Construction Workforce: A Gender-Based Case Study of Factors Influencing Sleep Deprivation

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Abstract

The construction workforce faces numerous challenges, including long hours, stressful conditions, demanding work, a hard-to-achieve work-life balance, and limited sleep time. Sleep is essential for maintaining the cognitive functions required in the construction industry. Unfortunately, sleep deprivation is prevalent among construction workers, adversely affecting their performance and companies. Thus, the problem addressed by this study is the gap in knowledge regarding the factors that influence sleep deprivation in the construction workforce. Therefore, the two objectives of this paper are to: (1) Quantify the factors contributing to sleep deprivation among the construction workforce, and (2) Compare these factors across gender. A quantitative methodology was employed in this study. The data was collected using an online survey with closed-ended questions. The statistical analysis employed to test the hypotheses was a Mann-Whitney U Test, which was used to identify significant predictors of sleep deprivation for each gender. The findings indicate that: (1) The top three factors influencing sleep deprivation are "Tight schedule of project", "Heavy workloads", and "Fatigue from the previous day"; and (2) Although females tended to rate "Fatigue from previous day" and "Heavy workloads" slightly higher and males identified "Working in afternoon or night shifts" as more influential, these gender-based differences were not statistically significant. The intellectual merit of this study lies in its contribution to a better understanding of sleep deprivation and the gender-specific factors influencing it within the construction workforce. The broader impact of this study is to provide insights that can inform workplace policies and interventions aimed at improving sleep quality and workforce performance.

Keywords

Construction Workforce, Factors, Gender Differences, Sleep, Sleep Deprivation

1. Background Literature Review

The construction industry is crucial in shaping our world by building structures and infrastructure that meet society's needs (Langar & Sulbaran, 2024). Construction is an industry that continually requires individuals (Harper & Sulbaran, 2019). The construction industry faces many well-known challenges with its workforce, such as a shortage of skilled labor, an aging workforce, high turnover, wage disparities, work-life balance, and geographical mobility, to mention a few. However, one lesser-known challenge of the construction workforce is sleep deprivation. Sleep deprivation occurs when an individual is not able to get enough hours of sleep needed for the person's body to repair itself, feel refreshed, and function well (Bandyopadhyay & Sigua, 2019). Sleep deprivation occurs when the individual has less restorative sleep than required for full restoration (Powell & Copping, 2010).

Unfortunately, sleep deprivation is becoming endemic in modern society, with its related risks (Ferrara & De Gennaro, 2001). In the United States (US), sleep deprivation is very common, with 35% of adults reporting less than 7 hours of sleep during a typical night (Bandyopadhyay & Sigua, 2019). Sleep deprivation is critically important and frequently experienced by the construction workforce (Kim et al., 2021). Unfortunately, the construction workers do not understand either their state of fatigue or its consequences, or both (Powell & Copping, 2010). The construction workforce is plagued with sleep deprivation. Kim's study using the Pittsburgh Sleep Quality Index revealed that almost 63% of the construction workforce is sleep deprived (Kim et al., 2021). Similarly, Powell used an actigraph

and also found that construction workers are sleep deprived (Powell & Copping, 2010). Ferrada's results similarly indicated that only 23.4% of the construction workforce had a good quality of sleep. (Ferrada et al., 2021)
Sleep deprivation negatively impacts many of the construction workforce's abilities, such as attention, working memory, and emotions (Krause et al., 2017). Several previous studies have reported that the construction workforce's sleep deprivation causes fatigue, pain, and multiple health diseases (Al-Bouwarthan et al., 2020; Chung et al., 2019; Kao et al., 2016; Powell & Copping, 2010). It also impairs human reaction times, leading to slower responses, increased lapses, and increased errors, especially in operations with high cognitive demand.(Lim & Dinges, 2008). Sleep deprivation also decreased performance, alertness, and health (Abrams, 2015; Bandyopadhyay & Sigua, 2019). It also decreases motor and cognitive performance (Ferrara & De Gennaro, 2001). It causes an increased risk of concentration at construction work (Sathvik & Krishnaraj, 2020). Sleep deprivation adversely affects brain and cognitive functions (Sathvik & Krishnaraj, 2020). It has major implications for cognitive performance, motor functioning, mental health, and long-term physical health (Litwiller et al., 2017). Sleep deprivation decreases construction workers' performance (Sathvik & Krishnaraj, 2020).

