

Improve Production Process Performance By Using Lean Management — A Case Study of Lady Underwear

(Full Paper)

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ABSTRACT

People around the world work every year to improve the requirement standards of various commodities. Product life cycles are getting shorter, replaced by a number of innovative products; thus, in order to adapt to social changes, companies must develop a number of innovative products to attract consumers to buy. In Taiwan, most development occurs in small and medium traditional industries. Women's underwear is a personal privacy product. As women are gradually being taken more seriously, women's underwear products are gradually increasing in value, but the women's underwear and underwear fabric design process is quite complex and time-consuming. To help enterprises improve production performance, this study introduces lean enterprise management, using IE tools for program analysis, which provides time to study the law, and 7S management practices, identifies problems, and proposes ways to improve in order to verify the practices and analysis of results. Research pointed out that introducing lean management for enterprises to improve process performance, so that women's underwear product processes achieve significant improvement, improved results as follows: Before and after the improvement, GAP reached 23.83%; product production time was reduced; employee take line operation time reduced; quantization benefits of \$1,909,425 improved the efficiency to \$1,023,225, putting the cost at \$106,200; and table bad rate increased the cost by \$780,000. These results show that in the present study, lean management practices successfully improved the production performance of the women's underwear industry included in this study. It is expected that the process improvements can provide a method for the lingerie industry to continuously improve and succeed in raising the performance feedback of employees to increase cohesion so that the company reaps more profits and benefits.

Keywords: Women's underwear industry, lean, 7s, program analysis, time study.

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INTRODUCTION

The global population and average number of people is increasing, gradually increasing daily necessities and other needs. The majority of demand is in the international market, so the industry has been actively developing new products and new equipment. The textile industry is currently Taiwan's industrial structure, the most complete production system, and is one of the main functions of the consumer market of textile raw material supply sources. Women in modern society pay more and more attention to lingerie fabrics, quality, and style, resulting in transitions in women's underwear brand products being sought in other ways. Product research and development performance, functionality, real-time market changes, the brand and needs of manufacturers, and other raw materials and materials have led to a certain amount of stock, likely to cause a huge increase in stock, for which management is not easy, leading to warehouse clutter and increased warehousing and staff time to pick up. In order to increase the competitiveness of enterprises, shorten production time, and reduce input costs to improve the process-oriented research for underwear and key job development projects, this project wants to help manufacturers effectively enhance corporate performance, creating a win-win situation for manufacturers and customers.

The objectives of this study are as follows:

1. Use 7S management practices to straighten, sweep, clean, ensure quality, ensure safety and conservation, and improve warehouse site problems.
2. Use 7S management and the existing management infrastructure to make certain adjustments, which will also ensure that underwear production site management achieves a certain level so that the whole production system uses a lean management system for continuous improvement.
3. Introduce lean management concepts to improve the company's visibility and demand and reduce unnecessary problems.
4. Use IE's seven tools program analysis method and time study to reduce waste and improve the underwear production line to improve the manufacturing process.

BACKGROUND

The content of this section is divided into the textile industry, women's underwear industry, lean management, PDCA, 7S management practices, IE's seven tools, lean management literature, the textile and garment industry, textile policy analysis, and manufacturing processes. The current status and evolution of some women's underwear industries, mainly in Taiwan, will be provided, as well as the main content of lean management, PDCA, 7S, IE's seven tools for documentation methods and techniques, literature, and finally, lean management applications in different fields of information to provide a clear understanding of how lean management works.

2.1 Textile and Clothing Industry SWOT Analysis

Superiority (Chung, 2015):

- Construction of a complete system supplier, in close connection with the upstream fiber, yarn, and fabric of the supply chain to ensure a fast response.
- Solid industry clusters, focusing on strategic alliances and technical cooperation to improve the hardware and software infrastructure, as well as a good investment environment.
- In recent years, the government created four modernizations of industry policy.

Weakness:

- Output is concentrated in the upper reaches of export-oriented, competitive prices vulnerable to fluctuations in climate impact.
- Innovative research and development and design of marketing talent, as well as inadequate investment.
- Mostly take orders OEM mode operation; lack of international brands and sales channels.

Opportunity:

- Fast fashion market rise, shorter product life cycles and increased demand for underwear.
- Growing importance of the governance of traditional industries.
- Foreign manufacturers come to Taiwan, commissioned by the processing and opportunity to increase cooperation.
- Consumer brand loyalty is not high; thus, enhancing the product's advertising and promotional activities to attract consumers is important.
- Cooperative education and cultivation of underwear design talent; transition from the OEM ODM own underwear brand, with international visibility and easy access to international markets.

