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Risk assessment of the procurement and permitting (pre-construction) process for green retrofitting in high-rise buildings in Jakarta: A risk model-based approach

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A B S T R A C T

The importance of green building concepts is emphasized in the current era due to the drastic decline in global climate conditions. However, their development is hindered as they are primarily applied to new buildings, while almost two-thirds of the world's buildings are already constructed. This study aims to improve the efficiency of Green Retrofitting, accelerating the growth of green buildings in Indonesia. It identifies the procurement and permitting processes for Green Retrofitting in high-rise office buildings in Jakarta, along with high-risk activities from these processes. Additionally, it develops a model of the relationship between these high-risk activities and the implementation efficiency of green retrofitting, using a Monte Carlo approach based on the Regulation of the Minister of Public Works and Housing No. 21 of 2021 and the Green Building Council Indonesia. The analysis uses data from 26 expert respondents on green retrofitting procurement and permitting, finding 83 activities with 214 risk indicators influencing green retrofitting efficiency, including 57 high risks. Identifying the most risky activities, the study develops a relationship model and conducts simulation and optimization to improve project time efficiency, ultimately accelerating the growth of green buildings in Indonesia.

1. Introduction

Several studies in recent years have estimated the impacts of global and regional climate change across various sectors. These changes pose challenges for all countries worldwide (Arnell et al., 2019). Based on the literature review, current climate change has reached a range of 0.5-0.8°C over the past century (Huang et al., 2000; Hansen & Labedeff, 1987). The goal is to keep the global average temperature increase below 2 °C compared to the level before the Industrial Revolution and to limit the temperature increase to 1.5 °C compared to the level before the Industrial Revolution (Skytt et al., 2020).

Gases such as CO2, methane, nitrous oxide, CFCs, and other elements are the main contributors to climate change and the greenhouse effect. Among these gases, CO2 is the largest contributor, accounting for approximately 50% of the global greenhouse effect, with billions of tons being emitted into the Earth's atmosphere each year. Other gases, such as CFCs, CH4 (methane), O3, and NOx, contribute in smaller proportions, approximately 20%, 15%, 8%, and 7% respectively (Eko et al., 2010). In 2018, CO2 emissions reached a record high of around 33.1 billion tons, further exacerbating global warming (Izumi, 2020). The construction/building industry has a significant contribution to CO2 emissions, which play a role in global warming. It is estimated that around 33% of CO2 gas emissions worldwide come from buildings (Crawford, 2022). According to the Global Share of Buildings and Construction Final Energy and Emissions 2019 data, carbon emissions generated by the building industry reached 38% of the total global carbon emissions. The construction sector itself contributes to emissions in several categories, with 27% coming from the operational phase of existing buildings, 6% from the construction of new buildings, and 7% from other sectors within the construction industry (Architecture 2030, 2022). This indicates that the construction/building industry plays a crucial role in environmental degradation and contributes significantly to CO2 emissions.

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In response to that, it is necessary to implement the concept of green building. Green building is a concept for 'sustainable buildings' and has specific requirements, including location, planning and design systems, renovation, and operation, which adhere to energy-saving principles and must have a positive impact on the environment, economy, and society (Sudarwani, 2021). Green buildings are structures and processes which are environmentally friendly and resource efficient throughout their life cycle, from site selection through demolition. This practice supplements the traditional building design considerations of economy, usefulness, durability and comfort (Sudarwani, 2021). According to the Regulation of the Minister of Public Works and Housing No. 21 of 2021 in Indonesia, a green building is defined to be a building that meets the technical standards for building construction and achieves substantial measurable performance in energy, water and resource savings through the application of green building guidelines according to its function and classification at each stage of its realization. However, looking at the projected number of buildings already constructed by 2040, existing buildings are estimated to make up two-thirds of the buildings in that year (Architecture 2030, 2022). The demolition of non-green buildings not only involves a significant waste of resources and energy but also leads to secondary pollution and ecological damage. On the other hand, if non-green buildings continue to be used, their negative impact on the environment will persist. Therefore, retrofitting existing buildings with green solutions (Green Retrofitting) is a more resource-efficient and sustainable approach compared to developing new green buildings. Management of permitting in Indonesia is still hindered by several issues, such as poor and slow service, as well as bribery practices involving officials in related agencies. Permitting is a key factor in construction projects as it impacts the performance of implementation time. The procurement system for construction projects, including green retrofitting, also affects the efficiency and effectiveness of state financial management. E-procurement is a solution to improve the efficiency of the procurement process. However, there are still challenges such as tender evaluation that only focuses on price, not on the overall project risk. Problems in public procurement include deviations from regulations, such as bribery, bundling or splitting of work packages, and collusion. Corruption cases in procurement of goods/services are quite high, reaching 30% of all corruption cases. The sources of problems in tender procurement in Indonesia include corruption, lack of transparency, discrimination, non-compliance with procedures, and legal uncertainty. This leads to poor tender quality and often results in unfairness to tender participants and tender failures. All of these issues impact the efficiency of green retrofitting implementation in Indonesia, resulting in its very slow growth (Mandi et al., 2019).

To achieve success and ensure proper implementation in green retrofitting activities, it is important to have adequate procurement and permitting processes. In this regard, a comprehensive reference is needed that covers all stages of the building lifecycle, including procurement and permitting stages. Therefore, this research is deemed important for green retrofitting growth in Indonesia. The development of a Work Breakdown Structure (WBS) and risk management are also crucial in this context. WBS helps identify and organize the work activities involved in the project, while risk management helps identify high-risk stages of work and offers appropriate solutions and responses to mitigate those risks.

Materials and Methods

2.1. Research Methodology

Research methods refer to the systematic process by which data are collected, analyzed and interpreted to answer research questions or test hypotheses. It outlines the theoretical framework, data collection methods, sampling techniques, and data analysis procedures that will be used in a research study. The flowchart depicted below (Fig. 1) provides a visual representation of the comprehensive research methodology, highlighting the sequential steps from problem identification and data collection to final analysis and conclusion.

