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The Impact of Safety Management on the Project Performance and Behavioral Safety Performance in the Construction of Local Cold Storage at Talavera, Nueva Ecija Philippines

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Abstract—**The construction industry faces a considerable number of accidents and is widely recognized for its heavy reliance on manual labor. Thus, ensuring safety in construction projects becomes of utmost importance. Despite substantial efforts from the government, industry, and academia to improve safety in construction, the occurrence of occupational incidents remains high among construction workers. Moreover, the primary aim of this study is to explore and examine the risk assessment methodology, safety training programs, and accident prevention measures. Additionally, the study focuses on investigating safety management techniques in the construction of 60,000 bags of onion cold storage and 15 Metric Tons of Block Ice Plant and their impact on various aspects of project performance and worker productivity. With that being said, after analyzing the data from the survey questionnaire, the result of Spearman's Correlation Test in the first survey using Microsoft Excel is 0.69839, indicating that the safety management and behavioral safety performance have a moderately positive relationship. On the other hand, the result of the percentage analysis that was used in the second part of the survey from the respondents shows a positive correlation between the safety management factors and the project performance factor.**

Keywords—safety management, cold storage, project performance, behavioral safety performance

I. INTRODUCTION

The construction industry is heavily reliant on manual labor and consistently reports a high incidence of accidents, making safety a critical concern [1]. Construction work is inherently hazardous due to the dynamic and unpredictable nature of job sites, involving heavy machinery, working at heights, exposure to hazardous materials, and various environmental risks such as extreme weather conditions. Workers often perform tasks in confined spaces, near electrical installations, or in proximity to moving vehicles, further increasing the likelihood of accidents. These risks place immense responsibility on employers, site managers, and regulatory bodies to enforce stringent safety protocols, conduct regular inspections, and ensure compliance with industry standards.

Despite concerted efforts from governmental bodies, industry stakeholders, and academic institutions to improve safety standards, occupational incidents among construction workers remain prevalent [2]. The persistence of high accident rates suggests that existing safety measures may be inadequate or inconsistently implemented. Factors such as worker non-compliance, insufficient safety training, lack of proper personal protective equipment (PPE), and the pressure to meet tight project deadlines often contribute to unsafe work conditions. Additionally, language barriers among multinational construction crews and the varying levels of experience among workers can hinder effective communication and the proper execution of safety guidelines.

The transient and site-specific nature of construction projects further complicates effective safety management, as each site presents unique challenges that require tailored approaches to risk assessment and accident prevention [3]. Unlike other industries with fixed work environments, construction sites are constantly evolving, with structures being erected, demolished, or modified, leading to continuously shifting risks. This dynamic setting necessitates adaptive safety measures that evolve alongside the project's progress. Furthermore, contractors and subcontractors often work together on the same site, sometimes following different safety cultures and protocols, which can create inconsistencies in safety practices. Addressing these challenges requires a multi-faceted approach, including comprehensive risk assessment methodologies, effective safety training programs, and proactive accident prevention strategies to enhance overall workplace safety.

This study aims to explore risk assessment methodologies, safety training programs, and accident prevention measures, evaluating their impact on project outcomes and employee well-being. Specifically, it focuses on safety management

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techniques employed in the construction of a 60,000-bag onion cold storage facility and a 15 Metric Ton Block Ice Plant, analyzing their effects on worker productivity and overall project performance.

A quantitative research methodology will be utilized, incorporating survey questionnaires for data collection and statistical analysis. This approach facilitates a comprehensive examination of the relationships between risk assessment, safety training, accident prevention measures, and both project outcomes and worker well-being. The study underscores the importance of robust safety management in reducing accidents and promoting a healthy work environment. However, its applicability may be influenced by varying safety regulations across different regions. Additionally, factors such as weather disruptions and unforeseen events can affect project performance and worker productivity, highlighting the necessity for continuous evaluation of safety practices in construction projects.

$$\% = {}_{NF} \times 100 \qquad (1)$$

The statistical method that is used in this study to analyze and discuss the data that were obtained from the survey questionnaire is percentage technique where in this method is employed to assess and quantify the knowledge gathered in this study by analyzing respondents' answers. It is commonly utilized to determine the average percentage for each specific response to a particular question. Equation (1) denotes that F = answer , % = percentage and N = number of respondents.

$$r_s = 1 - {}_{n(6n\xi 2d - 2i1)} \qquad (2)$$

The Spearman rank correlation test was utilized to explore and qualify the relationship between the two key variables needed in the data: safety management and behavioral safety performance. The data collected in this research is survey responses. It allows the assessment of the correlation between the Safety Management practices on the site and the Behavioral Safety Performance of the workers that are needed to distribute the data. The finding's importance in safety management can promote better behavioral safety performance that can contribute to enhancing worker productivity and project performance. The key findings in Spearman's Rank Correlation are the moderate positive correlation between safety management and behavioral safety performance. The p-value of the data proves the evidence in the suggested better safety management practice that is needed to improve in safety behaviors of workers in construction areas.

