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The Simulation Model of Iron Sponge Plant Layout for the Defense Industry Based on Industry 4.0 Model

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ABSTRACT
The Industry 4.0 is a change in the perspective of how to view an industry based on the resources owned, to operate according to needs. The sponge iron industry is a raw material industry to support the steel industry which is intended as material for shipbuilding and combat vehicles used by the Indonesian National Millitary. It is necessary to plan and design a sponge iron plant with an Industrial 4.0 model. The implementation of the Industry 4.0 model aims to optimize the operational needs of the plant, especially the sponge iron plant, which is relatively rare in Indonesia. The concept of a factory layout (cellular layout, modular layout), the concept of lean manufacturing, as well as the concepts and principles of the smart factory (Cyber-Physical Systems) are concepts that will be applied in the planning and design of the Industrial 4.0 sponge iron plant layout. In order to produce an optimal layout, a simulation model using FlexSim 2018 Software and layout optimization is used the Computerized Relative Allocation of Facilities Technique (CRAFT) algorithm with the help of CRAFT Software Integrated Microsoft Excel 2019.

INTRODUCTION

The Industry 4.0 is a change in the perspective of how to view an industry based on the resources owned, to operate according to needs. Industry 4.0 is very different from the previous industrial era, namely the industrial era 3.0, especially with Industry 2.0 and Industry 1.0. Industry 4.0 is a revolution in the industrial sector with the implementation of Cybers Physical Systems (CPS), as well as manufacturing collaboration [1-2], this characteristic distinguishes from the previous industrial revolution. The difference is attributed to the existence of the Indonesian defense industry, especially the steel raw material industry, namely iron sponge, is an industry to support the steel industry used for the manufacture of ships and combat vehicles used by the Indonesian National Army, which is still rare in Indonesia. the implementation of the sponge iron industry, even the steel industry itself if seen by the application of technology is still far from Industry 4.0, even Industry 3.0.

Realize that the steel raw material industry enters Industry 4.0, it is necessary to plan and design that applies the Industrial 4.0 concept that is adapted to the resources, culture and character of the industry in Indonesia. In realizing this, it is necessary to plan and design a sponge iron plant by applying the requirements specified in Industry 4.0. The concept of planning and designing plant layout, with the application of the concepts of modular layout and cellular layouts, the concept of lean manufacturing and the concept of smart factory are those concepts that can be applied in the construction of industrial sponge iron 4.0 plant models. The application of these concepts aims to optimize the operational needs of factories, especially iron sponge factories which are relatively rare in Indonesia. To produce an optimal layout can use a simulation model and the Computerized Relative Allocation of Facilities Technique (CRAFT) algorithm in constructing the layout of the sponge iron plant.

METHOD

The basis of planning and designing the factory layout is the process of making the product that is made. Iron sand is the raw material for making iron sponges, with a reduction process, the result of reduction (concentrate) is the main raw material in making iron sponges. To reduce iron sand is very important, but it needs preparation of reduction raw materials [3].

The process of making iron sponge operation consists of three stages which are: preparation stages, production stages, and finishing stages. The preparation stage is the stage of taking iron sand concentrate by using a magnetic separator then filtering, the production stage is mixing the iron sand concentrate with a binder, then the homogeneous concentrate and binder are added with a solvent in the form of water then stirred into a mixture which is then printed and oven according the desired product, as well as the finishing stage is the product packaging process and receiving (final storage). This stage can be integrated with modular concepts and cellular layouts, Modular layouts that are a group of machines and equipment connected by the flow of material between machines that have a certain pattern, is a specific pattern that is Flow line Module, Branched Flow line Module, Call Module, Machining Center Module, Functional Layout Module [4]. Lean manufacturing, lean is defined as an ongoing effort to stop waste so that it will increase the added value (value added) of a product (goods or services) in order to provide customer value (customer value). The lean goal is continuous improvement of customer value through continuous improvement of the ratio of value added to waste (the value-to-waste ratio) [5]. and smart factory which is a broad manufacturing category with the aim of optimizing the manufacturing process, processes that use computer control, modeling, large data and other automation to improve manufacturing efficiency [6], for planning and designing in building a sponge iron plant.