Threat:

- Environmental issues derived from green trade barriers.
- The rapid rise of emerging countries such as China and Southeast Asian countries, the garment industry, and heavy investment in fiber raw materials, production technology, and low-cost products to China pose a threat.
- Internationally signed FTA with the RTA increases the pressure on China's exports.
- Taiwan businessmen can set up factories overseas, ensuring overseas transfer of production technology to local competition and the formation of the Taiwan situation.

2.2. Clothing Industry Manufacturing Process

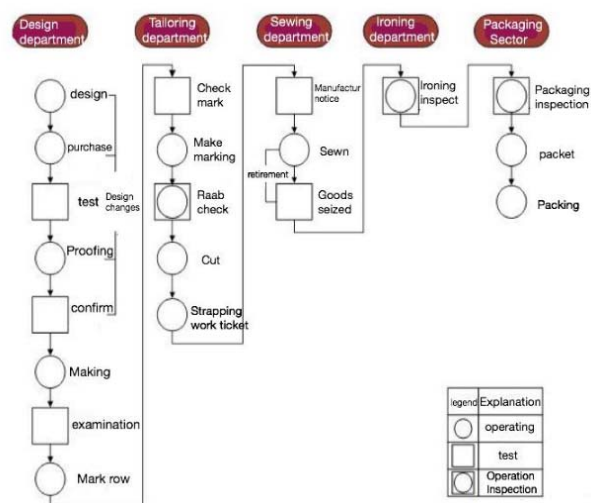


Figure 2.1 Clothing Textile Process Diagram
(Taiwan Textile Foundation, 2015)

2.3. Lean Management

Katayama and Bennet (1996) gave a brief definition of lean production, stating that “lean production is a dynamic system,” which requires less investment of resources, but it can get better, yielding high added value. This refers to a dynamic system; for example, Toyota implemented the Toyota Production System, as shown in Figure 2.7, which involves six main processes: (1) lean design, (2) lean supply, (3) lean manufacturing, (4) lean distribution, (5) lean, and (6) mining value. With these six processes and continuous improvement of the rotation, plus the five principles of lean, lean production forms the entire structure to achieve minimal investment to create products with high added worth.

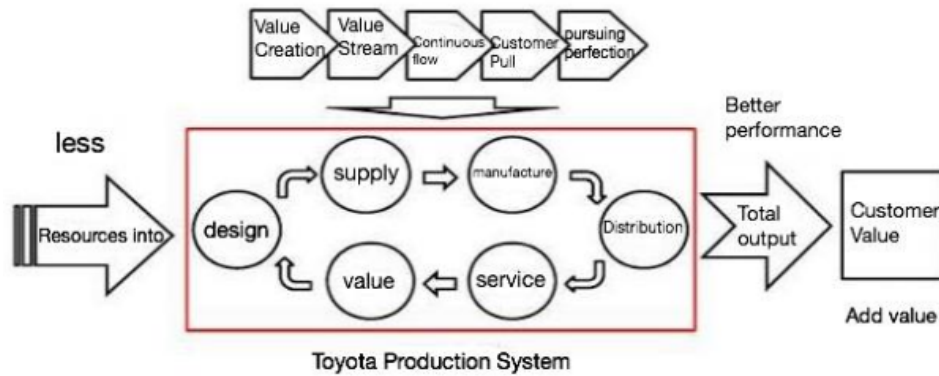


Figure 2.2 Lean Production System Diagram

2.3.1 Five Principles

These six processes and continuous improvement of the rotation, plus five lean principles—(1) value, (2) value stream, (3) flow, (4) pull, and (5) perfection—form the entire lean production structure to achieve the minimal investment to create products with high added worth (Womack and Jones, 2004).

2.3.2 Seven Wastes

The spindle lean production system was developed by the Toyota Production System founder, Ohno (1912-1990), called the father of Japanese resurrection and the production management godfather by the Japanese. He categorized the seven wastes as follows: (1) manufacturing excessive waste, (2) waiting, (3) waste handling, (4) processing itself, (5) inventory of waste, (6) the action of waste, and (7) producing undesirable waste.

2.4. PDCA (Plan-Do-Check-Action)

The PDCA (Plan-Do-Check-Action) cycle is a quality management cycle developed by the American scholar W Edward Deming to ensure the goal of reaching reliability and thus promoting continuous quality improvement. It is usually used to improve product quality and the production process.