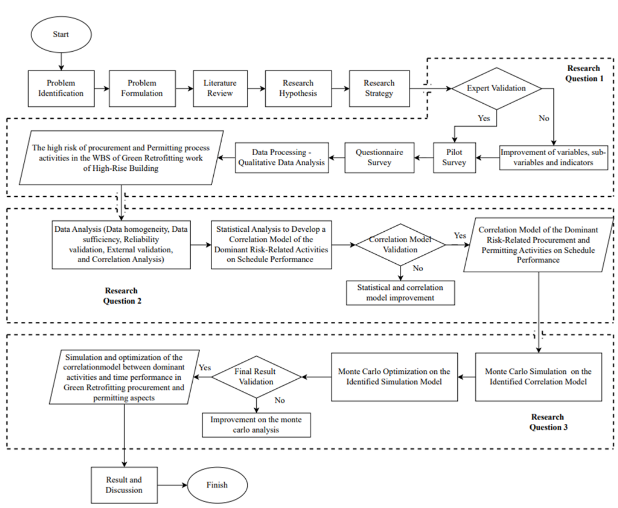


Fig. 1. Research flow framework

2.2. Green Retrofitting Procurement and Permitting Process in Indonesia

The definition of green retrofitting according to Regulation of the Minister number 21 of 2021 is the effort to adjust the performance of a utilized building to meet the requirements of Green Building Criteria (Bangunan Gedung Hijau - BGH) (Ministry of Public Works and Housing of the Republic of Indonesia, 2021). According to the USGBC, "green building retrofits are all types of improvements made to existing buildings, both occupied and unoccupied, that are designed to improve energy efficiency, reduce waterconsumption, and enhance indoor comfort and acoustics while providing a financial benefit to the owner" (USGBC, 2014). According to the President's Regulation No. 12 of 2021 on the Government Procurement of Goods and Services, the procurement of goods and services through providers is a means of from economic entities, which are defined as companies or individuals engaged in specific business or activities. Business Entities refer to companies or individuals engaged in specific fields of business or activities. The providers of government goods and services, hereafter referred to as "providers", are economic entities that provide goods and services on the basis of contracts (President Regulation of Indonesia, 2021). The implementation of government goods and services is carried out by the Electronic Procurement Services (LPSE) (President Regulation of Indonesia, 2021). E-procurement is a government auction system for procuring goods and services, using Internet-based technology, information and communication to ensure effectiveness, efficiency, transparency and accountability (Sutedi, 2012). According to (Andrianto, 2007), e-procurement is defined as the digitalization process of government procurement tender/auction assisted by the Internet. The features of e-procurement include E-auction, E-Tender, and E-catalogue. E-auction is an online auction system between goods/services providers and users. E-Tender is the procedure for selecting goods/services providers, open to all registered providers in LPSE. E-catalog is an electronic list developed by LKPP. Permitting is a process where the government unilaterally grants approval to individuals or communities to legally perform certain acts or activities. In essence, this process serves as a regulatory instrument by the state to control the conduct of its citizens in activities that should not violate the law or harm others (Priyanta, 2019). Based on Ministerial Regulation Number 21 of 2021, the permitting process applicable to green retrofitting activities involves PBG (Building Use Approval) and SLF (Certificate of Functionality) during the utilization phase of green retrofitting work. Meanwhile, for the disposal phase, the required permit is RTB (Technical Demolition Plan). According to GREENSHIP Existing Building (EB) by GBCI (Ministry of Public Works and Housing of the Republic of Indonesia, 2021)., the necessary permits for green retrofitting are :

1. PBG, (Building Use Approval), A building owner's permit allows him to build, alter, extend, reduce and/or maintain a building to technical standards (Government of Indonesia, 2021).
2. SLF (Certificate of Functionality), proof that a building has been tested for its safety and functionality. By possessing an SLF, a building is officially recognized and is expected to provide a sense of safety and comfort to its occupants (Minister of Public Works and Housing Regulation, 2018)
3. AMDAL UKL-UPL documents issued by BAPPEDAL (Environmental Impact Control Agency), Environmental Documents that must be prepared by businesses whose activities have a significant impact on the environment.
4. RTB (Technical Demolition Plan), a document that details the steps and procedures to be followed in the demolition process of a building or structure. This plan is typically prepared to ensure that the demolition is carried out safely, efficiently, and in compliance with relevant regulations of the Government of Indonesia. (Government of Indonesia, 2021).

2.3. Green Retrofitting Procurement and Permitting Work Breakdown Structure (WBS)

The Work Breakdown Structure (WBS) is a highly effective tool used in project management. It serves as the foundation for effective project planning, execution, control, status tracking, and reporting. The WBS identifies, estimates, schedules, and budgets all the work required for the project, along with the necessary resources (scope, schedule, and cost) (Burghate, 2018). A project WBS involves grouping project work elements oriented towards products that organize and define the total project scope. The Work Breakdown Structure (WBS) is a graphical representation of project elements that shows the logical relationships between them. It is a multi-level framework where each lower level provides a more detailed definition or division of project components. The WBS integrates and links all project work and is used throughout the project life cycle to identify, establish, and track specific work scope. It is important to maintain objectivity, comprehensibility, conventional structure, clear and objective language, format, formal register, structure, balance, precise word choice, and grammatical correctness when creating a WBS. The WBS is prepared in sufficient detail to ensure that each control account has a unique WBS element (Burghate, 2018). In this research, the Work Breakdown Structure (WBS) for the Procurement and Permitting Process of Green Retrofitting Activity aims to define activities within a project related to the procurement process and permitting process at the utilization and demolition stages. The development of the WBS structure for the Procurement and Permitting Process of Green Retrofitting Activity is based on the requirements of GREENSHIP Existing Building (EB) and on Peraturan Menteri PUPR No. 21 Year 2021 (Regulation of the Minister of Public Works and Housing Number 21 of 2021). The following details the levels in the WBS for the Procurement and Permitting Process of Green Retrofitting Activity:

Level 1: Green Retrofitting
Level 2: Work Phases
Level 3: Work Phase Processes
Level 4: Process Methods
Level 5: Process Support
Level 6: Work Activities

