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Value Engineering Model of Hospital Buildings According to Building Technical Standards in Indonesia

Joko Riyanto, Slamet Imam Wahyudi, Kartono Wibowo

Program Doktor Teknik Sipil Universitas Islam Sultan Agung Semarang, INDONESIA

E-mail: joko_riyant@yahoo.com, wahyudi@unissula.ac.id

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ABSTRACT

This study develops a Value Engineering model for hospital buildings that is in accordance with the rules of building technical standards in Indonesia. This standard includes Government Regulation, Regulation of the Minister of Health, and Regulation of the Minister of Public Works and Public Housing. This model aims to, obtain Variable Criteria that meet the requirements of Design eligibility, obtain Solution Strategies for fixing Variables that are less qualified to produce design recommendations with the lowest cost or net and highest benefits, and Provide a Value Engineering model that can be used to assess Design Feasibility, Variables that meet and do not meet the requirements, Strategies for fixing less qualified variables, Strategies for obtaining Design Recommendations at the lowest price or net benefit as high as possible. The results of the model can be applied to the design phase in planning. This Value Engineering Model is an Abstract Development of a soft system model with DSS (Decision Support System).

Keywords: value engineering model, hospital buildings, technical standards, government regulation.

INTRODUCTION

Hospital building planning and construction must be based on technical standards that guarantee aspects of safety, health, comfort and convenience for users. According to [1], [2] concerning Technical Guidelines for Building Construction and Permenkes (2022) Number 40 concerning Regulations on Technical Requirements for Hospital Buildings as the main reference in designing and building hospital buildings. In the Building Approval (PBG) planning must be in accordance with Technical Standards [2]. The construction process follows the Life Cycle Project [3]. In the design planning, a technical review needs to be carried out again to align perceptions and resolve differences of opinion before the construction phase begins [4]. One effective approach in building planning and development is Value Engineering. According to [5]. Value Engineering not only achieves an economical design but also ensures that all design feasibility criteria are met, including aspects of safety, comfort, and accessibility [6]. Value Engineering is a method to solve problems and reduce costs while improving performance standards or quality [7]. The system has been evaluated to produce the desired product value [8]. Value Engineering workshop on building construction projects with a building area of over 12,000 m^2 or a minimum number of floors is 8 floors, in the construction planning phase according to PUPR Regulation [2] concerning the Construction of State Buildings. The objectives of this study are as follows: 1) to obtain Variable Criteria that meet the Design feasibility requirements, 2) to obtain a Solution Strategy for improving Variables that do not meet the requirements, 3) to obtain Design Recommendations with the lowest Cost / highest net benefit. Originality and Research Updates are to describe the differences and similarities between various studies conducted by various researchers and previous research by scientists. The identified research gap is still a lack of comprehensive literature discussing this topic in one study, Figure 1 illustrates the relationship between the themes that have been discussed as follows below:

