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Modeling Workplace Well-Being Factors in Infrastructure Construction Projects: PLS-SEM Approach

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Abstract: Working at construction sites can harm individuals' health and well-being. However, stakeholders often focus on improving health while discounting well-being. Establishing a better workplace environment can improve workplace well-being. Therefore, this study aims to investigate the factors influencing workplace well-being in infrastructure construction projects. To achieve this aim, the study objectives are to (1) identify the critical factors influencing workplace well-being in infrastructure construction projects; (2) develop an interrelationship model between underlying constructs of the factors; and (3) assess the influence of the underlying constructs on workplace well-being in infrastructure construction projects. First, a list of factors influencing workplace well-being was established using data from a systematic literature review and semi-structured interviews. Then, a survey was developed using the list of factors and distributed to infrastructure construction practitioners. In total, 124 responses were retrieved and analyzed using normalized mean analysis, exploratory factor analysis (EFA) and partial least square structural equation modeling (PLS-SEM). The analyses reveal that the critical factors include workload, salary package, the timeline of salary payment, working hours, planning of the project, insurance for construction workers, workers' welfare and project progress. Furthermore, the underlying constructs are physical factors and psychosocial factors. Finally, both physical and psychosocial factors are found to significantly influence workplace well-being in infrastructure construction projects. Focusing solely on physical factors may not sufficiently enhance workplace well-being in construction projects, as there are also non-visible factors, such as psychosocial factors. Thus, exploring the interplay between visible and non-visible factors and their influence on workplace well-being in construction projects is crucial. Nevertheless, the findings have several limitations, including using data from a single country and non-hands-on construction practitioners, as well as the underlying constructs being derived solely using statistical methods. Still, the study is original in its focus on modeling the relationship between the factors influencing workplace well-being within the context of infrastructure construction projects. In other words, this study differs from prior research by specifically modeling the factors that influence well-being in infrastructure construction projects.

Keywords: well-being; factor analysis; PLS-SEM; infrastructure; construction projects

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Citation: Alhammadi, Y.; Radzi, A.R.; Alias, A.R.; Rahman, R.A. Modeling Workplace Well-Being Factors in Infrastructure Construction Projects: PLS-SEM Approach. *Buildings* **2024**, *14*, 2289. https://doi.org/10.3390/buildings14082289

Academic Editor: Biao Hu

Received: 28 May 2024
Revised: 11 July 2024
Accepted: 19 July 2024
Published: 24 July 2024

1. Introduction

Well-being in working environments is called workplace well-being. According to the International Labor Organization, workplace well-being is about everything at work, including how safe and good the place is physically, how employees feel about their jobs, where they work, the atmosphere and how work is organized [1]. Construction projects are widely acknowledged as one of the most hazardous workplaces [2]. Construction projects lose millions of lives annually from occupational accidents and workplace-related diseases [3]. Additionally, millions suffer from non-fatal injuries, such as stress and psychological risks. The average working hours in a construction project could be up to 60 h per week, influencing workplace well-being [4]. Poor workplace well-being may lead to stress, resulting in low performance at work [5]. Furthermore, pain, injuries and disabilities are common because construction work is physically demanding. These pain and injuries negatively influence workplace well-being due to higher levels of depression, anxiety and stress [6]. Accordingly, stress contributes to lower productivity, higher-than-average absenteeism and poor work performance [7]. Therefore, there is a need to address workplace well-being to avoid poor construction project performance.

Most of the prior construction project management research focused on investigating workplace well-being in general. For instance, Campbell and Gunning (2020) [8] identified the strategies to enhance workplace well-being in the UK construction industry, and Carvajal-Arango et al. (2021) [9] identified the most influential dimensions in the workplace well-being of construction employees. However, the research was conducted without limiting the scope to specific types of construction projects. Given that dissimilarities exist among different types of construction projects, it is essential to investigate each type specifically. For example, infrastructure construction projects typically involve large-scale and complex developments, such as highways, bridges, airports and utilities [10]. Moreover, infrastructure construction projects often have longer durations, spanning several years or even decades [11]. Additionally, the cultural background in infrastructure projects might differ from other types of projects due to these dissimilarities. The work environment in infrastructure projects, which often includes remote and outdoor locations, can be vastly different from other construction projects that might take place in more controlled, urban settings. Furthermore, prior research does not examine the relationship between these factors and overall workplace well-being. Without understanding how the factors interact and influence overall well-being, stakeholders lack a comprehensive view of the well-being landscape. Therefore, it is essential to critically examine workplace well-being in infrastructure construction projects.

As every construction project is unique [12], workplace well-being issues may vary greatly even among similar projects. It is evident that infrastructure projects are different from other types of construction projects [10,11]. Additionally, insights into the potential relationships between the factors affecting workplace well-being are still lacking. By modeling these relationships, valuable insights can be gained into the dynamics of these factors. Through this modeling process, researchers can verify the existence and strength of relationships between different factors and workplace well-being. Furthermore, modeling these relationships allows researchers to identify which factors significantly influence workplace well-being. This information can be used to prioritize interventions and strategies aimed at improving workplace well-being. By rigorously modeling the relationship between the influencing factors and workplace well-being, scholars can contribute to a deeper understanding of how to create a better workplace. Therefore, there is a need to model the relationship between the factors influencing workplace well-being in construction projects.

Based on the background presented, this study aims to investigate the factors influencing workplace well-being in infrastructure construction projects. To achieve this aim, the study objectives are to (1) identify the critical factors influencing workplace well-being in infrastructure construction projects; (2) develop an interrelationship model between underlying constructs of the factors; and (3) assess the influence of the underlying constructs on workplace well-being in infrastructure construction projects. The novelty and originality of this study lie in its focus on modeling the interrelationship between the factors influencing workplace well-being in infrastructure construction projects. Although previous research has investigated workplace well-being in construction projects more broadly, limited attention has been given to the unique challenges and dynamics present in infrastructure construction projects. By narrowing the scope to this specific project type, the study can uncover insights that may not be apparent in research covering a broader range of construction projects. Additionally, exploring workplace well-being within infrastructure construction projects contributes to filling a gap in the existing literature, as there is currently limited research addressing this aspect of well-being in this context. Therefore, the novelty of this study lies in its targeted investigation of workplace well-being within infrastructure construction projects, which has the potential to generate new knowledge and inform practical interventions to improve workplace well-being in construction projects.

