical approval from Institutional Review Board was obtained for conducting the survey and this study. The respondents were asked to rate the factors in various categories according to the Likert-Scale. The survey questionnaire can be found in Appendix A.

3. Background

3.1. Impacts of Substance Abuse

The National Household Survey of Drug Abuse (NHSDA) has shown in recent data that 70% of all current users (used within the last 30 days) of illicit drugs are employed full time [8,9]. According to the 2015 national survey, the construction industry had the fifth-highest rate of illicit drug use [10]. The rate of substance abuse in the construction industry alone is almost twice the national average [9,11]. The National Council on Alcoholism and Drug Dependence (NCADD) states that “15% of construction workers are involved in drug abuse” [12]. The effects of intoxicating substances are more or less the same on all human beings across the world, and therefore would show more or less the same lapses in work at the construction sites. Thus, the literature study for only this section has been conducted irrespective of geographical location.

Previous studies have shown that there is a significant relationship between drug abuse and workplace safety [13]. In a study Frank V. Mushi and Sylvester L. Manegi claimed that being intoxicated at work is not only dangerous for oneself since it leads to “needless risk-taking behavior and ignorance towards safety” but it also adversely affects the quality of work due to reduced attention [4]. This, in turn, leads to an increase in the cost of the project due to rework and injuries.

The major impacts of substance abuse in the construction industry may be listed as follows [3,9,14–16]:

- Accidents and injuries leading to deaths.
- Loss of productivity.
- Cost overruns.
- Legal issues.
- Absenteeism

3.1.1. Fatal Accidents and Injuries

The construction industry is prone to injuries and accidents that may lead to fatality. Substance abusers are three to four times more likely to be involved in an accident at work [3]. An accident is not only fatal for the worker who may be crippled for life but may also be fatal for the family which is financially dependent on his income. Thus, these accidents not only can cause the death of a worker but may also endanger the ability of his family to sustain a quality life [17].

Workplace safety gets significantly compromised when workers use illicit drugs during work. The National Occupational Mortality Surveillance (NOMS) also mentions that “the death rate for construction workers due to unintentional and undetermined drug-involved overdose was 1.4% of the total death of construction workers during 2007–2012.” [18]. Any intoxicating substance affects our neuromotor activity. As such, it tends to slow down the capacity to think and react. In a vulnerable environment such as a construction site that is prone to accidents, this can tend to be extremely dangerous and fatal to life. The four most common forms of accidents, known as the “Fatal Four” account for about 54% of the total accidents and injuries caused on the construction site. They include [19]:

- Fall
- Struck by objects
- Electrocution
- Caught between objects

3.1.2. Loss of Productivity

Drugs including certain prescriptive ones such as opioids have sedative qualities that impair the ability to think and react. As such, workplace drug abuse can interfere with the performance of the abuser and impact his productivity [14]. According to a report produced by the U.S. Department of Labor, substance abusers are 25–30% less productive than non-abusing employees [3]. Also, the quality of work gets hampered due to a lack of accuracy and consciousness, which leads to rework. Thus, tasks do not get completed within their assigned schedule which in turn leads to other consequences, especially financial losses. The loss in productivity due to the use of illicit drugs can be caused in the following ways [14]:

- Tardiness/sleeping on the job.
- Hangover or withdrawal affecting job performance.
- Poor decision making.
- Lower morale.
- Increased likelihood of having trouble with coworkers/supervisors or tasks.
- Preoccupation with obtaining and using substances while at work, interfering with attention and concentration.
- Too many errors in work.
- Increase in the number of injuries.

3.1.3. Cost-Overruns

Cost overrun is a common problem in the construction industry. It gets even more enhanced when workers use drugs at work. The major causes of cost overrun due to intoxicated workers are:

- Delay in construction due to lack of productivity.
- Compensations and insurance claims—the U.S. Department of Labor estimates that substance abuse costs American business about \$100 billion/year [3].
- Increased health care expenses.
- Training of new employees.

- Higher turnover [16].
- Theft—80% of substance-abusing employees steal from their employers to support their drug use [3].

3.1.4. Legal Issues

Workers who are in the habit of using illicit drugs may also get involved in legal issues such as:

- Not being able to meet the terms and clauses of the hiring document.
- Fired from job [15].
- Illegal activities at work including selling illicit drugs to other employees.
- Disciplinary procedures due to an increase in violence and crime [16].

3.1.5. Other Issues

Timelines dictate the length of work for each phase in the construction industry. Missing job deadlines and schedules affect the contractor financially. So, absenteeism due to drug-related illnesses [15,16] or physical and mental incapacity jeopardizes the work program and leads to massive losses for the employers [15]. An employee involved in substance abuse is absent between 3.8 and 8.3 times as often as a non-substance-abusing employee [3]. Besides, intoxicated employees are more prone to being short-tempered and irrational. Poor communication and heated arguments may also give rise to fights and ill-feelings for each other at work [15].