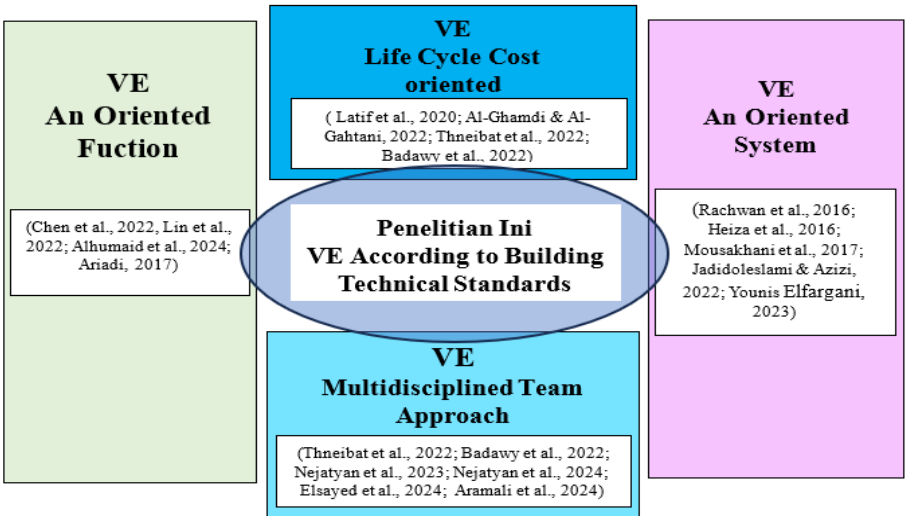

Figure 1. State of The Art (Author, 2024)

The novelty in this study is: Addition of research variables and variable rankings, Solutions for improving variables that are less than satisfactory. Abstract Qualitative Model Form soft system model and Computer Model DSS (Decision Support System) Abstract model soft system model with DSS (Decision Support System).

Value Engineering

Value Engineering is an innovative and systematic strategy aimed at achieving an optimal functional balance between cost, reliability, and performance in a project [9]. Project value has a utility dimension with intrinsic properties that must be met [10].

According to [11] Value Engineering is described as a systematic and innovative method that focuses on reducing and minimizing unnecessary costs. With the following definition:

1. System Oriented reduces the amount of unnecessary costs
2. Multidisciplinary team approach, is saving costs by involving all teams involved in the project
3. Life Cycle Cost Oriented, the total cost associated with the production process and aims to optimize the operation of all supporting facilities
4. Proven Management Technique, proven cost savings that produce various quality products at relatively low prices.
5. Functional Oriented focuses on function Detailed specifications are required for each item or system evaluated in order to achieve the desired product value.

Value engineering decomposition requires 3 basic elements, namely function, quality and cost [9], These three elements can be explained by the relationship:

$$\text{Value} = \frac{\text{Fungtion} + \text{Quality}}{\text{Cost}} \quad (1)$$

Where:
Function: Tasks that have been set according to the design plan
Quality: Owner requirements, desires and expectations
Cost: Financial estimates of all elements involved in the planned work.
Value Engineering System Components,
The composition of the Value Engineering system is shown in Figure 1 [12],

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Sistem Value Engineering	Komponen Value Engineering
Definisi Fungsi *(Function definition)*	Berdasarkan Fungsi Proyek
	Berdasarkan Fungsi Ruang
	Berdasarkan Fungsi Elemen
Evaluasi Fungsi *(Function Evalution)*	Fungsi dengan biaya terendah
Teknik Sistem Analisis Fungsi *(FAST Diagram)*	Digunakan
	Tidak di gunakan
Alokasi Fungsi Terhadap Biaya *(Allocated Cost to Function)*	Iya
	Tidak
Perhitungan Nilai *(Calliculated Worth)*	Iya
	Tidak
Pengembangan Alternatif *(Generation of alternative)*	Brainstorming
	Teknik Lainnya *(Other Creative Techniques)*
Waktu Study *(The Timing of Study)*	Permulaan *(Inception)*
	Laporan Singkat *(Brief)*
	Gambaran Desain *(Sketch design)*
	Fase Konstruksi *(Construction stage)*
	Proses Kombinasi *(Combination of Above)*
	Tahapan Proses *(Continous Proses)*
Evaluasi Alternatif *(Evaluation of Alternative)*	Matrix Pembobotan *(Weight matrix)*
	Teknik Matematika *(Other Mathematikal Techniques)*
	Evaluasi subyektif *(Evaluasi subyektif)*

Sumber : Mc George D and Palmer, (1997)

Figure 2. Value Engineering System Components

The best time to apply Value Engineering is during the planning and early design stages. Studies according to [13] Planners have the biggest role in project costs, along with project owners. Approximately 70% of project costs are estimated to be determined by concept planners, planners will prepare this with the project owner.