Sleep deprivation is detrimental to all people, but it is especially critical for the construction workforce because: (1) the construction workforce commonly performs high-intensity work for extended hours in an unpleasant environment due to the job characteristics (Kim et al., 2021), (2) the construction workforce works in environments that are always changing due to the number of people on the site from day to day, and project progress (Phegley, 2017); (3) Risks at construction sites may be heightened due to inclement weather and mobile equipment, as well as changing and demanding schedules requiring additional work hours (Powell & Copping, 2010); and (4) the construction workforce may have long commute times before and after work depending on the jobsite location that may add to their risk (Phegley, 2017) among others. In a National Safety Council (NSC) study, 71% of the construction employers indicated that workers' sleep deprivation affected productivity (NSC, 2017).

Sleep deprivation affects not only the workers individually, but also the nation's productivity(Kim et al., 2021). Regretfully, sleep deprivation has been very poorly studied in the construction industry (Ferrada et al., 2021). Therefore, it is necessary to explore factors related to sleep deprivation in the construction workforce (Kim et al., 2021). Thus, the problem addressed by this study is the gap in knowledge regarding the factors that influence sleep deprivation in the construction workforce.

2. Research Methodology

This study followed a quantitative research methodology. Quantitative research methodology is founded on the scientific method and uses experimental and observed measurements to advance knowledge in the research area (Mohajan, 2020). A quantitative approach was selected because it enabled the systematic collection and analysis of data, allowing for generalization of findings and the identification of statistically significant patterns. Furthermore, quantitative research methodology is dominant in the context of testing and assessment research (Rahman, 2016)

2.1. Data Collection

An online survey was developed, including only closed-ended questions to reduce time to complete, ensure response consistency, and facilitate descriptive and inferential statistical analysis. Online surveys include the following advantages: speed and reach, ease, cost, flexibility, and automation (Ball, 2019). The survey included questions aimed at capturing demographic information, sleep habits, and factors influencing sleep deprivation.

The completed survey and study details were submitted to the university's Institutional Review Board for review and approval. Upon receiving approval, the survey was sent twice to the students as an announcement in a student's newsletter, with two weeks in between. Additionally, the survey was also sent via e-mail also twice, with two weeks in between. This allows the potential participants to respond at their convenience, adding another layer of anonymity to increase response rates (Ball, 2019).

The inclusion criteria were (1) students in the college and (2) in the majors of the study. Explicit informed consent was obtained from all participants. The respondents were informed that their Participation was totally voluntary. The participants were also informed that they could agree to take part in the study and later change their minds. It was also explicitly stated that their decision not to participate would not be held against them.

2.2. Statistical Analysis

A quantitative research methodology is characterized by obtaining the results through statistical analysis (Mohajan, 2020). The statistical analysis employed in this study included descriptive and inferential. The Descriptive statistics included pie charts, bar charts, and stack bar charts with central tendency metrics. Central tendency metrics were used because they can communicate a great deal about a dataset and lay the foundation for calculating and interpreting many inferential statistics.(Adamson & Prion, 2013). The inferential statistic employed in this study was the Mann-Whitney U Test as shown in Eq. 1. The Mann–Whitney U Test is a test to compare two independent samples (Hinton, 2010). It is a nonparametric test, as the analysis is undertaken on the rank order of the scores (Hinton, 2010). The Mann-Whitney U Test was used because the data collected was ordinal based on a Likert scale, and there was no assumption of normal distribution.

$$U = n1n2 + \frac{n1(n1+1)}{2} - R1 \qquad \textbf{(1)}$$

U = *U statistics* | *n1* = Group Size 1 | *n2* = Group Size 2 | *R1* = Sum of the ranks for Group 1

A quantitative research methodology is also characterized by clearly defined variables (Mohajan, 2020).Thus, in this study, the primary variables of interest were the (1) factors contributing to sleep deprivation and (2) gender. The chi-square test was used to determine whether significant differences existed between male and female civil engineers and construction participants with regard to the factors influencing sleep deprivation.

