Research Inventy: International Journal of Engineering And Science
Vol.15, Issue 5 (May 2025), PP 86-93
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

The Analysis Of Factors Affecting Industrial Fuel Consumption In Construction Projects In Pasangkayu Regency, Indonesia

Tutang Muhtar Kamaludin[1], Nirmalawati[2], Gusti Made Oka[3]AuthorAnzar[4]
[1,2,3]*Civil Engineering Department, Faculty of Engineering, Tadulako University, Indonesia*
[4]*Postgraduate Student Of Civil Engineering Department, Tadulako University,Indonesia*
[1]*Corresponding Author*

Abstract:*A study has been conducted on the Analysis of Factors Affecting Industrial Fuel Usage by Construction Workers in Pasangkayu Regency. The purpose of this research is to identify the factors that cause contractors to either use or not use industrial fuel for construction projects in Pasangkayu Regency. This research employs a quantitative descriptive method, utilizing a questionnaire for data collection, with a total sample of 24 respondents, who are construction contractors in Pasangkayu during the years 20222023. The results show that out of five factors analyzed, namely Project Time and Cost, Project Type, Operational Equipment/Machinery, Availability of Industrial Fuel, and Industrial Fuel Quality, these were suspected to be the factors influencing construction workers to use industrial fuel. After analyzing these factors using the SPSS data processing software, it was found that only one component factor emerged. Therefore, to determine the most influential factor, the highest value was considered. The distribution of values for each factor is as follows: Project Time and Cost: 0.683, Project Type: 0.798, Operational Equipment/Machinery: 0.795, Availability of Industrial Fuel: 0.870 and Industrial Fuel Quality: 0.715. Based on these values, the availability of industrial fuel is the dominant factor that causes construction workers to use industrial fuel*
Keywords:*Industrial Fuel, Construction Workers, Pasangkayu Regency*

Date of Submission: 09-05-2025 Date of Acceptance: 22-05-2025

I. INTRODUCTION

The construction project is a series of activities involving company management(Akinradewo, Aigbavboa, and Akinradewo 2019), labor, technical equipment, and construction materials, typically carried out in both indoor and outdoor settings(Jacobsen et al. 2024). The construction services industry in Indonesia is growing rapidly, handling various projects that contribute to national infrastructure development(Kabirifar and Mojtahedi 2019). This growth drives construction service providers to offer the best services to gain trust from both the government and the private sector. Advances in project management technology have also accelerated the construction process more effectively and efficiently, resulting in better quality compared to conventional methods(Montaser et al. 2018).

To Control Fuel Consumption in the Construction Industry, a Comprehensive Approach is Needed That Includes Equipment Selection, Operator Training, Machine Maintenance, Mature Project Planning, and the Use of Monitoring Technology(Huo et al. 2012). In the Construction Industry, Fuel Oil (Fuel Oil) Plays a Very Vital Role as the Main Energy Source for Various Types of Heavy Equipment and Operational Vehicles. Tools Such as Excavators, Bulldozers, Wheel Loaders, and Dump Trucks All Rely on Fuel Oil, Especially Diesel, to Perform Their Functions Optimally in the Field(Rasoulinezhad, Taghizadeh-Hesary, and Taghizadeh-Hesary 2020).

The Use of Fuel Oil in Construction Projects is Not Only Related to Operational Needs, But Also Has a Direct Impact on Cost Efficiency and Work Schedules(Türkakın, Manisalı, and Arditi 2020). High Fuel Oil Consumption Without Proper Management Can Cause Budget Waste, Increase Project Costs, and Increase the Carbon Emission Burden to the Environment(Romero et al. 2024).Factors That Influence the Level of Fuel Oil Use Include Machine Conditions(Olivieri, Seppänen, and Denis Granja 2018), Operator Skills, Work Areas, and Project Management(Tang 2003). Unmaintained or inefficiently operated machines will consume more fuel. So too with poor logistics and work planning arrangements(Callistus and Clinton 2018), which can extend the working time of the equipment and increase the burden of energy consumption(Eliasson, Kärhä, and Arlinger 2023).

