Comparing lean and agile logistics strategies: a case study

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Abstract

The purpose of this paper is to compare the effect of lean and agile strategies on the manufacturing process of an aquarium manufacturer. Numerous studies has demonstrated the benefits of lean and agile strategies in enhancing the competitiveness of firms but none has really discussed or compared how performance differed when utilizing either strategies. Lean strategy can reduce, or even eliminate waste in the production process but lean might not be able to respond to fluctuation in customer demand while agile strategy enhance the responsiveness of the manufacturer. The results of this research show that both strategies provide different types of impact for the manufacturer. The findings also suggest that the manufacturer should not select either a lean or agile strategy but rather to combine both strategies.

Keywords: lean, agile, manufacturing strategy, case study, Thailand

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Background

The aquarium industry and in particular an aquarium manufacturer in Thailand has been chosen in this paper as the study object for the implementation of a lean strategy versus an agile strategy. The purpose of this paper is to compare the effect of lean and agile strategies on the manufacturing process of an aquarium manufacturer.

Customers demand has changed significantly in Thailand since the economic crisis of 1997, this has lead the aquarium manufacturer to adjust itself to be ready to serve all kinds of customers' demand by enhancing its capability to produce and distribute both made-to-order and ordinary products while trying to lower production costs at the same time.

PD Aquarium manufacturing firm has been in the aquarium industry for more than over 30 years. PD Aquarium has a 1540 square meter plant (22 x 70 meters) located on the outskirt of Bangkok. Since PD Aquarium is selling its products to aquarium retailers, its customers are not the end-users therefore stock-outs at retailers' premises becomes critical to PD Aquarium. A high level of customer service is needed to keep clients satisfied.

The outline of the paper is as follows. In the next section, a brief literature reviews on lean and agile logistics strategies are provided. Then the case study of PD Aquarium will be described in details, followed by the implementation of a lean and an agile strategy. Finally, their results will be evaluated and compared.

Literature Review

One of the most important external factors that impact firms is the increasing expectations of customers. In order to be successful, companies need to clearly understand the requirements and constraints of the market place and then develop a strategy that will meet the need of both logistics system requirements and customers (Landis, 1999). One of the main objectives of logistics management is to meet customers' requirements while lowering costs. There has recently been some significant debate about the "lean" and "agile" paradigms as key enablers (Steele, 2001). To understand the evolution of these paradigms, a brief history of industrial production processes need to be described. There exist three major phase or paradigm shifts of industrial production in the modern world (Hormozi 2001). These 3 phases are as follows:

A. Craft production. The craftsmen contracted and completed individual projects on a job-by-job basis. Consumer requests were typically for unique products, which varied to some extent from previously manufactured item.

B. Mass production. This phase is largely associated with the coming of age of Henry Ford's mass production assembly line this was the time in which "cookie-cutter" products were rolled off the end of the line at breakneck speeds. Product variety was minimal at the beginning of this phase and increased somewhat as time progressed.

C. Lean/JIT production. This is a phase which has only recently been recognized as a viable production alternative. Lean/just-in-time (JIT) manufacturing attempts to use the advantages of mass production in concert with the principles of JIT and elimination of waste in order to minimize the total cost of producing a product (Gonzalez-Benito, 2002).

Economic pressure, global competition, quality consciousness and high demand for logistics system reliability continue to challenge traditional approaches to product manufacturing.

Lean production requires keeping far less than half the needed inventory on site, resulting in fewer defects, while being able to produce a greater and ever-growing variety of products (Womack et al., 1990). Parallel to lean thinking, the agile manufacturing concept was developed (Gunasekaran, 1999; Assen, 2000). The different perspective of agile manufacturing and what it means is summarized in Table I, with a comparison of lean, agile, and the other two preceding phases. This table shows that craft production was an overall positive force for society as a whole. It freed up creative workers from the burdens of difficult manual labor and allowed them the time to utilize their creativity to increase their income and their standard of living but craft production could not compete with the next phases in manufacturing, such as mass production or lean production.