To test the hypotheses, the data was first categorized into different groups based on gender, and then analyzed to identify any patterns or significant differences in the factors contributing to sleep deprivation. The chi-square test assessed whether the distribution of responses regarding sleep deprivation factors differed significantly between males and females. A significance level of 0.05 was set for all statistical tests, with p-values less than 0.05 considered statistically significant. This was selected because in many studies, the significance level is set to 0.05 to compare with the significance probability value, p-value (Kwak, 2023).

3. Results

3.1 Demographics

The construction workforce is composed of individuals with a diverse level of educational attainment, ranging from individuals who were not able to complete high school to individuals who have completed university degrees (bachelor's or master's). Construction workforce development programs exist at high schools, trade schools, community colleges, and universities (Sulbaran & Kisi, 2023). The most popular university degrees of the construction workforce are Bachelor's in construction management/science and civil engineering (Nichols, 2024) . Therefore, this case study focused on these two degrees.

There were 69 participants in the study, all from the University of Texas at San Antonio. However, not all participants responded to all the questions. As shown in the Fig. 1Thirty-one participants (44.9%) were in civil engineering, and thirty-eight participants (55.1%) were in construction management. Twenty-four participants (24.8%) were female, and forty-five (65.2 %) were male. Of the sixty-three participants who responded to this question, only 17 participants (27 %) of the respondents had 3 or fewer months of work experience, meaning that the majority of the participants had four or more months of work experience.

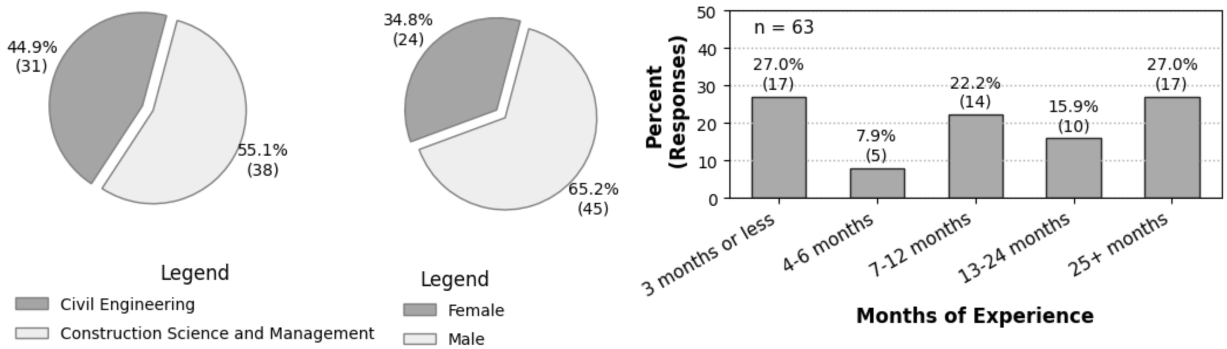

Fig. 1. Participants Demographic Information

3.2 Factors Influencing Sleep Deprivation

The questions regarding factors that influence sleep deprivation were answered by 17 females and 28 males for a total of 45 respondents of the 69 participants. The distribution of all responses is shown in Fig. 2 with stacked bars. Each factor was rated by the participants on an ordinal scale from 1 (Very Low) to 5 (Very High) influence, represented by different shades of blue (light green to dark green) using the left axis to show the number of responses for each effect level. Additionally, the central tendency metrics of mean, median, and mode were overlaid using distinct markers and colors to provide insight into each factor. The values of all central tendency metrics can be read on the right axis.

