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Enhancing Engineering Intuition for Shipyard Investment Cost Estimation through a Computer-Aided Training Framework

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Abstract. Estimating investment costs for a shipyard requires a high level of expertise, which typically takes time and experience to develop. This research presents a computer-aided training framework to train intuitive skills in estimating investment costs for new shipyards. The study begins with a review of the parametric method, a relevant approach for estimating shipyard investment costs. Subsequently, the recognition-triggered decision method, a technique based on intuitive decision-making, is integrated into a predetermined estimation method. Program and application algorithms are developed accordingly. A prototype of the application is tested on ten participants using the "Two Mean Difference Test." Prospective estimators undergo pre-test and post-test assessments to evaluate the improvement in their intuitive skills. The results demonstrate that the application effectively enhances the intuitive skills of prospective estimators in estimating the investment costs of new shipyards. This conclusion is supported by the values of "t" and "t of the table," where 11.53 > 2.262, within a critical range of 5%.

1. Introduction

Intuition plays a pivotal role in engineering, serving as an essential skill that enhances problem-solving and decision-making capabilities [1]. Defined as the ability to understand and address complex issues without relying solely on analytical reasoning, engineering intuition is developed through extensive experience and education [2]. This skill enables engineers to recognize patterns, predict outcomes, and make swift decisions even when faced with incomplete information. As such, it differentiates exceptional engineers from their peers, allowing them to navigate challenges effectively in various fields [3].

In the global context, intuition is increasingly recognized as a crucial soft skill across engineering disciplines [4]. It facilitates creative problem-solving and quick identification of potential issues, thereby improving project efficiency and outcomes. Engineers who harness their intuition can adapt to rapidly changing environments and make informed choices that align with both technical requirements and broader project goals. This adaptability is particularly vital in today's fast-paced technological landscape, where the ability to synthesize knowledge from diverse experiences can lead to innovative solutions. The paper "Situating Intuition in Engineering Practice" [5] explores how intuition, developed through experience, complements logical analysis in engineering decision-making. The authors define intuition as a subconscious process that allows experienced engineers to assess situations or predict outcomes efficiently, especially when under constraints like time or incomplete data. Through the Leveraging Intuition Toward Engineering Solutions (LITES) framework, they illustrate how intuition integrates with problem-solving by blending instinctive responses with holistic and data-based approaches. Intuition, linked to expertise and System 1 thinking, helps engineers make quick, informed decisions, particularly when traditional analytical methods are insufficient. This highlights the importance of intuition as a critical skill for navigating complex and ambiguous engineering challenges [6].

Specifically in shipbuilding engineering, intuition becomes even more significant due to the intricate nature of maritime projects. Shipbuilding involves complex systems that must operate reliably under various conditions, necessitating a deep understanding of both engineering principles and practical applications. Experienced shipbuilders often rely on their intuitive insights to foresee potential design flaws or operational challenges before they arise. This foresight not only enhances safety [7] but also optimizes resource allocation and project timelines [8].

An attempt has been proposed by Pradisa [9], in utilising the knowledge of intuition to predict the new shipbuilding cost by using computer applications. The framework proposed that through the computer applications, the parameter used in estimating the new shipbuilding price can be trained to the human. The learning process through this approach can be used to initiate the intuition knowledge in engineering, in this case, estimating the new shipbuilding price.

In this article, through the similar approach, it is applied to predict the shipyard investment cost. The breakdown investment cost in shipyard is defined as several item contribute to the investment cost. Each cost components are then ranged into several variable sized to accommodate the different size of the shipyard.

2. Literature Study

2.1 Cost Estimation Method

Estimating investment costs in shipyards is a multifaceted process that requires a systematic approach to ensure accuracy and reliability. One of the primary methodologies used is Cost Estimating Relationships (CERs), which express the relationship between various performance parameters and total costs. This method allows estimators to predict how changes in design specifications, such as a 5% increase in engine power, will impact overall costs. By utilizing historical cost data from previously built vessels, engineers can identify patterns and develop regression models that articulate unit costs per cost-driving parameter for different vessel types. This parametric top-down estimation approach not only enhances precision but also helps inexperienced personnel gain insights into the complexities of shipbuilding costing [10].

Another effective methodology employed in shipyard cost estimation is Activity-Based Costing (ABC). This approach allocates costs based on the actual activities involved in ship construction, providing a clearer picture of both direct and indirect costs [11]. By developing a Work Breakdown Structure (WBS), shipyards can break down all necessary activities for construction, enabling more accurate cost allocation. This method also helps identify inefficiencies and hidden costs that may not be apparent through traditional costing methods [12]. ABC is particularly beneficial for shipyards transitioning from military to commercial shipbuilding, as it allows for a detailed analysis of operational costs and resource utilization.