3.2. Rules and Regulations Regarding Drug Use and Drug-Testing

3.2.1. Federal and State Laws

The Federal government under the SAMHSA (Substance Abuse and Mental Health Services Administration) program has taken many initiatives in preventing substance abuse by making health insurance more affordable and available to people with substance use disorders. It mandated the Federal Workplace Drug Testing by Executive Order 12564 and Public Law 100-71. This program aims at (1) addressing illegal drug use by federal employees, (2) certifying executive agency drug-free workplace plans, and (3) identifying safety-sensitive positions subject to random drug testing [8]. However, there is no hard and fast rule for private organization and companies that enforces them to conduct Workplace Drug Testing. Most construction companies in the U.S. are small companies where safety training and education are less consistent, and therefore they are less likely to have strong policies regarding drug-testing in place [17]. On the other hand, companies that employ thousands of construction workers may find drug-testing expensive as it often becomes a financial burden on the company to conduct such tests at regular intervals for all the employees. Yet, most of them do have policies to restrict the use of such substances, as any injury or death of worker caused by an accident at workplace not only leads to huge losses on the part of the company as it is compelled to pay heavy compensation to the workers concerned, but also leads to bad reputation which is harmful to business.

In the construction industry, OSHA (Occupational Safety and Health Administration) is responsible for overseeing all safety-related issues of workers at job sites. All construction companies must adhere to OSHA rules and policies to conduct any construction-related activity. OSHA currently does not have any policies of its own but borrows the guidelines set by other authorities such as DOT (Department of Transportation). It only encourages a drug-free environment, whereas the responsibility of ensuring it, is left to the company owners [20].

A general question that might arise is, why it is not possible to restrict the production of such intoxicating substances. In the book, "The Politics of Sin: Drug, Alcohol and Public Abuse", Kenneth J. Meier throws light on the dilemma of the government when it comes to prohibiting the use of such substances. He states that drugs and alcohol not only have a consumer industry but also a production industry and banning their production can lead to their markets going underground and increasing violence and crime [21].

3.2.2. State Laws

In the article “State Drug Testing Laws: An Employer’s Guide”, Katherine Miller writes about the limitations of the state laws regarding substance abuse and the dilemma of employers regarding drug testing. The key points can be summarized as follows [22]:

- Individual states have their own laws for drug testing of employers. Thus, employers must adhere to both federal and state laws when determining which employees can be subjected to drug testing as well as how, when, where, and why employees can be tested as per the state laws.
- Most of the states only allow urine testing despite other methods of testing such as oral fluid testing and hair testing being more effective in terms of positivity rates. This is due to the states not updating their laws regularly.
- States have their own restrictions regarding how and when testing is permitted. For example, none of the states permit Point of Collection Testing (POCT).
- Since state laws differ from state to state and also changes from time to time, employers are forced to keep up with these changes and alter and update company policies accordingly.
- While some states offer incentives to workers for participating in drug testing programs, others have laws denying compensations to workers if found involved in substance abuse. For example, Illinois allows workers’ compensation denial based on a positive drug or alcohol test though it is subjected to other conditions mentioned in the law.
- For companies operating in multiple states, the employers are bound to comply with the laws of each state that the company operates in.
- Generally, states fall into three categories when it comes to drug and alcohol testing—states with mandatory laws, states with voluntary laws, and states with no drug or alcohol testing laws. States with no drug or alcohol testing laws generally leave the option up to the employers to decide whether they want to have a drug-testing program in place or not.
- A total of 15 states currently have voluntary drug testing laws, whereas, 17 states have mandatory drug testing law(s), meaning that employers are required to comply.
- The state of Louisiana has voluntary laws regarding drug testing, where the employer may require employees and applicants to submit drug test reports [23].

3.2.3. Impacts of Marijuana Legalization on the Construction Industry

Due to the recent change in laws regarding the use of marijuana, there has been a surge in medical marijuana prescriptions, leading to an increase in the use of recreational marijuana, thereby causing numerous human resource-related issues. Even though marijuana is still illegal on the Federal level, the laws in certain states may be forcefully interpreted as requiring accommodation for its use, which is even more harmful to the construction industry than any other industry because the construction industry already suffers from a shortage of skilled labor [24].

In a state where recreational marijuana is legalized, even the drug testing system will fail, since the employee can inevitably argue to have used marijuana out of work hours, in which case, the employers will have no power to take action against such employees and will be forced to bear the risk of liability [24]. Thus, the new laws regarding the use of marijuana have made the construction industry extremely vulnerable to safety challenges and at the same time have posed a new challenge to the employers in these states to adapt their company policies to accommodate the new situation. Adding new policy statements to their human resource manuals can solve the problem to an extent, but any ambiguity in the statements can create bigger issues regarding a drug-free workplace environment and compliance with OSHA regulations. This implies that employers need to have a separate section in their manuals for marijuana with robust policies outlining limitations of testing, random drug tests, and implications, which is nothing but an added burden for the company [24].

3.3. Current Practices for Drug-Related Training and Testing

Two major strategies that had been generally employed in the past to address the problem of substance abuse in the workforce were: (1) employee assistance programs, designed to identify workers with substance abuse problems and provide them with treatment, and (2) drug testing, designed to identify drug-using workers and depending on the program exclude/remove them from the workforce and/or provide them with treatment. Though these strategies helped to detect intoxication to some extent, they were not primarily preventive and did not aim at providing workers with the skills and knowledge to abstain or reduce the use of alcohol and other drugs before it becomes harmful for their health and job performance [9].