Therefore, fuel management is one of the important aspects in construction project management(Nguyen et al. 2023). The application of technology such as real-time fuel monitoring systems(Kermanshachi, Rouhanizadeh, and Govan 2021), the use of energy-efficient heavy equipment, and operator training on fuel-saving techniques can be strategic solutions in reducing fuel consumption and

increasing overall work efficiency(Nguyen et al. 2023).As the main energy source, fuel oil remains an inevitable necessity in the construction sector. However, with the right management approach, its use can be controlled to support project sustainability and efficiency(Arantes and Ferreira 2020).

Fuel oil (fuel oil), especially diesel, has a major impact on the operation of the construction industry. Fuel oil is the main energy source that drives heavy equipment and project vehicles(Huo et al. 2012). Here is an explanation of the various effects of fuel oil in the construction industry. Fuel oil determines whether heavy equipment can operate continuously or not(Romero et al. 2024). Without sufficient fuel oil supply, the construction process can be hampered or even stopped. This has a direct impact on project delays and decreased productivity.Fuel oil is one of the largest cost components in a construction project. Increases in fuel oil prices will directly increase total operating costs. Therefore, controlling fuel oil consumption is very important so that the project remains within the set budget(Eliasson, Kärhä, and Arlinger 2023).

The type and efficiency of fuel used can affect the selection of heavy equipment. More modern equipment is usually designed to be more fuel efficient and environmentally friendly. Construction companies now tend to choose equipment with more efficient fuel oil consumption to reduce costs and emissions.(Nguyen et al. 2023)The use of large amounts of fuel oil contributes to carbon emissions and air pollution. This is an important concern in large-scale construction projects or those in densely populated areas. Some Regulations Even Mandate Emission Reductions(Rudzki, Gomulka, and Hoang 2022), Which Means Fuel Consumption Must Be Reduced.Timely Fuel Supply and Distribution Are Crucial to Logistics Planning. If Fuel is not available when needed, heavy equipment can stop working and cause costly downtime. Therefore, Fuel Management Must Be an Integral Part of Project Planning.Fuel has a Major Impact on Almost Every Aspect of the Construction Industry—From (Ozturk et al. 2020), Cost Efficiency, Technology Choices, Environmental Impacts, to Project Management. Efficient Fuel Use and Proper Management Are Key to the Success of Modern Construction Projects(Van Tam et al. 2021).

In Pasangkayu Regency, the funds allocated for construction services were recorded at IDR 700.61 billion in 2016, and this figure is projected to continue increasing in line with the rising prices of raw materials and fuel (BBM). In project implementation, the use of fuel, particularly diesel and gasoline, is an essential component for the operation of heavy equipment. Regulations, such as Presidential Regulation No. 69 of 2020, mandate the use of industrial fuel in construction work to maintain the availability of subsidized fuel at gas stations(Turner et al. 2021).

However, despite these regulations, there are still instances of subsidized fuel misuse by contractors in construction projects, which remains a significant issue. During the 2022-2023 period, Pasangkayu Regency has engaged in 31 construction project partnerships worth around IDR 170 billion. Therefore, an evaluation of the implementation of industrial fuel usage is needed to understand the factors that drive contractors to comply with the regulations. This is important because the Ministry of Industry has revealed that some businesses are still not adhering to fuel usage rules, necessitating firm action. Research on the factors influencing the use of industrial fuel in construction projects in Pasangkayu Regency is highly relevant.

II. METHODOLOGY

Obtaining profen and the origin of the reagents.The profen used were from the brand Neoquímica® 600mg with 30 tablets. The tablets were triturated and the powder placed in ethanol P.A under orbital shaking (150rpm) for two hours at room temperature. Then, vacuum filtration was performed for separation of the insoluble solids in ethanol. The liquid phase containing the ibuprofen was then concentrated in rotoevaporator under reduced pressure and the resulting solid characterized by gas chromatography coupled to mass spectrometry (90% yield).