Simulation models based on the operating process can be used in the planning and design of the construction a sponge iron plant. Furthermore, to optimize the optimal layout results, the Computerized Relative Allocation Facilities (CRAFT) algorithm is used. The CRAFT (Computerized Relative Allocation Facility Technique) algorithm is one of the layout algorithms for repair methods developed by Armor, Buffa, and Vollman [7]. This algorithm uses from to chart as input data for its transfer flow [8]. Compared to other algorithms, CRAFT can produce solutions that are quite good and require relatively short computing time. The resulting solution is a sub-optimal solution.

The integration of these concepts must be in accordance with the requirements of Industry 4.0. These requirements for each concept can be seen in the following tables.

Table 1. Requirement of Smart Factory In Industry 4.0 [9]

No.	Requirement
1	Modular Machine Tools or Workstations
2	Modular Material Handling Equipment
3	Multi-Skilled Workforce
4	Reconfigurable fixture
5	Reconfigurable tools
6	Standard Infrastructure, CPS, etc

Table 2. Equiremen of Lean in Industry 4.0 [10]

No	Requirement
1	Pull Production
2	Continuous Flow
3	Setup time reduction
4	Supplier Feedback
5	Supplier Development
6	Just In Time (JIT) Delivery by Suppliers
7	Customers Involvement
8	Total Productive Maintenance (TPM)
9	Statistical Process Control (SPC)
10	Employee Involvement

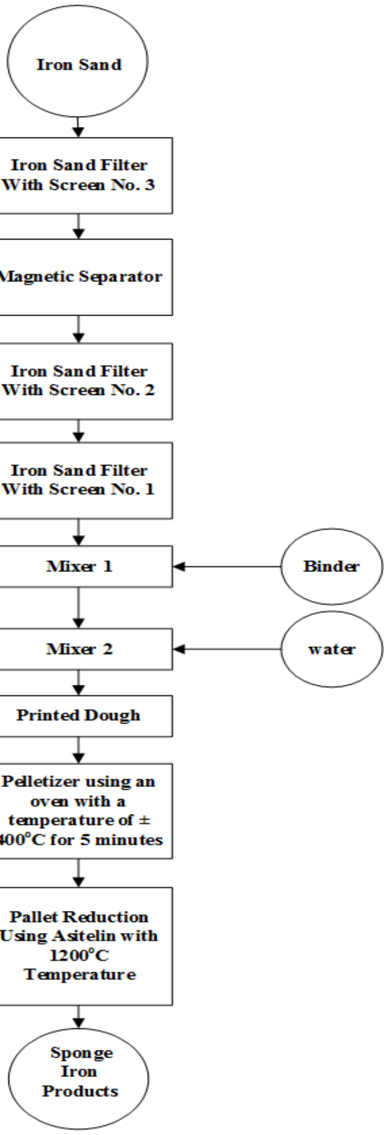

Fig. 1 *Iron Sponge Manufacturing Operation Process*

RESULTS AND DISCUSSIONS

The connecting between these concepts in accordance with industry model 4.0, the layout of the iron sponge plant is obtained according to needs, while the relationship between concepts can be seen in Figure 2 below.