According to PUPR Regulation [2], in building structures with a minimum area of 12,000 m^2 or a minimum height of 8 floors, a Value Engineering workshop is required during the construction planning phase.

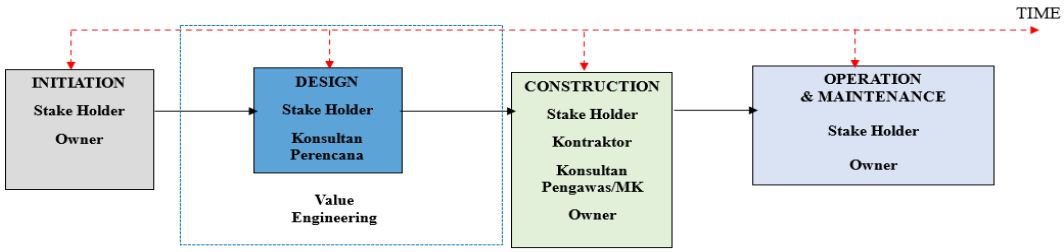

Figure 3. Life Cycle Project on Building Structures [2]

Hospital buildings must meet the requirements for safety, health, comfort and convenience for users, efficient in the use of resources, harmonious and in harmony with their environment. According to Permenkses [15]. Hospital Types and Area Standards are: 1) type A hospitals with a minimum number of beds of 250, 2) type B hospitals with a minimum number of beds of 200, 3) type C hospitals with a minimum number of beds of 100 (4) type D hospitals with a minimum number of beds of 50.

The Technical Standards for Buildings in Indonesia are as follows:

1. Technical Standards for Buildings Government Regulation [1] number 16 concerning building structures.
2. Regulation of the Minister of Health [15] concerning Technical Requirements for Buildings, Infrastructure, and Health Equipment for Hospitals
3. Regulation of the Minister of PUPR [2] concerning the Assessment of Green Building Performance.

Value Engineering Variable Improvement Solution is a systematic method to increase the value of a project by improving functions and reducing costs. According to [5] Lowest Cost Recommendations, Some recommendations to achieve the lowest cost in Value Engineering include organizations can be more effective in managing costs and increasing the value of the project. Modular Design, [14]-[26]. Design Recommendations with the Highest Net Benefits

The increase in benefits arising from the results of the net benefits of Value Engineering in Construction Projects are: Function Analysis [5], [27]-[34], Improving more Functions [35], Improving Team Communication and Performance, Achieving Value For Money [36]-[40].

Comparison of alternative ratios of benefits to costs, namely with 4 alternatives, namely:

1. Increasing function or benefits without increasing costs
2. Function or benefits remain the same by reducing the amount of costs
3. Increasing function or benefits and increasing costs
4. Increasing function or benefits and reducing costs

From the results of the net benefit analysis above, one of the results with the highest ratio value can be selected.

A model is interpreted as a prototype or example. Usually, models are used to describe, explain (prescription), and predict real-world situations being studied [41]-[44]. This study uses the Abstract Qualitative model of the soft system model and the DSS (Decision Support System) Computer Model.

The framework for thinking in this research is based on the background of the identification of the problems and objectives of the research, the basis of thinking is continued by exploring and reviewing the theoretical basis and research on Value Engineering, as follows.

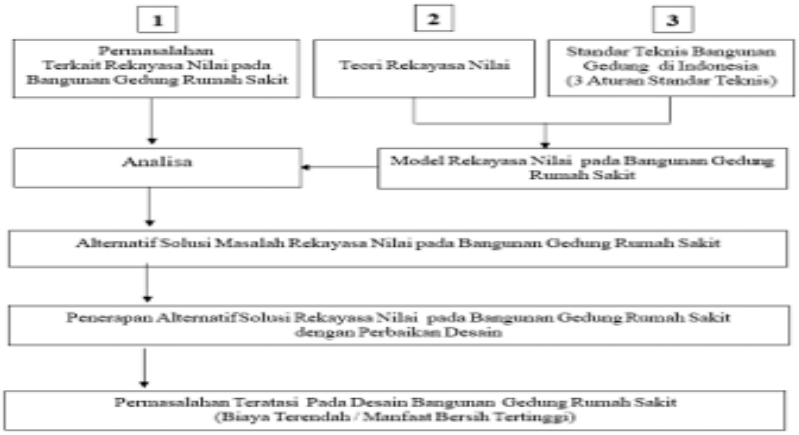

Figure 4. Framework of Thinking (Author, 2025)