Table I: Comparison of Industry Objectives of Craft, Mass, Lean and Agile Production

Industry objectives	Craft production	Mass production	Lean production	Agile production
Emphasis on elimination of waste	Medium	Low	High	High
Degree of production leveling	Low	Medium/high	High	Flexible
Degree of organizational communication	High	Low	High	High
Sensitivity to customer demands	High	Low	Medium	High
Need for skilled employees	High	Low	Medium	High
Degree of cooperation between companies	Medium	Low	Low	High
Piece cost of small runs relative to large runs	Same	High	Medium	Same
Lead times for existing products	Varies	Short	Short	Short
Degree of product marketing required	Low	High	High	Low

Source: Hormozi (2001)

Even though many industries implemented lean thinking, it was considered that lean had limitations. Naylor et al., (1999) argued that the lean production model might not be robust enough as an approach to cope with present day changing and volatile market conditions since lean depended largely on a stable environment in which to maximize efficiencies of scale. Cost and quality have now become market entry qualifiers in the globally-competitive environment and firms are now turning to agile manufacturing system to achieve customer satisfaction and expand market share (Narasimhan, 1999).

The main drivers of agility includes; quality and speed to market; widening customer choice and expectation; competitive priorities for responsiveness, new product introduction, delivery, flexibility, concern for the environment and international competitiveness (Goldman et al., 1995).

The comparison between lean and agile paradigm within the manufacturing environment has been discussed in various aspects. Naylor et al., (1999) had discussed both lean and agile paradigms in relation to supply chain strategies:

> "**Leanness** means developing a value stream to eliminate all waste, including time, and to enable a level schedule while **Agility** means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place."

In the case of lean, when demand is smooth, the concept of lean can be used to eliminate waste by aiming to maximize profit through the minimizing of physical costs (Womack & Jones, 1996). In contrast, in the case of agility, the key point is that the marketplace demand is extremely volatile (Christopher, 2000). Agility will allow businesses not to cope with, but exploit this volatility to their strategic advantage (Rigby et al., 2000). In order to summarize, lean offers customers good quality products at low price by removing inventory and waste from the manufacturing process, agile manufacturing is on the other hand a strategy for rapidly entering niche markets and being able to serve the specific needs of customers on an individual basis (Maskell, 2001).

Manufacturing Aquariums

The normal production cycle at PD aquarium is 5 working days or more (if the order is received on Monday, the aquarium will be delivered the following Friday but if the aquarium is ordered on Tuesday/Wednesday/Thursday/Friday then the customer will have to wait until Friday, the week after). As a company policy, no orders are received during the weekends. After orders receipt, the administration clerks would check inventory and raw materials. If raw materials were found to be insufficient then an order for raw materials would be sent to the suppliers.

An aquarium consists of an aquarium body, which is made of glass and the cover, which is made of acrylic plate. The two parts are separately manufactured. The final assembly is done by installing an acrylic stripe on the aquarium to support the aquarium cover. The most important raw materials for aquarium making are glass sidings. The glass suppliers usually supply the required pieces of glass in size and thickness as per the order requested. Their delivery lead time is usually within 1 to 2 days.

For the cover, the main materials are acrylic plate, and some imported chemicals for cleaning and fixing the acrylic plate. The suppliers need at least 10-15 days to deliver the acrylic plates and around 30 to 45 days for the chemical substances. Therefore, at least one hundred acrylic plates in various colors and thickness must be kept at PD manufacturing plant. Another main component for cover is the lighting set, in order to save time and reduce the work-load, the ready-to-install standardized lighting sets must be pre-ordered. The lighting sets can usually be delivered to PD aquarium within 7-10 days. The summary of order cycle time for materials is shown in Table II here below.

Table II: Summary of Raw Material for Aquarium Production

Production Part	Raw Material	Delivery lead time
Aquarium Body	Glass	1-2 days
Cover	Acrylic	10-15 days
	Chemical Substances	30-45 days
	Lighting sets	7-10 days

Source: the Authors

The orders received from retailers are used to set up the weekly production schedule, which will be sent to the production line. The production schedule is copied into three sets to be sent to three groups of workers; 10 workers are assigned to aquarium glass assembly, 5 workers for sawing. The rest (35 workers) are responsible for activities such as material and component preparation, cover producing, or any other production activities within the firm. After manufacturing, the finished products will be kept in the finished product area, until it is the shipped to customers (only on Friday). Most customers are aware of this peculiar production rule and usually place orders on Mondays in order to receive aquariums on Fridays. This inflexible production schedule of the company does not allow the company to respond quickly enough to emergency orders or specific made-to-order.