- (1) Plan: Establish a clear vision, develop relevant programs, and determine the necessary procedures.
- (2) Do: This step is performed on the specified plans and procedures to collect the necessary information to provide the basis for further amendments and improvements.
- (3) Check: Product reliability assessment and evaluation of the reliability of operational control and auditing. This step involves collecting information on the research, design, and expectations to compare. These differences are the next step in the necessary data assessment.
- (4) Act: Between various operating units of the reliability of work coordination, improvement measures are set to improve the implementation of actions. This step is performed to find ways to reduce the considerable gap between program objectives and the implementation process, so that the next scheduled process will become more perfect.

2.5 7S Management



Figure 2.3 7S Schematic

2.6 IE's Seven Tools

The basic technique is motion study developed by the parent of industrial engineering (Taylor, 1911). These two inventions are based on an extension of the development so far. Practical work, continuing to use a variety of knowledge, discover, analyze, and summarize is summarized in the seven field engineering tools to improve the common methods, or IE's seven tools.

2.6.1 Process Analysis

The following questions (5W1H) are usually asked based on the analysis of the selected job regarding object, place, time, personnel, and methods: (1) Why, (2) What, (3) Where, (4) When, (5) Who, and (6) How. This is combined with the four ECRS principles (delete, merge, rearrange, and simplify) to improve and find smoother working practices and workflow.

2.6.2 Time Study

Taylor (1911) pursued a fair standard to measure the time required for a variety of work and training workers to work at a predetermined speed, thereby obtaining the most efficient results. The research was to determine the time required for one reasonable method of workload; time was the ultimate goal of the research. Considered a reasonable workload for both employers and employees as fair. In addition to a reasonably wide release time, employees should be committed to the implementation of production operations and abide by the established methods of work in order to obtain reasonable remuneration.

2.6.3 Motion Study

This is a subtle analysis of human movement during the operation of a variety of work, aimed at eliminating redundant operations to make the operation easy and effective to improve efficiency and reduce worker fatigue, as well as to develop best practices. Operator action will be implemented in order to record with a specific mark the hand and eye as the center of the human body in motion content to grasp the actual situation, and the recording of the chart is a basis to determine the action as good or bad to find a way to improve the focus of the analysis.

2.6.4 Work Sampling

This is the use of sampling methods of observation dispersed quickly and effectively to understand the truth of the matter and develop ways to improve. The main application checks the work setting and works to improve the standard time in practice. The work sampling method and time to study the law code table method are very similar; the differences in the code table method are the continuously short observation period of the operator or machine operations, application of high and repetitive short weeks away work, work and checking randomly over a long period, and decentralized earth observation of operator or machine, which is more suitable for non-repetitive jobs or longer work week processes.

2.6.5 Man-Machine Chart

This is a graphical study to explore the worker and machine operation process and to record and conduct further analysis to improve the waiting time to find out the working balance, reduce cycle time, maximize machine utilization, properly assign personnel, and determine the most appropriate method.

2.6.6 Foolproof

This is prevention of common life careless errors to prevent the risk of error and determine a foolproof mechanism to apply to the mechanical operation of the workplace, the general life of the product, and even word processing. The basic principles include the following four points: (1) make the job operation easier, (2) does not need to make the job skills and intuition, (3) ensure that the job is not in danger, and (4) ensure that the job does not rely on the senses.

2.6.7 Line Balance

Based on the job engineering sequential pipeline operations, the production target is calculated cycle time, split the job, or in combination; the load of each step is averaged to remove the production process of handling or stagnant waste, thereby producing a smooth flow to increase productivity. This is done to achieve the production line balance rate and per capita production increase, unit product cost reduction, and other results.