This type of research is descriptive quantitative(Rudzki, Gomulka, and Hoang 2022), which is a study that provides a depiction and analysis based on theoretical literature(Xiang et al. 2022). In this research, the results of data processing will be described in detail to strengthen the researcher's analysis in drawing conclusions from the study conducted(Ghani et al. n.d.). Thus, this research can focus on the Analysis of Fuel Consumption(Lin et al. 2013) Factors in Industrial Work on Construction Projects in Pasangkayu Regency(Hu et al. 2019).This research uses quantitative descriptive analysis with factor analysis(Singh and Sharma 2015), presented in numerical form for easy understanding, and employs questionnaires with direct questions to respondents(Singh and Sharma 2015).

The method used to determine the factors influencing industrial fuel use in construction(Turner et al. 2021) work in Pasangkayu Regency involves scoring/weighting/respond(Lin et al. 2013)ent answers numerically, with the analysis employing a Likert scale and results from the questionnaire responses are tabulated, and then calculated using(Golding et al. 2018) the following formula:

Score = { Total Score (A) / Total Value (B) } x 100%

Note: Total Score (A) = Total Value Score (1-5) where:

STS = 1 (Percentage less than 20%)
TS = 2 (Percentage 21% - 40%)
N = 3 (Percentage 41% - 60%)
S = 4 (Percentage 61% - 80%)
SS = 5 (Percentage 81% - 100%)
Total Value (B) = Total Maximum Value Score

Tabel 1..Description of Data Analysis Results

No.	Total Value Range	Notes
1	$x \geq 95$	Very Influential
2	$75 \leq x \leq 95$	Very Influential
3	$50 \leq x \leq 75$	Less Influential
4	$x \leq 50$	Less Influential

After obtaining all the necessary data, the next step is to process the data using SPSS version 24 and Excel 2013. To interpret the weighting, the highest value (X) must first be determined using the following formula (based on a respondent count of 24 people), resulting in: X = highest Likert scale x number of respondents = 5 x 24 = 120 X = lowest Likert scale x number of respondents = 1 x 24 = 24

The interpretation of respondents' evaluation of the questionnaire items is the result value calculated using the index % formula as follows: Index % formula = {(total score : highest value (X))} x 100%
The data analysis technique used in this research employs SPSS software with the following stages:

1. Validity Test The validity test determines the accuracy and correctness of a research instrument in measuring research variables. In other words, if the measurement tool is valid, then the results of the measurements will also be valid.
2. Reliability Test The reliability test measures the stability and consistency of the research measurement tool. This means that the instrument is reliable and trustworthy and remains consistent if measurements are repeated. The testing technique uses Cronbach's Alpha method.
3. Descriptive Statistical Interpretation From the descriptive analysis conducted, the characteristics of the obtained data can be identified.
4. Factor Analysis/Data Analysis using SPSS version 24 This is a statistical analysis used to reduce or summarize several independent variables into fewer variables. The stages are as follows: a. Kaiser-Meyer-Olkin (KMO) Analysis and Bartlett's Test of Sphericity KMO and Bartlett's Test of Sphericity are statistical tests used to check for correlations among variables in the population. b. Correlation Matrix Analysis This analysis involves the table to observe correlations between independent variables. c. Total Variance Explained Analysis This analysis shows the percentage of total variance that can be explained by the variance of the formed factors. d. Rotated Component Matrix Analysis The varimax rotation method is used to ensure and clarify the positioning of variables within a group or factor.

III. RESULT AND DISCUSSION'

The research that has been conducted to analyze several factors suspected to be the reasons why contractors use industrial fuel in construction projects in Pasangkayu Regency used several analytical techniques with the aid of SPSS statistical data processing software, and the results are as follows:

a. Validity and Reliability Testing In the validity test, the following results were obtained:

Table 2. Results of Validity Test for the Questionnaire on Factors Analysis of Industrial Fuel Usage in Construction Projects in Pasangkayu Regency

Case Processing Summary

		N	%
Cases	Valid	24	100.0
	Excluded[a]	0	.0
	Total	24	100.0

a. Listwise deletion based on all variables in the procedure.