Methodology

Process mapping was done in order to understand the processes involved in aquarium manufacturing. The process mapping of PD aquarium firm in this study is illustrated in figure 1. The process mapping identifies key activities of the processes from the starting point where customer place an order to the point where the order is physically delivered to customer. The flows of information and physical products are linked together with the control mechanisms, such as production schedule and raw material inventory control.

Figure 1: Process mapping for aquarium manufacturing firm

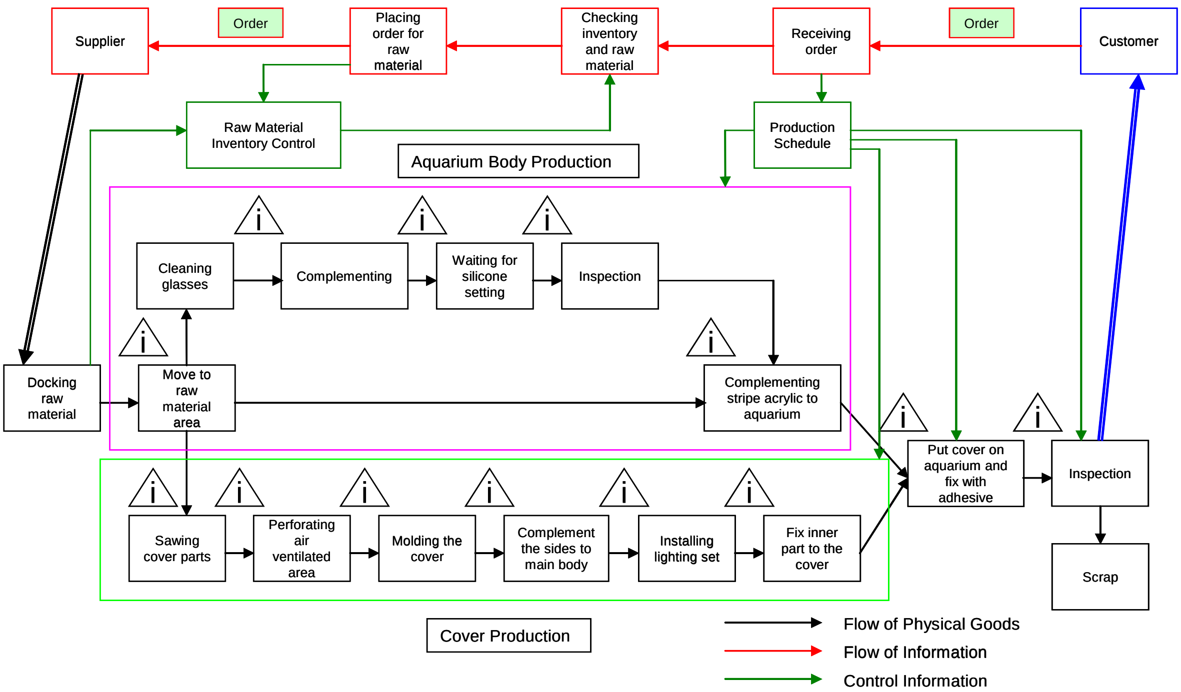

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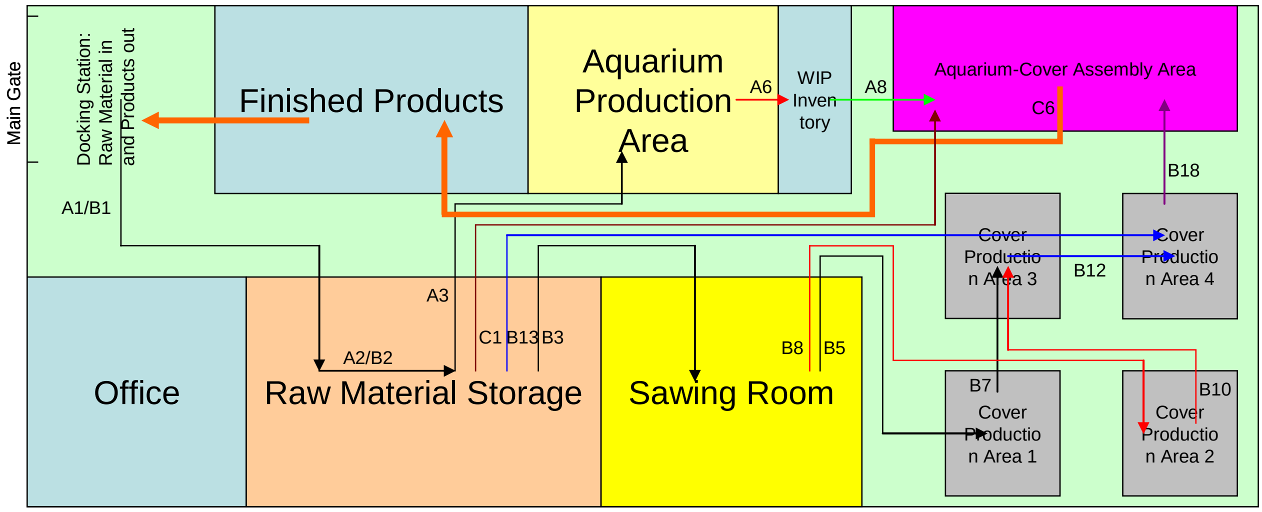
Figure 2: Existing factory layout and movements of WIP



Remark: Based on Process Activity Mapping Tables

A: Aquarium Body Production Process

B: Cover Production Process

C: Component Assembly Process

Source: The Authors

Figure 2 illustrate the plant layout and the movement of WIP within the plant. In order to understand more in details the activities involved, the authors appraised the value stream (Hines & Rich, 1997), which identifies activities, type of activities (i.e. value-added, non value-added and necessary but non value-added), and the time involved for each activity. Since the production of an aquarium is divided into three major phases, the aquarium body, the cover, and the assembly between the two components, these 3phases are represented in Table III to Table V.

Table III: Activity Mapping of Aquarium Body