As shown in the Fig. 2, the participants vary in their perspective on the influence of each factor on sleep deprivation, with all factors having some participants indicating very low influence and others indicating very high influence. The median indicated that seven of the factors have a high influence (4). Those factors include: "Tight Schedule of Project", "Working overtime", "Working in afternoon or night shifts", "Intensity and nature of the industry", "Fatigue from previous day", "Early start time of the work", and "Heavy workloads". Six of them also had a mode of 4 (high), indicating that most people gave a similar answer, and the distribution of responses is relatively symmetrical around 4 (high). The only factor with a 4 (high) median, 3 (moderate), and mode was "Early start time of the work" indicating that the most common responses were at the lower end, but there were some responses in the higher end, pushing the median up. This also indicates that the responses were not symmetrical but rather skewed towards the lower end.

The factor with the higher central tendency values was "Tight schedule of project" followed by "Heavy workloads" indicating a general agreement among the respondents that these two factors are the ones that have the most impact on sleep deprivation. "Scarcity of labor resources" and "Family" central tendency values were lower, indicating also an agreement among the respondents that while these factors impact sleep deprivation, they do it moderately.

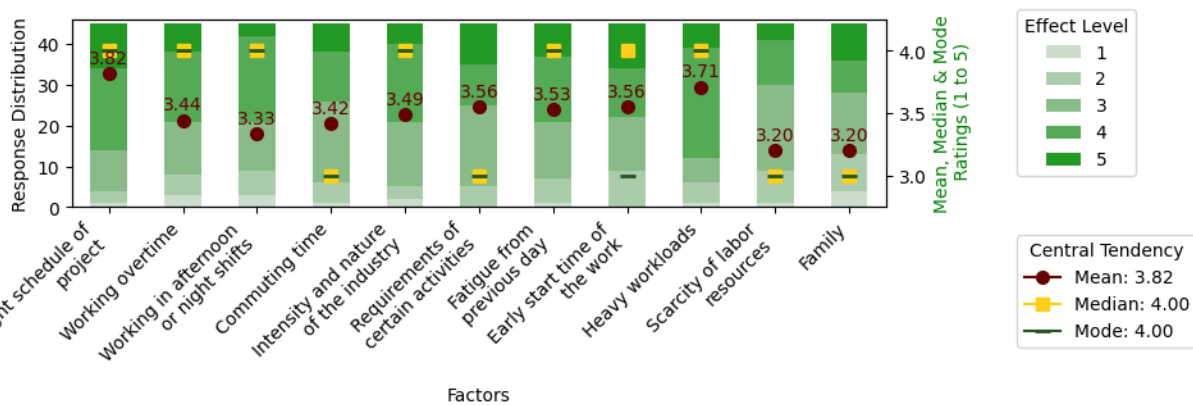

Fig. 2. Factors that Influence Sleep Deprivation

3.3 Factor Difference between Gender Differences

Fig. 3 shows two stacked bar graphs, the one on top (in red) corresponds to the responses from female participants, and the one at the bottom (in blue) corresponds to the responses from the male participants. It can be observed in the Fig. 3 that the biggest difference between females and males on the factors that influence sleep deprivation was "Fatigue from previous days", with females' mean value of 3.82 and males' mean value of 3.36 representing a mean difference of 0.47. Meaning that the female participants consider "Fatigue from the previous day" a more important factor than the male participants. The second biggest difference was on the "Heavy workload" with females' mean value of 3.94 and males' mean value of 3.57, representing a mean difference of 0.37. The biggest difference where the male participants considered to be more important for sleep deprivation than females, was "Working in the afternoon or night shifts" with the female mean value of 3.11 and the male mean value of 3.46, representing a mean difference of 0.35. Meaning that the female participants consider this factor of less importance than the male participants. The smallest difference between females and males was on "Scarcity of labor resources" with female mean value of 3.18 and males mean value of 3.21 representing a mean difference of 0.03 the second lowest difference was on "Commuting time" with female mean value of 3.35 and males mean value of 3.46 representing a mean difference of 0.11.