Preliminary cost estimation models are also crucial for providing early assessments of investment needs based on high-level design specifications. These models utilize initial design parameters to generate rough estimates of acquisition and lifecycle costs. The iterative nature of this process allows for continuous refinement as more detailed design information becomes available. By focusing on the consequences of changes in high-level performance requirements, shipyards can respond more quickly to customer inquiries and improve their competitive advantage in the market [13].

Advanced methodologies such as simulation and predictive modelling are increasingly being utilized to estimate investment costs in shipyards. These techniques involve scenario analysis to forecast potential cost outcomes based on various design choices and operational conditions. By employing data-driven approaches, engineers can anticipate future costs more accurately, taking into account factors such as market demand, material availability, and technological integration [14]. Overall, these methodologies collectively enhance the accuracy and efficiency of investment cost estimations in shipbuilding, ultimately contributing to better financial planning and resource management within the industry.

Shipyard is a place designed to build and / or repair and maintain ships. Generally, shipyards are built on land directly adjacent to the water or sea level [15]. In estimating the cost of a new building shipyard investment project, there are many methods that can be used. One of the methods that can be used is the parametric method. The parametric method is a method that estimates the cost of investment components of new building shipyards by considering parameters that affect the cost of these components.

Cost estimation methods have been used in research on designing applications to train intuition in estimating the price of new ships [9]. According to the research, this method is suitable to be applied to intuition training because the information that will be provided for estimating is very minimal, so that prospective estimators must analyze and explore for themselves the information obtained as material for making intuitive estimation decisions. Therefore, this method can also be used in this study because the application designed is also related to practicing intuition. The use of this parametric method will adjust for the parameters that affect the cost of the investment in a new building shipyard. The parameters used in the application are:

Geography and Topography of The Land. Geographical conditions are the conditions or circumstances of a region that are seen from its state in relation to geographical aspects. Those aspects include the location, interrelationships, area, shape, and coordinate position of the map. While topography is the surface of a land that is grouped or determined according to the height of the land from the earth's surface. The topography of the land will determine the magnitude of the land price. The price of land will be higher if the location of the land is more ideal for a development. In addition to affecting land prices, soil topography also affects the cost of earthwork, which includes land clearing, soil management, and soil compaction.

Bathymetry. Bathymetry is the mapping of the depths of the waters, also known as sea topography. Bathymetry will lead to cost-related expenditures in the form of land dredging. The dredging of the soil is caused not only by the depth of the waters, but also by the height of ship`s.

If the height of ships is greater than the depth of the waters at the site, then dredging in the water needs to be carried out.

Ship Size. The size of the ship that is planned to be built in the shipyard greatly affects the investment costs that will be incurred. From the size of the ship or the DWT of the planned ship, the cost of meeting the ship's production process at the shipyard can be determined. These costs include production equipment, buildings at the shipyard, and other costs in the production process [16].

Technology. In general, the application of technology management in the shipbuilding industry, especially in shipyards in Indonesia, is still developing. Several developed tools are integrated with digital technologies, including wearable devices for identifying welders [17], radio-frequency identification (RFID) [18], quick-response code application [8], indoor positioning technologies [19], and robotic welding [20], all of which contribute to improving the efficiency of shipyard operations [21].

2.2 Intuitive Proficiency Improvement Method

Intuition is a personal cognitive resource or a person cultural capital [22]. In Figure 1, you can see the flow of the intuitive proficiency improvement method that will be used in the application, namely the recognition-triggered decision method [3]. The flow of this method will be implemented in the application as a way to improve intuitive proficiency in estimation. Studies point towards that work-related flow (work motivation, enjoyment and absorption) increase personal and organizational resources, a positive mood, and that flow is connected to situational characteristics [6].

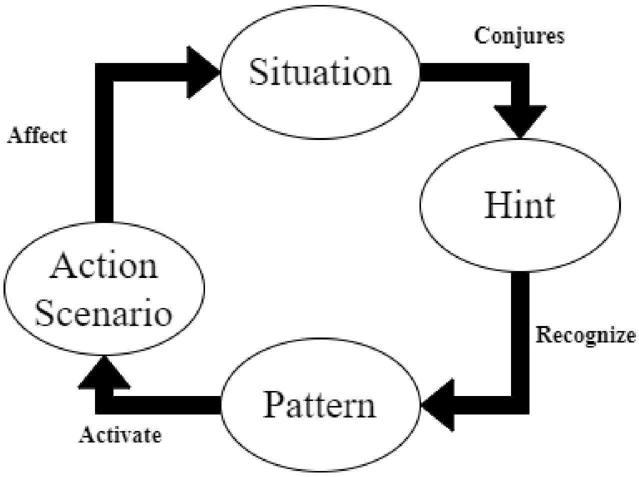

Figure 1. KDP Method (Source: The Power of intuition Book)

First, an understanding of the situation. The situation that the prospective estimator will understand is the relationship between the cost influence parameter and the cost-forming component. The appearance of this relationship is a parametric flowchart. Understanding this situation is also helped by the introduction of the components that make up investment costs and examples of case studies of estimates that have been given previously. In this situation understanding session, the prospective estimator will also enter inputs in the form of influence parameter values and produce outputs in the form of the cost of forming components. The prospective estimator can then analyze the relationship for himself. Secondly, the understood situation gives rise to clues.