#	Step	Flow	Area	Dist	Ave Time	V	N	NN
1	Docking raw material (glass)	S	Docking Station		1.0			
2	Move raw material to raw material area	T	Raw Material Storage	39	3.8			
3	Move raw materails (Glass) to Aquarium production area	T		33	3.8			
4	Cleaning 5 major pieces of glass	O	Aquarium Product. Area		10.0			
5	Complementing	O	Aquarium Product. Area		20.0			
6	Waiting for silicone setting	D	WIP Inventory		1440.0			
7	Inspection	I	WIP Inventory		2.0			
8	Move to finished Aquarium-Cover Assemble area	T		21	7.5			
	Remarks: V - Value-Added Activity			Total Time		30.0	15.0	1443.0
	N - Non Value-Added Activity			Percent		2.02%	1.01%	96.98%
	NN - Necessary but Non Value-Added Activity		Percent (exclude silicone setting time)			62.50%	31.25%	6.25%

Source: The Authors

From Table III, it can be observed that non value-added activity contributes to more than 30 percent of total lead-time. The process of silicone setting as seen in step 6 is considered as a necessary but non-value added activity instead of non-value added because of the technical characteristic of the production process. At least 24 hours has to be allowed for the silicone to set, if not production defect will occur.

From Table IV, non value-added activities for aquarium cover contribute to 19 percent of the total lead time, which is considerably lower than that of the aquarium body production process. The reason is mostly due to the acrylic plate, which is easier to move and less time consuming to assemble than the aquarium body production process.

