Modularization with Rule Based Algorithm in Three-Dimensional Design of Engine Room Layout Harbour Tug Diesel – LNG Dual Fuel Engine 2 X 2500 HP

Aguk Zuhdi Muhammad Fathallah*, Laurensius Abhisa Valasranggi Prasojo, Semin

Department of Marine Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

fathalaz@its.ac.id

Abstract. Implementation of the dual-fuel engine as ship main propulsion in Indonesia is low. There is a need for a study about the ship design process for dual fuel engine ship, especially for the engine room. Process and instrumentation diagram can't give a whole picture of the real engine room, but three-dimensional can provide this. First, this study is to know about the process and instrumentation diagram on harbour tug diesel-LNG dual fuel engine 2 x 2500 HP. Second, this study is to know about the original, clustered, and reordered design structure matrix of all piping components. Third, this study is to know about three-dimensional design using modularization with rule-based algorithm. Components from the bilge & ballast system, oily water separator system, firefighting system, domestic supply and discharge system, marine diesel fuel oil system, LNG fuel oil system, lubricating oil system, cooling system, and compressed air system are inserted in original DSM. The rule-based algorithm is for clustering and reordering. At the end of the original, clustered, and reordered DSM there is a need for the objective function and sum value calculation. In this study, DSM modeler is used to do the clustering and reordering process included in one by clicked clustering algorithm feature. So, in this study is decided that reordering process is done manually using the workflow of the system to ensure that clustering algorithm feature can give clustered and reordered DSM, by compared the objective function and sum value from the original, clustered, and reordered DSM. The result of the objective function and sum value comparison always give less value than the original and clustered DSM. Clustered and reordered DSM had the same value. Sometimes the objective function and sum value of reordered DSM is greater than clustered DSM, which means there is human error when manually reordering the clustered DSM. Less value of the objective function and sum value DSM is used to create three-dimensional. Components that are included in one cluster need to be located nearly. Modularization with rule-based algorithm is applicable in three-dimensional design engine room layout.

1. Introduction

Ship emission cause large damage to global environment. Studies revealed that shipping-related particulate matter emissions are responsible for 3%-8% of global particulate matter-related mortalities. Compressed natural gas is considered to be an environmentally clean alternative to those fuels [1]. The International Maritime Organization (IMO) Marine Environment Protection Committee adopted amendments of the International Convention for the Prevention of Pollution from Ships (MARPOL)
Annex VI regulated on sulphur oxide requiring a maximum 0.5% by 1 January 2020 globally [2]. Liquefied Natural Gas (LNG) was developing as alternative marine fuel to comply with MARPOL Annex VI [3]. This dual fuel engine can be completely switched to conventional diesel fuel operation without compromising the power output [4]. In an effort to develop relatively clean and efficient fuels, the application of engines that use gas fuel for power production in dual fuel engine is applied [5].

Gaseous fuel injection is carried out during the intake stroke resulting in a decrease in the temperature mixture with the air [6]. The dual fuel type engine that uses LNG as one of the fuels has a fuel system design that is made specifically so that the performance and efficiency of the engine meet the specifications that have been tested [7]. In dual fuel engines that operate using natural gas as the main fuel, the gaseous fuel is injected together with the intake air and compressed as in a conventional diesel engine [8]. The air and fuel gas mixture does not ignite automatically because natural gas requires a lighter to ignite. A small amount of diesel oil is injected near the end of the compression stroke using pilot injection to ignite the gas mixture [9]. The advantages of dual fuel engines are reduced NOx and particulate matter emissions as well as reduced fuel costs due to the much lower cost of natural gas compared to diesel oil [10]. The increase in thermal efficiency is directly proportional to the increase in load and maintenance costs that do not increase more because most of the engine parts have not changed [11]. A large amount of diesel fuel is replaced by natural gas up to 70%, so carbonization is also decreased, this will result in reduced overhaul and decarbonization in dual fuel engines [12]. Diesel mode and gas mode transitions on dual fuel engines can be performed when there is no engine fault. If natural gas is not available, the gas mode will be switched to diesel mode without interfering with the power generated [13].