The clue obtained after understanding the situation is an empirical graph of the investment cost of each component. This empirical graph will also aid aspiring estimators in pattern recognition. Third, from pattern recognition and clues in the form of empirical graphs, prospective estimators will recognize patterns in estimating the investment of each component. Fourth, perform actions based on patterns. The familiar pattern will help potential estimators take action in the simulation session of the estimated total investment. This simulation will be carried out repeatedly under different conditions. The more simulations you run, the more patterns you will recognize.

2.3 Intuitive Decision Making

A key issue in decision research has been to understand how individual dispositions are related to decision making [23]. A person who has repeated knowledge and experience of something will find it easier and more precise to make a decision related to it [24]. It is an intuition formed in the mind because of the knowledge and experience that have been gained by that person. Intuitive judgments are automatic and effortless. It become particularly salient in the presence of risk and ambiguity [25]. From the flow of intuitive proficiency improvement methods to be carried out, prospective estimators can make informed decisions related to the estimated investment costs of new building shipyards. This decision is taken based on the pattern that has been obtained after conducting training.

3. Methodology

Problem Identification. The background of this research is the importance of estimating before starting a construction project, especially the construction of a new building shipyard. However, to estimate something requires knowledge and experience about the field or thing you want to estimate. It takes a long time for an estimator to gain such knowledge and experience. Therefore, a means is needed in this study in the form of a web-based application that can train a person's intuitive skills in estimating the investment costs of a new building shipyard.

Literature Studies. Literature study is necessary to understand the theories that will be used in working on this research. Literature studies can be supplemented with references from relevant scientific journals, books, articles, previous final projects, and the internet.

Analysis of the Implementation of Intuition Training in the Investment Estimation of New Building Shipyard. An analysis of how to implement intuition in the estimated investment cost of a new building shipyard in the form of determining how to estimate the investment cost of a new building shipyard, determining the method of increasing intuition, and how to implement both in the application.

Application Design. The computer application will be designed based on the analysis that has been carried out so that the purpose of this research can be fulfilled. The goal is to create a tool that can train user intuition in estimating the investment cost of a new building shipyard.
In the design of this application, there is also a validity test for the cyst. The data calculated in Excel calculations using the flow system is the same as the flow of the program or application. The value to be validated is the value of the investment cost of the new building shipyard for each component.

Application Analysis and Discussion. Computer applications that have been designed will be tested on users with regard to the accuracy and effectiveness of the purpose and function of making applications according to the hypothesis. The hypothesis is to train intuition in the estimation of new building shipyard investments. The correctness of this hypothesis will be tested using one of the parametric statistical tests, namely the "t" test.

Conclusion. Conclusions will be reached after all stages are completed. This conclusion will address whether the study's findings are hypothesized or even contradictory.

4. Development of the Computer Aided-Training Framework

4.1 Determination of the Components that Make Up the Investment Cost of a New Building Shipyard

In Figure 2, you can see the flowchart of the components that make up the investment cost of the new building shipyard. The investment cost of the shipyard is the total of the estimated costs of all forming components.

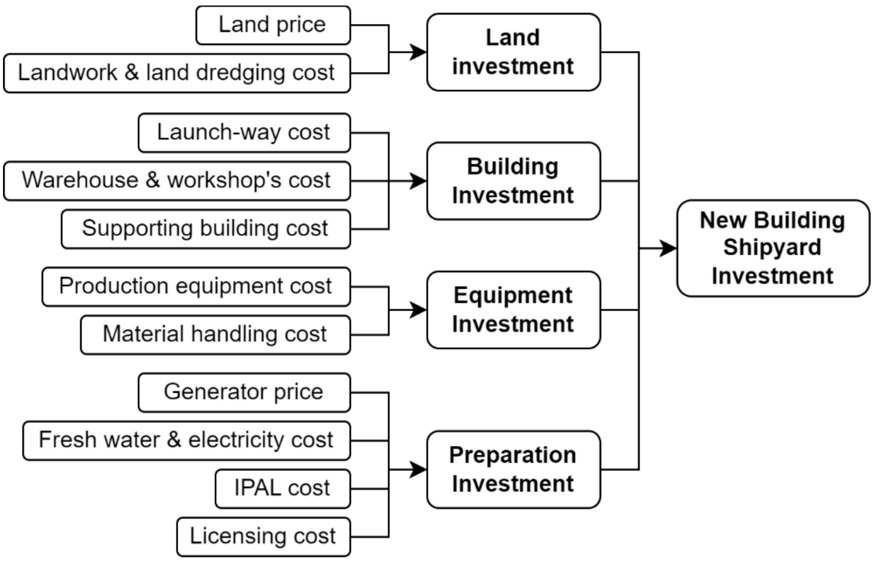

Figure 2. Component Forming Investment Cost.