2. Literature Review

2.1. Workplace Well-Being in Construction Projects

Good workplace well-being is crucial, as it increases worker productivity and performance. Hence, researchers have investigated workplace well-being in construction projects. Rotimi et al. (2023) [13] examined the influence of sexism and unfavorable job conditions in construction projects on the workplace well-being of women. The results revealed that both benevolent and hostile sexism have a direct influence on work morale and indirectly influence the workplace well-being of women in construction projects. Li et al. (2022) [14] conducted a thorough review, identifying five primary themes of workplace well-being antecedents: motivational, relational, working environment, personal attributes and social cognitive factors. Carvajal-Arango et al. (2021) [9] delved into factors influencing workplace well-being in construction projects from the perspective of employees, pinpointing rewards and recognition, growth and projection, sense of work and interpersonal relationships, activity performed, physical work environment and physical and mental health as the most influential factors. Chan et al. (2020) [15] developed a conceptual framework and checklist on the risk factors influencing workplace well-being in construction projects. Fordjour et al. (2021) [16] identified the impact of construction projects on workplace well-being, focusing on psychological conditions, identifying seven critical constructs among forty-two risk factors: high task demands, high role demands, poor relationships, poor work conditions, lack of autonomy, lack of feedback and unfair treatments. Langdon and Sawang (2018) [17] explored the primary stressors and coping strategies influencing workplace well-being in construction projects, revealing that time, personal finance and task nature significantly contribute to stress levels. Furthermore, coping strategies like acceptance, self-blame and disengagement are linked to heightened psychological distress.

Each construction project possesses its distinct characteristics [12], leading to variations in workplace well-being concerns even within projects of similar types. Therefore, specific research efforts have been directed toward understanding workplace well-being in different types of construction projects. For instance, Asare et al. (2021) [18] investigated the influence of rotation work on mental and physical outcomes among rotation employees in mining and offshore oil and gas projects. Their findings highlighted that rotation work is linked to several adverse behaviors and outcomes, including sleep problems, smoking, alcohol consumption and overweight/obesity. Similarly, Rani et al. (2022) [19] focused on workplace well-being in building construction projects. Halim et al. (2022) [20] also examined the key factors influencing workplace well-being in high-rise construction projects. This prior research emphasizes the importance of investigating workplace well-being tailored to the unique characteristics of different types of construction projects.

2.2. Modeling Interrelationships between Variables in Construction Projects

Various models have been constructed to depict the relationships between different variables or factors within the context of infrastructure construction projects. Accordingly, infrastructure construction projects involve numerous interconnected variables and stakeholders. Relationship models can help understand the complex interactions between these factors, allowing for more informed decision making. For example, Gamil and Abd Rahman (2023) [21] developed a structural equation model to elucidate the intricate relationships between the causes and effects of poor communication in construction projects. Their model provided insights into the degree of relationships among the different factors contributing to poor communication in construction projects. Abdulai et al. (2024) [22] delved into the relationship between barriers and drivers of circular economy adoption in developing countries. Their research highlighted the significant relationship between barriers and drivers, shedding light on the threats and opportunities in implementing circular economy in construction projects. Similarly, Munianday et al. (2022) [23] constructed a structural equation model to explore the causal relationships between factors and strategies related to organizational building information modeling (BIM) capabilities. Their findings revealed that organizational culture positively influences organizational and BIM capabilities, with organizational competitiveness also playing a significant role. Furthermore, Buniya et al. (2021) [24] investigated the relationship between barriers to safety program implementation in construction projects, identifying four significant barriers, including non-conductive work climate, poor governance, poor safety awareness and unsupportive industry norms. Despite these valuable contributions to relationship modeling in construction projects, a research gap remains pertaining to relationship models focused explicitly on workplace well-being, particularly within infrastructure construction projects.

2.3. Well-Being in Malaysian Construction Industry

There has been limited research conducted specifically on well-being in the construction industry in Malaysia. Musarat et al. (2022) [25] examined how IR-4.0-related technologies can enhance health and safety in Malaysia's construction industry by utilizing the analytical hierarchy process (AHP) technique. Building information modeling (BIM) and integrated systems show the highest potential among advanced technologies and should be prioritized for implementation in the construction industry to enhance current health and safety performance. Wong (2023) [26] aimed to explore the intricate relationship between working conditions and occupational health and well-being within the construction industry. The results indicated that higher levels of job demands and support were positively correlated with improved well-being. Esa et al. (2024) [27] aimed to explore how aware the Malaysian construction industry is of mental illness and its perceptions of this issue. The data collected indicate that mental illness among respondents is not extremely severe, but the prevalence is significant enough to warrant attention. This subsection highlights the gap in understanding and addressing well-being in the Malaysian construction industry.

2.4. Knowledge Gap and Study Positioning

Based on the existing literature, prior research has extensively explored various facets of workplace well-being. Furthermore, numerous research works have delved into modeling different relationships within construction projects, highlighting the importance of understanding these dynamics. However, despite these efforts, a notable gap exists in understanding the specific relationship between factors influencing workplace well-being, particularly in infrastructure construction projects. In other words, although significant research has been conducted on workplace well-being and relationship modeling, the intersection of these areas, particularly within infrastructure construction projects, has not been thoroughly investigated. To address this research gap, this study aims to investigate the factors influencing workplace well-being in infrastructure construction projects. This investigation seeks to contribute to a deeper understanding of the intricate dynamics surrounding workplace well-being in infrastructure construction projects.

3. Methodology

This study used a questionnaire survey to gather quantitative data systematically [28]. A questionnaire survey facilitates the collection of quantitative data in a standardized manner, ensuring that the data are internally consistent and coherent for analysis [29]. Moreover, it is one of the most cost-effective ways to gather data from a sample representing the large population under examination [30,31]. Figure 1 depicts the study's framework.