Dual fuel engine is the key to provide high fuel economy, reliable, high-power output and more environmentally friendly [4]. In recent years, the use of LNG has grown with the application of dual fuel engines to various types of ships [14]. Since its first discovery by Wärtsilä in 1995, the dual-fuel engine is now seen as a reliable technology for use on various ships, such as use on harbor tugs [15]. The use of LNG as a fuel can reduce NOx, SOx, and also CO2 significantly [16]. LNG is the best alternative fuel compared to other ship fuels because of the proportional cost, following the development of current engine types, and the availability of LNG sources. LNG as a whole has almost no drawbacks, but LNG is non-renewable compared to hydrogen. The use of LNG as fuel in tugboats utilizes a fuel transfer system with pressure build up [15-17]. Ship must comply with MARPOL Annex VI especially harbor tug because there are people live near the port. In Indonesia the implementation of dual fuel engine as ship main propulsion still low. PT. Dok Warisan Pertama (PaxOcean) have built Transko Rajawali as the first built and operated dual fuel engine harbor tug in Indonesia owned by Pertamina Trans Kontinental [18].

To increase the implementation of dual fuel engine as Indonesia’s ship main engine, there is need a study about the ship design of dual fuel engine ship. Shipbuilding industry currently operating in a state of intense market competition in regional or international. Production methods are continuously being improved in a bid to achieve greater value of design efficiency [19].

Ship design Process and Instrumentation Diagram (P&ID) of the piping system only shows the equipment’s of the system and the flow direction of the process. P&ID can’t use as a reference for fabrication process. Engine room become the most complex room in ship because almost equipment and pipe located here. The system function of the engine room, it is possible to express by superimposing various system diagrams build a new integrated model and then modify [20]. Because software is embedded in many of today’s complex products, and it is prone to relatively rapid change, it is instructive to study software architecture evolution for general insights into product design [21]. This study using modularization concept method to reduce the complexity of piping design in the engine room [20]. To define an effective module that can be commonly used for various type of ship, the design structure matrix with rule-based algorithm method was adopted [21-23]. Design structure matrix with rule-based algorithm method used as base information to create three-dimensional engine room layout design. Three-dimensional engine room layout design used to preliminary review the ship building fabrication process.
2. Methods
The methodology was used in this research is began with collecting data. The data that already collected such as ship lines plan, ship general arrangement, and ship main engine project guide. Ship lines plan was used in the three-dimensional modelling for harbour tug hull. Ship general arrangement and ship main engine project guide contain so much information for calculate and create process and instrumentation diagram of the ship piping system step. Second step is calculated and created process and instrumentation diagram of the ship piping system, ship piping system is referred to bilge system, ballast system, oily water separator system, firefighting system, fuel oil system, lubricating system, cooling system, and compressed air system. In this paper author only discussed oily water separator system. Calculated and created instrumentation diagram of the oily water separator produced several components, this component used in the third step. Third step is modularization with rule based algorithm using DSM for ship piping system. In this study will used architecture DSM, the elements are referred to as product components and interactions will be the interface between components. Each of the DSM system modelling will need five steps. The first step is decomposing, breaking the system down based on its several hierarchical levels elements. The second one, is identifying the system, finding the connection among the system’s elements. The third one is to do the clustering algorithm in DSM modeler. The fourth one is to calculate the sum and objective function value from the clustered DSM. The fifth one is reordering the clustered DSM, which is analysing, rearrange the elements and connection to figure the structural patterns and their implications for systems behaviour. The sixth is calculate the sum and objective value form the reordered DSM, the value of sum and objective function must less than this step, less value of sum and objective function shows that DSM already in the best configuration. Fourth step is three-dimensional design engine room layout. Phase where the placement and arrangement of all components of the ballast system, bilge system, oily water separator system, firefighting system, domestic system, fuel oil system, lubrication oil system, cooling system and compressed air system in the engine room harbor tug. This process reviews the area of the engine room harbour tug and the dimensions of each component.

![Flowchart Diagram](image-url)
3. Result and Discussion

3.1. Harbour Tug 2 x 2500 HP Machinery System Calculation
The machinery system on the Harbour Tug 2x2500 HP that must be calculated includes ballast, bilge, oily water separator, firefighting, domestic, fuel oil, lubrication oil, cooling, and compressed air system. Calculation is carried out to obtain the components that fit for the system. The calculated system components include tank volume, pump capacity, pipe diameter, etc. So that the selection of component types can be adjusted based on the results of the calculations that have been carried out. In this paper will discussed only one example of ship piping system, the example is oily water separator system.