RESEARCH METHODS

In this study, there are 4 (four) research objectives using the following types and methods of research analysis:

1. To obtain the criteria for variables that meet the design eligibility requirements, qualitative, the type of Associative research is to determine the relationship between two or more variables using the Variable Analysis method
2. Obtaining a Solution Strategy for improving variables that do not meet the requirements, qualitative, the type of Associative research is to determine the relationship between two or more variables using the Variable Analysis method, namely Correlation Analysis

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3. Obtaining Design Recommendations with the lowest cost/highest net benefit. Quantitative, the type of Associative research is to determine the relationship between two or more variables using the Variable Analysis method, namely Factor Analysis
4. Obtaining a Value Engineering model, Recommendations with a model analysis test are carried out by validating the model to users. The model validation procedure can be carried out by requesting evaluations from experts and practitioners (improvement evaluations). Expert evaluation can be done through Model Validation through Focus Group Discussion (FGD).

The location of the research is throughout the territory of the Republic of Indonesia, based on the distribution of procurement data for goods and services of the LSPE Ministry of Health of the Republic of Indonesia in the Hospital Planning package. Population and Sample Collection based on the number of Hospital Planning work packages from 2023 to 2024. By taking the organizers of the Planning activities and Experts (Experts) for hospital planning. Determination of the criteria for Population and Sample Collection required is relevant to the objectives of this study

Population and Sample, Population does not only include people, but also objects and other objects. Population is not just the number of subjects studied. Population includes all characteristics/properties of subjects or objects [45].
Determination of sample size is based on the fact that a number of sample sizes are needed to produce significant results that allow a valid model to be built. respondents used to test the instrument.

Respondents according to the Research Objectives from the number of population calculations according to table 2 are less than 100 people, so the sample used is a saturated sample. According to [45], [46].

No	Pengelola Kegiatan Dan Tenaga Ahli	Populasi (orang)	Besarnya sampel Jenuh (n)
1.	Kuasa Pengguna Anggaran / Pejabat Pembuat Komitmen (PPK)	19	19
2.	Tenaga Ahli Arsitektur	19	19
3.	Tenaga Ahli Struktur	19	19
4.	Tenaga Ahli MEP	19	19
5.	Tenaga Ahli MARS (Magister Administrasi Rumah Sakit)	5	5
6	Tenaga Ahli Manajemen Konstruksi (MK)	3	3
	Total Responden	**84**	**84**

Figure 5. Population Size

Focus Group Discussion (FGD), in determining the number of participants, the Focus Group Discussion (FGD) Forum is chosen to represent a small part of the entire population. The number of participants in an FGD session is an important thing to consider. namely 4-7 people [47], or 6-8 people [48].

Research Variables are the result of meeting the objectives of the library that has dimensions. Variables are each construct or properties of an object to be studied, interpreting variables as a property that can have different values by describing it as something that varies [49].