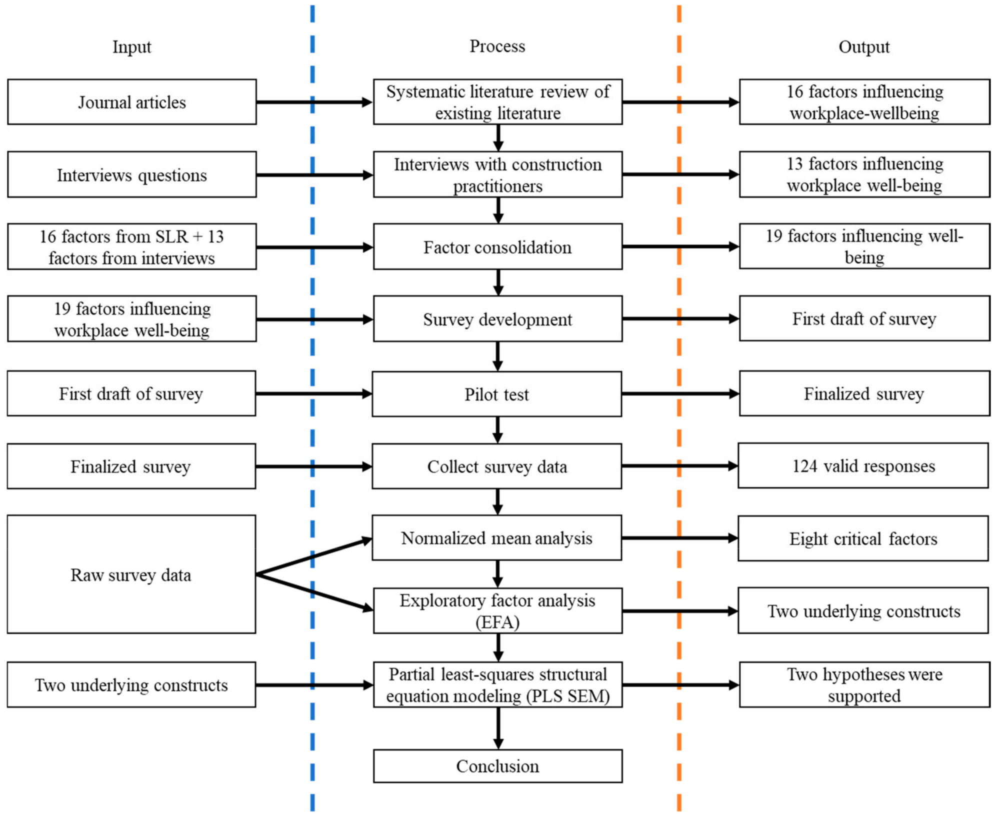

Figure 1. Research methodology.

3.1. Survey Development

First, a systematic literature review (SLR) was employed to identify the potential factors influencing workplace well-being for the survey. The Scopus database was used for the search. The initial search using the "title/abstract/keyword" function was conducted using the terms "construction workers" OR "workers well-being" OR "construction" OR "well-being" OR "construction project". After the search, 229 articles were retrieved. Next, inclusion and exclusion criteria were used to assess the articles. The inclusion criteria comprised works written in English, works related to workplace well-being and peer-reviewed journal articles. Articles written in languages other than English and those unrelated to workplace well-being were excluded. Additionally, conference proceedings were removed due to the possibility of inadequate quality [32]. Finally, twenty-one articles were chosen for further analysis. These articles used to identify the factors influencing workplace well-being in construction projects are only part of the survey development process. Furthermore, factors identified from the SLR were combined with those gathered from interviews with construction practitioners. Additionally, a pilot test was conducted to acquire more factors. There are other research works that also conduct SLR as part of survey development, and the number of articles used in these reviews is not significantly higher, such as 26 articles [23] and 13 articles [33]. Therefore, 21 articles are considered sufficient to identify the factors for survey development.

Then, twenty-one semi-structured interviews were carried out with construction practitioners to obtain information on other factors influencing workplace well-being. A robust qualitative inquiry involving interviews recommends a range of interviewees between 5 and 25 [34,35]. This step is a common method to elicit additional factors not reported in previous research [36,37]. The interviewees all had at least five years of experience working in the construction industry. The interview involved providing a quick introduction to the purpose and the main topic of the session. Afterward, a series of questions designed for the interview were asked. To ensure a thorough understanding of the responses and a firm grasp of the information provided by the interviewees, several follow-up questions were asked based on the answers given by the interviewees. If the interviewees could not reply or elaborate on the initial question, the interviewer rephrased the question and gave extra time to answer. Finally, the interviewer thanked the interviewees for their time and effort. Following each interview, a summary was compiled and presented to the interviewee for validation. After conducting 21 interviews, the researchers observed that the data had reached a state of saturation, where similar information was consistently acquired, and new perspectives or insights were no longer obtained from additional interviews. Thus, the data saturation point was reached, and further interviews were deemed unnecessary. Next, the interview data were analyzed using the thematic analysis technique [38]. Based on the interview, thirteen factors influencing workplace well-being were identified.

Then, a survey was created by merging the findings of the SLR and semi-structured interviews, generating a total of nineteen factors (see Table 1). The first page of the survey included the study objective and contact details. The survey was divided into two sections. The first section included questions regarding respondents' and organizations' backgrounds that were required to determine the reliability of the respondents. The second section of the survey probed respondents' perspectives on the nineteen factors. Respondents were required to assess the criticality of the factors using a five-point Likert scale (1 = not critical, 2 = less critical, 3 = moderately critical, 4 = critical and 5 = extremely critical). The five-point Likert scale was adopted due to its short length [23,36] and ability to convey precise information [39]. After the second section, respondents were given space at the end of the survey to describe and rank any additional factors.

A pilot test aims to identify any issues related to survey design and instrumentation [30]. Consequently, the results obtained from the pilot test play a pivotal role in improving the overall quality of the survey and determining the necessary time for its completion [40]. In addition, the results include ensuring that appropriate technical jargon is used and eliminating any unclear phrases. For this reason, a pilot test was conducted with four highly experienced construction project management experts: two academics and two construction practitioners with a combined total of more than ten years of experience. All pilot test respondents were given a copy of the survey and asked to share their thoughts on the different questions in the survey. Data saturation is recognized when further data collection fails to yield novel or distinct conclusions [41]. By the fourth respondent, the data gathered had reached data saturation. The survey was then improved after considering the feedback obtained during the pilot test.

Table 1. List of factors influencing workplace well-being in construction projects.

