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ORIGINAL ARTICLE

LAYOUT STRATEGY OF PROTEASE PRODUCTION FROM INDUSTRIAL FISHERY WASTES IN KUANTAN, PAHANG

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ABSTRACT – Layout strategy is considered as key decision that controls long-term effectiveness of production and operational activities. Fish wastes in the fisheries sector can have negative impact on the environment if not handled properly. This issue plays a huge role in the commitment for choosing the right layout suitable for production of protease from those wastes. The whole analysis of this research was conducted in Kuantan, Pahang that has concentration of many fisheries processing industries which generated quite huge tons of waste. The aim of this study was to define a layout strategy that was sufficient for production of protease from fishery waste. Data was obtained from interview sessions with manager of X Company followed by documents review and observations of production activities for layout analysis. Expert consultation was done to determined protease product process flow as recommended by product developer from Universiti Malaysia Pahang. The research team then further developed plan layout suited to the protease production processed from identified fishery wastes available at the site. Feasibility analysis performed had determined that proposed protease production would benefit consumers, increases manufacturing capacity which open up new market and business opportunity for the company. Protease production from fisheries waste increases career opportunities, generate new income and bringing positive environment impact to local community.

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INTRODUCTION

A significant amount of fish by-products is produced during fish processing. These by-products represent 20–80 percent of the fish and provide a good source of macro- and micronutrients. Yet they often go unutilized, when they can easily be converted into a variety of products including fishmeal and oil, fish hydrolysates, fish collagen, fish sauce, fish biodiesel and fish leather. Feasibility studies by Islam et al. (2021) on fish waste management writing on Bangladesh, Philippines and Thailand outline existing good practices on the utilization of by-products and fish waste. The insights provided on the potential production and utilization of fish silage in each of the country are promising in terms of increasing the productivity of the fisheries sector, reducing post-harvest waste, increasing economic value and improving environment sustainability.

Fishery waste has huge potential to be created into various by-products (Ben Rebah & Miled, 2013). The removal of these fishes' waste speaks to an expanding natural and health issues. To abstain from squandering these by-products, different removal strategies have been utilized including isolation, maturation, fish oil creation and hydrolysate. In addition, side-effects of fish give a great supplement source to microbial development valuable in the compound process of creation, that is generally represented through the expense identified with the development media. Fish wastes (heads, viscera, chitinous material, wastewater, and etc.) were processed and tried for development substrates for microbial catalysts creation, for example, protease, lipase, chitinolytic and ligninolytic chemicals.

Fisheries wastes are usable material that can be used further in the preparations for protease production. Fish waste needs to be handled with the proper planning to produce quality protease for market consumption (Alfio et al., 2021). Layout planning for the protease production need to be carefully considered as it is playing very important roles to make the production successful. Layout has strategic implication because it establishes an organization’s competitive priorities in regard to capacity, processes, flexibility, and cost, as well as quality of work life. An effective layout can help an organization achieve a strategy that support differentiation, low cost, or response time. (Süße & Putz, 2021). The purpose of this study is to elaborate more about the layout strategy of protease production from fishery wastes.

The scope of this study was focusing on layout strategy for production of protease from fishery waste. Study was conducted at X Company, a local business producer of fish crackers in Kuantan, Pahang. Preliminary study was conducted first by analyzing data and findings from past researchers. Then the research progressed further with ideas search for solving problem faced by the current X Company fish cracker producer for production of protease from process wastes generated. Layout strategy was selected to be in line with the current product development of X Company in determining the best physical course of action with all properties that use capacity inside a building that the company

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currently have. The company property includes a work space, a workplace, cabinets, employees, entire company work organization, and indeed the various business company operation functions.

RESEARCH OBJECTIVE

The aim of this research was to propose layout strategy suitable for the production of proteases from fish wastes generated by fishery processing industry at X Company. The research objectives were as follows:

a. To identify the layout requirements for protease production from industrial fish wastes.
b. To develop plant layout for production of protease from industrial fish wastes.

LITERATURE REVIEW

Layout strategy

Layout strategy is choosing the best physical course of action in arranging all assets that use up space inside an office. These assets may incorporate a work area, a workplace, a cabinet, an individual, a whole office, or even a division. Choices about the course of action of assets in a business are not made just when another office is being structured, they are made whenever there is an adjustment in the plan of assets, for example, another labourer being included, a machine being moved, or an adjustment in the system being actualized. Additionally, format arranging is performed whenever there is a development in the office or a space decrease according to Iqbal and Hashim (2001). The general target of plant layout is to structure a physical course of action that most financially meets the necessary output amount and product quality.

Facility layout planning (FLP) involves a set of design problems related to the arrangement of the elements that shape industrial production systems in a physical space. The fact that they are considered one of the most important design decisions as part of business operation strategies, and their proven repercussion on production systems' operation costs, efficiency and productivity, mean that this theme has been widely addressed in science. Recent review by Pablo et al. (2021) on articles based on type of problem, approach and planning stage and characteristics of production facilities are done by configuring the material handling system and methods to generate and assess layout alternatives. Generation of layout alternatives was done mainly using mathematical optimization models, specifically discrete quadratic programming models for similar sized departments, or continuous linear and non-linear mixed integer programming models for different sized departments. Other approaches followed to generate layout alternatives were expert's knowledge and specialized software packages. Generally speaking, the most frequent solution algorithms were metaheuristics. Other latest development in layout strategy including works on Systematic Layout Planning (SLP) method which was used to determine the best new alternative layout for a company (Masriah et al., 2021).