Research Variables, suitability with the research objectives as follows below:

No	Tujuan Penelitian	Sumber	Variabel	Metode Pengumpulan Data	Metode Analisis
1.	Mendapatkan Kriteria Variabel yang memenuhi syarat kelayakan Desain	Peraturan Pemerintah (2021) No. 16 tentang pelaksanaan Undang – undang No. 28 Tahun 2002 tentang Bangunan Gedung	○ Ketentuan peruntukan dan Intensitas Bangunan ○ Ketentuan Arsitektur ○ Ketentuan Kemampuan Bangunan Gedung terhadap beban muatan (struktur) ○ Persyaratan Aspek Bangunan gedung	Penyebaran Kuesioner, Wawancara	**Analisis Instrumen** Uji Validitas, Uji Reliabilitas **Analisis Variabel** Analisis Korelasi (Correlation Analysis) dengan SPSS
		Permenkes (2022) nomer 40 Tentang Persyaratan Teknis Bangunan, Prasarana, Rumah Sakit	○ Lahan dan Akses Bangunan ○ Tata Bangunan ○ Kebutuhan Luas Bangunan Rumah Sakit ○ Fasilitas Aksesibel ○ Ruang-ruang dalam rumah sakit ○ Pola Hubungan Antar Ruang Ruang ○ Desain Komponen Bangunan ○ Sarana Evakuasi Bangunan ○ Persyaratan struktur bangunan rumah sakit ○ Persyaratan MEP bangunan rumah sakit		
		Peraturan Menteri PUPR (2021) Tentang Tentang Penilaian Kinerja Bangunan Hijau	○ Penerapan Bangunan gedung hijau ○ Ketentuan Tahap Perencanaan Teknis BGH		
2	Mendapatkan Solusi perbaikan Variabel yang kurang memenuhi syarat	Peraturan Pemerintah (2021) No. 16 tentang pelaksanaan Undang – undang No. 28 Tahun 2002 tentang Bangunan Gedung	○ Ketentuan peruntukan dan Intensitas Bangunan ○ Ketentuan Arsitektur ○ Ketentuan Kemampuan Bangunan Gedung terhadap beban muatan (struktur) ○ Persyaratan Aspek Bangunan gedung	Penyebaran Kuesioner, Wawancara	**Analisis Instrumen** Uji Validitas, Uji Reliabilitas **Analisis Variabel** Analisis Korelasi (Correlation Analysis) dengan SPSS
		Permenkes (2022) nomer 40 Tentang Persyaratan Teknis Bangunan, Prasarana, Rumah Sakit	○ Lahan dan Akses Bangunan ○ Tata Bangunan ○ Kebutuhan Luas Bangunan Rumah Sakit ○ Fasilitas Aksesibel ○ Ruang-ruang dalam rumah sakit ○ Pola Hubungan Antar Ruang Ruang ○ Desain Komponen Bangunan ○ Sarana Evakuasi Bangunan ○ Persyaratan struktur bangunan rumah sakit ○ Persyaratan MEP bangunan rumah sakit		
		Peraturan Menteri PUPR (2021) nomor 21 Tentang Tentang Penilaian Kinerja Bangunan Hijau	○ Penerapan Bangunan gedung hijau ○ Ketentuan Tahap Perencanaan Teknis BGH		
3	a) Mendapatkan Rekomendasi Desain dengan Biaya terendah /	(J.A. Rain & Y. Sato, 2008)	Desain Moduler	Penyebaran Kuesioner, Wawancara	**Analisis Instrumen** Uji Validitas, Uji Reliabilitas **Analisis Variabel** Analisis Faktor dengan SPSS
		(Robbins & Judge, 2019), (Terry, 1998)	Tenaga Kerja (Man)		
		(Brigham & Houston, 2019)	Modal (Money)		
		(Ashby, 2005)	Pemilihan Material (Material)		
		(Heizer et al., 2019), (Stevenson, 2020)	Mesin (Machine)		
		(Hersey et al., 2012), (Surbakti, 2017)	Metode (Method)		
		Dell'Isola (1982)	Durasi Waktu		
		Mc George D and Palmer (1997), Connaughton (1996), G. Lin (2009), Robinson (2008)	Optimasi Biaya dan Efisiensi		
	b) Manfaat Bersih Tertinggi	Miles (1972)	Analisis Fungsi		
		Camp (1989)	Benchmarking		
		Dell'Isola (1982), Mc George D and Palmer (1997), Connaughton (1996)	Memperbaiki nilai dan kinerja Proyek		
		Dell'Isola (1982), Mc George D and Palmer (1997), Connaughton (1996), G. Lin (2009)	Memperbaiki Fungsi lebih (Provide more fuction)		
		Connaughton (1996), G. Lin (2009)	Memperbaiki Komunikasi dan Kinerja Tim		
		Connaughton (1996), G. Lin (2009)	Mencapai Value For Money		
4	Model Hasil Perencanaan DED Bangunan Gedung RS sesuai Aturan dan Standar Teknis Bangunan Gedung Negara di Indonesia	Sawson, Manderson & Tallo (1993), Irwanto (2006), Morgan D.L (1998), Koentjoro, (2005), Krueger & Casey (2015)	Validasi Model **Diskusi:** Peserta mengevaluasi model, mengidentifikasi kelemahan, dan memberikan masukan.	Kuesiener Focus Group Discussion (FGD)	**Analisis Instrumen** Uji Validitas, Uji Reliabilitas **Validasi model** FGD (Focus Group Discussion) **Analisis:** Hasil diskusi dirangkum dan digunakan untuk merevisi atau memperbaiki model
	Model Rekayasa Nilai Biaya Terendah atau manfaat setinggi tingginya	(J.A. Rain & Y. Sato, 2008) (Robbins & Judge, 2019), (Terry, 1998), (Brigham & Houston, 2019), (Ashby, 2005) (Heizer et al., 2019), (Stevenson, 2020), (Hersey et al., 2012), (Surbakti, 2017), Dell'Isola (1982), Mc George D and Palmer (1997), Connaughton (1996), G. Lin (2009), Robinson (2008) Miles (1972), Camp (1989) Dell'Isola (1982), Mc George D and Palmer (1997), Connaughton (1996), Dell'Isola Palmer (1997), Connaughton (1996), G. Lin (2009), Connaughton (1996), G. Lin (2009), Connaughton (1996), G. Lin (2009)	Validasi Model **Diskusi:** Peserta mengevaluasi model, mengidentifikasi kelemahan, dan memberikan masukan		