Code	Factors Influencing Well-Being	Sources
IWF1	Communication between workers	Interview; [42–48]
IWF2	General safety and health monitoring	Interview; [9,44–56]
IWF3	Employee work monitoring	[9,47]
IWF4	Worker facilities	Interview; [44]
IWF5	Collaboration between top management and employee	Interview
IWF6	Project progress	Interview; [48,53,55]
IWF7	Food at the rest area	[49]
IWF8	Comfort at the rest area	[49]
IWF9	Workload	Interview; [9,45,54,57]
IWF10	Insurance for construction workers	Interview
IWF11	Project leadership	[54–58]
IWF12	Workers' welfare	Interview; [46]
IWF13	Planning of the project	Interview
IWF14	Salary package	Interview; [59]
IWF15	Timeline of salary payment	Interview; [59]
IWF16	Relationship between top management and employees	[54,56,58,60]
IWF17	Transportation facilities for construction workers	Interview; [44]
IWF18	Working environment	[9,48,51]
IWF19	Working hours	Interview; [9,46–48,54,58,61]

3.2. Data Collection

The target population for this study is industry practitioners with experience in infrastructure construction projects in Malaysia. Due to the inability to name or identify individuals in the study population, this study used a non-probability sampling method [62]. The snowball sampling method was employed to access the intended target population, as it facilitates the collection of data from industry experts through referrals and social media networks [63]. The first respondent was determined by contacting infrastructure construction practitioners identified via referrals. Respondents were then asked to recommend other potential respondents suitable for the study. To boost the response rate of the survey and expand its outreach to a broader audience, follow-up reminders were dispatched to the target population two weeks after the initial contact. There were 124 valid responses in total. Respondents were classified based on their types of organizations, years of experience in the construction industry, number of projects involved and organization's number of employees (see Table 2).

Table 2. Respondent profile.

Characteristics	Category	Frequency	Percentage (%)
Types of organizations	Clients	9	7.3
	Contractors	87	70.2
	Consultants	28	22.6
Years of experience in the construction industry	Less than two years	25	20.2
	Two to five years	63	50.8
	Six to nine years	22	17.7
	More than ten years	14	11.3
Number of projects involved	Less than two projects	16	12.9
	Two to five projects	71	57.3
	Six to nine projects	22	17.7
	More than ten projects	15	12.1
Organizations' number of employees	201 employees or more	23	18.5
	76 to 200 employees	23	18.5
	31 to 75 employees	20	16.1
	6 to 30 employees	28	22.6
	Less than 5	11	8.9
	I cannot say	19	15.3

3.3. Data Analysis

3.3.1. Data Reliability

The consistency and reliability of the survey data were examined by conducting a reliability analysis. Cronbach's alpha (α) is a widely used method for assessing the average correlation or internal consistency among variables in a questionnaire survey. The reliability of the research instrument in the survey is measured on a scale from 0 to 1. To ascertain the reliability of the survey, the α value should exceed 0.70 [64]. The overall α value of the nineteen factors was 0.969. The results show that the five-point Likert scale is reliable at the 5% significance level. This means that the collected information is appropriate for further analysis.

Then, this study employed the Kruskal–Wallis test to assess whether there were significant differences in the ranking of factors influencing workplace well-being among respondents with varying years of experience in the construction industry. The results revealed that all p-values were above 0.05, indicating that there were no significant differences in how respondents ranked these factors based on their years of experience. This suggests that, despite varying levels of experience in the construction sector, respondents generally agreed on the importance and ranking of factors influencing workplace well-being.

3.3.2. Normalized Mean Analysis

The normalized mean analysis (NMA) was employed to identify the critical factors among the 19 factors influencing workplace well-being in infrastructure construction projects. In this method, the mean and standard deviation values for all factors were computed [23]. A smaller standard deviation means that the differences between responses are smaller, which suggests that the mean value is more likely to be correct [65]. When more than one factor has the same mean value, the one with the lowest standard deviation is ranked higher. Following that, the normalized mean values were calculated to pinpoint the critical factors. The normalized values were calculated using the following equation:

$$\text{Normalized value} = \frac{\text{Mean} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}}$$

This method was used in this study because it offers a clearer interpretation of the data, particularly for identifying significant or critical factors. Factors with normalized values of at least 0.50 were considered critical in influencing workplace well-being in infrastructure construction projects [66].

3.3.3. Exploratory Factor Analysis

Then, the exploratory factor analysis (EFA) was used to identify underlying groups among these 19 factors. EFA is a statistical technique used to identify underlying relationships between measured variables [67]. It helps in combining and reducing many interconnected variables into a smaller, more manageable and more relevant set of constructs. This method is useful in uncovering the underlying structure of a large set of variables without imposing a preconceived structure on the outcome. The suitability of the data was assessed using both the Kaiser–Meyer–Olkin (KMO) measure of sample adequacy and Bartlett's test of sphericity. The KMO test primarily checks whether the values in the factor analysis measurement sample are adequately distributed, for which a minimum KMO coefficient of 0.50 is necessary [68]. A high level of associated significance ($p < 0.05$) and a high value of Bartlett's test sphericity indicate that the correlation matrix is not an identity matrix, implying that EFA is acceptable [69].

The initial step involves extracting factors from the dataset. This study used principal component analysis (PCA) as the method for extraction. Then, factor rotation is performed to achieve a simpler and more interpretable structure. Varimax rotation was employed to help make the output more understandable by clarifying which variables load significantly onto which factors. Finally, the factors are interpreted by examining the factor loadings, which indicate the strength and direction of the relationship between each variable and the factor. The factor loading threshold value for detecting a construct factor is 0.50 [23].