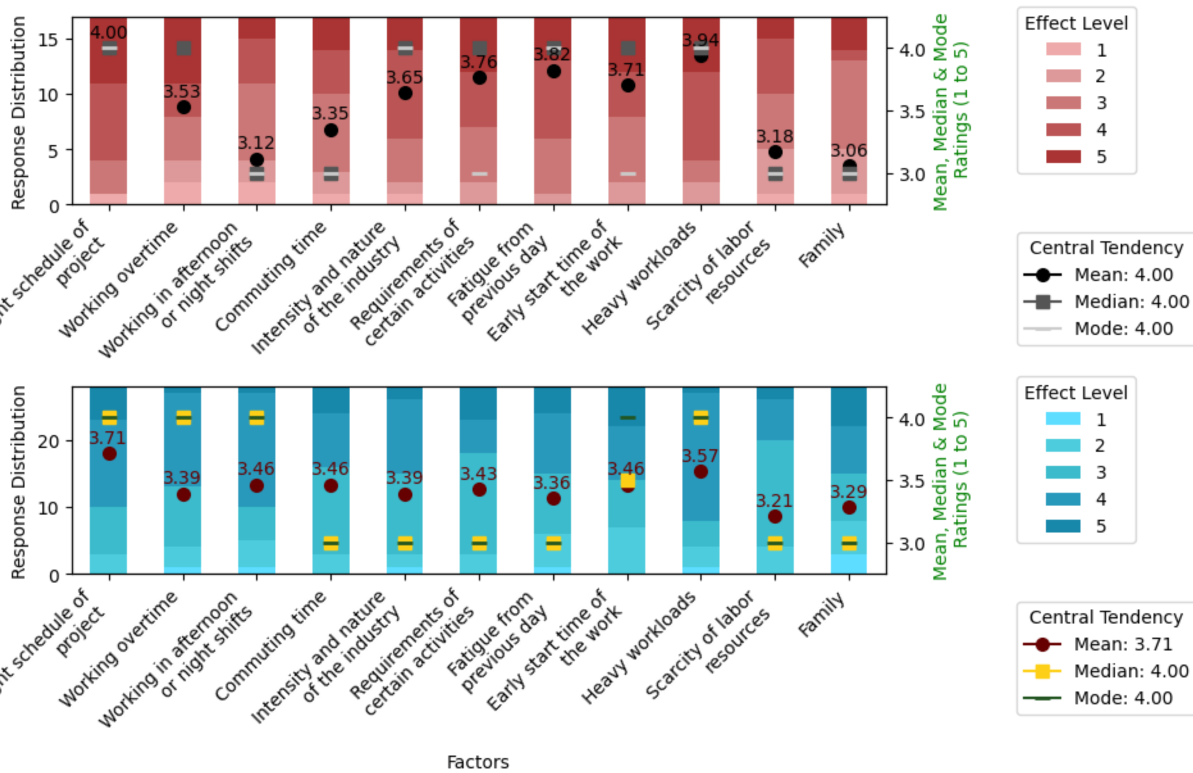

Fig. 3. Female (in red) vs Male (in blue) Factors that Influence Sleep Deprivation

Under further analysis performing the Mann-Whitney U test is shown in Table 1, it can be seen that the factors "Heavy workloads" ($p = 0.137$) and "Fatigue from previous day" ($p = 0.156$) had the lowest p-values, indicating potential areas where gender-based differences may exist, though they did not reach the conventional 0.05 level of significance. Therefore, no statistically significant differences were found between male and female respondents for these two factors or any of the other factors. In fact, the highest p-value was for "Scarcity of labor resources" ($p = 0.990$), suggesting this factor is viewed nearly identically by both genders. This means that based on the data, both males and females perceive the list of factors that influence sleep deprivation very similarly. The Mann-Whitney U test results indicate that, at the 95% confidence level, gender does not play a statistically significant role in how respondents perceive the factors that influence sleep deprivation. However, factors like "Heavy workloads" and "Fatigue" might be worthy of deeper qualitative follow-up or further quantitative investigation with larger samples, as small trends could be masked by limited power.