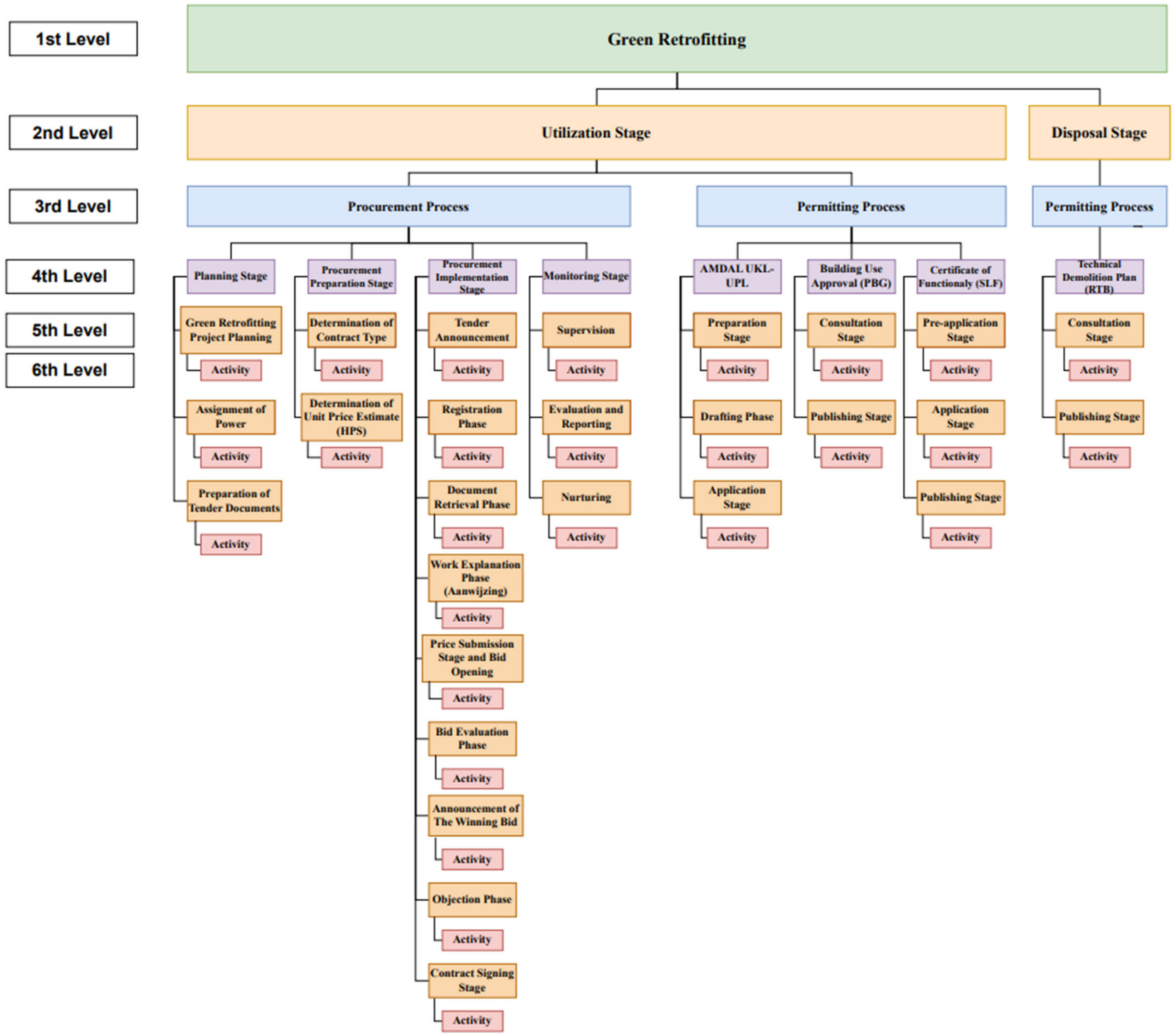


Fig. 2. Green Retrofitting Procurement and Permitting Process in Indonesia

2.4. Risk Assessment

According to the PMBOK 6th Edition, a risk event is a pre-identified event that may or may not occur and that can have a positive or negative impact on the project. Uncertainty refers to the lack of knowledge about an event, which reduces confidence in the conclusions drawn from data. Risk management involves identifying, evaluating, and planning responses to events, both positive and negative, that may occur during the project (PMBOK 6th Edition, 2017). Risk management is an approach taken toward the risks of a project, which, involves understanding, identifying, and evaluating the project's risks. Subsequently, it considers what actions to take in response to the potential impacts and the possibility of transferring or reducing the risks. Risk management encompasses a series of activities related to risk, including planning, assessment, handling, and monitoring of risks (Kerzner, 2017). Risks have a significant impact on the performance of construction projects, particularly in terms of time and cost. Risk management practices can directly influence project performance by identifying and assessing risks, which in turn can affect the project's success, budget, and schedule. The relationship between risk management and project performance has been extensively studied, with research indicating a strong connection between risk management practices at the planning stage and project performance in the construction industry (Su & Khallaf, 2022; Alsaadi & Norhayatizakuan, 2021)

The aim of risk management is to identify risks within a project and develop strategies to mitigate or even eliminate them, while also exploring ways to maximise existing opportunities (Wideman, 1992). According to the PMBOK 6th Edition, risk management processes are divided into 7 processes, namely: Risk Management Planning, Risk Identification, Qualitative Risk Analysis, Quantitative Risk Analysis, Risk Response Planning, Risk Response Implementation, and Risk Monitoring. The PMBOK 6th Edition is widely used as a reference for risk management planning, especially in construction projects (PMBOK 6th Edition, 2017).

2.5. Project Time Performance

Time performance is the comparison of the actual project implementation period to the estimated project implementation period. Time performance can be used as a measure of slippage in a construction schedule. The project implementation begins on the agreed-upon date specified in the contract agreement and ends when all the work is completed. This ratio or comparison serves as the standard measure of project performance, allowing the estimation of project performance through statistics (Kerzner, 2017). Time risk, also referred to as project schedule risk, is the possibility that tasks within a project will take longer than anticipated. This can have an impact on other aspects of the project, such as the budget, delivery date, or overall performance. To mitigate time risk, project managers should overestimate the time required to complete tasks during the planning phase and include time contingencies (Su & Khallaf, 2022). Time performance is crucial in construction implementation and is one of the primary factors for the success of a construction project. Both design-build and traditional systems of construction projects generally have specific implementation plans and schedules, determining when the project should start, when it should be completed, how it will be executed, and how resources will be allocated (Yean et al., 2010). Good time performance seems to be one of the indicators of project success. Poor time performance can lead to various undesirable issues and risks. Time performance is considered good when a project is completed according to the agreed-upon schedule by all parties (Lusi, 2017). In the procurement process, time performance control is crucial and requires leadership, strategy, and management systems. The time needed for procurement and permits significantly impacts the project's implementation and completion time (Huston, 1996). Project owners must have accurate scheduling, recording of work completion status, and contractual authority to accelerate project completion (project time efficiency) (Sudarwani, 2021). The time performance of the green retrofitting construction project will be the main and only dependent variable (Y) in this research.

2.5. Research Material

The research method used in this study includes a literature review to determine the stages of procurement and permitting for green retrofitting projects in high-rise buildings in Jakarta, using Work Breakdown Structure (WBS) tools, as well as the risks associated with each activity. A questionnaire survey was conducted to obtain input on the frequency and impact of each identified risk and to conduct a pilot survey. Expert interviews were conducted to validate the content and construct of the research, and statistical analysis and Monte Carlo simulation analysis were used to obtain a model of the correlation relationship between variables. The total number of risks identified in the procurement and permitting process for green retrofitting projects in Jakarta is 215, spread across each of the procurement and permitting activities. Procurement refers to the tender process for green retrofitting projects, while permitting refers to the document requirements for green retrofitting projects to proceed. From the 215 identified risks, a questionnaire was distributed to 26 respondents who understand procurement and permitting for green retrofitting in Jakarta, hold a bachelor's degree, and have at least 10 years of green retrofitting experience. The results showed that 58 of these risks were high, 69 were moderate, and 88 were low. Of the 215 risks classified as high (H), moderate (M), and low (L), the risk values were then averaged and assigned to the respective risk activities. The project time performance is also provided input by respondents regarding its effectiveness, which will be used as the Y variable in the study. This was followed by tests for homogeneity, data sufficiency, internal validity, reliability, external validity, reduction factor testing, linear regression testing, as well as F and T testing.

Table 1
Correlation Test Analysis Result

Variables		Activities	Number of Risk identified in Activities	Activity Risk Level	Correlation Coefficient	Sig, (2-tailed)
Process	X					
Procurement	X'1	Planning General Activities related to green retrofitting	4	H	-0.064	0.755
	X'2	Determination of green retrofitting certification rankings	2	M	-0.032	0.876
	X'3	Planning the steps of green retrofitting activities related to each aspect of green buildings	1	H	-.428*	0.029
	X'4	Preparation and determination of budgeting plans by the Budget User / Budget User Authority	5	H	0.008	0.969
	X'5	BU/BUA (Budget User/Budget User Authority) appoints the Commitment Making Officer (PPK)	3	M	-0.217	0.286