3.3.4. Partial Least Square Structural Equation Modeling

Finally, partial least square structural equation modeling (PLS-SEM) was used to explore the relationships between the identified groups of factors and workplace well-being. The two types of structural equation modeling are covariance-based structural equation modeling (CB-SEM) and PLS-SEM. PLS-SEM was preferred over CB-SEM, as it better handles non-normal datasets and smaller sample sizes [70]. It is also best suited for exploratory study with less developed theoretical models [71]. PLS-SEM generates a collection of measurement models in addition to a structural model. The outer measurement model can assess the consistency and validity of the variables observed. The validity of the measurement model was assessed using both convergent and discriminant validity. The indicator reliability was evaluated using loadings of measurement items on the corresponding construct of at least 0.4 [72]. Then, Cronbach's alpha, composite reliability (CR) values and average variance extracted (AVE) are the tests that can verify the measurement model's convergent validity. Cronbach's alpha is the coefficient used to calculate the indicators' internal consistency, and it should be greater than 0.7 [64]. Internal consistency is determined by CR values, which should be greater than 0.7. The AVE is then used to assess convergent validity, which should be larger than 0.5 [72]. Discriminant validity is necessary when evaluating hypothetical relationships between constructs [73]. Hulland (1999) [74] proposed two methods for testing discriminant validity: the Fornell–Larcker criterion and the indicators' cross-loading. After evaluating the measurement model, path analysis was used to generate the structural model. Path analysis is used to determine the path coefficients that measure the degree of correlation between constructs. The relevance of the path coefficient was then tested using a bootstrapping procedure.

4. Results

4.1. Normalized Mean Analysis

Table 3 displays the mean, standard deviation and normalized mean values for the factors influencing workplace well-being in infrastructure construction projects. Factors with normalized mean values exceeding 0.50 are categorized as critical. According to the results, eight factors exhibit normalized mean values exceeding 0.50: workload (1.000), salary package (0.963), working hours (0.622), the timeline of salary payment (0.622), planning of the project (0.598), insurance for construction workers (0.585), workers' welfare (0.549) and project progress (0.500). Thus, these factors are considered the critical factors influencing workplace well-being in infrastructure construction projects.

Table 3. Results for normalized mean analysis.

Code	Mean	Standard Deviation	Normalized Mean Value
IWF9	3.782	1.079	1.000 [a]
IWF14	3.758	1.136	0.963 [a]
IWF19	3.532	1.265	0.622 [a]
IWF15	3.532	1.364	0.622 [a]
IWF13	3.516	1.265	0.598 [a]
IWF10	3.508	1.253	0.585 [a]
IWF12	3.484	1.272	0.549 [a]
IWF6	3.452	1.258	0.500 [a]
IWF5	3.444	1.171	0.488
IWF2	3.444	1.333	0.488
IWF4	3.395	1.181	0.415
IWF3	3.395	1.274	0.415
IWF11	3.395	1.299	0.415
IWF1	3.379	1.285	0.390
IWF18	3.363	1.205	0.366
IWF16	3.347	1.282	0.341
IWF8	3.258	1.118	0.207
IWF17	3.258	1.222	0.207
IWF7	3.121	1.187	0.000

[a] = Critical factors.

4.2. Exploratory Factor Analysis

The study's sub-objective was to develop constructs for the factors identified. However, upon conducting EFA specifically on these eight critical factors, the results indicated that all critical factors loaded onto a single underlying construct. The reason for this could be the small number of critical factors identified (only eight). EFA works by identifying the patterns of correlations among variables [75]. When there are fewer variables (factors), EFA may not identify distinct separate factors but rather combine them into one if they are highly correlated. Consequently, the study then expanded the EFA to include all 19 factors influencing workplace well-being. Nevertheless, this broader analysis aimed to uncover additional underlying structures and relationships among the factors beyond the initial set of critical factors.

The KMO value for the 19 factors influencing workplace well-being is 0.943, which is higher than the 0.50 value. This result indicates that the factors have a strong connection for a satisfactory factor analysis [68]. On the contrary, Bartlett's test value is 2261.861 and significant at $p = 0.000$, showing that the correlation matrix is not an identity matrix. In other words, both tests indicate that the factors are suitable for EFA. Table 4 shows that all nineteen factors were retrieved under two constructs with factor loadings larger than 0.50, showing that the factors are practically significant [23]. Finally, the constructs were named based on the factors with the highest factor loadings or on the whole collection of factors represented by the variables [76].

Table 4. Results for exploratory factor analysis.

Constructs	Code	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Psychosocial factors	IWF11	0.862	64.311	0.969
	IWF1	0.850		
	IWF6	0.843		
	IWF13	0.831		
	IWF2	0.807		
	IWF3	0.799		
	IWF15	0.782		
	IWF4	0.719		
	IWF16	0.718		
	IWF18	0.713		
	IWF10	0.711		
	IWF12	0.702		
	IWF5	0.692		
	IWF19	0.639		
	IWF14	0.623		
Physical factors	IWF7	0.888	6.049	0.833
	IWF8	0.847		
	IWF17	0.586		
	IWF9	0.512		

4.3. Partial Least Square Structural Equation Modeling

4.3.1. Hypothesis Development

The following hypotheses were formulated to explore the relationships between factors influencing workplace well-being in infrastructure construction projects based on the EFA findings:

H1: *Psychosocial factors positively influence workplace well-being in infrastructure construction projects.*

H2: *Physical factors positively influence workplace well-being in infrastructure construction projects.*

The hypotheses developed were tested using PLS-SEM. PLS-SEM produces a set of measurement models, as well as a structural model. Both the measurement model and the structural model were examined.

4.3.2. Measurement Model Evaluation

Figure 2 shows that the loadings for all the indicators exceeded the recommended value of 0.70 for exploratory research [77]. Then, Cronbach's alpha value, CR and AVE were used to assess the convergent validity of the measurement model [78]. Cronbach's alpha values for all the constructs were more than 0.70, indicating sufficient reliability [64] (see Table 5). Also, the CR values, which depict the internal consistency range from 0.889 to 0.972, exceeded 0.70. Thus, the internal consistency reliability of this model is adequate. AVE values for both constructs are higher than the 0.50 value required for convergent reliability [78].