Based on the table above, it is known that the answers to 22 questions in the questionnaire given to 24 respondents are valid. In the Reliability Test, the following results were found:

Table 3. Results of the Reliability Test for the Questionnaire on Factor Analysis of Fuel Consumption in Construction Projects in Pasangkayu Regency

Reliability Statistics

Cronbach's Alpha	N of Items
.739	23

Based on the table above, the results of the reliability test using the Cronbach's Alpha method show a value of 0.739, which is greater than the value of 0.50, indicating that the questions given to the respondents are considered reliable.

a. Descriptive Statistical Test.
The results of the Descriptive Statistical Test in this study can be seen in the following table:

Table 4. Results of the Descriptive Statistical Test for the Questionnaire on the Factor Analysis of Industrial Fuel Usage in Construction Projects in Pasangkayu Regency

Descrpive Statictics	N	Minimum	Maximum	Mean	Std Deviation
Project Implementation Time and Cost	24	6	10	8,79	1.250
Project Work Type Operational	24	13	22	19,12	2.610
Operational	24	25	41	32,71	4.486
Tools/Machinery Industrial Fuel	24	16	20	17,71	1.706
Industrial Fuel	24	4	10	6,17	1.834
Quality Valid N(listwise)	24				

Based on the table above, it is known that:
a) The time and cost of project implementation from 24 respondents who answered the questionnaire have a minimum value of 6, a maximum of 10, a mean of 8.79, and a standard deviation of 1.250.
b) The type of project work from 24 respondents who answered the questionnaire has a minimum value of 13, a maximum value of 22, a mean of 19.12, and a standard deviation of 2.610.
c) Operational tools/machines from 24 respondents who answered the questionnaire have a minimum value of 25, a maximum value of 41, a mean of 32.71, and a standard deviation of 4.486.
d) The availability of industrial fuel from 24 respondents who answered the questionnaire has a minimum value of 16, a maximum value of 20, a mean of 17.71, and a standard deviation of 1.706.
e) The quality of industrial fuel from 24 respondents who answered the questionnaire has a minimum value of 4, a maximum value of 10, a mean of 6.17, and a standard deviation of 1.834.

a. Factor Analysis

Factor analysis is conducted to identify the factors that truly affect the object under study. In this research, there are 5 factors analyzed, namely:

1. Time and cost of project implementation
2. Type of project work
3. Operational tools/machines
4. Availability of industrial fuel
5. Quality of industrial fuel

Based on these five factors, the factor that most significantly influences the use of industrial fuel in project work in Pasangkayu Regency is determined with the help of SPSS software. The results can be seen in the following table:

Table 5. KMO (Kaiser Meyer Olkin) Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.746
Bartlett's Test of Sphericity	Approx. Chi-Square	43.690
	df	10
	Sig.	.000

Based on the table above, it can be observed that the KMO value of the research data is 0.746, which is greater than the significance value of 0.05. This means that the testing can proceed to the next analysis, which is the Anti-Image Matrix. The results of this analysis can be seen in Table 6 below:

Anti- Image Matrices

		Project Implementation Time and Cost	Project Work Type Operational	Tools/Machinery Industrial Fuel	Industrial Fuel	Quality Valid N(listwise)
Anti-Image Covariance	Project Implementation Time and Cost	0,627	186	-019'	-141	111
	Project Work Type Operational	-186	491	-017'	- 074'	-251
	Tools/Machinery Industrial Fuel	-019'	017'	449	-237	-086'
	Industrial Fuel	-141	-0,74'	-237	358	-057'
	Quality Valid N(listwise)	111	-251	-086'	-057'	572
Anti-Image Covariance	Project Implementation Time and Cost	764	-336	-035'	-298	186
	Project Work Type Operational	-336	749	036'	-177	-474
	Tools/Machinery Industrial Fuel	-035'	- 036'	744	-591	-170
	Industrial Fuel	298	-177	-591	739	-127

Based on the table above, it is known that the Anti-Image Correlation values for the factors are as follows: the time and cost factor for project implementation is 0.764a, the type of project work factor is 0.749a, the operational equipment/machine factor is 0.744a, the availability of industrial fuel factor is 0.739a, and the quality of industrial fuel factor is 0.740a.