Variables		Activities	Number of Risk identified in Activities	Activity Risk Level	Correlation Coefficient	Sig, (2-tailed)
Process	X					
	X'6	Commitment Making Officer (PPK) prepares the procurement plan for goods and services along with its completeness and submits it to the Head of the Procurement Service Unit (ULP)	3	M	0.153	0.457
	X'7	The Head of ULP appoints ULP members as implementers of goods and services activities (Pokja)	4	L	-0.080	0.697
	X'8	Formation of PPTK (Technical Activity Implementing Officer) with competence (ability) and expertise demonstrated by the certification they possess.	3	L	-0.064	0.755
	X'9	Identification of goods/services needs	1	M	-0.130	0.527
	X'10	Determination of general policies on work packaging	3	L	-0.088	0.668
	X'11	Determination of general policies on procurement methods and procedures (Methods)	2	L	-0.032	0.876
	X'12	Preparation of work reference framework (KAK)	2	H	-0.249	0.219
	X'13	Preparation of procurement activity schedule	2	H	0.016	0.938
	X'14	Determination of contract types (Lumpsum, unit price, combined contract and unit price, percentage, and turnkey)	1	L	-0.024	0.906
	X'15	Calculation of the estimated price of the work to be tendered must not include unforeseen costs, other costs, and Income Tax (PPh) but must already include VAT, general costs, and profit (Overhead Cost and Profit)	7	M	0.056	0.785
	X'16	Announcement distributed through mass media on the national procurement website for 7 days	1	L	-0.032	0.875
	X'17	Announcement distributed through media via national newspapers at least once during the announcement period	1	L	-0.057	0.783
	X'18	Online E-procurement registration through the Electronic Procurement System Application (SPSE) website	1	L	-0.016	0.938
	X'19	Offline data verification by bringing the required documents	1	H	-0.065	0.753
	X'20	Prospective suppliers download and upload the required documents, namely pre-qualification documents (technical and price)	3	L	-0.032	0.876
	X'21	Evaluation by the Pokja and announcement of qualified providers on the SPSE website	2	M	-0.306	0.128
	X'22	Aanwijzing, The Pokja explains the RKS (work plan and conditions) and conducts Q&A sessions regarding technical and administrative matters with qualified goods/services providers on the SPSE website	1	L	0.146	0.477
	X'23	Goods/services providers upload documents within the specified time frame via SPSE according to the specified bid submission method (price submission)	10	M	-0.120	0.558
	X'24	The Pokja evaluates all types of documents (administrative, technical, and price) to avoid errors in the requirements. Administrative evaluation considers the completeness and bid guarantee. Technical evaluation ensures that goods/services providers meet technical specifications, delivery schedules, clear identification of goods, and clear quantity of goods/services	1	M	-0.244	0.230
	X'25	Formulating results by the committee and being accountable to the Commitment Making Officer (PPK).	4	M	-0.040	0.846
	X'26	Winner Announcement on the SPSE website clearly, in detail, and broadly by the Pokja	2	H	0.105	0.611

Variables		Activities	Number of Risk identified in Activities	Activity Risk Level	Correlation Coefficient	Sig, (2-tailed)
Process	X					
	X'27	The Pokja answers all objections from other goods/services providers for 5 days	3	M	-0.177	0.388
	X'28	If there are no objections, the Pokja prepares a procurement process report and submits it to the PPK as the basis for issuing SPPBJ and work contracts as work agreements between the agency and goods/services providers	4	L	-0.008	0.969
	X'29	Filling in the observation/question list to determine the compliance of goods/services providers with the established procedures	2	L	0.363	0.068
	X'30	Task implementation and evaluation of goods/services planning to conduct monitoring and evaluation of Goods/Services Procurement Planning and submit the monitoring and evaluation results report to the BU for further handling.	3	M	0.354	0.076
	X'31	Goods/Services Procurement Planning development can be conducted to improve the quality of procurement planning through socialization, dissemination, or workshops conducted periodically as needed.	3	L	.412*	0.037
UKL-UPL Permit	X'32	Collection of initial business data (location, activities, methods, materials, machines)	4	M	0.282	0.164
	X'33	Identification of hazards and potential waste from business activities	4	H	0.265	0.190
	X'34	Adjustment of business activity locations with the RTRW to BAPPEDA as a reference for spatial utilization or development in the district or city and as a reference for achieving balanced development in the district or city	2	L	0.057	0.784
	X'35	Conducting spatial analysis of the suitability of planned business activities and/or activities with an indicative map of new permit postponements (PIPIB)	3	L	0.008	0.969
	X'36	Preparation of requirements to complete UKL-UPL documents, namely 1. ID Card of the Responsible Party (usually the business owner) 2. Proof of Land Ownership (SHM, SHGB, and others) 3. Layout of Business Activity Building, etc	1	L	0.138	0.503
	X'37	Identification and Preparation of various related institutions for environmental management and environmental monitoring	1	L	0.033	0.874
	X'38	Filling in the Initiator's Identity (1. Name of the Initiator (Responsible person); 2.Office Address, Postal Code, Telephone Number, fax, and email)	1	L	0.106	0.606
	X'39	Filling in the Business Plan and/or Activity (1. Business and/or activity name; 2. Location; 3. Scale/magnitude of the business). The business name should match the official name listed in legal documents. Meanwhile, for the location, attach a map that complies with cartographic principles).	1	L	0.141	0.492
	X'40	Filling in the suitability of the planned activity location with the city's regional spatial plan in the form of an overlay map between the project site boundary map and the applicable and established RTRW and PIPIB maps	1	H	.439*	0.025
	X'41	Detailing the the approval principle stating that the type of business activity can, in principle, be carried out by the authorized party. Formal evidence of this approval principle must be attached	2	H	0.315	0.118
	X'42	Detailing the the components of the activity/business plan that can have environmental impacts or are believed to have impacts on the environment	4	M	.394*	0.047

Variables		Activities	Number of Risk identified in Activities	Activity Risk Level	Correlation Coefficient	Sig, (2-tailed)
Process	X					
	X'43	Detailing the Environmental Management Efforts in matrix form (Form of Environmental Management Efforts, Environmental Management Location, Environmental Management Period).	4	L	0.104	0.612
	X'44	Detailing the Environmental Monitoring Efforts (Form of Environmental Monitoring Efforts, Environmental Monitoring Location, Environmental Monitoring Period)	4	L	-0.153	0.457
	X'45	Detailing the institutions for environmental management and monitoring	1	M	0.259	0.201
	X'46	Detailing the the number and types of PPLH (Environmental protection and management) permits needed based on Environmental Management Efforts	4	M	0.096	0.639
	X'47	Filling out a statement letter that the initiator is committed to implementing the Environmental Impact Assessment (UKL UPL), signed on stamped paper	1	L	0.195	0.339
	X'48	Filling out the Bibliography. In this section, state the sources of data and information used in the preparation of the Environmental Impact Assessment (UKL-UPL), including books, magazines, papers, articles, and research reports.	1	H	0.145	0.479
	X'49	Filling out the appendix consisting of (1) formal evidence stating that the type of business activity can be conducted in principle, (2) formal evidence that the location plan of the Business and/or Activity complies with the applicable spatial planning (the spatial planning conformity is indicated by a letter from the National Spatial Planning Coordination Board (BKPTRN)), etc	2	L	0.121	0.556
	X'50	Request for UKL-UPL recommendation and approval	3	M	0.145	0.481
	X'51	Administrative inspection	3	H	0.306	0.129
	X'52	Inspection of UKL-UPL documents	4	H	-0.112	0.584
	X'53	Correction of UKL-UPL Documents (If any)	1	M	-0.229	0.261
	X'54	Finalization of Documents	1	L	0.065	0.754
	X'55	Issuance of UKL-UPL Approval Recommendation	2	L	0.129	0.531
PBG Permit	X'56	Registration stage of Building Permit documents (Including Building Data documents and Technical Plan documents)	11	M	0.233	0.252
	X'57	Stage of Inspection for Compliance with Technical Standards of Utilization	7	M	0.008	0.969
	X'58	Stage of Declaration of Compliance with Technical Standards of Utilization	2	H	0.097	0.638
	X'59	Determination of Local Retribution Value"	1	L	-0.267	0.187
	X'60	Payment of Local Retribution	1	M	-0.154	0.452
	X'61	Issuance of Building Functionality Certificate (PBG)	2	H	-0.121	0.557
SLF Permit	X'62	Preparation of documents related for the building functionality suitability (SLF) permit	4	L	-0.048	0.815
	X'63	Inspection of building functionality suitability	3	M	0.016	0.938
	X'64	Issuance of inspection results of building functionality suitability	2	L	0.193	0.344
	X'65	Declaration letter of building functionality suitability	1	L	$.536^{**}$	0.005
	X'66	Preparation of completeness of SLF application documents	1	L	-0.163	0.427
	X'67	Submission of SLF Application	3	M	0.217	0.287
	X'68	Inspection of completeness of SLF application documents	2	H	0.307	0.128