Protease Production From Industrial Fisheries Waste

According to Ben Rebah and Miled (2013), basic protease from the fish squander has been given more consideration since it can withstand high temperatures and high action over a wide scope of pH levels. Protease is well-known as enzyme that are included in food production such as baking industry, dairy industry and also soy sauce production. Ben Rebah and Miled (2013) also founded that industrial fishery waste can be used to create various by-products. The removal of these fishes' waste speaks to an expanding natural and health issues. To abstain from squandering these by-products, different removal strategies have been utilized including isolation, maturation, fish oil creation and hydrolysate. In addition, side-effects of fish give a great supplement source to microbial development valuable in the compound process of creation, that is generally represented through the expense identified with the development media. Fish wastes (heads, viscera, chitinous material, wastewater, and etc.) were processed and tried for development substrates in microbial catalysts creation for example protease, lipase, chitinolytic and ligninolytic chemicals. (Chee Kuan Ooi et al., 2021).

Overview types of layout strategy

The general target of plant layout is to structure a physical course of action that most financially meets the necessary output amount and product quality requirements of the production system. Wanniarachchi (2014) suggested five different types of food production layout to choose from.

a. Repetitive and product-oriented layout

Product-oriented layout is viewed as a sequence with interconnected productive resource structures which refers to the development of a product or ordering of just a similar item simultaneously. and in a coordinated way, along with the required manufacturing and assembling. This is more suitable for layout of proteases production. Protease product is a repetitive production which it will repeat to produce the same thing every day. Using this type of layout is more clearly justifies that production flow more arranged with the machine that needed. (Liggett, 2000).

b. Process or functional oriented layout

Process-oriented layout traditionally selected in manufacture of an expanded product range in relatively small lots production, and a common manufacturing process or it is a job shop with a process layout. This layout has high degree of flexibility. Possibility of slightly higher use of equipment with little capital expenditure; unlike product based layouts, gives maximum satisfaction to the workers.

c. Fixed position layout

Generally, this layout usually used to produce bulky, huge and also too fragile product to move from area to another area. Product will remain just in one location for the whole entire manufacturing assembly time. For example, this layout usually used to produce ships or plane.

d. Cellular layout

Dissimilar machines need to be grouped into assembly line to operate on items with identical structure and processing specifications. Similar to a process layout, layout of group technology is structured to execute specific processes. This is closely matched to product structure requirements since each cells are devoted to specific product range.

Elements and factors of layout strategy

Factory layout strategy must be in line with the current product development of the company in determining the best physical course of action with all properties that use capacity inside a plant that the company planning to have (Yang et al., 2000). Consideration on elements of factory layout were based on the following criteria.

a. Simplicity and future extension

Simplicity of future extension or change one of the element factors that need to be considered. The structures should be constructed in such a way that they were being easily renewed or adopted in order to meet the evolving requirements of production. Despite the reality that design of any factory was a significant, costing initiative that needed more concerns, there was also consistently the possibility that a future upgrade would be vital. (Ali Naqvi et al., 2016).

b. Flow of movement influence layout decision

Factory design should represent an understanding on the importance of flow diagram to be applied at the respective manufacturing plant planning. Moreover, on how to run the small business in factory planning, "in an ideal world, the design would reveal the raw resources entering the manufacturing line through one direction and indeed the finished product expending on the other side. The straight line is not practical in each steam line. U-shaped lines, zig-zag or parallel flows, which usually end up each finished product right at the shipping bays, could also be effective. (Ali Naqvi et al., 2016).

c. Capacity utilization and path lane

Capacity utilization needs to be part of the layout design, to ensuring the flow routes is wide enough to allow for checking the stock storage warehouses or rooms, to see how much physical capacity may be required.

d. Fulfillment of worker requirements

This factor influenced in determining the design of the plant layout. Designer need to pay more attention because it involved with effect on representative resolved and occupation fulfillment in their respective everyday work life. Because endless analyses had shown legislative nature did have a significant impact on performance, company owners and administrations. A few different ways format configuration could expand confidence were self-evident, for example, by accommodating windows, space and also providing light colored walls. Different ways and not straightforwardly were identified to be appropriated with the manufacturing process requirements. (Yang et al., 2000).

e. Transporting and receiving

The factor that impact manufacturing in layout strategy was in the area of transporting as well as receiving. The J. K. Lasser Institute guided businessmen to leave plenty of space for this element in their practices. "While space will in general top itself off, receiving and transporting once in a while get enough space for the work to be done adequately," they said in their How to Run a Small Business guide. (Lasser, 1994).

f. Ease communication and support

An ease of communication and support likewise included in procedure design activity since it was identified with the supplier from fisheries industry. Facilities should be spread out so that interaction would be achievable among various business areas and partnerships with protease development merchants and customers in a clear and convincing way. (Yang et al., 2000).