In response to the lack of substance abuse prevention approaches in the workplace, several investigators have been developing and testing the effectiveness of preventive interventions designed specifically to provide workers with the skills and knowledge to avoid substance abuse [25]. Based mainly on social-cognitive and health behavior change theories, today these psycho-educational interventions have typically taken the form of group-based classes or seminars presented in the workplace [9].

There is no doubt that construction work is strenuous and difficult. But any job, no matter how difficult, can be made easy by a team effort. The construction company can play a huge role in curbing the use of intoxicating materials in the workplace. The construction company's strategies to build good teams on worksites may help to a certain extent in replacing alcohol and drugs on job sites. Currently, the following strategies are adopted by the construction industry in the U.S. to restrain the use of intoxicating materials while at work: policies, education, and drug testing [25].

3.3.1. Policies

A written documentation such as a policy or rule and their implementation always has more impact than verbal advice. Offering benefits including comprehensive coverage for substance abuse disorders including aftercare and counseling, reduce the stigma and provides support for a safe return to work, thereby focusing on promoting workability rather than disability. This can be a useful tool in the prevention of using intoxicating substances especially for addicts who desire to recover from their situation.

3.3.2. Education

Educating the workers about the effects and consequences of using intoxicating substances is important to prevent its use, which can be achieved by establishing and promoting programs focused on improving health. It is necessary to educate workers on the responsible use of prescriptive drugs including the impact it has on job performance and the possibility for addiction. Some workplace programs also aid for the treatment of addiction issues. Such programs not only provide information about drug abuse to the employers but also assist them with contacts of community-based treatment providers and structures employee assistance programs (EAPs) [26].

3.3.3. Drug Testing

The most commonly used method for testing the presence of drugs in the human system is a chemical-based test that involves the collection of a biological sample such as hair, urine, sweat, or saliva from the person to be tested. Thus, this procedure is invasive in nature, and more than often employees are reluctant to participate in it [27]. Some tests help to detect immediate use while others help to detect whether the drug had been used during a certain period. Also, different drugs remain in the system for different periods, ranging from few hours to a few weeks, during which they may be detected by a test. Urine test is the most common test that is used in the construction industry [13]. However, the results of this drug test can be easily cheated as urine samples are vulnerable to interference or tampering [28].

Moreover, most drugs are detected in urine for only 3–4 days which gives a scope to workers to go back to their habits once they succeed in getting the job after their pre-employment test [29].

The ‘Society for Human Resource Management’ lists approximately 135 companies that provide drug testing services at present. The cost of drug testing and the time required for obtaining the results vary depending on the type of sample and the type of test. Table 1 gives a comparative analysis of the cost and time required for different methods of testing [12,30].

Table 1. Comparative analysis of the cost and time required for different drug testing methods.

Method	Cost of Home-Test	Cost of Lab-Test	Duration for Receiving Results (after the Sample Reaches Lab)
Urine	\$10–\$50	\$50–\$80	3 business days
Saliva	\$10–\$50	\$50–\$80	1–3 business days
Blood	N/A	\$100–\$650	24 h, additional 3 or more days if the screening test is positive
Hair	N/A	\$100–\$650	5–10 business days

Though expensive to implement, drug-testing has always produced better results than any other strategy. Types of workplace drug testing typically used by contractors include the following [7,31]:

- Pre-employment testing.
- Reasonable suspicion testing.
- Routine fitness-for-duty testing.
- Post-accident testing.
- Random testing.
- Follow-up to rehabilitation (after returning to work from drug/alcohol treatment) testing.

The most commonly used test methods include the urine drug screen and the saliva testing though they might change depending on needs and requirements. This method is generally used as a front-line defense against intoxication at work by larger companies who can absorb the costs associated with it. Small construction companies, having fewer than 20 workers, comprise approximately 90% of the industry. These are particularly vulnerable to having workers on the job site who abuse drugs and alcohol since they are less likely to have a drug testing policy in place [17]. Studies in the past have shown some commendable results for companies that have implemented a drug-testing program. According to a national study conducted by Cornell University, companies that tested job applicants and workers for drugs experienced a 51% reduction in injury rates within two years of implementing a drug-testing program as compared to an industry-wide reduction average of 14% over the same two-year period. The overall injury rate at construction companies that tested for drug use dipped from 4.46 to 2.18 incidents/100,000 worker hours with the implementation of the program [3].

Only a handful of studies regarding the problem of substance abuse in the construction industry have previously been conducted, and very few concerning the U.S. Most of these studies have been either conducted to identify the impact or the extent of the impact of substance abuse. However, none of these studies have conducted an in-depth study to identify the underlying causes that may be causing a barrier for the mitigation practices to be successful in restraining the issue. Therefore, in this study, the aim was to identify all possible impacts of substance abuse as well as new knowledge that might be beneficial towards curbing this problem.

4. Materials and Methods

From the information gathered in Section 3 along with face to face informal conversations with construction professionals regarding this topic, the study was summed up into certain hypotheses. The questionnaire for the survey was designed to seek answers to these hypotheses. Reference for creating the questionnaire was taken from similar surveys conducted in previous studies [32,33].

The results obtained from the survey were analyzed based on these hypotheses. The hypotheses are stated as below:

- (1) There is a significant difference in the perception of risks involved with substance abuse between the onsite team and the administrative team.
- (2) The possibility of the occurrence of all major categories of impacts of substance abuse is not equal. There may be some subcategories of impacts that are common in reality but have not been acknowledged in previous studies.
- (3) The efficiency of all three current practices is not equal. Drug-testing is more effective than other methods.