These forming components need to be detailed more specifically so that it is known what sub-components are contained in each component. Here is a breakdown of the components that make up the investment cost of the new building shipyard. will be broken down into smaller components as follows:

1. Land investment can be broken down into land prices, land clearing, soil decomposition, soil compaction, and dredging in water.
2. Building investment can be broken down into launch facilities, storage warehouses, preparatory workshops, fabrication workshops, sub assembly workshops, assembly workshops, blasting and painting workshops, security posts, parking areas, offices, prayer rooms, toilets, and electrical rooms.

3. Equipment investment can be detailed into rack, straightening machine, shot blasting machine, CNC plasma cutting, flame planner, bending machine, SAW welding machine, FCAW welding machine, forklift, overhead crane, mobile crane, and transporter
4. Preparatory investments can be broken down into generators, clean water and electricity installations, IPAL, and licensing.

4.2 Relationship of Cost Effect Parameters with Cost-Forming Components of New Building Shipyards.

In Table 1, it can be seen the relationship between the parameters and components of the investment cost of the new building shipyard. The cost influence parameter is the condition that causes the large investment value of the forming component. This relationship needs to be known so the investment cost of each component of the new building shipyard can be estimated. Components that have no relationship with the influence parameter are assumed to be equally costly under each known condition of the application. This is because the size of the ship that will be used as a reference in intuition training does not have a significant size difference, which is 5000–9999 DWT. This component consists of supporting buildings, material handling prices, and preparation investment costs.

Table 1. Parameters Affecting Cost of the Components

Component	Parameters
Land Price	Location and Land Area
Landwork Cost	Rock Structures, Slope of the Area, and Land Area
Dredging Cost	Depth of Water, Size of Ship, and Land Area
Launchway Cost	Size of Ship and Type of Launch-way
Warehouse and Workshops Cost	Size of Ship
Supporting Building Cost	Assumed to be Same
Production Equipment Cost	Size of Ship
Material Handling Cost	Assumed to be Same
Generator Price	Assumed to be Same
Fresh Water and Electricity Installation Cost	Assumed to be Same
IPAL Cost	Assumed to be Same
Licensing Cost	Assumed to be Same

4.3 Estimated Investment Cost of a New Building Shipyard Based on Component needs

The next thing to do after knowing the relationship between the parameters that affect costs and the components that make up the investment costs of the new building shipyard is to start estimating the cost of each component according to known conditions or parameters [11]. Especially with the use of slipway launching facilities and airbag systems, a winch is needed to hold the ship when launching. Therefore, it is necessary to calculate the winch needs on each DWT ship. Table 2 shows the formula for estimating the investment cost of each component based on its needs.

Table 2. Component Investment Cost Estimation Formula

Component	Estimation Formula
Land Price	Land area x Land area cost

Landwork Cost	Land area x Landwork Cost
Dredging Cost	Dredging volume x Dredging Cost
Launchway Cost	Size or amount of the launchway x Launchway Cost
Warehouse and Workshops Cost	Building Area x Warehouse and Workshops Cost
Production Equipment Cost	Amount of machine x Production Equipment Cost

4.4 Implementation of Intuition Training in Estimating the Investment Cost of New Building Shipyards

The value or cost of investing in components that have been obtained in the estimation calculation will be used as a database in this intuition training application. Here is the flow of the intuition training method implemented into the investment cost estimation.

In Figure 3, you can see the flow of intuition training in the estimated investment cost that was applied to the application. In each training session, prospective estimators will be given an empirical graph related to the cost of the components being trained. Here is an empirical graph of each component obtained using the calculation of the estimation formula in Table 2.

Land & land-working cost component. In Figure 4a, you can see a pattern in the form of an empirical graph of the investment costs of the land price component in Indonesian Rupiah (Rp). This graph displays the investment cost of the land price component against the land area. The cost of the land price component is divided into three places, namely Lamongan, Gresik, and Batam. In Figure 4b, a pattern can be seen in the form of an empirical graph of the investment costs of the landwork component relative to the land area. This graph displays three types of earthwork costs, namely land clearing costs, soil compaction costs, and soil compaction costs.