METHODOLOGY

This research technique would address the process used to collect data for the purpose for gathering information. Observers utilized quantitative methods for data gathering obtained from document review and interviews. Qualitative method were employed here based on discussion and consultation with product experts from Universiti Malaysia Pahang (UMP) collaboratively been working on this protease research project. Bickle (1995) and Khan (2014) said that qualitative methodology was an evaluative philosophy, phenomenological approach, or conceptualism also as foundational basis of a qualitative research approach that was significantly related to the meaning and characteristics of case studies. Case studies are used in design research to analyze a phenomenon, to generate hypotheses, and to validate a method. Though they are used extensively, there appears to be no accepted systematic case study method used by design researchers. Considering its nature and objectives, the case study method could be considered as a suitable method for conducting design research. (Teegavarapu et al., 2008)

DATA COLLECTION

Interview

There was a face-to-face discussion implemented with the factory management. This analysis was conducted on a field trip to the research site of X Company factory in Kuantan. The aim of this cooperative activity was to gather data and feedback from the factory manager. Discussion, question and answer session throughout the interview was done in just an easy going manner that allowed the respondent reacted to both the relevant information and facts about disposal of fish wastes, production and the expenses pertaining to managing company business.

Document review

Document review was a way of collecting data by reviewing existing documents. Documents might be hard copy or electronic and might include the previous research studies about the fishery waste industry or the journals that had been published about the layout strategies. In this study, researchers reviewed past year studies of previous researchers to seek for the best layout option of proteases production extracted from fishery wastes at X Company.

RESULTS

Framework for layout development

There were six steps for developing the layout of X Company factory framework as outlined below:
Step A: identification of machine capacity
Phase A focuses on the identification of the system capability of the manufacturing plant. To handle the demand of product every month the factory must be constructed with appropriate handling the capacity. When demand is a marked rise beyond regular demand, a strategic decision must be made to improvement the inventory of finished products. It means that the consumer demand is completely fulfilled. The real capacity of the machines can be determined as soon as the estimated performance with all facilities of the factory is identified. (Wanniarachchi et al., 2016).
Step B: consolidating manufacturing process
In this stage, there were two main steps. First the details of the machine, which meant that the physical size of the machine should be identified and known. The height and footprint of the machine were important dimensions for the design of the facility. Second step was gathering details of the production process. Specific information related to the manufacturing process needed to be established at this point. There might be batch processing or continuous production as per the requirements of the product. (Wanniarachchi et.al., 2016).
Step C: identification of space requirement
The space requirement was for the additional space or area for the new construction to final derive the optimum mixes of the space or area section. The design parameters design needed to be considered the utility space requirement at every space area. Example of facilities that needed to match the process requirements were chill water lines, air conditioning systems, the electrical systems and so forth. The manufacturing process needed design layout which covering all the aspect of environment, safety and health conditions such as the emergency evacuation, noise propagation and also ergonomic aspects. (Wanniarachchi et al., 2016).
Step D: Layout development
In this step introduction to computer simulation for sketching-up the layout plant was employed. SmartDraw was selected as an alternative that runs on both Windows or Mac platforms available online with the best Visio® import and export capabilities. From industry point of view, and it was easy to use and also powerful much more affordable alternative. It was also found to be much easier to master compared to standard drawing tools like Microsoft Office and Google Workspace. This software provided solutions for managing layout arrangement in looking for effective production of proteases. The generated the solution would provide layout to be matched exactly to actual plant layout by using surveying mapping and navigation equipment. (Gyulai et al., 2016).
Step E: Selection of layout This last stage was to establish the functional elements of the layout. Economic condition and sustainability of implementing that the only desired layout design selected as the final project were considered in this phase (Wanniarachchi et al., 2016).

Step F: Development of a model layout for protease production

A structure model of layout development for protease production could be designed at this stage to support step D which was layout development of the framework from the discussion gathered from previous steps (Wanniarachchi et al., 2016).

Protease production process

Figure 1 illustrates the process flow of producing fish waste protease. Interviews were performed in order to ensure accuracy and validity of the process with product experts from UMP. Fishery industry residues were identified to be adequate as substrate due to their low cost and supplier availability. The supply of industrial fishery waste that came from X Company only utilized fish fillings with other unused portion or part of the fish removed. The conversion ratio to produce protease from fish waste was 4:1 or around 400kg of industrial fish waste would produce around 100kg of protease powder. (Chee Kuan Ooi et al., 2021).