For this study, the survey questionnaire was distributed by an email to a database of construction professionals and experts who were members of the CIAC. The database contained a total of 276 participants, which was the total population considered for this study. These participants work for various companies across the state of Louisiana and have been involved in projects in Louisiana as well as in other states in the U.S. Since in this study, we were more interested in the viewpoint of the professionals in the position of a supervisor or higher, how the company was being affected by this issue, and how they dealt with it, the following criteria were used for selecting the participants:

- The participant should be a full-time professional in the construction industry, i.e., working at least 8 h a day for their respective construction companies.
- The participant should be working in a managerial position in the company either onsite or in the administration.
- The company in which the participant works should not have a labor union.

The participants holding the positions of Director of Safety, Risk Management/Administrator/Controller/Vice President/CFO/Manager/CEO/President/Owner in a company were pooled into the category of higher administrative officials. These officials are mostly responsible for looking after the administration and overall workflow of the company. The participants holding the positions of Site Supervisor/Project Manager/Personnel, Human Resources were pooled into the category of project-specific supervisors. These officials are mostly associated with managing and supervising specific projects in the construction company. Since the study was restricted only to participants who are employed full-time in the industry in higher positions such as managers and supervisors and felt that they had a certain level of experience dealing with workplace substance abuse, and their companies did not have a labor union, we received only 27 responses for our survey, which became our sample for the study. Out of these 27 participants, 12 belonged to the higher administrative officials category, whereas, 15 belonged to the category of project-specific supervisors. For the first hypothesis the two categories were considered as independent, whereas, for the second and third hypotheses, they were considered as a single group of construction professionals as the separate categories did not yield significantly different results.

The data collected through the survey was a random sample, and the entire data set received from the survey was used. The Likert scale was adopted to obtain a response from participants. Since data collected through a Likert scale provides ordinal data, tests for Normality such as the Shapiro Wilk's Test or any other will not be valid. However, it is not uncommon to conduct parametric tests on ordinal data, if the data follows certain criteria, which include: 1. The sampling distribution is normal, 2. The Likert scale has at least 5 levels, 3. There are no extreme scores, and 4. The variance for the data sets which are compared is approximately equal. Since we used the entire data set obtained from the survey for this study and the researchers had no role to play in the sampling, we assumed a normal sampling distribution. The other criteria were also met, and therefore it was assumed that the data are fit for parametric analysis.

5. Results

Prior to conducting an in-depth analysis of each of the formulated hypotheses, the Cronbach's alpha test was conducted to check the internal reliability of the data. The test was conducted in two parts. First, for the data obtained for conducting hypothesis 1 and hypothesis 2, and second, for the data obtained for hypothesis 3. The reasons for the two different tests are as follows.

- Since all participants did not have all three current mitigation practices available in their companies, there were several missing data in the data set for hypothesis 3 unlike the data sets for hypotheses 1 and 2.
- The Likert scale for hypothesis 1 and hypothesis 2 was slightly different from that used in hypothesis 3.

The Cronbach's alpha test was not conducted separately for hypothesis 1 as it consisted of only 1 item, which meant the test would have been invalid. The two sets of results for Cronbach's alpha test are shown below in Tables 2 and 3 respectively.

Table 2. Cronbach's alpha test for hypothesis 1 and hypothesis 2.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.97	0.97	27

Table 3. Cronbach's alpha test for hypothesis 3.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.96	0.96	39

In general, if the value of Cronbach's alpha is greater than 0.9, the internal reliability of the data is considered as excellent [34]. As is evident from Tables 2 and 3, the high value of Cronbach's alpha proves the high internal reliability of the data used for this study. Moreover, since the Cronbach's alpha was so high for the study, we also tested the data for redundancy by calculating Cronbach's alpha after deleting an item. This was conducted for all items in each of the two sets. The results showed no redundancy for the data set used in hypothesis 1 and hypothesis 2. For the data set used in hypothesis 3, three of the items when deleted had Cronbach's alpha value as 0.96 which is equal to the value shown in Table 3. However, this discrepancy is too small for the item to be considered as redundant and the discrepancy can be attributed to the fact that there were missing data in this data set due to all companies not having all three practices in place. Therefore, the discrepancy was ignored.

5.1. Hypothesis 1

A construction company generally handles multiple projects at a time. Hence, there is generally an administrative team that monitors the overall workflow in the company, and then there are project-specific teams that are assigned to individual projects that may be located in various parts of the country. As such, project-specific supervisors, for example, site supervisor or the project manager who deals with the workers daily can be expected to have better knowledge and understanding of the risks involved when workers are involved in substance abuse. On the other hand, the issue of substance abuse among workers varies from place to place depending on the community they come from, the location of the project, applicable federal and state laws, etc. As such, if a project-specific supervisor does not face substance abuse related issues on his project, it might be possible that he is not aware of the existence of the problem in his company, which a person in a higher administrative position in the company might be more aware of. Therefore, the participants were posed with the

question of whether they perceived substance abuse among construction workers as a threat to their company (Appendix A, Q5).

To be able to statistically estimate the data, numerical values were assigned to the ratings as follows: serious risk (5), moderate risk (4), slight risk (3), insignificant risk (2), and none (1). All participants were asked to rate their understanding of whether the issue of substance abuse posed a risk for their project or company. The observations obtained from the survey are listed in Table 4 below.