II. METHODOLOGY

A. *Experimental Set-up*

The researchers of this study will use the design of qualitative research, where they believe that it is the best option to gather the data from the involved situations and participants for this study. Moreover, in this study, the researchers will use a survey questionnaire and linear regression for statistical treatment of data. Wherein the goal of the survey questionnaire is aligned with the focus and objective of the study, such that it aims to investigate and analyze risk assessment methodology, safety training programs, accident prevention measures, and their impact on overall project outcomes and the well-being of employees.

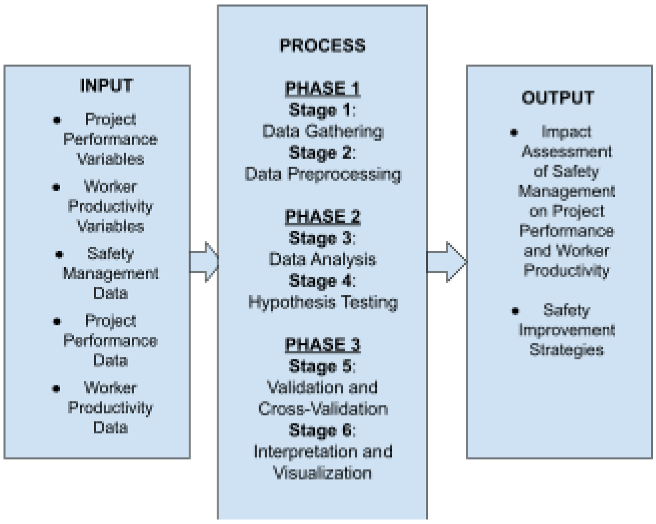

Fig.1. Conceptual Framework

The conceptual framework for assessing the impact of safety management on project performance and worker productivity is a structured approach that involves several key components. In the initial phase, it begins with conducting a thorough safety management assessment, which includes analyzing safety protocols, incident reports, and safety training records through a survey questionnaire. The process involves three distinct phases. In Phase 1, the initial stages consist of data gathering (Stage 1) where relevant data is collected, and data preprocessing (Stage 2) is conducted to clean and organize the data. Phase 2 follows, where data analysis (Stage 3) is focused on identifying patterns and initial relationships between safety management, project performance, and worker productivity. Subsequently, in Stage 4, hypothesis testing employs statistical techniques to determine if there exists a significant association between safety management practices and project or worker performance. In Phase 3, the process moves to validation and cross-validation (Stage 5), ensuring the reliability and applicability of the results across different scenarios. The final stage, interpretation and visualization (Stage 6), entails extracting meaningful insights from the analysis and presenting them visually for a better understanding of the data.

The output of this comprehensive framework includes an Impact Assessment of Safety Management on Project Performance and Worker Productivity, providing a quantified understanding of how safety practices influence these two critical aspects. Moreover, the framework generates Safety Improvement Strategies based on the findings, charting pathways for enhancing safety practices and consequently project performance. Finally, an Assessment of Linear Regression to provide a more comprehensive understanding of the relationship between safety management, project performance, and worker productivity. In conclusion, this framework offers a systematic and data-driven approach to assess, understand, and improve safety management practices in project management, ultimately benefiting project outcomes and worker productivity.

B. Project Details

The study will be implemented at the Construction of 60,000 bags of Onion Cold Storage and 15MT Block Ice Plant located at Brgy. Tabacao, Talavera, Nueva Ecija. Under the implementing office of the Department of Agriculture. The aim of this project is to construct a cold storage facility for storing over supply of onion from farms and block ice making facilities for fish market demands in the community of Brgy. Tabacao, Talavera, Nueva Ecija The said project was awarded to the contractor Reftec Industrial Supply and Services Inc. last June 2023 and the cold storage facility is expected to be finished by June 2024. Moreover, the design and specifications that was used by the contractor to this project was a supply of Ready Mix Concrete with compressive strength of 3,000PSI and Steel Reinforcements with Grade 40. Furthermore, the design and analysis of the structure is aligned and compliant to the Philippine Codes and Standards.