Variables		Activities	Number of Risk identified in Activities	Activity Risk Level	Correlation Coefficient	Sig, (2-tailed)
Process	X					
	X'69	Building data collection	1	M	-0.090	0.661
	X'70	Verification of document compliance inspection results	3	M	0.121	0.557
	X'71	Field verification of building functionality inspection results	3	M	-0.032	0.876
	X'72	SLF approval process	1	M	.393*	0.047
	X'73	Updating building data	1	M	-	-
	X'74	Submission of SLF recommendation or documents to PTSP	1	M	-	-
	X'75	Issuance of IMB changes (if the old IMB is not in accordance with the existing building condition)	1	M	0.232	0.254
	X'76	Submission of SLF and/or recommendation to the applicant	1	L	0.008	0.969
RTB Permit	X'77	Registration stage for the Techinal Standards for Demolition (RTB) permit	11	M	-0.104	0.612
	X'78	Inspection stage for Compliance with Technical Standards for Demolition	6	M	-0.185	0.366
	X'79	Declaration stage of Compliance with Technical Standards for Demolition	2	M	0.040	0.845
	X'80	Determination of Local Retribution Value	1	L	0.024	0.906
	X'81	Payment of Local Retribution	1	L	-0.074	0.720
	X'82	Issuance of RTB	2	M	-0.048	0.814

Table 2
Kaiser Meyer Olkin and Bartletts's Test Result

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.860
Bartlett's Test of Sphericity	Approx. Chi-Square	281.156
	df	66
	Sig.	0.000

Table 3
Rotated Component Matrix Result

Var.	Rotated Component Matrix: Component Factor 1	Factor 2	Grouping
X'3	0.135	0.950	Factor 2
X'21	0.291	0.895	Factor 2
X'29	0.830	0.289	Factor 1
X'30	0.772	0.507	Factor 1
X'31	0.791	0.380	Factor 1
X'40	0.815	0.195	Factor 1
X'41	0.811	0.111	Factor 1
X'42	0.902	0.231	Factor 1
X'51	0.766	0.413	Factor 1
X'65	0.860	0.073	Factor 1
X'68	0.737	0.299	Factor 1
X'72	0.828	0.215	Factor 1

3. Results

3.1. Correlation Analysis

The correlation test was conducted to determine the strength of the relationship between the dependent variable X and the independent variable Y. In this study, variable X represents the activities involved in the procurement and permitting stages of green retrofitting activities for multi-storey office buildings in Jakarta, while variable Y represents the project time performance of the implementation of green retrofitting activities for high-rise office buildings in Jakarta. The foundation of decision-making is characterized by the Pearson correlation value, which indicates that variables are uncorrelated if it falls below 0.3. Conversely, variables are considered correlated when the Pearson correlation value exceeds 0.3. Another way to determine whether variable X (Green retrofitting procurement and permitting activities) is correlated with variable Y (Green retrofitting project implementation time performance) is by examining the significance value. If the significance value is below 0.005, the variables have a significant relationship. If the significance value is above 0.005, the variables are not significantly related. The asterisk (*) or double asterisk (**) will appear when variable x is significantly related to variable Y. Table 1 describes the outcome of this research correlation test. The results show that out of 82 procurement and permitting activities for green retrofitting (variable x) along with the risks associated with these activities, only 12 have a significant relationship with the time performance of the construction project's of green retrofitting in high-rise office buildings in Jakarta.

3.2. Factor Analysis

Kaiser-Meyer-Olkin (KMO) is a measure of sampling adequacy used in factor analysis to determine whether data is suitable for this type of analysis. It evaluates the amount of shared variance among variables. A KMO value greater than 0.5 is generally considered acceptable. The closer the KMO value is to 1, the more suitable the data are for factor analysis. Table 2 presents the results of the factor analysis in this research. Keiser-Meyer-Olkin (KMO) and Bartlett's tests were conducted on each variable X that is significantly related to variable Y. The results indicate a significant value of 0.000 and a KMO value of 0.860, which exceeds the minimum threshold of 0.5 and is close to 1. Therefore, variables X and Y are considered sufficient and can be tested for factor reduction analysis. A factor reduction analysis was then carried out using the method of a rotated component matrix in order to group the X variables that are related to Y into variable factor group , as shown in Table 3. Six rounds of rotation were executed, resulting in the formation of two component factors. Subsequently, the variables were grouped based on the highest correlation value within each component. In factor 1, the variable with the strongest correlation is X’3, where This variable refers to the characteristics of green retrofitting procurement, specifically the initial planning activities related to each green aspect in green retrofitting. In factor 2, the variable with the strongest correlation is X’42,the variable refers to the initial environmental permitting planning process for AMDAL UKL-UPL, which includes outlining the components of the business plan that may have environmental impacts during the pre-construction, construction and post-construction periods.

3.3. Boxplot Analysis and Regression Analysis

Boxplot analysis, also known as box plots or box-and-whisker plots, is a graphical representation of the distribution of a dataset. It displays the median, quartiles, and outliers of the data, providing information about the spread, symmetry, and skewness of the data. Boxplots are particularly useful for comparing the distributions of two or more groups of data. Regression analysis, on the other hand, is a statistical technique employed to represent the correlation between a dependent variable and one or more independent variables, with the goal of forecasting the dependent variable's value based on the independent variables' values.. Regression analysis can be linear or non-linear and can be used for various purposes, such as forecasting, hypothesis testing, and identifying the relationship between variables. The result of factor analysis are regressed using SPSS (Statistical Product and Service Solutions) 26 .The variables used in linear regression testing are selected from each group of latent variables Factor 1 and Factor 2. The variables with the strongest correlation are chosen by testing the internal validation of each group of latent variables Factor 1 and Factor 2. These two variables, X’3 and X’42 are used in the linear regression test. The value of the adjusted R square from model 2 of the regression is above 0.5, which could be classified as valid regression model with the value of 0.505 and level confidence of 46.2% . However, the confidence level obtained is still relatively low at 46.2%. Therefore, a boxplot analysis method was conducted to remove outlier data and improve the model's relationship confidence in this study, the value of the regression analysis result before boxplot shown at Yable 4. After conducting a boxplot analysis, a more reliable model of the relationship was obtained with an increased R-squared value of 0.637 and a confidence level of 59.2%, shown at Table 5. ANOVA results show that the model has marks of the independent variable on the dependent with Sig. value smaller than 0.05, shown at table 6. This shows a significant effect on green retrofitting construction schedule time performance. Table 7 shows the coefficient value for the regression model as the result of regression analysis. The regression model also has significant value smaller than 0.05, which indicates that the regression model can be used as an equation because of its effect on green retrofitting schedule time performance. Based on the analysis of the box plot and regression as well as the coefficient value, a linear equation model was obtained to describe the relationship between variables X and Y, which is

$$Y = 2.096 + 0.56\,X'42 - 0.623\,X'3 \tag{1}$$

Description :

Y = Green retrofitting schedule time performance

X’3 = Planning the steps of green retrofitting activities related to each aspect of green buildings (strongest correlation variable of latent variables Factor 1 chosen by testing the internal validation)

X’42 = Detailing the the components of the activity/business plan that can have environmental impacts or are believed to have impacts on the environment (strongest correlation variable of latent variables Factor 2 chosen by testing the internal validation).