Table 4. Observations from the survey.

Categories	Observations	Mean	Standard Deviation
Higher Administrative Officials	5, 5, 4, 3, 4, 4, 5, 4, 3, 4, 3, 3	3.92	0.79
Project Specific Supervisors	5, 5, 3, 5, 5, 5, 5, 5, 5, 3, 4, 5, 4, 5	4.57	0.74

It was assumed that the observations of the two populations follow a normal distribution with $n - 1$ degrees of freedom, where n is the number of observations in the sample.

$$H_0: \mu_2 - \mu_1 = 0$$

$$H_A: \mu_1 < \mu_2$$

where,

μ_1 = Sample average score from Higher Administrative Officials

μ_2 = Sample average score from Project Specific Supervisors

Considering Type I error to be equal to 0.05, the p -value was calculated for the test statistics. The result is shown in Table 5 below.

Table 5. Results for hypothesis 1.

Variance 1	Variance 2	Test Statistics	p -Value
0.63	0.57	2.27	Lies between 0.01 and 0.02

where,

Variance 1 = Sample variance for Higher Administrative Officials

Variance 2 = Sample variance for Project Specific Supervisors

Since the p -value came out to be less than 0.05, the null hypothesis can be rejected in favor of the alternate. Also, a 95% confidence interval was calculated, according to which the average score from Project Specific Supervisors will be at least 0.5 and at most 0.86 points higher than the average score from Higher Administrative Officials when sampled from the population of construction professionals.

Furthermore, when asked about the existence of the problem of substance abuse in their company, where the answer choices were 'yes', 'no', or 'maybe', 4 out of 27 participants opted for 'maybe', all of whom belonged to the 'Project Specific Supervisors' category. Thus, from this analysis, it may be concluded that the perception of risks associated with substance abuse is not the same across all hierarchical levels among constructional professionals. There is a difference in the understanding of the seriousness of the problem and this gap can only be filled through further study, research, and collaboration of knowledge in this area. To improve this situation, higher administrative officials must take more interest in knowing the issues related to workers who are the bottom-most level in the hierarchy, to efficiently help in mitigating the problem.

5.2. Hypothesis 2

Though all possible impacts of substance abuse were categorized under major categories in Section 3, it was expected that there will be a significant difference between the possibilities of their occurrence. Since drug mainly affects our nervous system, thereby interfering with our focus and concentration, we hypothesized that risks of substance abuse related to loss in productivity should have a higher possibility as compared to any other category.

In the survey, each participant was asked to rate the possibility of each of the subtypes of the impact categories that we listed in Section 3 based on their understanding of the possibility of their occurrence (Appendix A, Q6). The rating was as follows: 5 = highly possible, 4 = possible, 3 = neutral, 2 = rarely possible, 1 = hardly possible.

To analyze whether there is a significant difference between the perceptions of the possibility of each category of impact, the Analysis of Variance (ANOVA) using the F-test as well as the Post Hoc multiple comparisons using Bonferroni's method were conducted. The data obtained from the survey are listed in Table 6 below.

Table 6. Observations from the survey.

Categories	μ_1	μ_2	μ_3	μ_4	μ_5
Mean	4	4.28	3.91	4	4.24
Standard Deviation	0.85	0.86	0.89	0.97	0.80

where,

μ_1 = Average rating across all subfactors under 'fatal accidents'

μ_2 = Average rating across all subfactors under 'loss of productivity'

μ_3 = Average rating across all subfactors under 'cost overruns'

μ_4 = Average rating across all subfactors under 'legal issues'

μ_5 = Average rating across all subfactors under 'other impacts'

It was assumed that the observations for the different populations follow a normal distribution and they have an equal standard deviation. Also, the Type I error was considered to be equal to 0.05. The results obtained are shown in Tables 7 and 8 below.

Table 7. ANOVA and linear contrasts test results for hypothesis 2.

Null Hypotheses	Test Statistic	<i>p</i> -Value
$\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$	F = 4.1	Lies between 0.025 and 0.01
$L_1 = \mu_2 - \mu_1$	t = 6.36	Less than 0.0005
$L_2 = \mu_2 - \mu_3$	t = 9.5	Less than 0.0005
$L_3 = \mu_2 - \mu_4$	t = 5.28	Less than 0.0005
$L_4 = \mu_2 - \mu_5$	t = 0.41	Greater than 0.25

Table 8. Two-sided 95% confidence interval results for hypothesis 2.

Null Hypotheses	Lower	Upper
$L_1 = \mu_2 - \mu_1$	0.19	0.37
$L_2 = \mu_2 - \mu_3$	0.29	0.45
$L_3 = \mu_2 - \mu_4$	0.17	0.39
$L_4 = \mu_2 - \mu_5$	−0.16	0.24

From the above results, since *p*-value is less than 0.05 for the ANOVA test, it may be concluded that there is a significant difference between the means of each category of impact. On further investigation of the linear contrasts, we found that as per industry perception, the possibility of 'loss of productivity' is significantly higher than other categories except for the category 'other issues' where the *p*-value is greater than 0.25, and therefore we fail to reject the null hypothesis. Also, the same can be observed from the confidence intervals where all the linear contrasts have a positive interval except for the 'other impacts' which has a negative interval. From this, it can be concluded that though 'loss of productivity' has a higher possibility of occurrence, there is a high probability that other impacts of substance abuse that have not been detected or investigated in previous studies may have a higher rate of occurrence in practice.