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Table IV: Activity Mapping of Aquarium Cover

#	Step	Flow	Area	Dist	Ave time (Min)	V	N	NN
1	Docking raw material (Acrylic plate and lighting set)	S	Docking Station		0.2			
2	Move raw materials to raw-material-area	T	Raw Material Storage	39	0.4			
3	Move raw materails (Acrilic) to sawing-room	T	Sawing Room	22	0.3			
4	Sawing cover parts							
	main	O	Sawing Room		10.0			
	sides	O	Sawing Room		5.0			
	inner part and acceessories	O	Sawing Room		10.0			
5	Move "sides" to the production area 1	T		21	0.6			
6	Perforating and decorating the air ventilated area	O	Cover Production Area 1		12.5			
7	Move the completed ones to production area 3	T		10	1.2			
8	Move the "body Plate" to the production area 2	T		33	1.5			
9	Moulding the body of the cover	O	Cover Production Area 2		7.5			
10	Move the complete ones to production area 3	T		18	3.0			
11	Complement the sides to the main body	O	Cover Production Area 3		12.5			
12	Move the complete ones to production area 4	T		10	5.0			
13	Move inner parts and accessories to productiion area 4	T		48	1.2			
14	Move lighting sets from raw-material-area to production area 4	T		48	1.0			
15	Installing the lighting set	O	Cover Production Area 4		15.0			
16	Fixed the inner part to the cover.	O	Cover Production Area 4		15.0			
17	Lighting test	I	Cover Production Area 4		15.0			
18	Move the complete cover to Aquarium-Cover Assemble area	T	Finished Product Area	10	10.0			
				Total Time		87.5	24.2	15.2
				Percent		68.95%	19.05%	12.00%

Source: The Authors

Table V: Activity Mapping of Component Assembly

#	Step	Flow	Area	Dist	Aver Time	V	N	NN
1	Move acrylic raw material from sawing room to Aquarium-Cover Assemble ar	T		45	0.3			
2	Complementing the stripe acrylic to the aquaruim	O	Aq-Cover Assembly Area		20.0			
3	Wait for silicone setting	D			1440.0			
4	Put the cover on the aquarium	O	Aq-Cover Assembly Area		1.0			
5	Fixed with adhesive tape	O	Aq-Cover Assembly Area		2.0			
6	Move to the finished product area.	T		45	5.0			
7	Inspection	I	Finished Product Area		5.0			
				Total Time		23.0	5.3	1445.0
				Percent		1.56%	0.36%	98.08%
			Percent (exclude silicone setting time)			69.07%	15.92%	15.02%

Source: The Authors

From Table V, the waiting time for silicone setting and inspection are considered necessary but non value-added activities. The percentage of each type of activity is similar to that of the cover production process.

Existing Problems

Under the current production processes, there are three major problems within the company that must be addressed. The first problem is the unnecessary/excessive movement of work in process within the company. From Figure 2, it can be seen that the work in process has to move back and forth within the factory area. This causes inefficiencies in the production processes which results in unnecessary high production lead time and increased workload. The unnecessary movement of raw material and work in process is mainly caused by inappropriate plant layout.