Each value obtained for these factors exceeds the significance level of 0.05, allowing for further analysis, namely the Total Variance Explained Analysis, which can be seen in Table 7 below:

Table 7. Total Variance Explained Analysis

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.004	60.087	60.087	3.004	60.087	60.087
2	.774	15.486	75.572			
3	.660	13.198	88.770			
4	.319	6.389	95.159			
5	.242	4.841	100.000			

Extraction Method: Principal Component Analysis.

Based on Table 4.6, it can be observed that out of the 5 factors/components tested, only one component is suspected to be the main factor compared to the others. This is because, after further extraction, only one component has a value above one, which is 3.004, while the other components have values below one.

However, to determine which factor most influences the use of industrial fuel by construction workers in Pasangkayu Regency among the five analyzed factors, further analysis is needed. This includes a component matrix analysis, which can be seen in Table 8 below:

Table 8. Results of Component Matrix Analysis

	Component
	1
Project Implementation Time and Cost	0,683
Project Work Type Operational	0,798
Operational	0,795
Tools/Machinery Industrial Fuel	0,870'
Industrial Fuel	0,715

Extraction Method: Prinsipal Component Analysis

Based on Table 8, it is known that the factor of time and project implementation costs has a value of 0.683, the factor of project work type has a value of 0.798, the factor of operational tools/machines has a value of 0.795, the factor of industrial fuel availability has a value of 0.870, and the factor of industrial fuel quality has a value of 0.715.

From these results, it can be concluded that out of the 5 factors analyzed, only one factor influences construction workers in Pasangkayu Regency to use industrial fuel, which is the availability of industrial fuel. Based on the research results, it is found that among the five tested and analyzed factors, the only factor that leads construction workers to use industrial fuel is the availability of industrial fuel.

In the questionnaire filled out by contractors working on construction projects in Pasangkayu Regency, it was found that the availability of industrial fuel greatly affects the construction project process. The scarcity of industrial fuel and its high cost compared to subsidized fuel often forces contractors to consider operational costs, especially fuel use, to remain profitable while maintaining project quality. To address this, based on the researcher's observations and questionnaires, it is known that contractors still frequently use subsidized fuel for construction projects due to its availability and lower price, particularly contractors with smaller project values.

This is consistent with Eka's 2023 study, which explains that the availability of industrial fuel is also influenced by the purchasing power of business actors who still often use subsidized fuel with the help of subsidized fuel distributors, leading to decreased demand for industrial fuel.

In line with this, the questionnaire distributed to contractors included four statements regarding the availability of industrial fuel:

1. Industrial fuel must always be available to distributors and easily purchasable by contractors.
2. Industrial fuel should not experience shortages to support the execution of construction projects.

3. The price of industrial fuel must be stable.

4. In case of industrial fuel shortages, contractors can purchase subsidized fuel.

Based on these four statements, it is evident that the majority of contractors strongly agree with all of them. This proves that the availability of industrial fuel should also be supported by stable prices and ease of access for purchase. Without these conditions, the purchasing power of contractors will remain low, even if the availability of industrial fuel is sufficient for construction projects in Pasangkayu Regency.

IV. CONCLUSION

Among the various factors studied and analyzed, the availability of industrial fuel (BBM) is the primary factor influencing the use of industrial fuel in construction projects in Pasangkayu Regency and Contractors sometimes use industrial fuel but may also use subsidized fuel when there is a fuel shortage or to save on operational costs for vehicles or construction machinery.The recommendation of this study is to conduct further research on government oversight in enforcing regulations and policies regarding the prohibition of subsidized fuel usage in construction projects in Pasangkayu Regency, as well as the development of standard operating procedures to make it easier for contractors to obtain and access industrial fuel for use in construction projects.