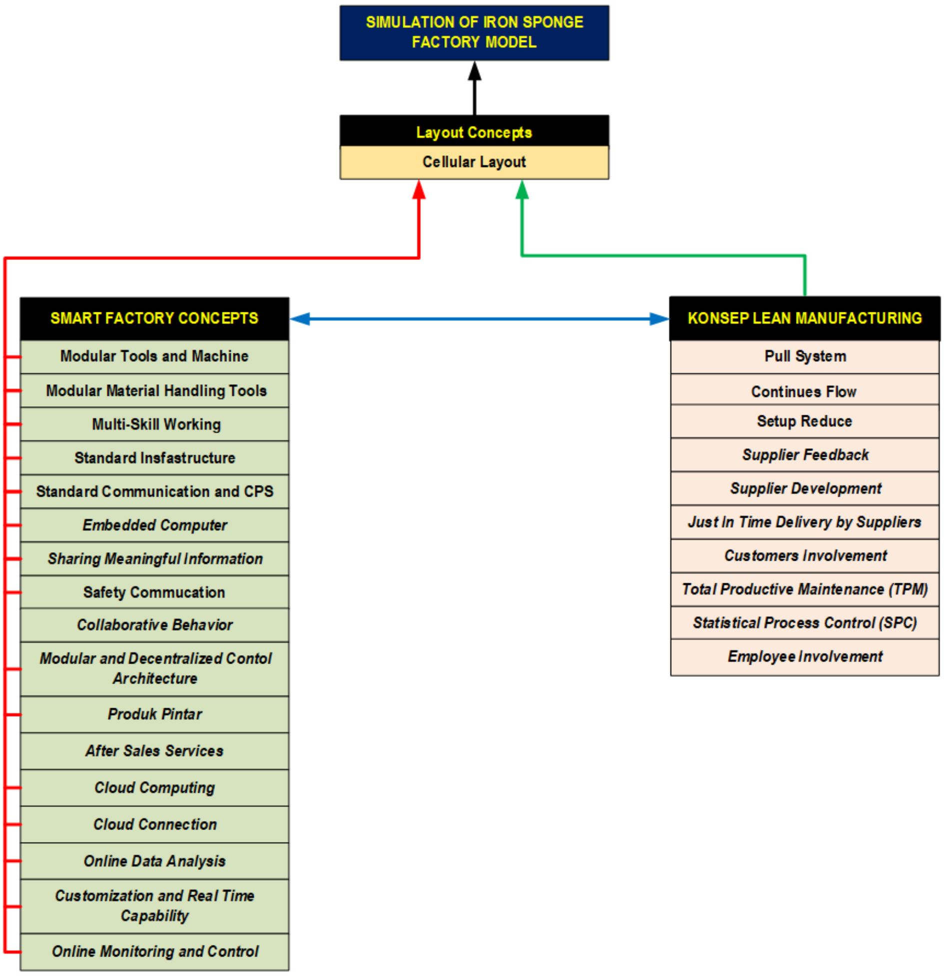

Fig 2. *Relationship Between Concepts*

Then the relationship between concepts can be simulated according to the operating process to get optimal results, this simulation can use FlexSim Software, with the layout results can be seen in Figure 3 below.

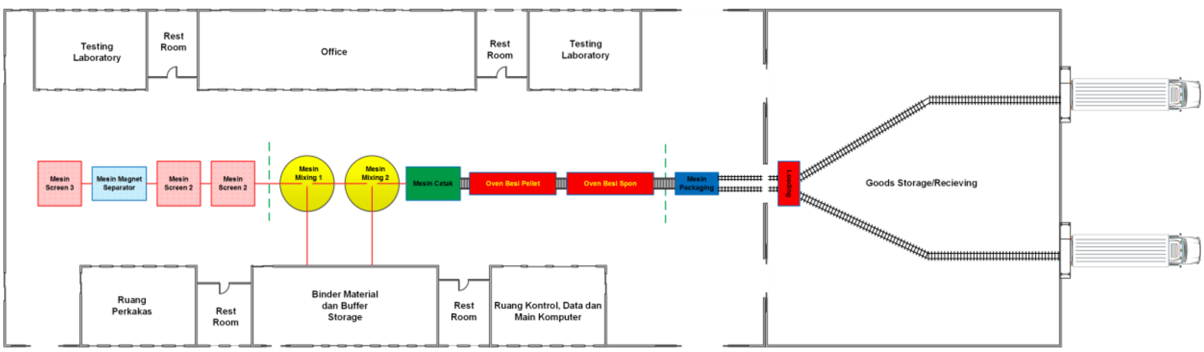

Fig 3. *The Layout Results Designed Based on the Operating Process*

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For the repair layout can use CRAFT (Computerized Relative Allocation Facility Technique) Algorithm, with the required data that is the cost of movement and distance between departments, and to speed up the calculation can use CRAFT Software integrated Microsoft Excel 2019, with the layout result can be seen in Figure 4 below.