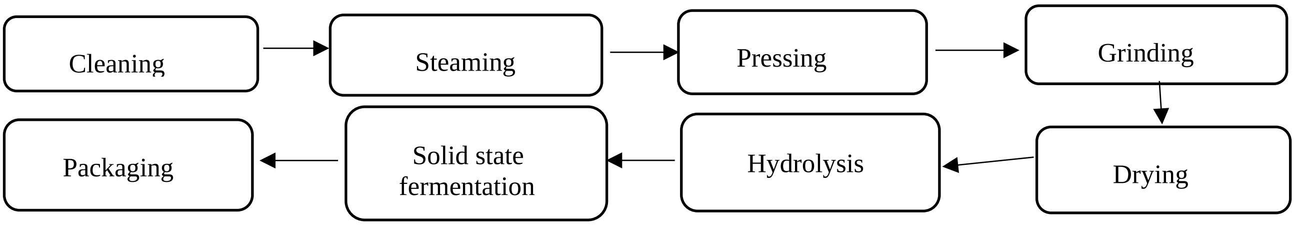


Figure 1. **Protease Production Process Flow.**

Assembly-line balancing

The line balancing basically was done to minimize imbalance of machinery with the workers while meeting the required output of the production line. Management needed to know the tools, equipment, and also the method of work production to produce product at the specific rate (Wanniarachchi, 2014). Table 1 showing the process time that was needed for each task assembly. Process activities required were cleaning fish waste, steaming, pressing, grinding, drying then hydrolysis, solid-state fermentation and finally packaging. Figure 2 showing precedence diagram relationship between all process activities where all the tasks must be performed along the right sequence.

Table 1. **Precedence data for protease production line.**

Activity	Task	Predecessor	Performance time (minutes)	Performance time in (hours)
Cleaning	A	-	30	0.5
Steaming	B	A	20	0.33
Pressing	C	B	30	0.5
Grinding	D	C	30	0.5
Drying	E	D	2160	36
Hydrolysis	F	D, E	900	15
Solid-state fermentation	G	F	120	2
Packaging	H	G	60	1

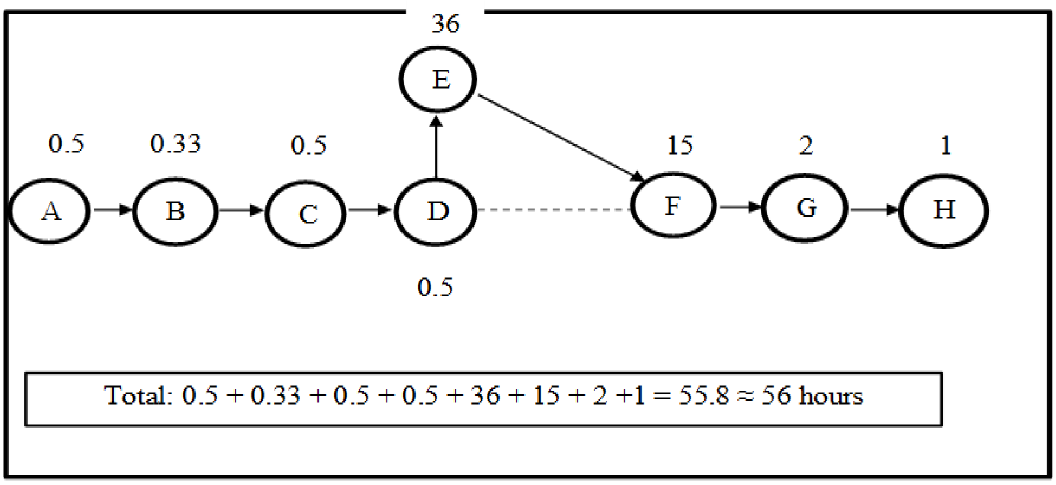


Figure 2. **Precedence diagram of protease production line.**

Factory plan layout for protease production from fishery wastes.

Figure 3 showing layout for protease production from fishery wastes in an overall sketch. The research had configured the overall layout sketched outlined by the machinery needed, the space for the staff and also the space for the movement in every part of the working areas from Table 2. The study found that the measurement that suitable for protease production from fishery waste was 44.19 x 50 square feet. This layout drawing could be divided into eight sections. These plans were illustrated in Figure 4.

Table 2. Types of machinery and dimensions in production area.

Workstation	Machine	No. of machine needed (units)	Sizes of the machine (wide x length) = feet (ft)
Cleaning	Conveyor belt washing machine	2	(304.8mm x 304.8mm) = (0.3048m x 0.3048m) =0.093m (0.3051ft) 0.3051 x 2 units = 0.6102ft
Steaming	Steaming machine	1	(2700mm x 2100mm) = (2.7m x 2.1m) =5.67m (18.6 ft)
Pressing	Screw press	3	(1650mm x1400mm) = (1.65m x 1.4m) =2.31m (7.58ft)7.58 x 3 units = 22.74ft
Grinding	Fish waste grinding	2	(154.9mm x 450mm) = (0.45m x 0.1549m) =0.0697m (0.23ft) 0.23 x 2 units = 0.46ft
Drying	Drying oven machine	4	(1200mm x 1400mm) = (1.2m x 1.4m) =1.68m (5.5ft)5.5 x 4units= 22ft
Hydrolysis	Hydrolysis machine	1	(660mm x 1380mm) = (0.6m x 1.38m) =0.828m(2.71ft)
Solid state fermentation	Fermenter machine	1	762mm x 2718mm) = (0.762mm x 2.718m) = 2.071m (6.79ft)
Packaging	Powder filling packaging	2	1500mm x 3000mm) = (1.5m x 3m) =4.5m (14.8ft) 14.8 x 2units = 29.6ft

Note: mm = millimeters; m=meters.