3.1.1. Harbour Tug Dual Fuel Engine Principal Dimension
Harbour tug dual fuel engine has principal dimension shown in Table 1.
### Table 1. Principal Dimension

| Parameter               | Value | Unit  |
|-------------------------|-------|-------|
| Length O. A             | 34.00 | meter |
| Length W. L             | 32.80 | meter |
| Beam MLD                | 11.30 | meter |
| Depth MLD               | 5.25  | meter |
| Draft MAX               | 4.20  | meter |
| Draft MAX (SKEG)        | 5.26  | meter |
| Complement              | 10    | men   |
| Bollard Pull            | 60    | MT    |
| Gross Tonnage           | <500  | GT    |
| LNG Tank                | Approx. 20 | m³ |

### 3.1.2. Calculation of Bilge Well

Volume bilge well is not less than 0.15 m³, so planning bilge well dimension is shown in Table 2.

| Parameter           | Value | Unit |
|---------------------|-------|------|
| Length              | 1     | meter|
| Width               | 0.5   | meter|
| Height              | 1     | meter|
| Volume              | 0.5   | m³   |
| Amount of Bilge Well| 3     | unit |
| Total volume of Bilge Well | 1.5 | m³ |

### 3.1.3. Calculation of Sludge Tank Volume

Sludge tank main function is to collect the oil from separator, if the harbour tug is berthing at port the sludge will pump out through international shore connection. According to ANNEX I MARPOL 73/78-chapter II Regulation 17, capacity of sludge tank can be calculated with equation below:

\[ V = K_1 \times C \times D \] (1)

where \( V \) is volume of sludge tank; \( K_1 \) is constant, 0.015 for the ship which use HFO and purifier, 0.005 for the ship which use MDO or HFO without purifier; \( C \) is consumption of fuel oil in one day; \( D \) is range trip port to port. Because of this harbour tug is designed not to travel port to port, the value of \( D \) will replace with the value of harbour tug endurance at 5 days. Harbour tug using marine diesel oil (MDO) and liquefied natural gas (LNG), but for this calculation will assumed that this harbour tug only uses MDO in the amount of 10.58 m³/day for two engines. So, the volume of the sludge tank is:

\[ V = K_1 \times C \times D \]

\[ V = 0.005 \times 10.58 \times 5 \]

\[ = 0.2645 \text{ m}^3 \]

So, the volume of sludge tank is 0.2645 m³

### 3.1.4. Calculation of Bilge Holding Tank Volume

The mixture of oil and water that accumulated in harbour tug compartments should pump and store at bilge holding tank before separating process. Based on MEPC 1/Circular 642 about revision of system for handling oily waste in machinery space (IMO, 2008). So, the volume of bilge holding tank is:

\[ V_{bht} = P/250 \] (2)
Where \( V_{bh} \) is volume of bilge holding tank; \( P \) is engine power.

\[
V_{bh} = \frac{P}{250}
\]

\[
V_{bh} = \frac{3728.499}{250} = 14.92 \text{ m}^3
\]

Bilge holding tank will be designed on frame 35 until frame 43 in the center of the ship at the engine room below the main engine. The actual volume of bilge holding tank calculation using Simpson method is shown in Table 3.

**Table 3. Bilge Holding Tank Volume Calculation using Simpson Method**

| \( H \) | \( A (m^2) \) | \( FS \) | \( A \times FS \) |
|---|---|---|---|
| 17 | 2.37 | 1 | 2.37 |
| 17.5 | 2.40 | 4 | 9.60 |
| 18 | 2.41 | 2 | 4.83 |
| 18.5 | 2.42 | 4 | 9.66 |
| 19 | 2.40 | 2 | 4.81 |
| 19.5 | 2.38 | 4 | 9.53 |
| 20 | 2.37 | 2 | 4.74 |
| 20.5 | 2.34 | 4 | 9.37 |
| 21 | 2.29 | 1 | 2.29 |

\[
\sum A \times FS = 54.83
\]

\[
h = 0.5
\]

\[
V_{\text{simpson}} = \frac{1}{3} \times h \times (\sum A \times FS)
\]

\[
V_{\text{simpson}} = \frac{1}{3} \times 0.5 \times 54.83
\]

\[
V_{\text{simpson}} = 9.13 \text{ m}^3
\]

\[
V_{\text{total \ Bilge \ Holding \ Tank}} = V_{\text{simpson}} \times 2
\]

\[
V_{\text{total \ Bilge \ Holding \ Tank}} = 18.28 \text{ m}^3
\]

So, the total volume of bilge holding tank is 18.28 m³.