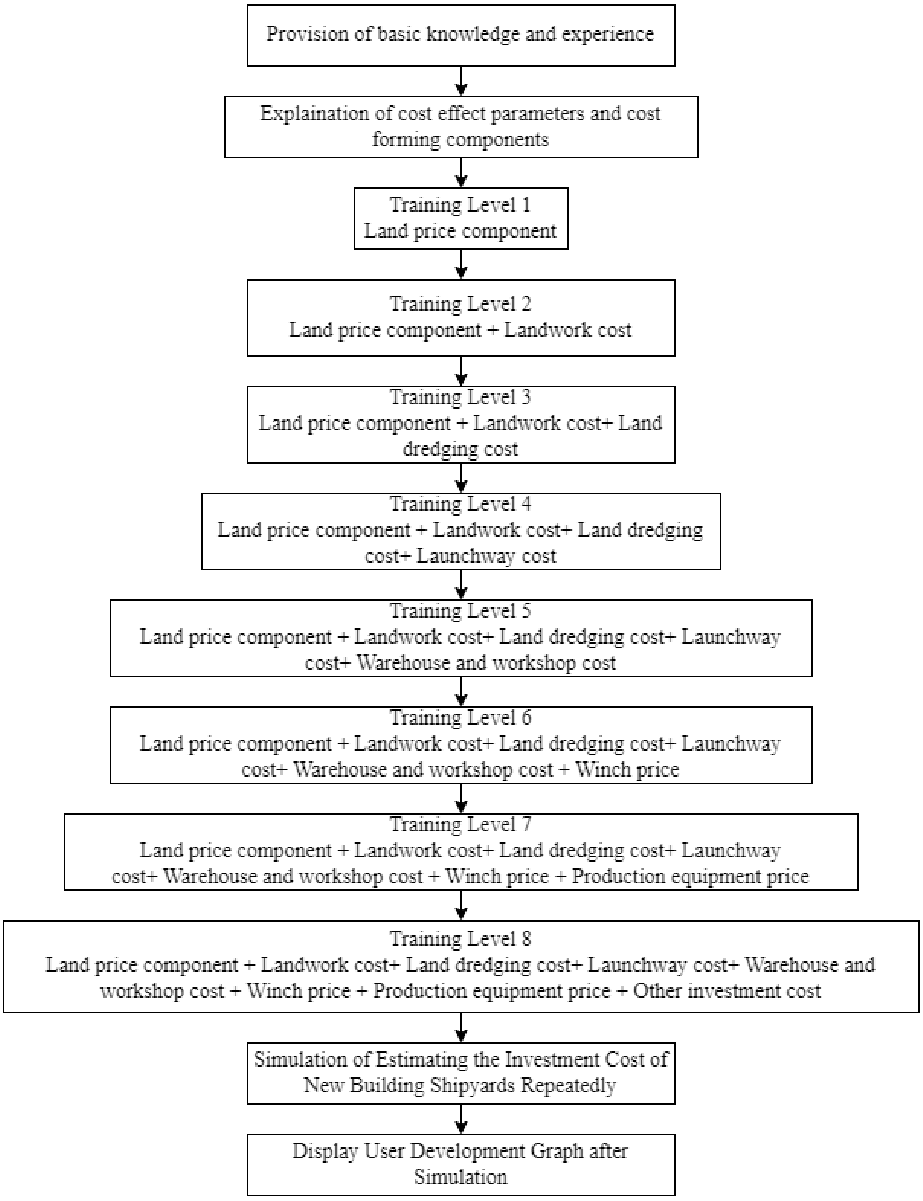

Figure 3. Training Flow

a b

Figure 4. Empirical Graph of Investment Cost of Land Price & Land-working Components

Land Dredging Cost & Cost of Launch Facilities. In Figure 5a, you can see one of the patterns in the form of an empirical graph of the investment cost of the soil dredging component with a ship size of 5000 DWT. The cost component of dredging land has three variables in estimating its cost: location, ship size, and land area. Therefore, the cost of this component cannot be displayed in a single graph. On the application, an empirical graph of the cost of the soil dredging components will be displayed based on the vessel sizes of 5000 DWT and 9999 DWT. In Figure 5b, you can see a pattern in the form of an empirical graph of the investment cost of one of the launching, namely the graving dock. In the application, the launch facilities that will be used are graving docks, slipways, and airbag systems.

a b

Figure 5. Empirical Graph of Investment Cost of Soil Dredging Components with Vessel Size 5000 DWT & Cost of Graving Dock Components

Cost of Building Warehouse and Workshops & cost of Winch. In Figure 6a, you can see a pattern in the form of an empirical graph of the investment costs of warehouse and workshop components. A warehouse is a temporary storage place for raw materials, while a workshop is a place to produce a ship. In Figure 6b, you can see a pattern in the form of an empirical graph of the investment cost of the winch price component. There are three winch capacities to be used in the application, namely 250 KN, 320 KN, and 400 KN.

a b

Figure 6. Empirical Graph of Investment Costs of Warehouse and Workshop Components & winch cost.