C. Respondents of the Study

In this research, the respondents consist of construction personnel who are usually exposed to risks and hazards at construction sites. Such as safety officers, foremen, project managers, site engineers, and any other construction-related jobs who are exposed to hazards and risks. Moreover, the respondents of this study should also be experienced in working at residential and medium-rise construction projects that are located in municipality of Talavera, Nueva Ecija Therefore, the coverage of the study tackles the range of safety management and its impact on the workers and project performance of construction activity specifically in the Construction of Onion Cold Storage (60,000 bags) and 15MT Block Ice Plant that was located at Brgy. Tabacao, Talavera, Nueva Ecija under the company of Reftec Industrial Supply and Services Inc. Consequently, this study will cater to about 30 respondents and it will be randomly selected by the researchers among the construction-related jobs that are exposed to hazards and risks in construction sites. (eg. site engineers, laborers, safety officers, etc.)

Moreover, this study will also use a non-probability sampling method where the non-probability sampling refers to the creation of a sample through methods that are not random. In addition, it also encompasses targeted research that intentionally selects participants from specific lists, such as aid recipients or individuals enrolled in particular training programs. Non-probability sampling methods are commonly employed in the exploratory phase of research projects and in qualitative studies, where the focus is on subjective understanding rather than numerical data. Elliot [5] said that these methods are utilized in research involving specific target groups.

Correspondingly, a snowball sample will be used by the researchers, a snowball sample is a technique wherein initial sample members recruit individuals they are acquainted with, who in turn invite others to participate in the sample. This method is particularly effective for accessing highly specific populations likely to be connected with others meeting the selection criteria. Furthermore, snowball sampling, a non-probability approach, involves the recruitment of new units into the sample through existing units. It proves valuable in researching individuals possessing distinct traits that might otherwise be challenging to identify. Sometimes referred to as chain sampling or network sampling, this method starts with one or more participants in a study. Subsequently, the sample expands as these participants refer others, continuing until the desired sample size is achieved or a saturation point is reached as described by Elliot [5].

D. Data Gathering Procedures and Instruments

In this study, data collection is initiated through survey questionnaires distributed via an online platform, Google Forms. These questionnaires are designed to gauge participants' satisfaction levels, utilizing a scale that ranges from "not satisfied" to "satisfied" and "very satisfied." The aim is to investigate and analyze various aspects related to safety management, encompassing risk assessment methodology, safety training programs, accident prevention measures, and their influence on project outcomes and employee well-being.

The research focuses on a specific group of participants, including safety officers, foremen, project managers, site engineers, and other professionals engaged in construction work, particularly those exposed to hazards and risks engagement in the construction site. Ethical considerations are paramount, ensuring that participants provide informed consent and that their privacy is safeguarded. [5]

Following data collection, the analysis involves using Spearman Rank Correlation and Percentage Analysis techniques. Spearman Rank Correlation helps to measure the strength and direction of the safety management practices and behavioral safety performance in construction projects. On the other hand, the inclusion of Percentage Analysis suggests that this method is employed to assess and quantify the knowledge gathered in this study by analyzing respondents' answers. It is commonly utilized to determine the average percentage for each specific response to a particular question

The goal of this research is to test four hypotheses. The null hypothesis (H0) posits that there is no significant relationship between safety management and project performance/worker productivity in construction projects, while the alternative hypothesis (H1) suggests a significant positive relationship between safety management and these key project outcomes. The results of the survey, analyzed using the specified statistical tools, will provide insights into which of these hypotheses holds true.

III. Results And Discussions

The Spearman's Rank Correlation analysis yielded a correlation coefficient of ρ=0.3318\rho = 0.3318ρ=0.3318, indicating a moderate positive correlation between Safety Management and Behavioral Safety Performance in construction projects. The correlation was statistically significant ($t = 1.7588$, $p = 0.0454$, $df = 25$), suggesting that improvements in safety management practices are associated with better behavioral safety performance at a 95% confidence level.

The Spearman's Rank connection shows a modest positive connection (ρ = 0.3318) between safety management and behavioral safety performance in construction projects, with a statistically significant p-value of 0.045. This validates alternative hypotheses (H_2 and H_3), confirming a considerable beneficial association between safety management practices, project performance, and worker productivity. The null hypotheses (H_0 and H_1), which predicted no meaningful association, are rejected. The results show that enhancing safety management practices can improve both worker behavior and overall project performance.