The material flow and the people movement were started from right to left side. The raw material of fish wastes received at the inbound from right upward side of the layout then converted to the work preparation and transferred to the production area at the left side of the layout. Then after gone through the U-shaped flow assembling line in production, the product would be transferred to the right below of the layout which was the packaging store before the final product of proteases would be shipped out to the customers. Furthermore, it happened the same flow with movement of the workers. The workers would start from the entrance at administration office first. Then, the workers could continue the flow with each department that they belonged to. (Watanapa et al., 2011)

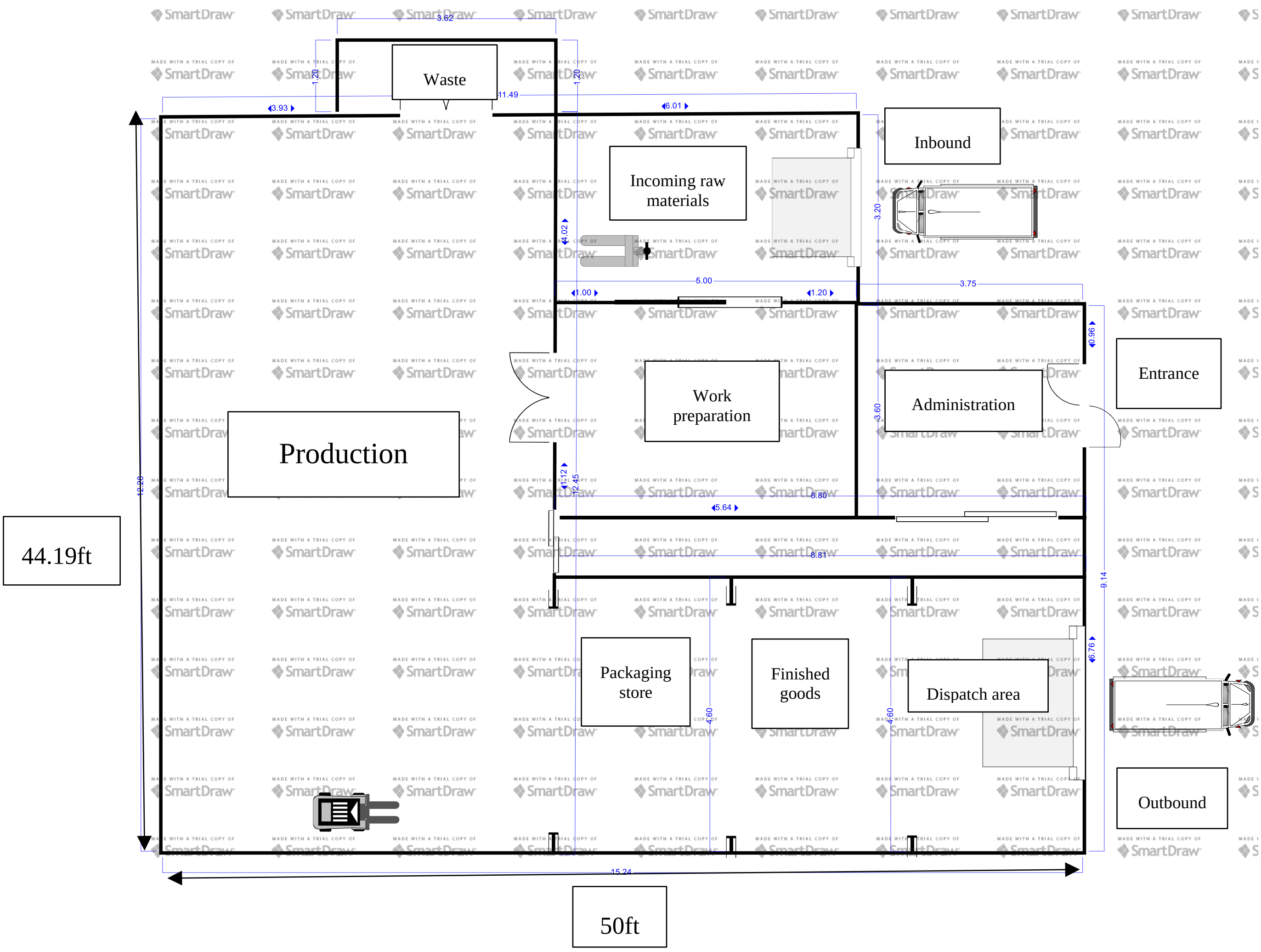


Figure 3. Plan layout for factory of protease production.

Plan layout for production department of protease manufacturer.

The research team decided to utilise a U-shaped layout for the manufacturing of proteases production from the company fish wastes. The diameter for layout production was 40 x 18 feet so that every single machinery that needed in the production just fixed nicely to the diameters. The research used colours schematics to describe the arrangement of machine in production layout so that it could be determined more clearly and also the researcher stated the dimensions or spaces that were required by every machine in the layout production. By using the U-shaped production assembly line, it would help the workers have better access. By using U-shaped work flows its might reduce material and also worker movements. It also reduced space requirement, made process inspection easier. Table 3 state types of machine using colour scheme method. Warnniarachchi (2014) stated that the various colour would help differentiate the type of machines in the layout drawing and if the drawing would later be use in future production it would be simpler to learn the layout drawing.