Production Equipment Price & Other Component Cost. In Figure 7, you can see a pattern in the form of an empirical graph of the investment costs of production equipment components. The specifics of the production equipment used are the same. Therefore, the variable that changes with each size of the ship is the amount of production equipment.

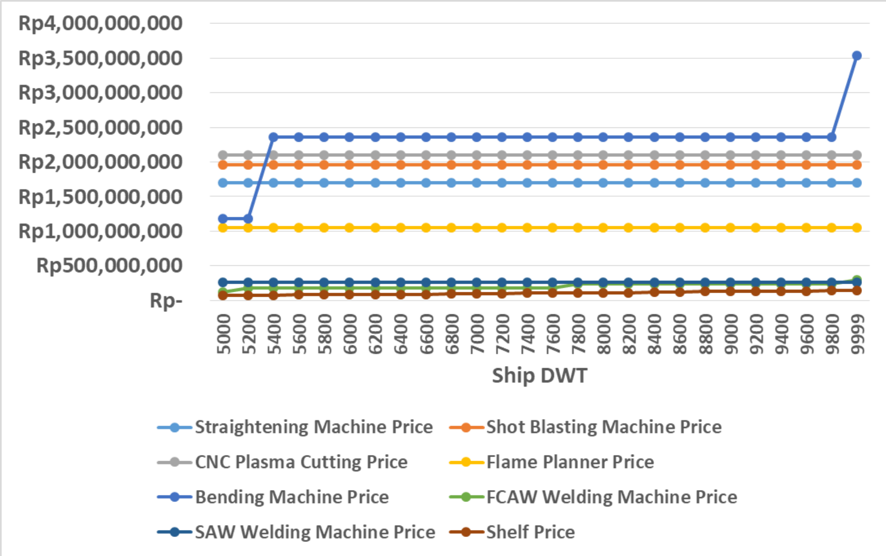

Figure 7. Empirical Graph of Investment Cost of Production Equipment Components

The investment cost of the other component is a component that has no relationship with the cost influence parameter. The investment cost of these components will be equal under each condition. A list of investment costs for other components can be seen in Table 3.

Table 3. Investment Costs of Other Components

Cost of Supporting Building (Rp)	
Security	200,000,000
Parking Area	800,00,000
Office	3,750,000,000
Prayer room	500,000,000
Toilet	75,000,000
Electricity Room	250,000,000
Cost of Material Handlings (Rp)	
Forklift	322,000,000
Overhead Crane 5 ton	435,000,000
Mobile Crane 25 ton	2,175,000,000
Mobile Crane 50 ton	3,088,500,000
Transporter	4,350,000,000
Cost of Preparatory Installation (Rp)	
Generator (100 KVA)	1,800,000,000
Generator (80 KVA)	650,000,000
Generator (60 KVA)	430,000,000
Clean Water and Electricity Installation	50,000,000
IPAL	40,000,000
Licensing	10,000,000

The implementation of this intuition training will be carried out in stages, as can be seen in Figure 3. Level one intuition training consists of the components of land price and the parameters that affect them; level two intuition training consists of components of land price and earthworking costs as well as parameters that affect both. And so on until the last level, level eight, which is intuition training in estimating the investment cost of components as a whole and each parameter that affects each component.

At this level of training, the first thing to train is to understand the situation. The situation that will be understood by the user is the relationship between the cost influence parameter and the cost-forming component. When understanding the situation, the user will enter input in the form of parameter values that affect the cost of the new component being trained. By entering inputs in the form of influential parameter values, users will understand what situations affect the investment size of each component.

After understanding the situation, the user will get a hint in the form of component investment costs. When the user enters input in the form of a parameter size, the cost of investing in the component will change depending on the value that has been entered. This is what will be the clues that users will get when they are doing training. After getting the clues, the user can figure out the pattern based on the clues that have been obtained. The pattern here is a graph of the cost of components for each condition.

The final session of this intuition training per level is an evaluation of the user's understanding by answering the questions to be given. Users must answer all questions correctly before proceeding to the next training. After the per-level intuition training is completed, users will be faced with a simulation session of estimating the investment cost of the new building shipyard. This simulation is repeated with different conditions in order for the user's intuitive skills to appear.As already explained, it takes knowledge and experience to develop intuition. The more knowledge and experience a person has, the more intelligent he will be in making decisions related to what he is familiar with. After each evaluation, the user will receive feedback in the form of errors he made.From this feedback, intuitive proficiency will emerge in the user regarding the estimated investment cost of the new building shipyard.

4.5 Application Design

Based on the implementation of intuition training in the investment estimates of new building shipyards that have been delivered, the flow of intuition training per level can be seen in Figure 3. Before conducting the training, users will be provided with basic knowledge and engineering experience. Basic knowledge in the form of component introduction and experience engineering in the form of example estimation case studies. After doing the simulation, there is a score graph for users to see their progress. Here is the arrangement of the application interface.