Table 1. Safety Management Factors

RESPONDENTS INFO		Average	Rank
Position & Gender	Age		
Architect - M	52	4.230769	27
Safety Officer - F	46	4.000000	23
Civil Engineer - M	29	3.923077	22
Foreman - M	50	3.384615	12
Civil Engineer - M	32	4.076923	24.5
Steel Man - M	38	3.461538	15
Carpenter - M	57	3.230769	3
Carpenter - M	36	3.307692	7.5
Skilled Labor - M	27	3.384615	12
Skilled Labor - M	34	3.307692	7.5
Foreman - M	58	3.615385	19.5
Mason - M	33	3.230769	3
Mason - M	46	3.230769	3
Steel Man - M	49	3.230769	3
Mason - M	42	3.384615	12
Steel Man - M	56	3.153846	1
Project Supervisor - M	55	3.846154	22
Mason - M	43	3.307692	8.5
Mason - M	47	3.384615	13
Mason - M	38	3.538462	18
Skilled Labor - M	30	3.230769	4
Skilled Labor - M	32	4.076923	25.5
Skilled Labor - M	29	3.307692	8.5
Skilled Labor - M	39	3.538462	18
Skilled Labor - F	29	3.384615	13
Skilled Labor - M	29	3.538462	18
Welder - M	46	3.615385	20.5
Mason - M	34	5.000000	39.5
Mason - M	28	4.538462	31
Mason - M	42	5.000000	39.5
Mason - M	32	5.000000	39.5
Skilled Labor - M	45	5.000000	39.5
Skilled Labor - M	32	5.000000	39.5
Mason - M	34	5.000000	39.5
Skilled Labor - M	47	4.461568	29.5
Skilled Labor - M	44	5.000000	39.5
Skilled Labor - M	33	4.153846	27
Skilled Labor - M	45	5.000000	39.5
Skilled Labor - M	28	4.923077	33
Skilled Labor - M	34	5.000000	39.5
Carpenter - M	45	5.000000	39.5
Carpenter - M	38	5.000000	39.5
Carpenter - M	52	5.000000	39.5
Carpenter - M	44	5.000000	39.5

Table 2. Behavioral Management Factors

Respondents Info		Average	Rank
Position & Gender	Age		
Architect - M	52	4.333333333	17
Safety Officer - F	46	4.833333333	17
Civil Engineer - M	29	3.333333333	1
Foreman - M	50	4.833333333	25
Civil Engineer - M	32	5.00000000	36.5
Steel Man - M	38	4.00000000	7
Carpenter - M	57	4.166666667	13
Carpenter - M	36	4.00000000	7
Skilled Labor - M	27	4.166666667	13
Skilled Labor - M	34	5.0000000	36.5
Foreman - M	58	5.0000000	36.5
Mason - M	33	4.0000000	7
Mason - M	46	4.0000000	7
Steel Man - M	49	4.333333333	17
Mason - M	42	4.0000000	7
Steel Man - M	56	5.0000000	36.5
Project Supervisor - M	55	4.833333333	25
Mason - M	43	4.0000000	7

Mason - M	47	3.833333333	2
Mason - M	38	4.166666667	13
Skilled Labor - M	30	4.500000000	21
Skilled Labor - M	32	4.333333333	17
Skilled Labor - M	29	4.0000000	7
Skilled Labor - M	39	4.333333333	17
Skilled Labor - F	29	4.0000000	7
Skilled Labor - M	29	4.50000000	21
Welder - M	46	4.50000000	21
Mason - M	34	5.0000000	36.5
Mason - M	28	5.0000000	36.5
Mason - M	42	5.0000000	36.5
Mason - M	32	5.0000000	36.5
Skilled Labor - M	45	5.0000000	36.5
Skilled Labor - M	32	5.0000000	36.5
Skilled Labor - M	24	5.0000000	36.5
Skilled Labor - M	32	4.8333333	25
Skilled Labor - M	47	5.0000000	36.5
Skilled Labor - M	44	4.0000000	7
Skilled Labor - M	33	4.8333333	25
Skilled Labor - M	45	5.0000000	36.5
Skilled Labor - M	28	4.8333333	25
Skilled Labor - M	34	5.0000000	36.5
Carpenter - M	45	5.0000000	36.5
Carpenter - M	38	5.0000000	36.5
Carpenter - M	52	5.0000000	36.5
Carpenter - M	44	5.0000000	36.5

The Bar Chart illustrates the Behavioral and Performance rank in Spearman’s correlation for individual workers, with the X-axis representing the rank in Spearman’s and the Y-axis representing the workers who answered the survey. The blue bars indicate Safety and Project Performance, while the orange bars represent Safety and Behavioral Performance. The data reveals that while most workers exhibit a relatively balanced relationship between behavioral and performance questions, notable variations exist. For instance, some workers (e.g., Workers 5, 10, and 24) have higher performance scores despite moderate behavioral scores, whereas others (e.g., Workers 6, 9, and 21) demonstrate high behavioral scores but relatively lower performance.