Table 1. Mann-Whitney U Test Males vs Females

Factors	R1 Sum Rank Female	R2 Sum Rank Male	U Statistics	p-value	p-value <0.05
Tight schedule of project'	441.0	594.0	188.0	0.218	No
Working overtime	418.0	617.0	211.0	0.517	No
Working in afternoon or night shifts	341.5	693.5	287.5	0.221	No
Commuting time	380.5	654.5	248.5	0.805	No
Intensity and nature of the industry	436.5	598.5	192.5	0.261	No
Requirements of certain activities	438.5	596.5	190.5	0.243	No
Fatigue from previous day	449.5	585.5	179.5	0.156	No
Early start time of the work	420.0	615.0	209.0	0.490	No
Heavy workloads	447.5	587.5	181.5	0.137	No
Scarcity of labor resources	390.0	645.0	239.0	0.990	No
Family	362.0	673.0	267.0	0.492	No

4. Discussion

The findings of this study underscore the significant burden that sleep deprivation places on individuals in the construction workforce and highlight the multifaceted nature of its contributing factors. The high median and mode ratings for factors such as “Tight schedule of project,” “Heavy workloads,” and “Fatigue from previous day” suggest these are consistently recognized as major contributors to sleep loss among construction students preparing to enter the industry. These results are consistent with prior research indicating that demanding work conditions and long hours are key contributors to sleep deprivation in the construction sector (Kim et al., 2021; Powell & Copping, 2010)

Although central tendency values suggest some gender-based trends, such as females rating “Fatigue from previous day” and “Heavy workloads” slightly higher than males, the Mann-Whitney U test revealed that none of the gender differences were statistically significant at the 0.05 level. This suggests that both male and female students perceive the stressors impacting sleep similarly, which may reflect a shared experience within the educational and pre-professional environment. However, the relatively low p-values for “Heavy workloads” ($p = 0.137$) and “Fatigue from previous day” ($p = 0.156$) may point to emerging gender-based differences that could become more pronounced with a larger sample size or through a more targeted qualitative exploration.

It is also important to consider that while this study focused on students in construction-related programs, these participants are likely to face similar working conditions as they transition into the field. Therefore, the stressors identified may not only reflect current academic pressures but also serve as a precursor to future industry-related challenges.

5. Conclusions

This study investigated the factors contributing to sleep deprivation within the construction workforce, with a specific focus on identifying potential gender-based differences. Using a quantitative methodology and statistical analysis, the findings confirmed that sleep deprivation is a prevalent issue influenced by a range of occupational factors. The most impactful contributors to sleep deprivation across participants were identified as “Tight schedule of project,” “Heavy workloads,” and “Fatigue from previous day,” based on their central tendency values.

Although descriptive statistics suggested some variation in how male and female participants perceived certain factors—such as females rating “Fatigue from previous day” and “Heavy workloads” higher, while males considered “Working in afternoon or night shifts” more influential—these differences were not statistically significant according to the Mann-Whitney U Test. Thus, the data indicate that both genders generally perceive the influence of these factors on sleep deprivation similarly.

The absence of statistical significance does not diminish the practical importance of the findings. The results of this study emphasize the importance of addressing systemic workload and scheduling practices within the construction industry to reduce sleep deprivation across the workforce. While gender-based perceptions were largely aligned, the observed trends warrant further exploration through larger sample sizes or multiple disciplines to better understand potential nuanced differences. Interventions aimed at mitigating sleep deprivation, such as flexible scheduling, better resource allocation, and wellness programs, would benefit all construction workers regardless of gender. Future research should continue to explore these factors using larger and more diverse populations to validate trends and identify effective policy interventions. Ultimately, improving sleep health in construction settings has the potential to enhance worker performance, and well-being across the board as well as the nation's productivity.

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