1. *Interface* 1. Interface 1 in this application displays the "login" feature. Every user who wants to run the application must first create an account by registering on this interface
2. *Interface* 2. After the user registers and enters the application, the user will be faced with Interface 2, which displays the operational systematics of the application in the form of functions, objectives, application limitations, and application operational methods.
3. *Interface* 3. The basic knowledge that will be presented to users is the component that forms the investment cost of a new building shipyard as a form of representation of user understanding related to the components that make up the investment cost of a new building shipyard. In addition to the introduction of components, interface 3 also provides a case study of the estimated investment cost of the new building shipyard, which can be seen in Table 4 as a material in the creation of an engineering experience for the user.

Table 4. Example of Case Study Estimation

Parameter	Value
Shipyard Location	Socah Village, Bangkalan City, Madura, Indonesia
Size of Land	160 x 110 m^2
Depth of Water	5 m
Land Price	Rp 600,000/m^2
Ship Size (Tanker Ship 6400 DWT)	
Length (L)	98.45 m
Breadth (B)	17.09 m
Height (H)	8.76 m
Actual Draft (Tactual)	6.24 m
Ship Steel Weight (Wst)	1755.96 Ton

4. *Interface 4.* Interface 4 is an introduction to the pattern of relationship between cost-building parameters (known conditions) and cost-forming components. By knowing the relationship between the two, it will be easier for users to estimate the investment cost of a new building shipyard in a simulation session based on the clues and patterns obtained.
5. *Interface 5*. Interface 5 is the initial stage of the user conducting intuition training. In this interface, users will be faced with level 1 intuition training, namely intuition training in estimating the cost of the land price component. First, the application will display the limitations on training to make it clear what components will be trained in this application. Furthermore, there are parameters in the form of location and land area that must be filled in by the user after understanding the situation. After the user inputs the value of the parameter, the cost of investing in the land price will appear based on the value of the parameter that has been input. This will be a clue to the user about what parameters affect the price of land. After that, users will get a pattern in the form of a graph of land prices based on each condition. Finally, users will be faced with an evaluation to answer the questions already provided. The user's answer must be all correct if you want to continue to the next level of training.

Table 5. Intuition Training Level 1

Parameter	Value
Location	Batam
Land Area	45000 m^2
Component	
Land Price	Rp 54,000,000,000
Total Investment	Rp 54,000,000,000

As shown in Table 5, the user will input the parameters for location and land area and will receive an output in the form of component investment costs that are affected by these parameters. From here, the user will analyze the relationship between the cost influence parameter and the cost-forming component.

6. *Interface 6.* Interface 6 is an intuition training in estimating the cost of land price components and earthwork costs. The inputted parameters will increase according to the addition of

components. In this interface, the parameters to be added are the rock structure and the slope of the soil. By entering the value of this parameter, the components of the cost of soil work in the form of land clearing costs, soil management costs, and soil compaction costs will change based on the inputted values. After that, a graph of the cost of earthwork is shown, and then there will be an evaluation.

7. *Interface 7.* Interface 7 is an intuition training in estimating the cost of the land price component, the cost of earthworks, and the cost of dredging the land. The inputted parameters will increase according to the addition of components. In this interface, the parameters to be added are the DWT of the ship and the depth of the waters. By entering the value of this parameter, the cost component of dredging the soil will change based on the inputted value. After that, a graph of the cost of dredging the land is shown, and then there will be an evaluation.
8. *Interface 8.* Interface 8 is an intuition training program for estimating the cost of land investment and launch facilities. By entering the value of the ship's DWT parameter and the type of launch means, the cost component of the launch means will change based on the inputted value. After that, a graph of the cost of the means of launch is shown, and then there will be an evaluation.
9. *Interface 9.* Interface 9 is an intuition training in estimating the cost of land investment, the cost of launching facilities, and the cost of building warehouses and workshops. By entering the value of the ship's DWT parameters, the cost component of building warehouses and workshops will change based on the inputted values. After that, a graph of the cost of building warehouses and workshops is shown, and then there will be an evaluation.
10. *Interface 10.* Interface 10 is an intuition training in estimating the cost of land investment, building investment, and winch. By entering the value of the ship's DWT parameters, the cost component of the winch needs will change based on the inputted value. After that, a graph of the cost of winch needs is shown, then there will be an evaluation.
11. *Interface 11*. Interface 11 is a training in intuition for estimating the cost of investing in land, building investments, winches, and manufacturing equipment. By entering the value of the ship's DWT parameter, the cost component of the production equipment will change based on the inputted value. After that, a graph of the cost of production equipment is shown, and then there will be an evaluation.
12. *Interface 12.* Interface 12 is an intuition training in estimating the total cost of investing in a new building shipyard. In this interface, other components will be added that have no relationship with parameters, so that the investment cost of these components will be equal in each condition. After that, there will be an evaluation.
13. *Interface 13.* Interface 13 user proficiency evaluation page after gaining knowledge about the estimated cost of investing in a new building shipyard. In this interface, a simulation will be carried out to estimate the investment cost of the new building shipyard based on the clues and patterns that have been obtained by the user. Every time they make one evaluation, users will be given feedback as a consideration for doing the next simulation. This simulation is carried out at least three times until the user feels that he has been trained in his intuitive skills in estimating the investment cost of the new building shipyard. A simulation of the