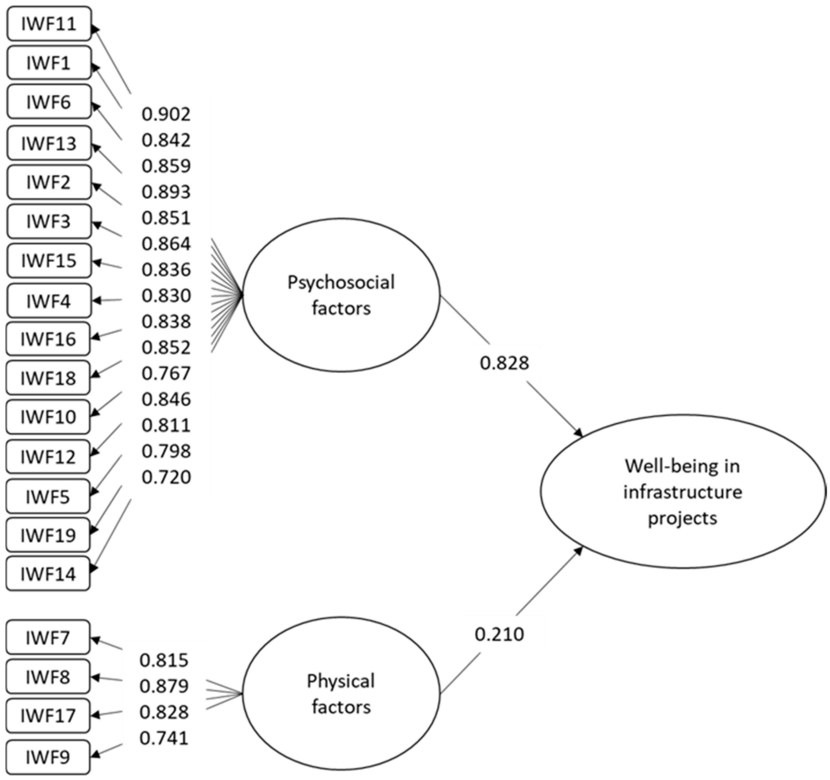

Figure 2. Measurement model.

Table 5. Measurement model assessment.

Constructs	Indicators	Outer Loadings	Cronbach's Alpha	CR	AVE
Psychosocial factors	IWF11	0.902	0.969	0.972	0.697
	IWF1	0.842			
	IWF6	0.859			
	IWF13	0.893			
	IWF2	0.851			
	IWF3	0.864			
	IWF15	0.836			
	IWF4	0.830			
	IWF16	0.838			
	IWF18	0.852			
	IWF10	0.767			
	IWF12	0.846			
	IWF5	0.811			
	IWF19	0.798			
	IWF14	0.720			
Physical factors	IWF7	0.815	0.833	0.889	0.668
	IWF8	0.879			
	IWF17	0.828			
	IWF9	0.741			

Then, the vertical collinearity of the measurement model was assessed. Discriminant validity can be evaluated using the Fornell and Larcker criterion to assess vertical collinearity. According to the findings, the measurement demonstrates satisfactory discriminant validity (see Table 6). This is because the correlation between a construct and itself is the correlation that has the highest overall value. Assessing the indicator's cross-loadings is another method for measuring the discriminant validity of the measurement model. Also, each indicator had the largest factor loading on the construct assigned to the measure in the model (see Table 7). The results confirm that the measurement model has sufficient convergent and discriminant validity for structural path modeling.

Table 6. Discriminant validity.

Constructs	Psychosocial Factors	Physical Factors
Psychosocial factors	0.835	-
Physical factors	0.780	0.817

Table 7. Indicators' cross-loading.

Indicators	Psychosocial Factors	Physical Factors
IWF11	0.902	0.660
IWF1	0.842	0.598
IWF6	0.859	0.626
IWF13	0.893	0.688
IWF2	0.851	0.634
IWF3	0.864	0.649
IWF15	0.836	0.619
IWF4	0.830	0.676
IWF16	0.838	0.696
IWF18	0.852	0.749
IWF10	0.767	0.575
IWF12	0.846	0.696
IWF5	0.811	0.650
IWF19	0.798	0.691
IWF14	0.720	0.540
IWF7	0.517	0.815
IWF8	0.650	0.879
IWF17	0.722	0.828
IWF9	0.634	0.741

4.3.3. Structural Model Evaluation

The bootstrapping technique was used to assess the significance of the path coefficient and the proposed hypotheses. It is a technique for estimating the distribution of any statistical distribution. The number of bootstrap samples was adjusted to 5000, as suggested by [70]. For a two-tailed test, the crucial t-value was 1.65 (significance level = 10%), 1.96 (significance level = 5%) and 2.58 (significance level = 1%). The results of the bootstrapping analysis are shown in Table 8. Table 8 reveals that psychosocial factors are the most influential construct positively influencing workplace well-being in infrastructure construction projects, followed by physical factors.

Table 8. Results for structural model evaluation.

Hypothesis	Path Coefficient	T Statistics	Results
H1: Psychosocial factors → Workplace well-being in infrastructure construction projects	0.828	84.159	Supported
H2: Physical factors → Workplace well-being in infrastructure construction projects	0.210	25.149	Supported

5. Discussion

This section discusses each critical factor influencing workplace well-being in infrastructure construction projects. The discussion section begins by discussing the critical factors under psychosocial factors, followed by the critical factors under physical factors.

5.1. Relationship between Psychosocial Factors and Workplace Well-Being

Table 5 demonstrates that psychosocial factors positively influence workplace well-being in infrastructure construction projects. Among the factors, salary package, working hours, the timeline of salary payment, planning of the project, insurance for construction workers, workers' welfare and project progress are considered the critical factors influencing workplace well-being in construction projects. The following paragraphs discuss each critical factor.

5.1.1. Salary Package

One of the critical factors is the salary package. The salary package refers to the compensation and benefits provided to employees in exchange for their work on a construction project. A good salary ensures employees can meet their basic needs, such as housing, food, healthcare and education, for themselves and their families. In contrast, low salaries lead to stress, reducing overall workplace well-being [79,80]. Therefore, organizations may conduct regular salary reviews to ensure that salary packages are competitive within the industry and reflect the value of employees' contributions. Also, salary packages could be enhanced with benefits such as health insurance, paid time off and bonuses to improve workplace well-being.

5.1.2. Working Hours

Another critical factor is working hours. Long working hours are detrimental to well-being. Research shows that long work hours contribute to psychological and occupational stress [81,82]. Also, longer hours lead to reduced productivity and increased stress [83], which raises the risks of depression and weight gain [84]. Working long hours influences the individual, family relationships and the organization. To address this, organizations can optimize work hours by ensuring employees are on-site only when their presence is required, allowing for better management of resources. Also, unnecessary time spent at the construction site could be minimized, thereby reducing fatigue and stress.