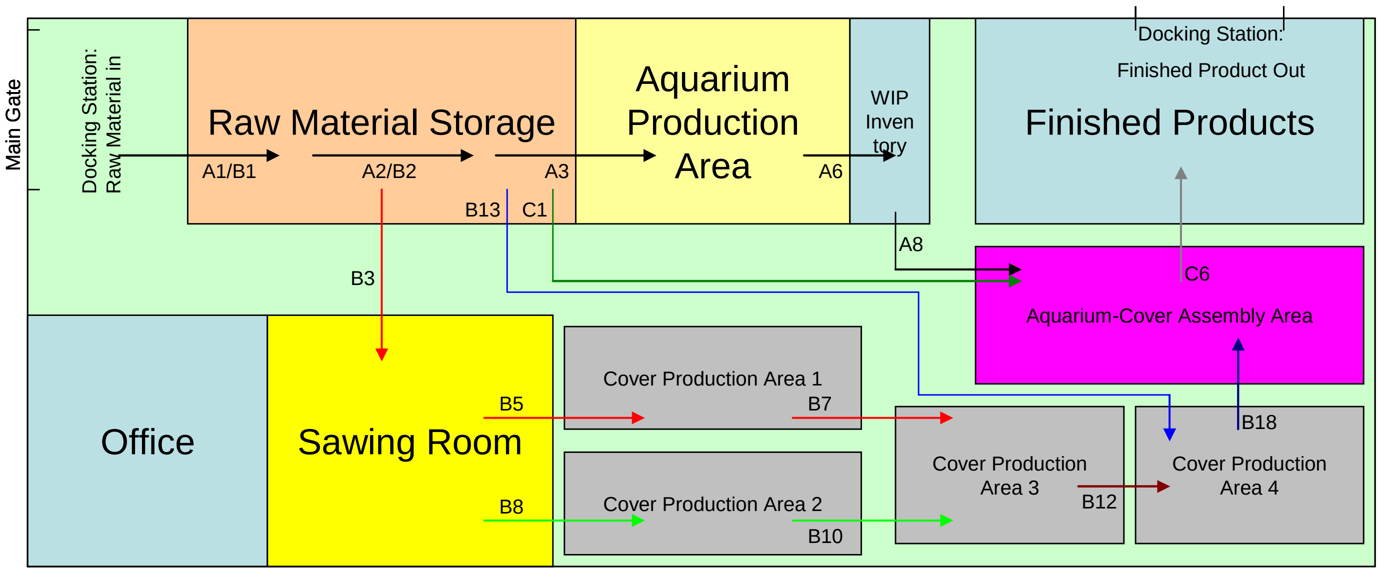
The second major problem is the long lead time for order delivery. Since the production schedule is set on a weekly basis, all orders coming later than the beginning of the production cycle (Monday) will have to be put into the next production cycle. This inflexible production schedule, based on the current production system, creates long lead time for order delivery and relative customer dissatisfaction

The third major problem is related with product quality. Normally, 10 to 15% of finished products are not up to standard and usually rejected by customers. All of these products cannot be reworked, but rather has to be scrapped. In addition, it is difficult to identify the responsible person for defective items.

Applying lean and agile strategies to PD aquarium

Under the concept of lean manufacturing, non value-added processes shall be minimized, or even eliminated if possible. The application of this concept is very appropriate in order to solve the first problem discussed in previous section; unnecessary movement of raw material and work in process must be eliminated. Therefore a new plan layout is proposed in order to reduce the movement of raw materials and WIP within the manufacturing plant as illustrated in Figure 3.

Figure 3: proposed factory layout and movements of WIP



Source: The Authors

It is noticed from the new plant layout that the total travel distance of work in process inside the factory has been reduced drastically. Raw materials and work in process flow in the same direction without going back and forth. The finished products can be sent out of the plant from the second docking station designed for the proposed factory layout, as seen in Figure 3. The details of the impact of the new plant layout can be seen in Table IV and Table V.

Table IV: Summary of Travel Reduction between Previous and Proposed Factory Layout

Production Process	Travel Distance Reduction (m)	Travel Distance Reduction (%)	Total Processing Time Reduction (min.)	Total Processing Time Reduction (%)
Aquarium Body	48	51.61%	8.2	17.08%
Cover	53	20.46%	4.0	3.13%
Component Assembly	45	50.00%	3.5	10.66%
Total	146	33.03%	15.7	7.55%

Source: The Authors

Table V: A Summary of Changes in Amount of Activity between Previous and Proposed Factory Layout

Production Process	Value-Added Activity	Non Value-Added Activity	Necessary but Non Value-Added Activity
Aquarium Body	12.88%	-14.16%	1.29%
Cover	2.23%	-2.62%	0.39%
Component Assembly	8.24%	-10.03%	1.79%

Source: The Authors

Only one lean strategy was proposed in this case (i.e. the elimination or reduction of travel distance for raw materials and WIP within the plant). This lean strategy has led to the redesign of the plant layout, which reduced the amount of non value added activities. However, if the lean paradigm was fully implemented, other types of waste would have been dealt with and the final results may possibly be even more impressive.