Table 4
Regression Analysis Result Before Boxplot Analysis

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.414[a]	0.172	0.137	0.303
2	.710[b]	0.505	0.462	0.239

a. Predictors: (Constant), X.1.1.1.1.1.3
b. Predictors: (Constant), X.1.1.1.1.1.3, X.1.1.2.1.2.5

Table 5
Regression Analysis Result After Boxplot Analysis

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.798[a]	0.637	0.592	0.239

a. Predictors: (Constant), X.1.1.1.1.1.3, X.1.1.2.1.2.5
a. Predictors: (Constant), X.1.1.1.1.1.3
b. Predictors: (Constant), X.1.1.1.1.1.3, X.1.1.2.1.2.5

Table 6
Result of ANOVA Test After Boxplot Analysis

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1.609	2	0.805	14.033	<.001[b]
	Residual	0.917	16	0.057		
	Total	2.526	18			

a. Dependent Variable: Y
b. Predictors: (Constant), X.1.1.1.1.1.3, X.1.1.2.1.2.5

Table 7
Coefficient Correlation Value

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	2.096	0.194		10.796	0.000
	X.1.1.2.1.2.5	0.046	0.013	0.560	3.704	0.002
	X.1.1.1.1.1.3	-0.036	0.009	-0.623	-4.115	0.001

3.4. F-Test

The F-test analysis is conducted to determine the potential relationships between procurement and permitting activities for green retrofitting, along with their associated risks, on the schedule time performance of green retrofitting construction. Based on the regression model in the previous discussion, the hypothesis is as follows:

H0: There is no relationship among the procurement and permitting activities for green retrofitting of High-rise building in Jakarta, along with their associated risks to the project schedule time performance of green retrofitting construction.
H1: There is a relationship among the procurement and permitting activities for green retrofitting of High-rise building in Jakarta, along with their associated risks to the project schedule time performance of green retrofitting construction.

H0 is rejected, and H1 is accepted when the F value of the research is bigger than the F table value at a 95% level of confidence of 26 data samples. The obtained research F-value was 14.033, which is greater than the tabled F-value of 3.42, shown at table 6. This shows that H0 is rejected and H1 is accepted. Therefore, There is a relationship among the procurement and permitting activities for green retrofitting of High-rise building in Jakarta, along with their associated risks to the project schedule time performance of green retrofitting construction.

3.5. T-Test

The T-test is used to compare the means of two data groups and determine if the difference between the two groups is considered statistically significant. The T-test used in this study is a two-tailed test. Based on the regression model in the previous discussion, the hypothesis is as follows:

H0: There is no relationship among the procurement and permitting activities for green retrofitting of High-rise building in Jakarta, along with their associated risks to the project schedule time performance of green retrofitting construction.
H1: There is a relationship among the procurement and permitting activities for green retrofitting of High-rise building in Jakarta, along with their associated risks to the project schedule time performance of green retrofitting construction.

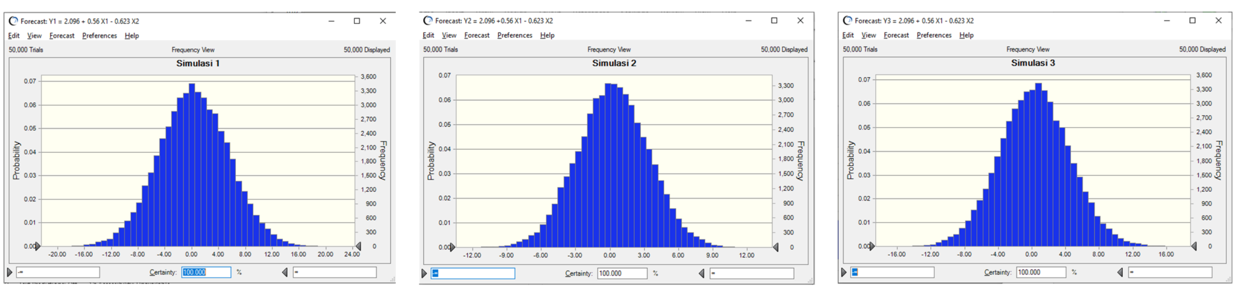
Based on the regression analysis, it was found that the T-value for variables X'3 and X'42 were -4.115 and 3.704, shown at table 7, respectively. Both values were greater than the critical T-value of 0.685, indicating that the difference between the two data groups is statistically significant, therefore H0 is rejected and H1 is accepted.
Meaning, there is a relationship among the procurement and permitting activities for green retrofitting of High-rise building in Jakarta, along with their associated risks to the project schedule time performance of green retrofitting construction.

3.6. Monte Carlo Simulation

A Monte Carlo simulation is a computational algorithm that uses repeated random sampling to estimate the likelihood of a range of results occurring. Monte Carlo simulation is a mathematical technique used to evaluate the effects of risk and uncertainty in a variety of fields, including investing, business, physics, and engineering. The simulation creates a model of potential outcomes by using a probability distribution for any variable that has inherent uncertainty. The simulation recalculates the results multiple times using different sets of random numbers within the specified range. The simulation produces a variety of potential outcomes, each with its own probability of occurrence. The Monte Carlo simulation in this study was conducted using the Crystal Ball software application. The inputs used in this Monte Carlo simulation are the mean values of each variable obtained from 26 respondents, which are then averaged, and their standard deviation is calculated. The simulation was iterated 50,000 times to ensure accurate results. Monte Carlo simulation was applied to the regression equation model obtained in the previous research process using SPSS 26 application. Variables X'3 and X'42, which were obtained previously, were simulated three times for three different scenarios. The linear equation model and the three scenarios are as follows:

$$Y = 2.096 + 0.56\,X'42 - 0.623\,X'3 \quad (2)$$

Simulation Model 1 : The mean values of variables X'3 and X'42 were randomly simulated together 50,000 times, and these random values were used as inputs in the linear equation model (2).
Simulation Model 2 : The mean values of variable X'3 remain linear, while the mean values of variable X'42 are randomly simulated 50,000 times. The X'3 mean values used as input in the linear equation model are linear, whereas the X'42 mean values are random inputs in the linear equation model (2).
Simulation Model 3 : The mean values of variable X'42 remain linear, while the mean values of variable X'3 are randomly simulated 50,000 times. The X'42 mean values used as input in the linear equation model are linear, whereas the X'3 mean values are random inputs in the linear equation model (2).