Plan layout of basic symbol for electrical supply in factory protease production

In every new development of factory, planned installation of electrical supply also needed to be considered because the planner needed to know where to install the electrical power and also how much its needed for every department. In every new development of factory, the planned installation of electrical supply also needed to be considered because the planner needs to know where to install the electrical power and also how much its needed for every department. Table 4 is showing basic electrical requirement for the factory production layout. Other than that, it also to be taking part because the cost of electrical supply would be counted every month for reading utility spending fixed cost. It is really complex when it comes to electrical power systems for industries (Pereyras, 2020). It was based on the fact how each factory

Table 3. **Arrangement of machines in production layout by colors.**

	Cleaning		Drying
	Steaming		Hydrolysis
	Grinding		Solid-state fermentation
	Pressing		Packaging

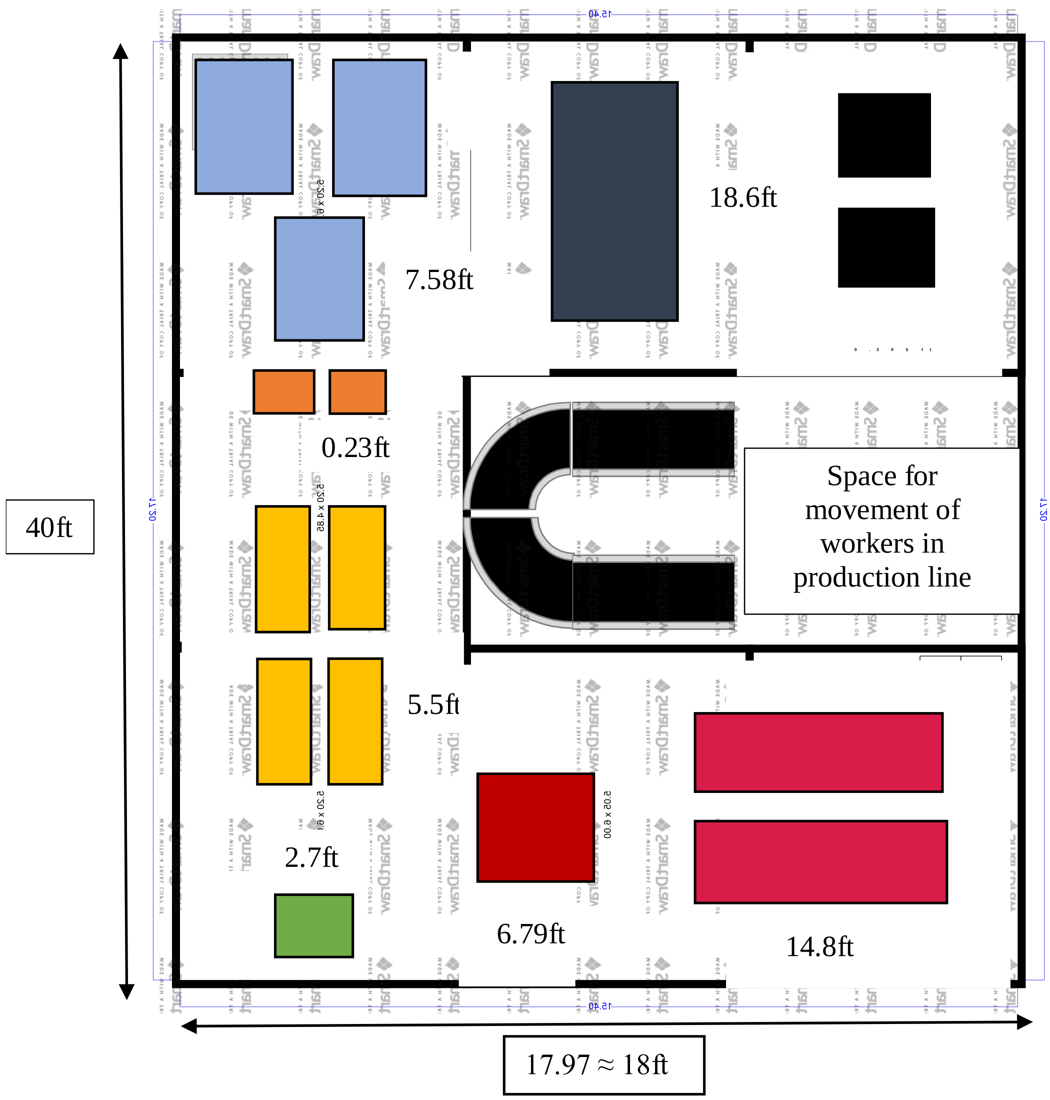


Figure 4. **Plan layout of production department for protease manufacturing.**

seemed to have its own configuration.For example, they all had one characteristic in mind, all of them should have light. Most might needed office building for workers and many others would need to have a Wi-Fi device to accommodate for entire stock. Some even were more difficult when they needed massive, industrial machinery with special specifications. Wiring required the skills of every other construction project. It was specifically linked to the protection of human existence and also the utilities people could handle. This variety of cabling must include its supply, installation, inspection or implementation with all duct system including appliances, socket outlets, spur outlets, switches, junction boxes or pull boxes, wiring, GI pull wires, ceiling rose connections, etc. All wiring must in compliance with IEE Regulation or the authorized alternative specification. Unless otherwise stated, all wiring should be in rigid PVC ducts embedded in the wall or ceiling or concealed in the false ceiling. Figure 5 showing the electrical supply for the factory layout. The size of the ducts should be chosen in compliance with the IEE regulations and the minimum size of the duct should be 20 mm, unless otherwise stated or authorised. The manufactured duct bends should be used where applicable. The pipes of other non-electrical utilities should be kept at least 100 mm from the pipes. (Pereyras, 2020).