To further investigate this situation, a fifth subcategory, ‘equipment related accidents’, was added to the Fatal Four under the ‘fatal accidents’ category in the survey and the respondents were asked to rate the possibility of their occurrence as per their perception according to the same rating system as mentioned above. OSHA only recognized the Fatal Four as the most common types of fatal accidents [19], but since machinery and equipment is an integral part of construction, it was speculated that equipment-related fatalities can be more common than the Fatal Four. This speculation was based on face-to-face conversations with some of the construction professional in the pre-study phase, before the decision to conduct the study was made. The data obtained from the survey are listed in Table 9 below.

Table 9. Observations from the survey.

Categories	μ_1	μ_2	μ_3	μ_4	μ_5
Range	1–5	2–5	1–5	1–5	3–5
Average	4.26	3.96	3.59	3.96	4.26

where,

μ_1 = Average rating for ‘fatal accidents’ due to fall

μ_2 = Average rating for ‘fatal accidents’ due to struck by an object

μ_3 = Average rating for ‘fatal accidents’ due to electrocution

μ_4 = Average rating for ‘fatal accidents’ due to caught between objects

μ_5 = Average rating for ‘fatal accidents’ due to equipment or machinery

It was assumed that the observations for the different categories follow a normal distribution and they have an equal standard deviation. Also, the Type I error was considered to be equal to 0.05. The ANOVA and pairwise comparisons were tested, and the corresponding results obtained are shown in Tables 10 and 11 below. Linear comparison between fall and equipment related incidents was not conducted as the mean value for both were the same, which means the test statistic would have resulted in a null value.

Table 10. Linear contrasts test results.

Null Hypotheses	Test Statistic	<i>p</i> -Value
$\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$	F = 6.08	Lies between 0.005 and 0.001
$L_2 = \mu_5 - \mu_2$	t = 7.14	Less than 0.0005
$L_3 = \mu_5 - \mu_3$	t = 39.4	Less than 0.0005
$L_4 = \mu_5 - \mu_4$	t = 7.14	Less than 0.0005

Table 11. Two-sided 95% confidence interval results.

Null Hypotheses	Lower	Upper
$L_2 = \mu_5 - \mu_2$	0.21	0.39
$L_3 = \mu_5 - \mu_3$	0.63	0.71
$L_4 = \mu_5 - \mu_4$	0.21	0.39

From the above results, since the *p*-value for the F-test is less than 0.05, it confirms that at least two means are significantly different. Also, since the *p*-value is less than 0.05 for all the Linear Contrasts, and the two-sided 95% confidence intervals also have positive values, it can be said with 95% confidence that the probability for the occurrence of an equipment-related accident due to substance abuse is significantly higher than any of the Fatal Four except fall. These results establish the need for further study and research in this area to adequately understand the entire range of impacts due to substance abuse at the construction sites.

5.3. Hypothesis 3

Substance abuse at work is a serious issue, and construction companies constantly battle to restrain such activities at work. The recent change of laws in the U.S. regarding the use of medical marijuana and recreational marijuana has only added to this challenge of restraining workplace substance abuse. Currently, three methods of mitigation are widely practiced by the construction industry. But all three methods are not practiced by all construction companies, which later became evident from the responses of the participants to the survey (Appendix A, Q7) as well. Therefore, it was hypothesized that the effectiveness of all three practices might not be the same. Also, since Drug Testing is a test that confirms whether or not a worker is involved in substance abuse, the industry tends to heavily rely on drug-testing as a mitigation practice due to its high reliability. Thus, to check the accuracy of the above statement and whether drug testing is more effective than other methods, it was hypothesized in this study that, drug-testing was a more efficient method of restraining substance abuse than the other practices, as per the perception of the participants.

In the survey, each participant was asked to rate each of the mitigation practices based on the effects it had on the company or business (Appendix A, Q9) [32,33]. The rating was as follows: -2 = adverse impact, -1 = slightly adverse impact, 0 = no impact, $+1$ = some improvement, and $+2$ = significant improvement.

To analyze whether there is a significant difference between the effectiveness of the three different mitigation practices as per the perception of the survey participants, the ANOVA using the F-test was conducted. The data obtained from the survey are listed in Table 12 below.

Table 12. Observations from the survey.

Categories	μ_1	μ_2	μ_3
Average	0.79	0.81	0.82
Standard Deviation	0.68	0.53	0.59

where,

μ_1 = Average rating for 'written policies'

μ_2 = Average rating for 'awareness programs'

μ_3 = Average rating for 'drug-testing'

It was assumed that the observations for the different populations follow a normal distribution and they have an equal standard deviation. Also, the Type I error was considered to be equal to 0.05. The ANOVA test was conducted, and the corresponding results obtained are shown in Table 13 below.

Table 13. ANOVA and linear contrasts test results for hypothesis 3.