Agile Strategy

While lean strategy is capable of dealing with problem of unnecessary movement of raw material and work in process effectively, the other two problems, long lead time for order delivery and production quality, must be dealt with by using agile strategy. In the current situation, the firm has 50 workers on the production floor. Five of the workers are responsible for making aquarium body, another five for sawing, and the rest for cover and component assembly.

In order to solve these two problems, team-based production has been introduced in the firm as part of agility improvement. Through this strategy, the workers will be divided into five groups. Each group will consist of one worker responsible for sawing, two workers for aquarium body, and seven workers for cover and component assembly. The main objectives of the team-based strategy are two folds. First, when the workers are divided into small groups, it will be much easier to identify the team responsible for product defects as each team will be each assigned with the manufacturing of an aquarium at a time. The comparison between the previous structure and team-based structure is described in Table VI.

Table VI: Comparison between Previous Structure and Team-based Structure on Quality Aspects

	Previous Structure				Team-Based Structure			
Process	Responsible Workers	Ability to Idenfity Cause of Problem	Ability to Implement Statistical Process Control	Ability to Improve Product Quality	Responsible Workers (per team)	Ability to Idenfity Cause of Problem	Ability to Implement Statistical Process Control	Ability to Improve Product Quality
Sawing	5	High	High	High	1	High	High	High
Aquarium Body Production	10	Medium	Medium	Medium	2	High	High	High
Cover Production	35	Low	Low	Low	7	High	High	High
Component Assembly	35	Low	Low	Low	7	High	High	High

Source: The Authors

The second objective of team-based manufacturing strategy is to enhance the firm's flexibility. The team-based strategy allows the production cycle of each team to be different, depending on the production schedule assigned to each team. If the order is received on during different days of the week other than Monday, the client will not have to wait for following week, but will rather be assigned to the next available team. The difference in lead time from order receipt to order shipment between the firm's previous structure and team-based structure is shown in Table VII.

Table VII: Comparison between Previous Structure and Team-based Structure on Cycle Time

Customer order placement date	Customer order shipment date				Order Lead Time Reduction (days)	Order Lead Time Reduction (percent)
	Previous Structure	Number of Days	Team-Based	Number of Days		
Monday	Friday	4	Wednesday	2	2	50.00%
Tuesday	Next Friday	8	Thursday	2	6	75.00%
Wednesday	Next Friday	7	Friday	2	5	71.43%
Thursday	Next Friday	6	Monday	2	4	66.67%
Friday	Next Friday	5	Tuesday	2	3	60.00%

Source: The Authors

From Table VII, it can be seen that the team-based structure allows the company to shorten the lead time between 2 to 6 days depending on the order date. This improvement will ultimately lead to better responsiveness to customer demand. In summary, the impact of the team-based strategy, based on the agile paradigm, can be illustrated in Table VIII.

Table VIII: Impact of Team-based Strategy

	Previous Structure	Team-based Structure
Lead time to deliver customer order	4-8 days	2 days
Ability to find causes of defects	Low	High
Responsiveness to emergency order	Low	High
Responsiveness to special order	Low	High
Flexibility in production schedule	Low	High

Source: The Authors

Conclusions

Many researchers and practitioners have argued on the respective merits of lean and agile strategies. The main objective of lean is on eliminating waste, while agile concentrates on maximizing responsiveness to customer demand. In this case study, lean strategy helped the firm to reduce the time and costs of transport for work in process by almost 10%, but lean does not deal much with regards to uncertainties from customer demand in particular emergency or special orders. An agile strategy may help the firm alleviate these customer demand problem, but it does not eliminate inefficiencies along the production processes. The summary of comparison between lean and agile strategy derived from this case study is shown in Table IX.