Sumber : Olahan Penulis (2024)

Figure 6. Research variable

Method of collecting data

Primary Data This study uses several primary data collection methods, namely:

1. Questionnaire Survey aims to obtain an overview of stakeholder perceptions on the Hospital Planning Project according to the Standard Technical Regulations for Building Construction in Indonesia, both government and professional communities (Planning Consultants, Construction Management Consultants, academics and Professionals).
2. The purpose of in-depth interviews is to involve collecting information through face-to-face question and answer sessions with informants who have extensive knowledge of Hospital Building Planning
3. Focus Group Discussion (FGD) Is one of the instruments used in the study that aims to clarify and validate the findings of the questionnaire survey.

Secondary Data Collection Method This approach involves the use of secondary survey methods, including literature reviews and institutional assessments to collect formal documentation. Institutional assessments are carried out to collect secondary data to support the hypothesis.

The research instrument is a tool for data collection. Without these tools, data collection is impossible [50], Research instruments are useful for answering research problems. This instrument must be valid and reliable to produce accurate data.
Validity refers to the extent to which an instrument measures what it is intended to measure.

Reliability Consistency in measurement results

The chosen Research Instrument Method must be in accordance with the type of data to be collected. This study uses Questionnaires, Interviews, and FGDs
Data Analysis Techniques The data analysis methods used in this study are respondent examination, instrument evaluation, variable analysis, and tracing the relationship between variables.
Respondent Analysis The purpose of detailing the characteristics of respondents is to provide an overview of their identity in this study

Instrument Analysis

This study uses SPSS to analyze data obtained from the questionnaire survey
1. Validity Comes from the word "valid" which means the level of accuracy and precision of a measuring instrument in carrying out its measurement function. Validity calculations are carried out using the product moment correlation method formula [45],
2. Reliability Test, The reliability of the research questionnaire used to collect variable data has been confirmed. This is an aspect of testing whether measurements obtained from the same object produce consistent data or not [46]. Reliability test using Cronbach's alpha method, which is a mathematical formula used to test the level of reliability of a measurement.