Null Hypotheses	Test Statistic	<i>p</i> -Value
$\mu_1 = \mu_2 = \mu_3$	F = 0.0325	Greater than 0.25

From the above result, since the *p*-value for F-test is greater than 0.25, the null hypothesis cannot be rejected and therefore it can be stated that there is no significant difference between the effects of the three different mitigation practices, as per the participants of the survey. Thus, as per the viewpoint of professionals involved with the construction industry, it cannot be stated that drug testing is a more efficient method of restraining drug abuse as compared to others. This difference between the information obtained in Section 3 and the outcomes of the survey may be attributed to the fact that drug testing being an invasive practice, the workers might be reluctant to provide biological samples. Also, it is expensive and practically not feasible to conduct regularly.

6. Discussion

As drug legalization is increasingly adopted in many states, the problem of substance abuse in the construction industry should be considered as a critical concern that can only be estimated to pose further issues in the future, if not put to check. Ignorance of the problem, as well as ignorance of the associated costs and liability of drug abuse in the workforce are the most important factors that need to be addressed to effectively mitigate this issue. This study was solely conducted from the viewpoint of supervisors and professionals posted higher in the hierarchy, to understand their perception of how workers involved in substance abuse may be detrimental to the construction business. According to this study, the construction industry may not be well prepared to handle the risks imposed by workers involved in drug abuse. Only 3 out of the 12 higher officials who responded to the survey considered substance abuse as a serious issue whereas 4 out of the 15 project-specific respondents were unsure about the existence of the issue in their companies. Thus, it is evident that there is a gap in understanding between the various hierarchical levels regarding the existence of the problem. This gap needs to be bridged to effectively tackle the issue. Furthermore, there is a crucial need to enhance the relationship between ground-level workers and higher officials in the company. Generally, in large companies, there is an administrative headquarter responsible for the overall functioning of the company. This team makes decisions regarding company policies, training and education programs, drug-testing requirements for their employees, etc. On the other hand, project managers and project supervisors assigned to individual projects, who are in direct communication with the workers, may be better aware of the problems, issues, and working conditions of the workers. As such, lack or inadequate communication between the administrative team and the onsite project supervisors and managers may lead to an insufficient exchange of knowledge required to make suitable decisions regarding worker's health, safety, and benefit. Bridging the gap to enhance direct communication between the administrative team and the ground-level employees can help the administration to better understand the ground-realities on the worksite and address issues that might cause workers to rely on substance abuse. The reasons for relying on substance abuse can be highly specific and differ from company to company depending on various factors including location, work hours, worker community, company policies, and others. The federal government, state government, and the construction industry should continue to adhere to strict policies, constant education, and daily onsite testing regarding drug use.

There is also a need to further investigate the impacts of substance abuse to quantitatively analyze the effects of each on the overall project. A fatal accident is the worst possible impact of substance abuse, and one may argue that accidents leading to death are a rare occurrence. However, loss of productivity is one of the most common issues that happen regularly onsite. If daily losses caused by productivity issues due to workers indulging in substance abuse are accounted for, it may sum up to huge losses. Therefore, substance abuse causing a loss in productivity cannot be ignored as it is capable of financially crippling the project.

Despite the background study suggesting that drug testing produces better results than any other strategy, the analysis of the survey responses in hypothesis 3 produced a different outcome. This difference may be attributed to the fact that drug testing is an invasive practice and that workers might be reluctant to provide biological samples, as they might find it demeaning. Also, with drug test being a test that is not always accurate, false positives can cause a worker to lose his job and hamper his reputation forever. As such, distrust and lack of willingness towards the prevention practice can affect their morale if they are subjected to it and hamper their productivity. Furthermore, since drug testing is expensive and time-consuming, it is not practically feasible to be conducted as frequently as required. As such, most companies only conduct random testing, other than during hiring. This often allows for some workers to go undetected even if they are involved in substance abuse. Thus, drug testing may not be efficiently and effectively practiced which can be a viable reason for the industry to not realize its full potential. This indicates the need for developing and designing better prevention systems that can effectively help to restrain the issue.

The present mitigation practices have helped to curb the problem to a certain extent, but the fact that substance abuse has been a constant problem in the construction industry for more than three decades and continues to persist, is proof enough that the current practices are not by themselves sufficient to handle the issue. Thus, more efficient and innovative mitigation practices are required to put a check on this problem. These practices not only need to be cost-effective but also should be automated with minimum human intervention so that they can be conducted even on a daily basis if required.

There are several limitations in this study due to the assumptions made to statistically analyze the data. Firstly, it was assumed that the data collected from the survey is independent, random, and follows a normal distribution. Secondly, the population of construction professionals and experts who responded to the survey belonged to construction companies and projects that did not have a labor or trade union. The authors propose to collect more data using databases of construction professionals in other states in the U.S. to improve the study in the future. Thirdly, the data size may not be big enough to capture substantial variations in data.