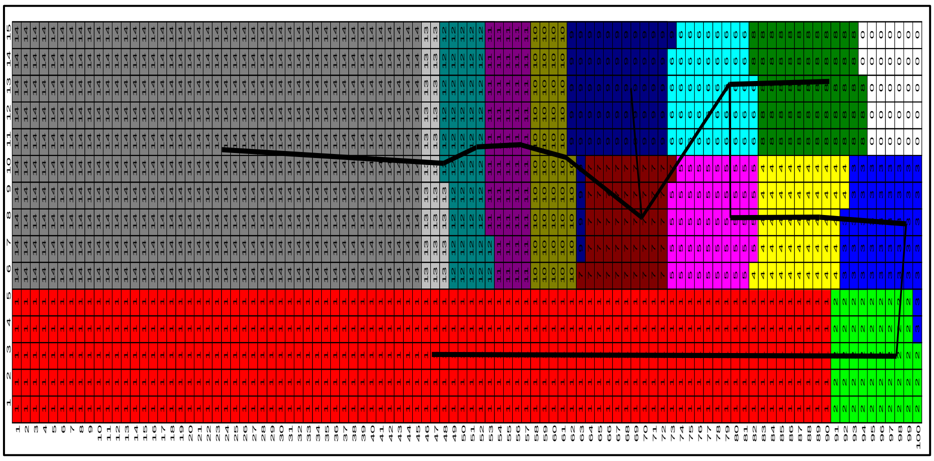

Fig 4. *The Layout Result of Designed Repair Can use CRAFT*

Table 3. Area and Coordinate of Machine/Department

Department	Color	Area-required	Area-defined	x-centroid	y-centroid	Sequence
Stockpile	1	450	450	2.5	45	1
Screen 3	2	48	48	2.4375	94.8125	2
Separator	3	45	45	7.27777767	95.8555527	3
Screen 2	4	48	48	7.52083349	86.6041641	4
Screen 1	5	48	48	7.5	77	5
Mixing 1	6	47	47	12.3936167	76.9042587	6
Mixing 2	7	47	47	7.5	67.5	7
Binder	8	60	60	12.5	87.5999985	8
Water	9	60	60	12.2333336	66.3333359	9
Cetak	10	45	45	9.72222233	59.2777786	10
Oven Petlet	11	48	48	10.166667	54.5833321	11
Oven Spon	12	48	48	10.083333	49.7916679	12
Packaging	13	24	24	9.5	46.25	13
Warehouse	14	450	450	10	22.5	14

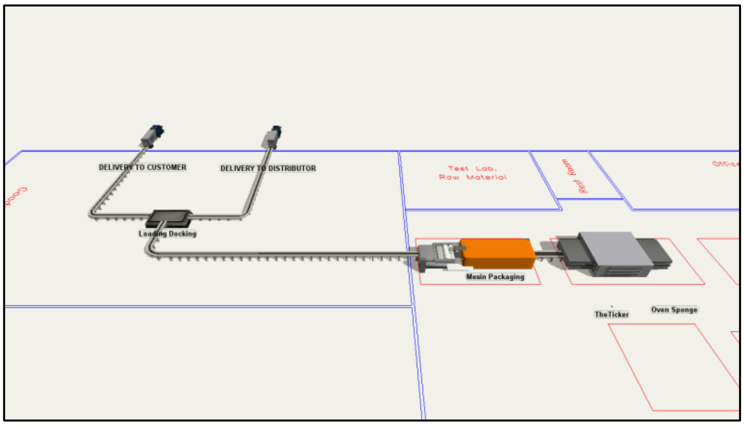

Fig 5. *The Simulation Models Result of Repair Layout Repair Can Use FlexSim*

CONCLUSION AND SUGGESTION

In the planning and design of sponge iron plant layout with industry model 4.0, do not necessarily about the concepts and theories used, but most importantly what product philosophy and process will be implemented in a planning and design. In planning and designing the plant or company layout that follows industry 4.0, the implementation of the concepts used (layout, lean, and smart factory concepts) should be sorted according to the needs of the process and what products will be produced. Then determine the industry model 4.0 concepts that will be used in accordance with the minimum requirements. Because by choosing the minimum elements can optimize the planning and design time so that it will optimize the costs incurred. To optimize time, costs and errors in designing it is very necessary to do simulations. This can prevent errors when implementing planning and design, in this case the planning and design of a sponge iron making plant.

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