Analysis of Variables In this study according to the purpose of the study is to use variable analysis is:
1. Obtaining Variable Criteria that meet the Design eligibility requirements, Using Correlation Analysis with SPSS. Correlation is. Correlation can indicate the direction (positive or negative) and strength of the relationship. [27] correlation measures the extent to which two variables move together. Correlation is usually expressed in the form of a correlation coefficient [39],
2. Obtaining Solutions to improve Variables that are less qualified Using Correlation Analysis with SPSS.
3. Obtaining Design Recommendations with the Lowest Cost or the Highest Net Benefit Using Factor Analysis with SPSS, factor analysis This method aims to reduce the dimensions of data and find patterns that underlie the relationship between variables. According to [30] factor analysis helps researchers understand complex data structures by exploring the relationships between variables.

Obtaining a Value Engineering model that can be used to assess the Criteria of Variables that meet the requirements of Design Feasibility, Variable Improvement Solutions, Design Recommendations with the Lowest Cost or the Highest Net Benefit using: Model Analysis Test by validating the model to the user. Model validation aims to control and improve the model that has been produced to make it better. The model validation procedure can be carried out by requesting evaluation from experts and practitioners (improvement evaluation). Expert evaluation can be done through - Focus Group

Discussion (FGD) while practitioner evaluation can be done after model testing to provide input for model improvement.

Research Flowchart, dissertation research flowchart. Value Engineering Model of Hospital Building with Functional Analysis according to the Building Technical Standards in Indonesia, as in Figure 7 below,