A. Abbreviations and Acronyms

The line graph depicts the Behavioral and Performance scores of 45 employees, highlighting variances in their work behavior and performance levels. The X-axis depicts individual workers, while the Y-axis shows the numerical scores for both variables. The blue line reflects performance scores, whereas the orange line denotes behavioral values.

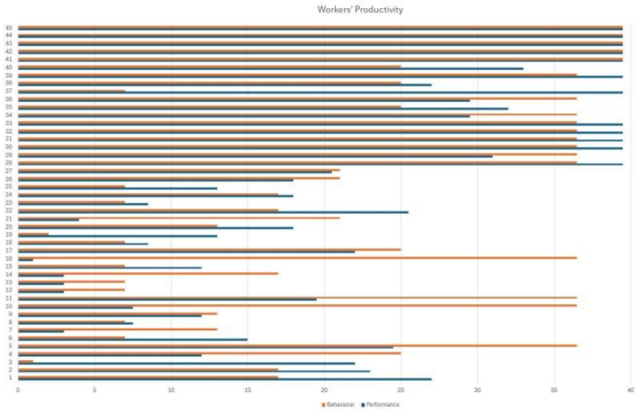

Fig. 2. Used Bar Chart for the Spearman's Results

Fig. 3. Used Line Chart for the Spearman's results

The graph shows that both behavioral and performance scores change greatly across workers, showing that neither characteristic is consistently high or low. When the two lines overlap, it indicates that the behavioral and performance scores are closely aligned. However, in some circumstances, one score is much greater or lower than the other.

Notably, there are multiple peaks and dips in the dataset. For example, some employees have high behavioral scores but poor performance scores, indicating that favorable behavioral attributes may not always translate into excellent performance. In contrast, some workers have high performance scores despite lower behavioral evaluations, implying that other factors—such as experience, technical skills, or motivation—may influence their performance.

The irregular pattern of both lines suggests that, while conduct can influence performance, the relationship is not completely linear. Additional statistical analysis, such as the Spearman's correlation test, is required to evaluate the strength and significance of their association. Understanding this correlation will assist in determining whether behavioral changes will improve performance outcomes.

IV. CONCLUSION

This study explores the influence of safety management practices on various aspects of project performance and worker productivity in the construction of a 60,000-bag onion cold storage facility and a 15-metric-ton Block Ice Plant. It delves into the methods of risk assessment, safety training programs, and accident prevention strategies, evaluating their effects on both project results and the well-being of workers. In addition, the objective of this study is to investigate and analyze risk assessment methodology, safety training programs, accident prevention measures, and their impact on overall project outcomes and the well-being of employees.

With that being said, after analyzing the statistical significance of this association is further supported by the t-statistic value of 6.399 and the p-value of 4.805×10^{-4}, which confirm that worker productivity and behavioral safety performance are positively impacted by effective safety management. These results demonstrate how important it is to have strong safety measures in place and provide ongoing safety training in order to improve project outcomes and advance worker well-being. On the other hand, the result of the percentage analysis that was used in the second part of the survey from 5 key main respondents shows a positive correlation between the safety management factors and project performance factors. According to the acquired statistics of data out of 6 questions in time questions the average score of the respondents shows 100% (5 out of 5 YES) which indicates that the safety management factors can affect the project performance in a positive relationship in consideration of time frame of the project. Moreover, another factor that was considered is the quality where in out of 5 questions the average score of the respondents is 90% (4 out of 5 YES) which translates that there is an evident positive correlation between safety management factors and quality of the project performance. Lastly, is the factor of cost in project performance where in out of 5 questions the average result of answers by the respondents are 100% (5 out of 5 YES) which means that there is a strong positive correlation between safety management and the cost of the project.

Moreover, the acquired findings and result of the study is only applicable to its given scope and limitation by the proponents of this study where in the scope tackles to examines safety management techniques in the construction of a 60,000-bag onion cold storage and a 15 Metric Ton Block Ice Plant, focusing on their impact on worker performance and productivity only. However, the findings may be limited by local safety regulations and the specific short time frame of the study. External factors such as weather and unforeseen incidents may also affect both worker productivity and overall project outcomes.

Meanwhile, the result of this study is limited to the research locale of this study. Thus, the overall result of this study recommends that improving safety management can lead to better worker behavior, linked to the overall project performance, and effective safety management practices including risk assessments and accident prevention measures of constructing a cold storage.

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