5.1.3. Timeline of Salary Payment

The timeline of salary payment is another critical factor. Timely salary payment is essential for ensuring the financial stability of employees. Employees rely on their salaries to meet their ongoing financial obligations, such as bills, rent or mortgage payments and other daily expenses. Delays in salary payments can lead to financial stress and instability [85]. Prior research has investigated the strategies to address late payment issues, such as financial management and cash-flow training, improved and amended legislation and changes in local culture and attitude [86].

5.1.4. Planning of the Project

Another critical factor is planning of the project. Well-defined project plans provide clarity and direction to all stakeholders involved. Clear objectives and well-established procedures help reduce confusion and uncertainty. In contrast, unclear job roles and unrealistic timelines can induce stress, particularly when tasks exceed their capabilities [87]. Project role ambiguity arises from the complexity of projects, insufficient information and the absence of clear deadlines [88]. Therefore, organizations should encourage open communication and collaboration among project stakeholders to ensure everyone is involved in the planning process and understands their roles, responsibilities and expectations.

5.1.5. Insurance for Construction Workers

Insurance for construction workers is also one of the critical factors. Dickson (1983) [89] characterizes construction insurance as a mechanism for smoothing costs, wherein contractors pay a set annual premium in exchange for coverage against unidentified potential losses. Construction work often involves inherent risks and hazards that can lead to injuries or accidents [90]. Insurance coverage ensures that employees receive financial support in the event of such incidents. This financial protection provides peace of mind and helps alleviate financial stress, improving workplace well-being. Therefore, organizations should provide employees with clear information about insurance benefits as well as promote awareness about the importance of insurance protection for workplace well-being and financial security.

5.1.6. Workers' Welfare

Another critical factor is workers' welfare. Welfare initiatives enhance the morale of employees and improve overall productivity [91]. Ensuring worker welfare involves providing a safe and healthy work environment free from hazards and risks. Prioritizing safety measures and implementing proper protocols for accident prevention reduces the likelihood of injuries and illnesses [92], promoting workplace well-being. Therefore, organizations should provide comprehensive safety training programs to educate employees about potential hazards and safe work practices.

5.1.7. Project Progress

Another critical factor influencing workplace well-being is project progress. Making progress in a construction project provides a sense of achievement and accomplishment, contributing to overall workplace well-being. In contrast, when projects face delays, extending the activities' duration is not always an option due to time constraints. Hence, site managers may accelerate the project by tightly scheduling tasks and pressuring employees to meet strict deadlines when time is limited [93]. Therefore, to ensure the progress of projects, organizations should develop comprehensive project plans and schedules that clearly define the tasks, deadlines and milestones. Also, larger project objectives should be broken down into smaller achievable goals to track progress more effectively and provide regular updates.

5.2. Relationship between Physical Factors and Workplace Well-Being

In addition to psychosocial factors, the results also show that physical factors have a significant relationship with workplace well-being. In this study, the physical factors include workload, comfort at the rest area, food at the rest area and transportation facilities for construction workers. Based on the NMA, workload emerges as the critical factor.

Workplace well-being may decrease when there is too much work to perform and insufficient time for its completion. Consistent overwork can negatively influence workplace well-being through increased stress and burnout, poor mental and physical health and subpar work performance [94]. Organizations can tackle physical workload by analyzing job descriptions to compare the tasks required by the job to the tasks and responsibilities performed by employees. If tasks must be reassigned, aligning tasks based on the role helps to balance the workload [95]. In contrast, organizations can offer training programs to tackle mental workload by developing coping strategies for managing stress and mental demands. Additionally, organizations should ensure that resources such as counseling services or employee assistance programs can be accessed to address any well-being concerns.

5.3. Comparison with Prior Research

A comparison of the study results with prior findings can reveal similarities and differences between the critical factors influencing workplace well-being in construction projects. Table 9 shows the output of this comparison. Prior research has examined well-being in the construction industry across various project types, including building construction [19], high-rise building construction [20] and with no specific categorization [9,17]. All this research employed survey methods to assess workplace well-being, with sample sizes ranging from 91 to 402 respondents. Specifically, two works used hands-on construction workers as respondents [17], while two others surveyed construction practitioners [19,20]. Additionally, three research works utilized 5-point Likert scales [9,19,20], whereas one research work used a 4-point Likert scale [17]. Furthermore, prior research has not used any structural equation modeling methods, including PLS-SEM, to examine workplace well-being. In other words, in prior research, the explicit causal relationship between the factors affecting workplace well-being and overall workplace well-being has not yet been identified. This comparison highlights the diverse approaches and respondent types used in examining workplace well-being in the construction industry.

Table 9. Comparison of the factors influencing workplace well-being in construction projects.

Authors/Characteristics		This Study	[17]	[9]	[19]	[20]
Type of projects		Infrastructure construction	No specific categorization	No specific categorization	Building construction	Highrise building construction
Sample size		124 respondents	91 respondents	402 respondents	205 respondents	341 respondents
Respondent background		Construction practitioners	Construction workers	Construction workers	Construction practitioners	Construction practitioners
Methodology		Survey	Survey	Survey	Survey	Survey
Grading system used in survey		5-point Likert scale	4-point Likert Scale	5-point Likert scale	5-point Likert scale	5-point Likert scale
Data analysis		Normalized mean analysis, EFA, PLS-SEM	Descriptive statistics, ranking, multiple regression analysis	EFA, Non-metric multidimensional scaling analysis (PROXSCAL)	Mean ranking, Kruskal-Wallis test, overlap analysis	Mean ranking, agreement analysis
Critical factors	Workload	✓	✓	✓	-	✓
	Salary package	✓	✓	✓	✓	✓
	Working hours	✓	✓	✓	✓	✓
	Timeline of salary payment	✓	✓	✓	✓	✓
	Planning of the project	✓	✓	✓	✓	✓
	Insurance for construction workers	✓	✓	-	✓	✓
	Workers' welfare	✓	✓	✓	✓	✓
	Project progress	✓	✓	-	✓	✓

Moreover, out of eight critical factors, three are not critical in other research works. Specifically, the workload is not critical in building construction projects [19]. Nevertheless, another research study found that workload is also critical for high-rise building construction projects [20]. These results illustrate that workload might not be critical for non-high-rise construction projects. Compared to non-high-rise, high-rise and infrastructure construction require individuals to travel vertically or horizontally using lifts or other forms of transport to execute project activities. As a result, similar project activities might require more time to complete in high-rise and infrastructure projects than in non-high-rise construction projects. Thus, workload is not as critical in non-high-rise projects as it is in high-rise and infrastructure construction projects. Future work should validate this finding to identify the optimal workload in different types of construction projects. Furthermore, insurance for construction workers and project progress were not considered critical in the research by [9]. However, these two factors were absent as variables in that research work. Hence, these two factors were not assessed. Thus, a lateral comparison between this study and that research is not feasible. Nevertheless, most of the critical factors identified in this study were also reported as critical in prior research. In other words, the consistent reporting of the same critical factors between different research works illustrates their central role in shaping workplace well-being. Recognizing and addressing these factors is essential for creating a supportive work environment that promotes workplace well-being.