### 3.1.5. Calculation of Oily Water Separator Pump Capacity

The mixture of oil and water in oily water bilge holding tank must be separated first before the water is discharged through overboard. The oily water bilge holding tank design to be empty at 6 hours. So, the value of oily water bilge separator pump capacity is:

\[
Q = \frac{V}{t}
\]

(3)

Where \( Q \) is oily water bilge separator pump capacity; \( V \) is volume of oily water bilge holding tank; \( t \) is time design to empty the oily water bilge holding tank.

\[
Q = \frac{18.28}{6} = 3.0467 \text{ m}^3/hr
\]

So, the capacity of Oily Water Separator Pump is 3.0467 m³/hr

### 3.1.6. Calculation of Oily Water Separator Main Pipe Diameter

Calculation of main oily water separator pipe diameter, using this formula below:
\[ Q = A \times V \]  

(4)

Where \( Q \) is capacity; \( A \) is cross sectional area of pipe; \( V \) is seawater velocity.

\[
\begin{align*}
A &= \frac{Q}{V} \\
A &= \frac{0.0008462}{2} = 0.000423 \text{ m}^2 \\
A &= \frac{1}{4} \times \pi \times D^2 \\
D &= \sqrt{\frac{4 \times 0.000423}{\pi}} = 0.023 \text{ m}
\end{align*}
\]

So, the inside diameter needed for Oily Waters Separator main pipe is 23 mm. For oily water separator pipe using carbon steel galvanized pipe based on Japanese Industrial Standard (JIS), with following specification as shown in Table 4.

**Table 4. Oily Water Separator Pipe Specification [24]**

| Type            | JIS G3452 |
|-----------------|-----------|
| Nominal Size    | 25 A      |
| Outside Diameter| 34 mm     |
| Thickness       | 3.2 mm    |
| Inside Diameter | 27.6 mm   |

### 3.1.7. Oily Water Separator Specification

Based on the calculation of oily water separator capacity, the oily water separator selected specification is shown in Table 5.

**Table 5. Oily Water Separator Specification [25]**

| Brand                  | Sili Oily Water Separator |
|------------------------|---------------------------|
| Model                  | YSZ-4                     |
| Treatment Capacity     | 4 m³/h                    |
| Discharge Standard     | \( \leq 15 \text{ ppm} \) |
| Working Standard       | \( \leq 0.3 \text{ Mpa} \) |
| Type                   | DZ-4000                   |
| Flow Rate              | 4 m³/h                    |
| Pressure               | 0.3 Mpa                   |
| Inhaling Height        | 6 m                       |
| Motor Power            | 1.5 kW                    |
| Electric Heating Power | 3 Phase / 380 / 50 Hz     |
| Control Mode           | Automatic                 |
| Oil Discharge Mode     | Automatic/Manual          |
3.1.8. Calculation of Sludge Pump Capacity
Calculation of sludge pump capacity, using formula below:

\[ Q_{sp} = \frac{V_{st}}{t} \]  

(5)

where \( Q_{sp} \) is capacity of sludge pump; \( V_{st} \) is volume of sludge tank; \( t \) is time to empty the sludge tank.

\[ Q_{st} = \frac{0.54}{0.25} = 2.16 \text{ m}^3/\text{h} \]

So, the capacity of sludge pump capacity is 2.16 m³/h.

3.1.9. Calculation of Sludge Transfer System Pipe Diameter
Calculation of sludge transfer system pipe diameter, using this formula below:

\[ Q_{sp} = A \times V \]  

(6)

where \( Q_{sp} \) is capacity of sludge pump; \( V_{st} \) is seawater velocity; \( t \) is cross sectional area of pipe.

\[ A = \frac{Q}{V} \]

\[ A = \frac{0.0006}{2} = 0.0003 \text{ m}^2 \]

\[ A = \frac{1}{4} \times \pi \times D^2 \]

\[ D = \sqrt{\frac{4 \times 0.0003}{\pi}} = 0.0195 \text{ m} \]

So, the inside diameter needed for sludge transfer system pipe is 19.5 mm. For sludge transfer system using carbon steel galvanized pipe based on Japanese Industrial Standard (JIS), with following specification as shown in Table 6.