7. Conclusions

The problem of substance abuse in the construction industry is constantly increasing and there is an urgent need to develop proper methods for restraining this issue. This study tried to identify new knowledge and information critical to the industry as well as researchers, for better understanding of the situation and deriving directives for further research. In addition, this study indicates current insufficient recognition regarding the seriousness and impacts of substance abuse in construction and shows the critical demands of methods to mitigate risk of substance abuse in industry. There is also a need for reinforcing knowledge regarding the seriousness of the issues related to substance abuse in the construction industry. Currently, as per the findings of our study, there is a significant difference in the understanding and perception of the situation between the onsite team and the administrative team. Thus, further research is required to find out the major factors causing this difference and how it can be mitigated. Besides, there may be several other impacts of substance abuse such as the ‘equipment related accidents’ that was acknowledged in this study, that are not yet identified. There is a need to further explore the impacts of substance abuse using surveys, historical data, and in-person onsite data collection, to have an in-depth qualitative and quantitative understanding of the seriousness of the issue. As per the perception of professionals involved with the construction industry, drug-testing may not be the best solution for mitigating this issue, since it is invasive and hurts the morale of employees which can hamper their productivity. Moreover, most companies depend on only random testing which may not be enough to guarantee that no employee is involved in substance abuse. Therefore, there is a need to develop non-invasive mitigation practices that are not only cheap but is also easy to conduct and can be conducted regularly at the construction sites.

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Appendix A. Survey Questionnaire

Appendix A.1. General Information

1. What is the position of the respondent in the company?
 - i. Site Supervisor ii. Project Manager iii. Personnel, Human Resources iv. Director of Safety, Risk Management v. Administrator, Controller vi. Vice President, CFO, Manager vii. CEO, President,

Owner viii. Others

If others, please mention the position: _____

2. What is the approximate number of workers in the company? Choose one of the following ranges.
i. Less than 50 ii. 50–100 iii. 100–250 iv. 250–500 v. More than 500
3. How many hours does the average daily shift consist of?
i. Less than 8 h ii. 8–10 h iii. 10–12 h iv. More than 12 h

Appendix A.2. Substance Abuse and Related Issues

1. Does your company face issues regarding substance abuse among construction workers?
i. Yes ii. No
2. Do you perceive substance abuse among construction workers as a threat or risk for the company?
i. Serious Risk ii. Moderate Risk iii. Slight Risk iv. Insignificant Risk v. None
3. Below are listed the major categories of risks caused by impaired workers on job sites, that have been identified through our research. Each category has several subcategories. Please rate each of the subcategories on the 5-point Likert-type scale, based on your experience and understanding of the possibility of each due to substance abuse among construction workers.
(5 = Highly Possible, 4 = Possible, 3 = Neutral, 2 = Rarely Possible, 1 = Hardly Possible)

A. Fatal Accidents

- | | |
|---------------------------------|------------------------------|
| a. Fall. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| b. Struck by Objects. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| c. Electrocution. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| d. Caught between Objects. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| e. Equipment related accidents. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| f. Others. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |

B. Loss of Productivity

- | | |
|---|------------------------------|
| a. Tardiness/sleeping on the job. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| b. Hangover or withdrawal affecting job performance. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| c. Poor decision making. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| d. Lower morale. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| e. Arguments with coworkers/supervisors or tasks. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| f. Preoccupation with obtaining and using substances while at work, interfering with attention and concentration. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| g. Too many errors in work. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| h. Increase in the number of injuries. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |

C. Cost over-runs

- | | |
|---|------------------------------|
| a. Delay in construction due to lack of productivity. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| b. Compensations and Insurance claims. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| c. Increased health care expenses. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| d. Training of new employees. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| e. Higher turnover. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| f. Theft. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |

D. Legal Issues

- | | |
|---|------------------------------|
| a. Not being able to meet the terms and clauses of the hiring document. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| b. Fired from job. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| c. Illegal activities at work including selling illicit drugs to other employees. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| d. Disciplinary procedures due to the increase in violence and crime. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |

E. Other Issues

- | | |
|-----------------------------------|------------------------------|
| a. Absenteeism. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| b. Short tempered and irrational. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |
| c. Poor communication. | i. 5 ii. 4 iii. 3 iv. 2 v. 1 |

Appendix A.3. Current Practices

Part 1 (Written policies)

1. Does the company have the following for the prevention of drug use among its workers?

A. Written Policies.	i. Yes ii. No.
B. Awareness Programs.	i. Yes ii. No.
C. Drug-Testing Program.	i. Yes ii. No.
2. If yes, since when are they incorporated? Select the most appropriate choice.

i. Less than 3-years ii. Less than 5 years iii. Less than 10 years iv. Less than 20 years v. More than 20 years vi. Right from the establishment of the company
3. Below is a list of organizational indicators which are generally associated with the incorporation of drug-use prevention method or program. Please rate each of them on a 5-point scale based on the impact that the incorporation of the method or program had on them.
It is recommended that you mark the methods comparatively for each of the indicators. (−2 = Adverse Impact, −1 = Slightly Adverse Impact, 0 = No Impact, +1 = Some Improvement and +2 = Significant Improvement)

A. Written Policies	
B. Awareness Programs	
C. Drug-Testing Program	
a. Reduction in workplace drug abuse	i. −2 ii. −1 iii. 0 iv. +1 v. +2
b. Less no. of accidents.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
c. Better communication and collaboration among workers	i. −2 ii. −1 iii. 0 iv. +1 v. +2
d. Timely completion of jobs.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
e. Reduction in losses.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
f. Less no. of workers fired from job.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
g. Company procured more projects.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
h. Overall quality of new applicants.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
i. Reduction in health care costs.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
j. Work place safety.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
k. Mental well-being of employees.	i. −2 ii. −1 iii. 0 iv. +1 v. +2
l. Number of work leaves.	i. −2 ii. −1 iii. 0 iv. +1 v. +2

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