Table 4. Basic symbol of electrical supply in proteases production factory.

Fluorescent lights (15 units)	Plug 13A (18 units)	Ceiling fan (2 Units)	Main board (1 unit)	Switch (15 units)
Twin fluorescent lights (46 units)	Plug 15A (8 units)	Exhaust fan (4 units)	Air conditioning (1 unit)	3 phases (3 units)

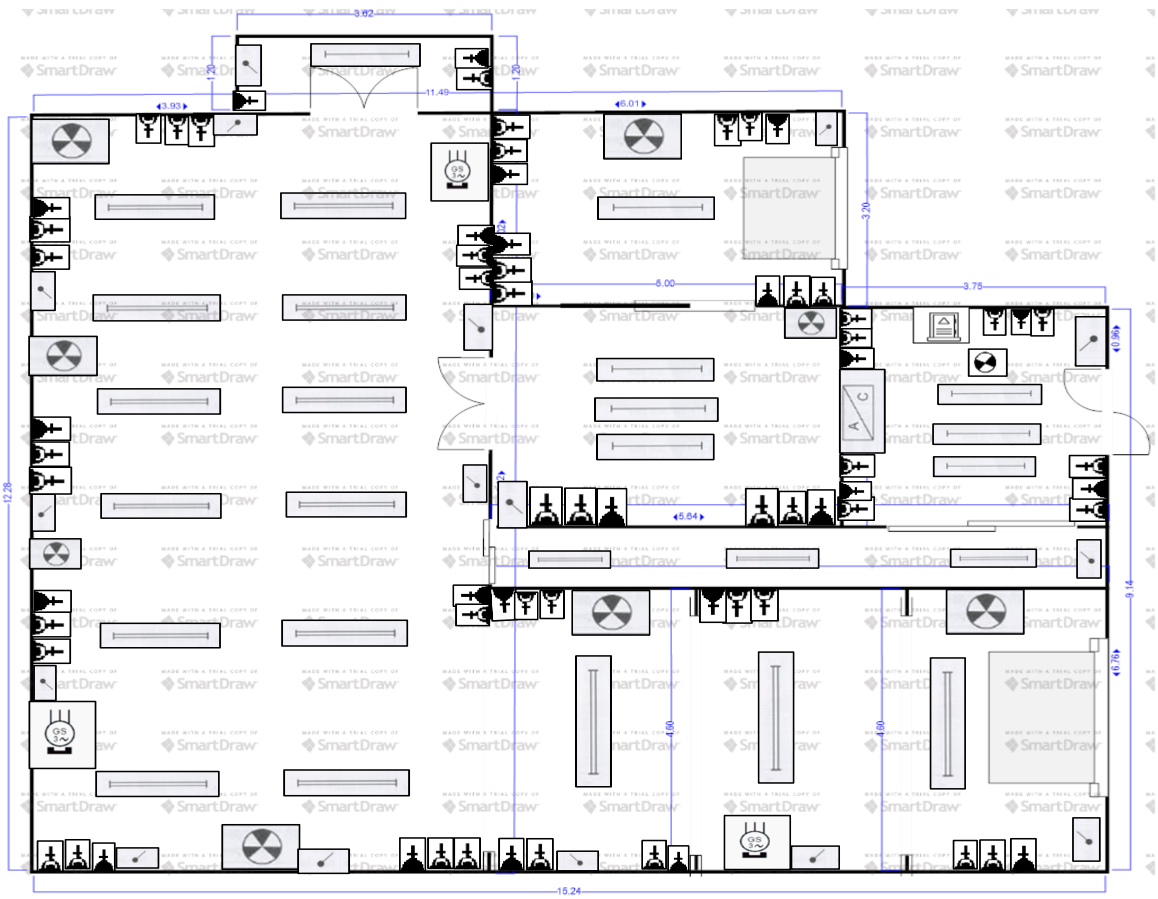
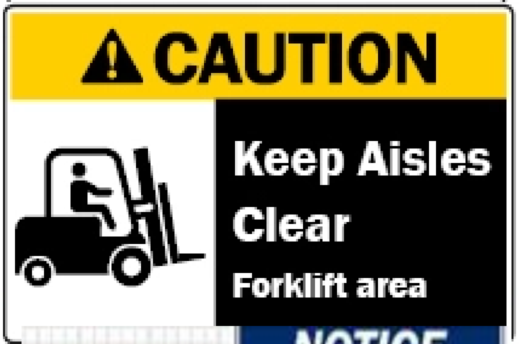


Figure 5. Plan layout of basic symbol for electrical supply in protease production factory.