| Table 6. Sludge Transfer Pipe Diameter [24] |
|---------------------------------------------|
| Type            | JIS G3452 |
| Nominal Size    | 25 A      |
| Outside Diameter| 34 mm     |
| Thickness       | 3.2 mm    |
| Inside Diameter | 27.6 mm   |

3.1.10. Sludge Transfer Pump Selection
Based on the calculation of sludge pump capacity, the sludge pump selected specification is shown in Table 7.
3.1.11. Oily Water Separator Process and Instrumentation Diagram
Process and instrumentation diagram (P&ID) will show work flow process and component that used in oily water separator system Figure 2. is the P&ID of oily water separator system in harbour tug diesel-LNG dual fuel engine 2 x 2500 HP.

![Oily Water Separator P&ID](image)

**Figure 2. Oily Water Separator P&ID**

3.2. Modularization With Rule Based Algorithm for Ship Piping
The P&ID machinery system on the Harbour Tug 2x2500 HP used as base information to create original, clustered, and reordered DSM. From the P&ID oily water separator obtained list of equipment. List of equipment inserted to original DSM is shown in Table 8.

### Table 7. Sludge Transfer Pump Specification [26]

| Brand  | Iron Pump |
|--------|-----------|
| Model  | ON-1 (Vertical) |
| Capacity | 2.5 m³/h |
| RPM    | 1150 RPM |
| Head   | 30 m     |
| Frequency | 50 Hz     |
| Motor Power | 0.7 HP |
Table 8. Oily Water Separator Original DSM

| OWS ORIGINAL DSM      | BILGE HOLDING TANK (1) | OILY WATER SEPARATOR (2) | OVERBOARD (3) | SLUDGE TANK (4) | SLUDGE TRANSFER PUMP (5) | ISC FOR SLUDGE DISCHARGE (6) |
|-----------------------|------------------------|--------------------------|---------------|----------------|--------------------------|-------------------------------|
| BILGE HOLDING TANK (1)| X                      |                          |               |                |                          |                               |
| OILY WATER SEPARATOR (2)|                      | X                        | X             |                |                          |                               |
| OVERBOARD (3)         |                        |                          |               |                |                          |                               |
| SLUDGE TANK (4)       |                        |                          |               |                |                          |                               |
| SLUDGE TRANSFER PUMP (5)|                     |                          |               |                |                          |                               |
| ISC FOR SLUDGE DISCHARGE (6)|       |                          |               |                |                          |                               |

Calculation of sum and objective function value formula of oily water separator system original DSM is shown below:

\[
\text{SUM} = \sum_{i=1}^{M} n - 1
\]

(7)

Where \( n \) is the number each element in the original DSM.

\[
\text{SUM} = 20
\]

\[
\text{Obj} = a \sum_{i=1}^{M} c^2 + bl
\]

(8)

Where \( a \) is number of columns/rows, \( c \) is the cluster size, \( b \) is the number of cells, and \( l \) is the amount of outside cluster.

\[
\text{Obj} = 180
\]

After inserted list of equipment in original DSM, the original DSM is applied with clustering algorithm in DSM modeler application. Oily Water Separator clustered DSM is shown in Table 9.

| OWS CLUSTERED DSM      | OVERBOARD (3) | ISC FOR SLUDGE DISCHARGE (6) | Cluster 1 | Cluster 2 |
|------------------------|---------------|-----------------------------|-----------|-----------|
|                        |               | BILGE HOLDING TANK (1)      | OILY WATER SEPARATOR (2) | SLUDGE TANK (4) | SLUDGE TRANSFER PUMP (5) |
| OVERBOARD (3)          |               | X                           | X         | X         |                          |
| ISC FOR SLUDGE DISCHARGE (6) |       |                              |           |           |                          |
| Cluster 1              |               | BILGE HOLDING TANK (1)      | X         | X         |                          |
| Clusters               |               | OILY WATER SEPARATOR (2)    | X         | X         |                          |
| Cluster 2              |               | SLUDGE TANK (4)             | X         | X         |                          |
|                        |               | SLUDGE TRANSFER PUMP (5)    | X         | X         |                          |

Table 9. Oily Water Separator Clustered DSM

Calculation of sum and objective function value formula of oily water separator system clustered DSM is shown below:

\[
\text{SUM} = \sum_{n=1}^{M} n - 1
\]

(9)
Where $n$ is the number each element in the clustered DSM.

\[
\text{SUM cluster } 1 = 2 \\
\text{SUM cluster } 2 = 8 \\
\text{Obj} = a \sum_{i=1}^{M} c^2 + bl
\]  

(10)

Where $a$ is number of columns/rows, $c$ is the cluster size, $b$ is the number of cells, and $l$ is the amount of outside cluster.

\[\text{Obj} = 120\]

Next step is reordering the oily water separator clustered DSM. Original oily water separator reordered DSM is shown in Table 10.