ACKNOWLEDGEMENT

We would like to express our sincere thanks and high appreciation to the research team, the leaders of the Civil Engineering Study Program and the Head of the Faculty of Engineering, Tadulako University

REFERENCES

[1]. AAkinradewo, Opeoluwa, Clinton Aigbavboa, and Olusola Akinradewo. 2019. "Impact of Construction Project Planning on Contractor's Profit." In *IOP Conference Series: Earth and Environmental Science*, IOP Publishing Ltd. doi:10.1088/1755-1315/385/1/012009.

[2]. Arantes, Amílcar, and Luís Miguel D.F. Ferreira. 2020. "Underlying Causes and Mitigation Measures of Delays in Construction Projects: An Empirical Study." *Journal of Financial Management of Property and Construction* 25(2): 165–81. doi:10.1108/JFMPC-03-2019-0029.

[3]. Callistus, Tengan, and Aigbavboa Clinton. 2018. "The Role of Monitoring and Evaluation in Construction Project Management." In *Advances in Intelligent Systems and Computing*, Springer Verlag, 571–82. doi:10.1007/978-3-319-73888-8_89.

[4]. Eliasson, Lars, Kalle Kärhä, and John Arlinger. 2023. "Fuel Consumption in Logging Operations in Sweden." *International Journal of Forest Engineering* 34(3): 366–72. doi:10.1080/14942119.2023.2229707.

[5]. Ghani, Muhammad Usman, Muhammad Umer Farooq, Shah Sawood Khan, Naveed Khan, and Mohsin Ali. *Factors Effecting Fuel Consumption Of Si Engine-A Case Study*.

[6]. Golding, Nick, Tom A. August, Tim C.D. Lucas, David J. Gavaghan, E. Emiel van Loon, and Greg McInerny. 2018. "The Zoon r Package for Reproducible and Shareable Species Distribution Modelling." *Methods in Ecology and Evolution* 9(2): 260–68. doi:10.1111/2041-210X.12858

[7]. Hu, Zhihui, Yongxin Jin, Qinyou Hu, Sukanta Sen, Tianrui Zhou, and Mohd Tarmizi Osman. 2019. "Prediction of Fuel Consumption for Enroute Ship Based on Machine Learning." *IEEE Access* 7: 119497–505. doi:10.1109/ACCESS.2019.2933630.

[8]. Huo, Hong, Kebin He, Michael Wang, and Zhiliang Yao. 2012. "Vehicle Technologies, Fuel-Economy Policies, and Fuel-Consumption Rates of Chinese Vehicles." *Energy Policy* 43: 30–36. doi:10.1016/j.enpol.2011.09.064

[9]. .Jacobsen, Emil L., Jochen Teizer, Søren Wandahl, and Ioannis Brilakis. 2024. "Probabilistic Forecasting Of Construction Labor Productivity Metrics." *Journal of Information Technology in Construction* 24: 58–83. doi:10.36680/j.itcon.2024.004.

[10]. Kabirifar, Kamyar, and Mohammad Mojtahedi. 2019. "The Impact of Engineering, Procurement and Construction (EPC) Phases on Project Performance: A Case of Large-Scale Residential Construction Project." *Buildings* 9(1). doi:10.3390/buildings9010015.

[11]. Kermanshachi, Sharareh, Behzad Rouhanizadeh, and Paul Govan. 2021. "Developing Management Policies and Analyzing Impact of Change Orders on Labor Productivity in Construction Projects." *Journal of Engineering, Design and Technology*. doi:10.1108/JEDT-10-2020-0428.

[12]. Lin, Borong, Qiong Yu, Ziwei Li, and Xiaoru Zhou. 2013. "Research on Parametric Design Method for Energy Efficiency of Green Building in Architectural Scheme Phase." *Frontiers of Architectural Research* 2(1): 11–22. doi:10.1016/j.foar.2012.10.005

[13]. Montaser, Nourhane M, Ibrahim M Mahdi, Hesham A Mahdi, and Ibrahim Abdul Rashid. 2018. "Factors Affecting Construction Labor Productivity for Construction of Pre-Stressed Concrete Bridges." *International Journal of Construction Engineering and Management* 7(6): 193–206. doi:10.5923/j.ijcem.20180706.01.