Table IX: A Comparison between Lean and Agile Strategy

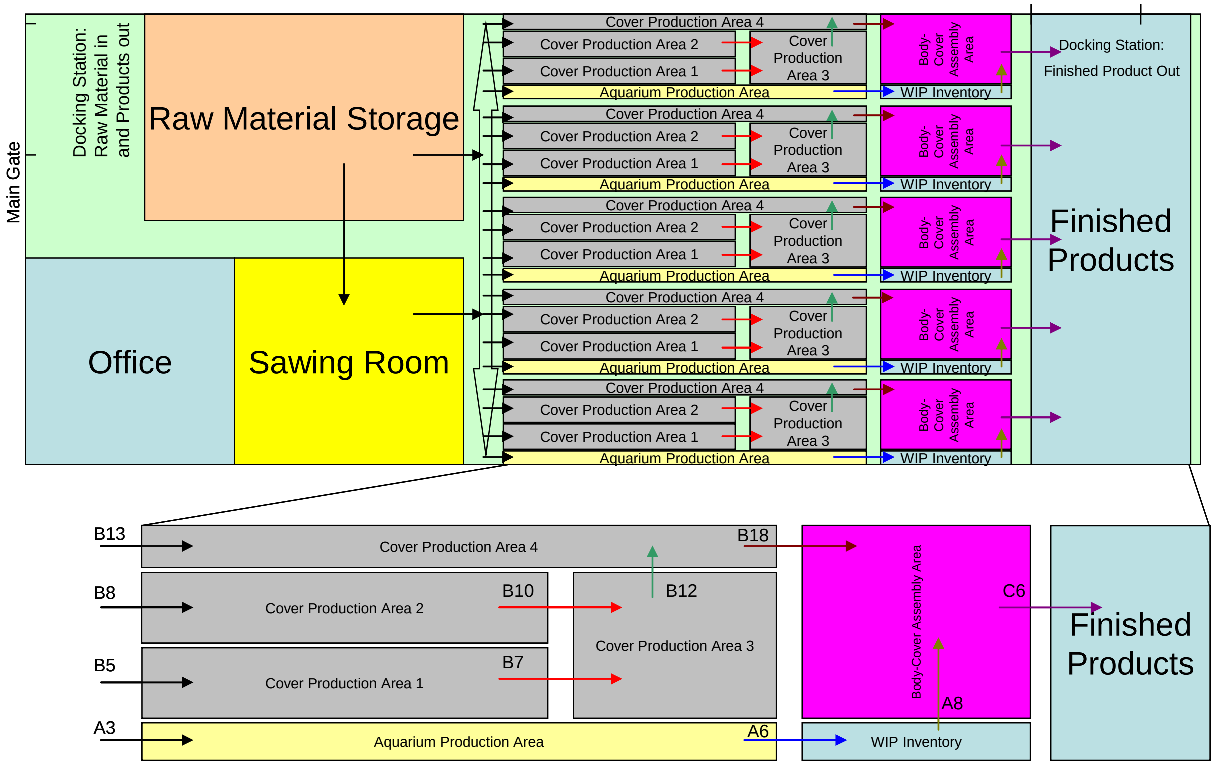
	Lean Strategy	Agile Strategy
Non value-added work	Decrease	No Change
Worker's productivity	Increase	No Change
Production cost	Decrease	No Change
Quality of product	No Change	Increase
Responsiveness to customer demand	No Change	Increase
Flexibility on production schedule	No Change	Increase
Inventory level	Decrease	Decrease

Source: The Authors

This study has attempted to demonstrate the impact of one lean and one agile strategy. The selection of only one strategy for each paradigm, rearranging factory layout for lean and team-based production for agile, provides very different results. It can thus be concluded that lean and agile strategies have their own strengths and weaknesses. It is therefore possible for PD Aquarium to apply both strategies in order to optimize their production process. In this case, what was proposed was to incorporate team-based strategy, based on the agile paradigm and optimized factory layout, based on the lean paradigm. The illustration of this combined strategy is shown in Figure 4 hereunder.

The main limitation in this study is the use of only one concept for each of the lean and agile strategy to demonstrate the different outputs. In reality, there are numerous strategies to choose from in order to enhance leanness and/or the agility of manufacturing firms. This might yield different results from those found in this study. Future research may explore more on the results of other lean and agile strategies in order to fully compare the two paradigms. Future research might also be conducted in order to see the result of the combination of both strategies, whether the summation of the strengths of each strategy will really deliver enhanced customer service while lowering cost at the same time.

Figure 4: Proposed new factory layout with team-based strategy



Source: The Authors

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