6. Conclusions

Few empirical research works have examined the relationship between the factors influencing workplace well-being in infrastructure construction projects. Therefore, this study aimed to investigate the factors influencing workplace well-being in infrastructure construction projects. To achieve this aim, this study identified critical factors influencing workplace well-being in infrastructure construction projects, developed an interrelationship model between underlying constructs of the factors and assessed the influence of the underlying constructs on workplace well-being in infrastructure construction projects. Questionnaire survey data were collected and analyzed using the NMA, EFA and PLS-SEM to achieve the study aim and objectives. The analyses reveal that the critical factors include workload, salary package, the timeline of salary payment, working hours, planning of the project, insurance for construction workers, workers' welfare and project progress. Furthermore, the underlying constructs are physical factors and psychosocial factors. Finally, both physical and psychosocial factors are found to significantly influence workplace well-being in infrastructure construction projects. These findings suggest that focusing solely on physical factors may not sufficiently enhance workplace well-being in construction projects, as there are also non-visible factors, such as psychosocial factors. Thus, exploring the interplay between visible and non-visible factors and their influence on workplace well-being in construction projects is crucial.

This study holds significant theoretical and practical implications. First, the study contributes to the theoretical understanding of workplace well-being in construction projects by investigating the influencing factors in infrastructure construction projects. The findings suggest that workplace well-being in construction projects is influenced by a wide range of factors, including visible and non-visible factors. Therefore, to improve workplace well-being in construction projects, it is crucial to delve deeper into the relationships and interactions between these different factors. By exploring the interplay between visible and non-visible factors, researchers and practitioners can gain a more comprehensive understanding of how to collectively influence workplace well-being. Moreover, in addition to well-being, psychosocial factors significantly influence mental health outcomes. Addressing these factors can promote workplace health and well-being and reduce the risk of stress, anxiety and depression among employees. Future works can build upon this foundation to delve deeper into the specific aspects of workplace well-being and explore potential interventions. Also, this study represents a multifaceted exploration beyond a simple mean-ranking analysis. This study offers several noteworthy theoretical implications by using EFA to categorize the factors and subsequent PLS-SEM to uncover significant relationships. In addition, this study's methodology, which includes questionnaire development, empirical analysis and statistical techniques, can serve as a reference for future work. Researchers can adopt similar methods to explore other dimensions of workplace well-being or investigate different industries. For practical implications, practitioners can use the findings to recognize the physical and psychosocial factors influencing workplace well-being. This awareness can guide the development of targeted strategies, such as improved working conditions, better communication and stress management programs, to enhance workplace well-being. Also, prioritizing workplace well-being can improve job satisfaction, lead to higher productivity, and reduce turnover. This, in turn, can positively impact project outcomes and contribute to the success of infrastructure construction projects.

This study has some limitations that should be addressed in future works, notwithstanding the significance of the findings. First, each country has its own characteristics that could greatly affect the results. Therefore, the study findings should be used cautiously before being applied to other countries. Future works could greatly benefit from expanding the scope and collecting data from multiple countries to enhance the generalizability and applicability of the study findings. Cross-validation across cultural, economic and geographical contexts can provide a more comprehensive understanding of the relationship between factors. Second, the survey was distributed to construction practitioners, including project managers, quantity surveyors, architects and engineers, rather than hands-on construction workers. Construction workers typically refer to laborers employed on construction sites to perform physical tasks requiring strength. Future works could explore similar topics with hands-on construction workers as the target population, as they may encounter different factors influencing their workplace well-being. This approach could unveil new insights specific to the experiences and challenges construction workers face in the workplace. Third, the underlying constructs were derived solely using statistical methods through EFA. Although this method provides a structured approach, it might not fully capture the nuanced perspectives of industry practitioners. Therefore, future works could consider employing a qualitative approach, such as conducting focus group discussions with industry experts. Another limitation of this study is its focus on a specific project type, namely infrastructure construction projects. While there is a recognized connection between culture and workplace well-being [96], and Monteiro and Joseph (2023) [97] have demonstrated that organizational culture significantly impacts the mental health and well-being of employees, this study does not primarily focus on these cultural aspects. Future research could explore the relationship between culture and workplace well-being to provide a more comprehensive understanding of the factors influencing well-being in the construction industry.

Author Contributions: Conceptualization, A.R.R. and R.A.R.; methodology, A.R.R. and R.A.R.; validation, R.A.R.; formal analysis, A.R.R.; investigation, A.R.R.; resources, A.R.R. and R.A.R.; data curation, A.R.A. and R.A.R.; writing—original draft preparation, Y.A. and A.R.R.; writing—review and editing, R.A.R.; visualization, A.R.R.; supervision, R.A.R.; project administration, R.A.R.; funding acquisition, Y.A. and R.A.R. All authors have read and agreed to the published version of the manuscript.

Funding: The authors extend their appreciation to Prince Sattam bin Abdulaziz University for funding this study work through project number (PSAU/2024/01/99523).

Data Availability Statement: The data presented in this study are available upon request from the corresponding authors. The data are not publicly available due to some data being proprietary or confidential in nature. Therefore, the data may only be provided with restrictions.

Acknowledgments: The authors are grateful to the editors and anonymous reviewers for their insightful comments, which improved this paper's quality. The authors are also thankful to the industry practitioners who participated in this work.

Conflicts of Interest: The authors declare no conflicts of interest.

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