[14]. Nguyen, Van Giao, Sakthivel Rajamohan, Krzysztof Rudzki, Janusz Kozak, Prabhakar Sharma, Nguyen Dang Khoa Pham, Phuoc Quy Phong Nguyen, and Phuong Nguyen Xuan. 2023. "Using Artificial Neural Networks for Predicting Ship Fuel Consumption." *Polish Maritime Research* 30(2): 39–60. doi:10.2478/pomr-2023-0020

[15]. Olivieri, Hylton, Olli Seppänen, and Ariovaldo Denis Granja. 2018. "Improving Workflow and Resource Usage in Construction Schedules through Location-Based Management System (LBMS)." *Construction Management and Economics* 36(2): 109–24. doi:10.1080/01446193.2017.1410561.

[16]. Ozturk, Mustafa, Serdar Durdyev, Osman Nuri Aras, Syuhaida Ismail, and Nerija Banaitienė. 2020. "How Effective Are Labor Wages on Labor Productivity?: An Empirical Investigation on the Construction Industry of New Zealand." *Technological and Economic Development of Economy* 26(1): 258–70. doi:10.3846/tede.2020.11917

[17]. Rasoulinezhad, Ehsan, Farhad Taghizadeh-Hesary, and Farzad Taghizadeh-Hesary. 2020. "How Is Mortality Affected by Fossil Fuel Consumption, CO2 Emissions and Economic Factors in CIS Region?" *Energies* 13(9). doi:10.3390/en13092255.

[18]. Romero, Carlos Alberto, Pablo Correa, Edwan Anderson Ariza Echeverri, and Diego Vergara. 2024. "Strategies for Reducing

Automobile Fuel Consumption." *Applied Sciences (Switzerland)* 14(2). doi:10.3390/app14020910.

[19]. Rudzki, Krzysztof, Piotr Gomulka, and Anh Tuan Hoang. 2022. "Optimization Model to Manage Ship Fuel Consumption and Navigation Time." *Polish Maritime Research* 29(3): 141–53. doi:10.2478/pomr-2022-0034.

[20]. Singh, Vedant, and Somesh Kumar Sharma. 2015. "Fuel Consumption Optimization in Air Transport: A Review, Classification, Critique, Simple Meta-Analysis, and Future Research Implications." *European Transport Research Review* 7(2). doi:10.1007/s12544-015-0160-x

[21]. Van Tam, Nguyen, Nguyen Quoc Toan, Dinh Tuan Hai, and Nguyen Le Dinh Quy. 2021. "Critical Factors Affecting Construction Labor Productivity: A Comparison between Perceptions of Project Managers and Contractors." *Cogent Business and Management* 8(1). doi:10.1080/23311975.2020.1863303.

[22]. Tang, S. L.. 2003. *Modern Construction Project Management, Second Edition*. Hong Kong University Press.

[23]. Türkakın, Osman Hürol, Ekrem Manisalı, and David Arditi. 2020. "Delay Analysis in Construction Projects with No Updated Work Schedules." *Engineering, Construction and Architectural Management* 27(10): 2893–2909. doi:10.1108/ECAM-09-2019-0470.

[24]. Turner, Christopher J., John Oyekan, Lampros Stergioulas, and David Griffin. 2021. "Utilizing Industry 4.0 on the Construction Site: Challenges and Opportunities." *IEEE Transactions on Industrial Informatics* 17(2): 746–56. doi:10.1109/TII.2020.3002197.

[25]. Xiang, Yong, Yonghua Chen, Jiaojiao Xu, and Zheyou Chen. 2022. "Research on Sustainability Evaluation of Green Building Engineering Based on Artificial Intelligence and Energy Consumption." *Energy Reports* 8: 11378–91. doi:10.1016/j.egyr.2022.08.266.