(a) (b) (c)

Fig. 3. Probability distribution graph of (**a**) Simulation Model 1; (**b**) Simulation Model 2; (**c**) Simulation Model 3, obtained from a Monte Carlo simulation using Crystal Ball software

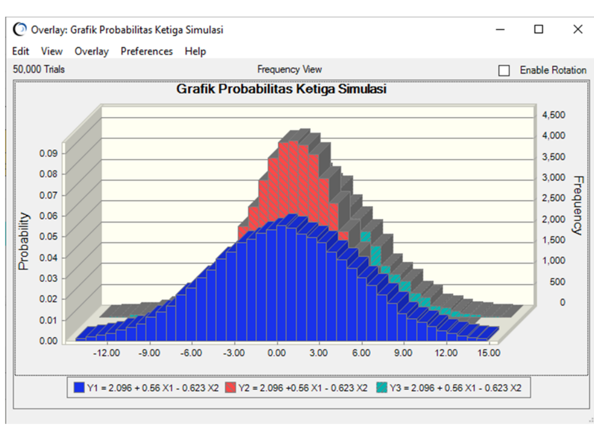
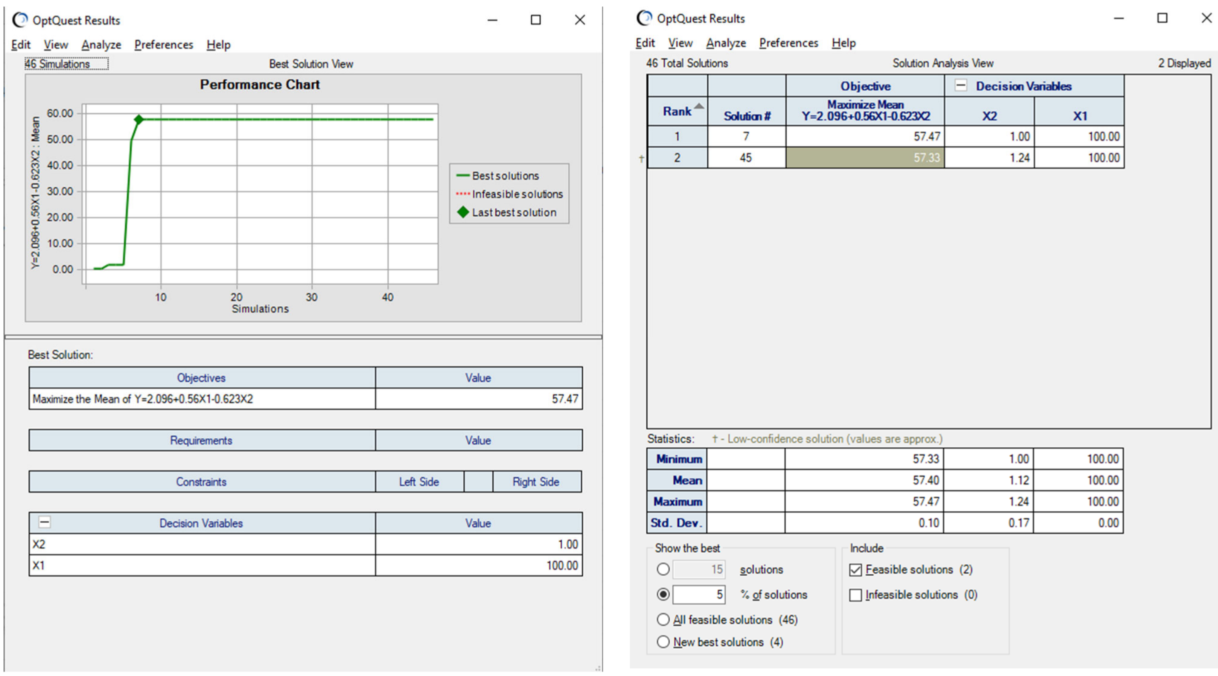


Fig. 4. overlay chart of the probability distribution graphs from the three simulation models

Table 8
Statistical Results: Conclusions from the Three Simulation Models

Statistical Component	Simulation Model 1	Simulation Model 2	Simulation Model 3
Number of Simulations	50,000	50,000	50,000
Minimum Value	-21.34	-12.79	-17.69
Mximum Value	23.14	13.48	17.89
Mean	0.33	0.27	0.34
Std. Error	0.02	0.01	0.02
Std. Dev	5.19	3.1	4.16
Median	0.3	0.27	0.35
25th Percentile	-3.225	-1.84	-2.5
75th percentile	3.905	2.395	3.15



(a) (b)

Fig. 5. Optimization Analysis result (**a**) Performance Chart; (**b**) Solution Analysis, obtained from a Optimization Analysis using Crystal Ball software

3.6 Sensitivity Analysis

Sensitivity analysis is the process of analyzing how variations or changes in one or more input variables can affect the outcomes or outputs in a model or decision.

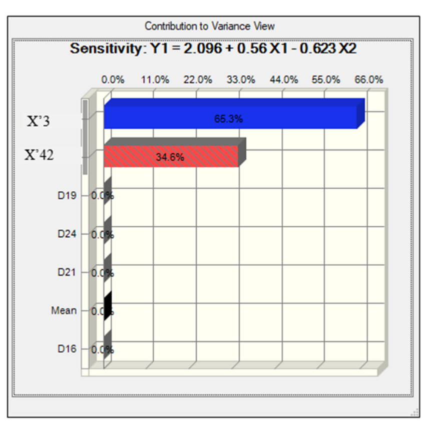


Fig. 6. Sensitivity Graph of Variable X in Relation to Variable Y

The objective of sensitivity analysis is to understand the extent to which uncertainty in in-put variables can influence the uncertainty in outcomes or decisions. The inputs used in this analysis are the probability distributions of each variable and the previously identified relationship model. Data processing for the probability distributions and the previously identified relationship model is done using Monte Carlo simulation. The output of this analysis is the identification of the input variables that most significantly affect output variation. This can be done by examining the contribution of each varia-ble to the variability of the outcomes. Based on the sensitivity analysis, it was found that variable X'3 has a greater influ-ence on the schedule time performance of green retrofitting construction, with a figure of 66.3%, as shown in Fig. 6. Meanwhile, variable X'42 has a smaller influence, name-ly 34.6%, as also seen in Fig. 6.

4. Discussion

This research identifies that the reference for procurement activities in green retrofitting is Ministerial Regulation No. 21 of 2021, while for permits, No. 16 of 2012 and PP No. 16 of 2021 are used. There are 4 main stages in procurement and 3 main stages in permitting. A total of 31 activities in procurement and 52 activities in permitting were identified. Out of a total of 83 activities in the pre-construction stages of green retrofitting, there are a total of 214 risks spread across these 83 activities, with 57 of them being high risks, 69 being medium risks, and 88 being low risks. High risks include design changes, planning errors, unexpected permit requirements, and lack of project team experience. The results indicate that high risks in the procurement and permitting processes can affect the timing performance of green retrofitting.

Several high risks identified in this study are supported by other research. For example, the risk of design changes due to initial uncertainty during the tender process is highlighted (Indeewari et al., 2018). Another study (Indeewari et al., 2018) found similar high risks in permitting approvals. Additionally, (Mohd Razali Ismail, 2020) identified risks related to inexperienced project teams and subcontractors, which align with the high-risk factors identified in this study. These findings emphasize the importance of addressing these high-risk factors in green retrofitting projects.

After assigning risks back to each procurement activity and green retrofitting pertmitting, and conducting a linear regression test to obtain a linear model equation, the eqution model is explained as follows :

- In the established relationship model, there is a coefficient of 2.096, indicating that the absence of procurement and permitting activities, each with their own risks, will increase the efficiency of the green retrofitting project's schedule implementation time.
- It was also found that the variable 'Planning the steps of green retrofitting activities related to each aspect of green buildings' had a coefficient value of -0.623, indicating that the activities involved in the procurement stage of green retrofitting, along with their associated risks, have a negative influence on the performance of green retrofitting construction project timelines.
- Meanwhile, the variable 'Detailing the components of the activity/business plan that can have environmental impacts or are believed to have impacts on the environment' has a coefficient value of positive 0.56, indicating that the activities involved in the environmental permitting phase of the AMDAL UKL-UPL green retrofitting project, along with their associated risks, have a positive influence on the project's implementation timeline.