**Table 10. Oily Water Separator Reordered DSM**

| Cluster 1 | Cluster 2 | ISC FOR SLUDGE DISCHARGE (6) |
|-----------|-----------|-------------------------------|
| OWS REORDERED DSM | BILGE HOLDING TANK (1) | OVERBOARD (3) | SLUDGE TANK (4) | SLUDGE TRANSFER PUMP (5) | |
| Cluster 1 | OVERBOARD (3) | X | | |
| Cluster 2 | SLUDGE TANK (4) | X | | |
| | SLUDGE TRANSFER PUMP (5) | X | | |

Calculation of sum and objective function value formula of oily water separator system reordered DSM is shown below:

\[
\text{SUM} = \sum_{n=1}^{M} n - 1
\]  

(11)

Where $n$ is the number each element in the reordered DSM.

\[
\text{SUM cluster } 1 = 2 \\
\text{SUM cluster } 2 = 8 \\
\text{Obj} = a \sum_{i=1}^{M} c^2 + bl
\]  

(12)

Where $a$ is number of columns/rows, $c$ is the cluster size, $b$ is the number of cells, and $l$ is the amount of outside cluster.

\[\text{Obj} = 120\]
Table 11. shown below is the summary of sum and objective function value of oil water separator original, clustered, and reordered DSM.

Table 11. Oily Water Separator System Sum and Objective Function Value Summary

|                     | Sum value | Objective function value |
|---------------------|-----------|--------------------------|
| Original DSM        | 20        | 180                      |
| Clustered DSM       | 2         | 120                      |
| Reordered DSM       | 2         | 120                      |

Clustered and reordered DSM have the same value of sum and objective calculation, but both value is smaller than the original DSM. It means that is efficient and effective clustering component and better module configuration than original DSM. Theoretically after the reordering process the sum value of oily water separator system reordered DSM is less than the oily water separator system clustered DSM. Authors find out that in this DSM modeler, when oily water separator system original DSM is applied by clustering algorithm feature the result is already clustered and reordered. So, author decided to do manual reordering process to make sure that reordered DSM can give real work flow of oily water separator system.

3.3. Three-Dimensional Engine Room Layout

Reordered DSM that already create and proven that sum and objective function value is less than original DSM is used as basis at three-dimensional design engine room layout. Three-dimensional engine room layout in Figure 3. is contain components of all ship piping system.

Figure 3. Isometric View of Three-Dimensional Engine Room Layout
In Figure 4, there is top view of engine room layout. From reordered DSM cluster 1 contains bilge holding tank and oily water separator. Cluster 2 contains sludge tank and sludge transfer pump.

Figure 4. Top View of Three-Dimensional Engine Room Layout

A is oily water separator, B is bilge holding tank located under the engine room floor. C is sludge transfer pump, and D is sludge tank.

4. Conclusion
Based on the results of calculation, analysis, and discussion of “Modularization with Rule Based Algorithms in Three-Dimensional Engine Room Layout of Harbour Tug Diesel-LNG Dual Fuel Engine 2 X 2500 HP”, the following conclusion are obtained.

1. P&ID that calculate and design is bilge & ballast system, oily water separator system, firefighting system, domestic system, fuel oil system, lubricating oil system, cooling system and compressed air system. P&ID calculation and design use Biro Klasifikasi Indonesia as rules and regulations. P&ID provide list of components to the next step that is modularization with rule-based algorithms.

2. Clustered and reordered DSM have the same value of sum and objective function value, but both value is smaller than the original DSM. It means that is effective and efficient clustering component and better module configuration than original DSM. Reordered DSM use as basis to create three-dimensional engine room layout.

3. Component that includes in one cluster must located nearly. There is no only one component movement, but cluster movement. Modularization with rule based algorithms can use to create three-dimensional engine room layout.

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