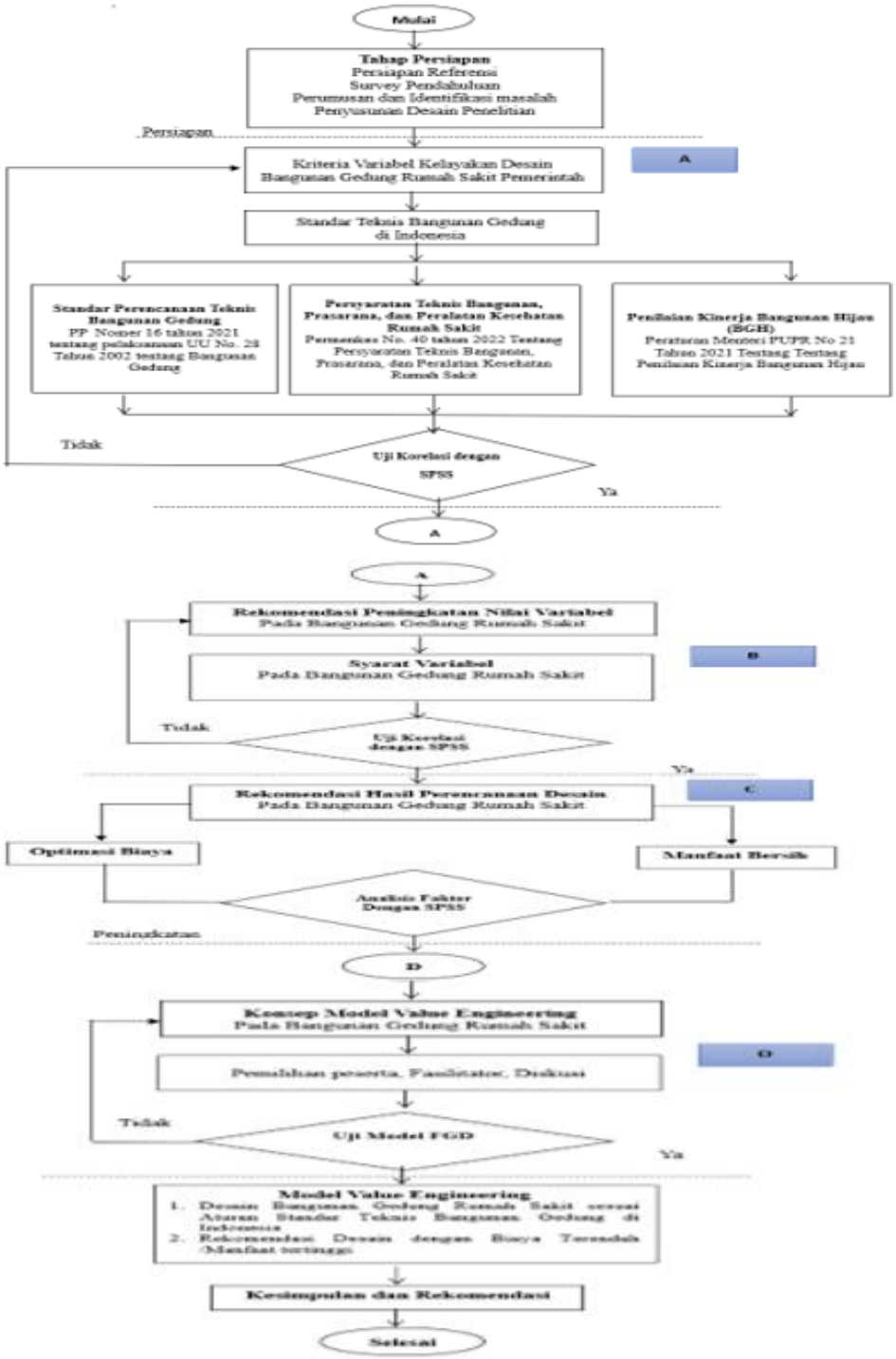

Figure 7. Research flowchart

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RESULTS AND DISCUSSION

In this study, the Value Engineering Model is applied to the planning and construction of hospital buildings in accordance with the technical standards applicable in Indonesia. The analysis was carried out based on Government Regulation [1], Minister of Health Regulation [15], and Minister of PUPR Regulation [2].

Implementation of Value Engineering Model

This study produces a Value Engineering model that can be used to assess design feasibility, identify variables that meet or do not meet the requirements, Solutions to improve variables that do not meet the requirements, Design Recommendations with the lowest Cost or the highest Net Benefit, Obtain a Value Engineering model for hospital building structures according to building technical standards in Indonesia

Results of Variable Analysis

The results of the variable analysis show that there are several main variables that affect the feasibility of hospital building designs, namely:

1. Obtaining Variable Criteria that meet the Design feasibility requirements according to Government Regulation [1], Minister of Health Regulation [15], and Minister of PUPR Regulation [2],
2. Obtaining Solutions to improve variables that do not meet the requirements according to Government Regulation [2], Minister of Health Regulation [15].
3. Recommendation of Design with the lowest cost according to variables: Modular design, Labor, Capital, Material selection, Machine, Method, Time duration, Cost optimization and Efficiency. Or the highest net benefit according to variables: Function analysis, Benchmarking, Improving project value and performance, Improving project value and performance, Improving team communication and performance, achieving value for money, and creating many ideas and innovations
4. Validation of the model through - Focus Group Discussion (FGD) shows that this approach can be applied in the construction planning stage to improve design effectiveness.

CONCLUSION

Based on the research conducted, the following conclusions were obtained: 1) The Value Engineering Model developed can be used to assess the feasibility of hospital building design according to technical standards in Indonesia, 2) the main variables that affect design include structure, facilities, cost efficiency, and use of materials and technology, 3) implementation of this model can produce design recommendations with the lowest cost but still meet technical standards and user comfort.

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