In the linear regression analysis, it was found that variables X'3 and X'42, along with their respective risks, have opposing effects. Specifically, the activity variable X'3 and its associated risks have a negative impact on the performance of green retrofitting completion time, while the activity variable X'42 has a positive impact on performance. This can happen because environmental regulations such as AMDAL UKL-UPL in Indonesia are very complicated and require a lengthy process. It is worth noting that the permitting process in Indonesia is more focused on money and bribery than on the quality of the documents produced. The risks associated with these activities lead to the creation of incomplete and inadequate AMDAL documents, which accelerates the pre-construction green retrofitting process.

Based on the previous F-test and T-test, it was found that the hypothesis in this study is supported, namely that there is a relationship among the procurement and permitting activities for green retrofitting of High-rise building in Jakarta, along with their associated risks to the project schedule time performance of green retrofitting construction. In the optimization and sensitivity analysis, it was found that variable X'3 (Planning the steps of green retrofitting activities related to each aspect of green buildings) played a more dominant role, with a percentage of 66.3%, while variable X'42 (Detailing the components of the activity/business plan that can have environmental impacts or are believed to have impacts on the environment) had an influence of 33.6%. This indicates that better planning is required to improve the pre-construction green retrofitting system in Jakarta, considering the high risks that may occur if the planning activities are not carried out as well as possible. Additionally, improvements are needed regarding the approval of pre-construction permits in Jakarta, especially in green retrofitting construction. Considering the potential impacts of inadequate and incomplete environmental planning documentation, it is crucial to thoroughly address all potential environmental issues and damages that may occur. This could cause further project delays, which would be more time-consuming than the acceleration gained by quickly and carelessly creating the document.

5. Conclusions

In conclusion, this study demonstrates the significant impact of pre-construction activities, namely the procurement and permitting stages of green retrofitting activities, along with their associated risks on the time performance of the green retrofitting project. These risks were identified starting from the Work Breakdown Structure (WBS) of the pre-construction activities for the green retrofitting of a high-rise office building in Jakarta.

Of the 83 procurement and permitting activities (pre-construction) for green retrofitting, there are 214 risks, including 57 high-risk, 69 medium-risk, and 88 low-risk. From the correlation analysis, it was found that the activities and their associated risks have a significant influence on the performance of green retrofitting activity completion time (variable Y) as seen from the linear equation relationship model.

From the F-test and T-test conducted on the statistical components of the linear relationship model, it was found that all X variables (green retrofitting procurement and permitting activities) have a significant impact on the Y variable (performance of green retrofitting activity implementation), despite some variables having conflicting effects. Although some variables have conflicting effects on performance time, there is a logical explanation for the impact of each variable. The activity variable X'3 and its associated risks negatively affect the completion time performance of green retrofitting, whereas the activity variable X'42 positively impacts performance. This phenomenon is attributed to the complex and time-consuming nature of environmental regulations such as AMDAL UKL-UPL in Indonesia. It is important to highlight that the permitting process in Indonesia tends to prioritize financial considerations and potential corruption over the quality of produced documents. These risks associated with these activities result in the generation of incomplete and insufficient AMDAL documents, thereby expediting the pre-construction phase of green retrofitting.

Finally, this research concludes that to improve the quality of green retrofitting construction work, it is necessary to consider the procurement and permitting activities of green retrofitting, along with their associated risks, through risk prevention and mitigation efforts to minimize or even eliminate risks comprehensively.

References

Alsaadi, N., & Norhayatizakuan. (2021). The impact of risk management practices on the performance of con struction projects. *Estudios de Economia Aplicada, 39*(4). https://doi.org/10.25115/eea.v39i4.4164

Andrianto, Nico., (2007) Transparency and public accountability through e-government

Architecture 2030. (2022*). Actions For Zero Carbon Buildings Existing Buildings*.

Arnell, N. W., Lowe, J. A., Challinor, A. J., & Osborn, T. J. (2019). Global and regional impacts of climate change at different levels of global temperature increase. *Climatic Change, 155*(3), 377–391. https://doi.org/10.1007/s10584- 019-02464-z.

Burghate, M. (2018). Work Breakdown Structure: Simplifying Project Management. *In International Journal of Commerce and Management Studies (IJCAMS), 3*(2). www.ijcams.com

Crawford, R.H. (2022) Greenhouse Gas Emissions of Global Construction Industries IOP Conf. Ser.: Mater. Sci. Eng. 1218 012047 https://iopscience.iop.org/article/10.1088/1757-899X/1218/1/012047

Eko, W., Peneliti Bidang, C., Ozon, P., & Udara, P. (2010). Pengaruh Pemanasan Global Terhadap Ling Kungan Bumi.

Government of Indonesia. (2021). Government Regulation Number 16 of 2021 concerning Building.

Hansen, J., Lebedeff S. (1987). Global trends of measured surface air temperature. *Journal of Geophysics Research, 92*, 13345–13372.

Huang S., Pollack, H.N., Shen, P.Y. (2000). Temperature trends over the past five centuries reconstructed from borehole temperatures. *Nature, 403*, 756–758.

Huston, C. L. (1996). *Management of Project Procurement*. New York: McGraw-Hill Publishers

Izumi, F. (2020). Climate Emergency Declaration. Climate Emergency Declaration.

Kerzner, H. (2017). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (Revised 13th ed.)

Lusi indah, W. (2017) Development of quality management system procurement consultant services to improve procure ment performance in Ministry of Transportation

Mandi, N.B.R., Adnyana, I.B.P., & Gunapatniyatsunu, I.P.E. (2019). Factors Affecting the Success of the Building Permit Licensing Service in Denpasar City, Bali Province. *International Journal of Technology, 10*(1), 94-104.

Ministry of Public Works and Housing of the Republic of Indonesia. (2021). Regulation of the Minister of Public Works and Housing of the Republic of Indonesia Number 21 of 2021 concerning Green Building Performance Assessment.

Ministry of Public Works and Housing. (2018). Regulation Number 27/PRT/M/2018 on the Certificate of Functionality for Buildings.

Presidential Regulation of Indonesia. (2012). Regulation of the President Number 12 of 2021 concerning Government Procurement of Goods/Services.

Priyanta, M. (2019). Regulasi Perizinan Mendirikan Bangunan dalam Mendukung Kemudahan Berusaha Menuju Bangsa yang Adil dan Makmur. https://doi.org/10.24843/JMHU.2019.v08.i03

Project Management Institute. (2017). A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Sixth Edition. Project Management Institute.

Skytt, T., Nielsen, S. N., & Jonsson, B. G. (2020). Global warming potential and absolute global temperature change po tential from carbon dioxide and methane fluxes as indicators of regional sustainability – A case study of Jämtland, Swe den. Ecological Indicators, 110. https://doi.org/10.1016/j.ecolind.2019.105831

Su, G., & Khallaf, R. (2022). Research on the influence of risk on construction project performance: a systematic review. *Sustainability, 14*(11), 6412. https://doi.org/10.3390/su14116412

Sudarwani, M. M. (2021). The implementation of green architecture and green building is an effort to achievesustainable architecture.

Sutedi, A. (2012) Legal aspects of the procurement of goods and services and their various issues

The U.S. Green Building Council. (2014). Building Retrofits. Retrieved from [https://www.usgbc.org/education/sessions/green-retrofits-4724579]

Wideman, R. (1992). Project and Program Risk Management. Project Management Institute.

Yean, F., Ling, Y., Swee, Chan, L., Chong, Edwin, & Ee, L. P. (2010). Predicting Performance of Design-Build and De sign-Bid-Build Projects. https://doi.org/10.1061/ASCE0733-93642004130:175