estimate can be seen in Table 6. Prospective estimators are required to fill in the empty answer fields so that the value of each simulation can be known.

Table 6. Investment Cost Estimation Simulation

Parameter	Value
Location	Lamongan
Depth of Water	2.5 m
Land Area	235 x 100 m^2
Ship DWT	5800 DWT
Length (L)	95.54 m
Breadth (B)	16.62 m
Height (H)	8.35 m
Actual Draft (Tactual)	6.03 m
Ship Steel Weight (Wst)	1580.94 ton
Launchway	Graving Dock

14. *Interface 14.* Interface 14 is the last page of this web-based application program. This interface displays a diagram of the development of user proficiency in estimating the investment costs of a new building shipyard. The progress graph will show the score obtained by the user after performing an estimated simulation. The purpose of this graph is to provide a result of evaluation that can be used as a representation of the development or progress of the user.

4.6 Application Validation Test

In this sub-chapter, we will discuss the validation of systems that have been made with manual calculations using Excel. The calculated data in Excel calculations uses the same system flow as the program or application flow that is built and is based on the calculation reference as calculated in the previous chapters. The value to be validated is the value of the investment cost of the new building shipyard for each component.

5. Analysis and discussion

5.1 Application Implementation Environment

The implementation environment is a specific area or condition where this training application can be operated. The result of this design is a web-based application using a MySQL database.

5.2 Application Verification Test

The prototype verification test of this application will use one of the parametric statistical tests, namely the "t" test. The t-test is used in testing to determine whether there is a significant difference between the two variables to be compared. The t test that will be used to test this application is the paired sample t test, which is a test that involves two measurements of the same subject against a certain influence. These two variables are the pre test given to the user before training using the application and the post test given to the user after training using the application. Table 7 is a recapitulation of respondents' values when filling out the pre-test and post test.

Table 7. Recapitulation of Respondent's Grade

Respondent	*Pre Test*	*Post Test*	d (Post – Pre)	d2
Respondent 1	0	6	6	36
Respondent 2	0	4	4	16
Respondent 3	2	7	5	25
Respondent 4	0	4	4	16
Respondent 5	0	6	6	36
Respondent 6	1	5	4	16
Respondent 7	0	6	6	36
Respondent 8	0	5	5	25
Respondent 9	1	7	6	36
Respondent 10	0	5	5	25

The formula used in this statistical test is:

$$t = \frac{\sum d}{\sqrt{\frac{N\sum d^2 - \left(\sum d\right)^2}{N-1}}}$$

The result obtained after testing is that the calculated t value is greater than the statistical table value t with a critical range of 5%, which is 11.53 > 2.262. This proves that this application can increase users' intuitive skills in estimating the investment costs of new building shipyards.

6. Conclusion

The following results were obtained after conducting experiments and analysis in this study:

1. A parametric method is the proper estimation method as a representation of performing an investment cost estimation of a new building intuitively. The parametric method is a method that estimates the cost of investment components of new building shipyards by considering parameters that affect the cost of these components.
2. The method of building the right intuition pattern to be implemented into the decision-making process of the investment cost estimation of the new building shipyard is the triggered decision-making (KDP) method. This KDP method consists of 4 sessions, namely situations, hints, patterns, and action scenarios. These four sessions will be conducted repeatedly so that intuitive skills can be obtained.
3. By dividing the application into two stages, it is possible to design an application program that can provide intuition training in estimating the investment costs of a new building shipyard. First, intuition training will be provided to users for estimating the cost of the components that make up the investment cost of a new building shipyard by considering the parameters of the cost effect. Second, after the user can estimate the cost of each component, a simulation of the total cost of investing in a new building shipyard is held on a recurring basis. Every time you finish estimating one condition, feedback is given so that you can find out the estimate of components that are not right

4. The prototype application created can train intuitive skills in estimating the investment costs of new building for small tankers of sizes 5000–9,999 DWT, among other limitations. This is based on the results of the verification test shown by taking response data from 10 respondents and using the "Two-Mean Difference Test" or "Paired T-Test (Pre-Post)" method, which produces a number of "t" and "t table" values of 11.53 > 2,262.

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