Safety signage meeting standard of OSHA requirement

Safety alerts played an important role with in creation of the healthy workplace. Employees who engaged in successful, straightforward communication tool would experience fewer incidents or injuries, productivity improvements or healthier behaviours in the facility. 29 CFR 1910.145, OSHA's hazard sign and tag manual, specified the design requirements and explained when safety signs should be used. This design features were applied in the OSHA's standard specifies any element of the sign design, as well as the standard sign and the labelling colours. Signal terms like danger or alert, therefore letter and size must also meet its pattern and, ultimately, the sign and label arrangement of the sign in the layout of the protease manufacturers. OSHA (2021) had identified three key intensity classifications of safety measures. Which were danger signals, alert signs and caution sign it referred directly to the seriousness of the hazards current and potentially present. Protection signs or labels should be shown whenever the hazards could be encountered in the building. However, certain types of signals might allow workers to remain healthy and active without recognizing particular hazards. Table 5 illustrates the simple way to identify the various safety measures signs and hazards related to the factory.

Table 5: Basic safety measures signs and hazards in factory fishery wastes.

Danger		Danger signs indicated the most serious risks; therefore, safety techniques should be made. That danger sign term was written in white letters on a red background, followed by a safety warning symbol which really seemed like an exclamation mark within that triangle. This form of sign means that death or serious injury would be almost certain if the danger wasn't prevented.
Warning		This signal identifies a threat which might lead in serious injury or death, but where the overall risk was not sufficient to require the sign of danger. The safety warning symbol accompanies the warning symbol phrase, that was written throughout black on an orange backdrop.
Caution		In caution sign it was mentioned that if not prevented the hazard might lead to minor or moderate injury. These were normally cautioning against dangerous practices. The hazards identified in a warning sign., if not prevented, result in minor or moderate injuries. These were normally cautioning against dangerous practices. On risk factors, the indicator signal term was written in black on the yellow background header and was followed by a safety warning icon.
Notice		The notice alerts board was for notifying the workers about information of the machinery, about the area or about the equipment to be use and also the building. These signs explained procedures, maintenance records, orders, rules and directions not relating to personal injury.
General safety signs:		This for general safety measures. It typically related to health of employees, the first aid and medical equipment and also housekeeping.
Admittance:		This admittance board of alert described that the hazard and dangers were associated with dangers or implications accessing the secure area.
Fire safety:		This fire safety signals indicated emergency fire extinguishers or emergency exits.
Non-hazard signs		They convey information on the general safety facilities, such as how to locate guidance procedure, typically by short text or recognizable symbols. It shouldn't be used to convey threats, dangers or hazards; these weren't actually safety signals but still encourage a safer workplace.

DISCUSSION

Based on research findings, results and discussions implemented during this study SmartDraw software had been very helpful in developing the layout operation arrangement for company proteases production extracted from fish wastes. The result of interviews and document analysis that had been done by researchers had shown that this was the suitable layout for the production of proteases production for delivery to prospective product customers.

Limitation of study

The research was constrained by some limitation inherent when finishing this study. One of the limitations that researchers faced was limited time to access all the factory operations. Researchers needed to plan well when doing the interview sessions because respondents from X Company also had limited time. Data captured were only performed during the duration of study which might not solve bottleneck problem, inventory and supply-chain management issues entirely. Layout solution provided also might be unique to the factory operations only thus requires further analysis for other factory or location applications.

Recommendation

The intended layout model can be used as a basis for in-depth study that further narrow down the layout options problem. Data needed to be collected; for examples in relation to the possibility of the presence of pests, in order to help enhance the model by providing extra information which might support designers of the layout matching with production activities in the fishery wastes processing industry. The layout development model also can be generalized to other food processing sectors such as bread egg and dairy industries. This will help test the applicability of the model to other forms of manufacturing environments and products market.

CONCLUSION AND IMPLICATIONS

Upon completion of this research it can be concluded that this protease product is desired to be mass manufactured because it is currently a fairly lucrative marketable item. This product commercialisation is strongly encouraged as it will earn attractive return on investment. The study results also indicated that protease production extracted from fishery wastes is highly feasible because it has added benefits to all stakeholders which are valuable to the sector. Finding the right protease layout design is a tricky issue. It will become or have become challenging throughout this sector if it involves method that includes hygiene. The aim of the layout design is clearly to select the optimal flow process for this operation. This strong visibility supports the decision-making process to address the layout issues and findings of the protease production.

An effective layout design tends to smooth the flow of work, material, and information through a system. Plant layout is intended to acquire a physical arrangement of various substances of a facility that most economically meets the necessary yield, in terms of both quality and quantity (Wanniarachchi et al., 2016). According to Shekhar Tak (2012) a plant layout preferably includes arrangement of equipment and allocation of space in appropriate ways that general working expenses are minimized. There are three main types of layouts that commonly encountered in manufacturing such as layouts of product, process and group. Layout of group can additionally be classified toward line of flow and centres (Jain et al., 2013).

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APPENDICES

Research and Observation Conducted During Fieldwork at X Company.

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