RESEARCH METHODS AND PROCESSES

3.1 Lean Management Import Steps

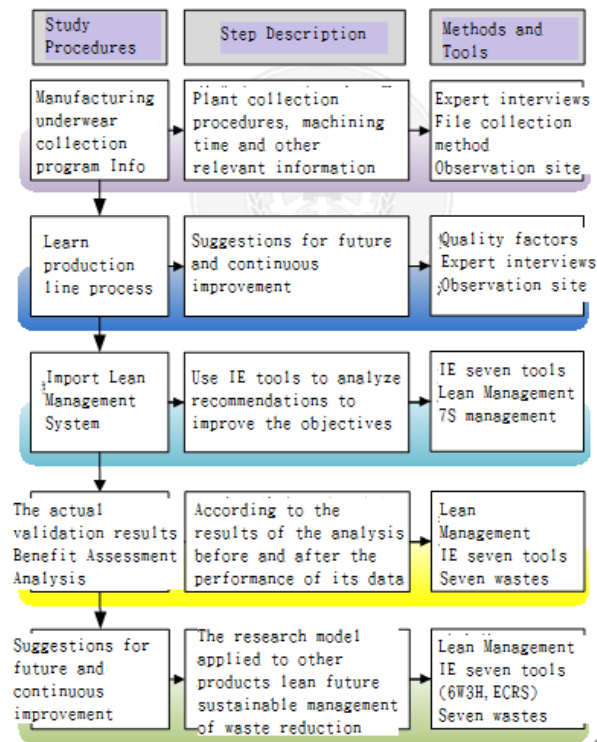


Figure 3.1 Study Flowchart

3.2 Lean Management Analysis Step

Step 1: Integrate lean management activities into the system. Step 2: Use IE's seven tools and look for value improvement tools after determining improvement targets. Step 3: Conduct application analysis of the target workstation job, as well as deeper analytical work.

Table 3.1 6W3H Asked France

6W3H	Question
Why	Why is this being done (purpose)
When	When should it be done (time)
Who	Who will execute it (equipment/person)
Whom	Who are the customers (Wacoal/case company)
Where	Where should it be implemented (place/position)
What	What to do (objects)
How	How to do it (method)
How much	How much does it cost (funding)

How many	To improve several production lines (program)
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Table 3.2 ECRS Analysis

ECRS	Explanation
Eliminate	Is it necessary? Why?
Combine	If the work cannot be canceled, you can consider the possibility of merging with other work.
Rearrange	Rearrange the order of the work.
Simplify	Simplify all work content and procedures.

Table 3.3 Program Focus Analysis

Engineering	Focus	Investigation of major projects
Overall	Is there a project that can be excluded?	Process number
	Are there workstations that can be combined?	Processing time
	Can you simplify the process?	The number of processes
Process	Is the process necessary?	Processing time
	Can you merge processes?	
	Can you change the order of processing?	
Examination	Is there a need to check?	Inspection method Check the time
	Will each product need to be checked?	
	Check whether the standards are appropriate. Can you reduce the number of inspections?	
Wait	Is there a long wait?	Waiting time
	Can the waiting time be eliminated?	Waiting times
Transport	Can you reduce the transportation distance?	The transportation distance
	Can you reduce handling times?	Handling times

WOMEN'S UNDERWEAR LEAN MANAGEMENT CASE VERIFICATION

This study focuses on the women's underwear industry in order to verify the substantive improvement in the status of the plant as a case study.

4.1 Case Company Profile

Founded in 1922, it is located in Taichung, and the brand is currently approached in the absence of the ability and talent development stage. The company is primarily an OEM manufacturer, one of Taiwan's traditional industries, and lacks a lot of work. It is focused on human services and the electronics industry. For the sake of innovation, the company completely eliminated the old employees and machines and shaved preconceived notions from OEM transformation into ODM to lay the foundation for the successful transformation of the case company. In response to the dramatic changes in the international competition, and internal and external business environment constraints, the case company's future development strategy is as follows:

1. The development of differentiated, multifunctional, and other products
2. Emphasis on innovation and design creativity
3. Development of own brand

4.2 Improvement Objectives

The case company's product categories are: recoil, pajamas, functional, health, clothing, standard, and numerous models of standard underwear products for maximum yield. Underwear is the company's biggest case and most stable product, so this study uses the case company's standard underwear products as the research object.

4.2.1 Before Improvement

This study will collect the required information as follows:

1. The working time of each workstation and employees: The factory production line time is 11 hours per day, minus one hour per day for meal breaks, which equals 10 actual working hours; after deducting machine malfunction, staff rest, maintenance, repairs, etc., the company's production capacity can be obtained, and gathering the actual number of jobs for each project personnel

member to improve workstations is required.

2. Product process will go through another workstation: This study will improve the target set for the standard underwear products and the understanding of the production process to collect information about the production line to better ensure that nothing is missing.
3. Standard underwear production process time: This study will improve the production of standard underwear products, provide in-depth understanding of the production process, and track the process of working hours, using the code table method of field to field observation. The observation environment must be comfortable, it must be easy to move, and it should not affect the position of product processing and operator work. After completion of the data collation, calculation will be conducted.
4. The sewing machine changeover time: The products of the case company come in many colors. In accordance with the manufacturer for replacement of wires of different colors, this study will record the time to take the wire and the wire change time; the multi-pen will be used to represent the average changeover time.

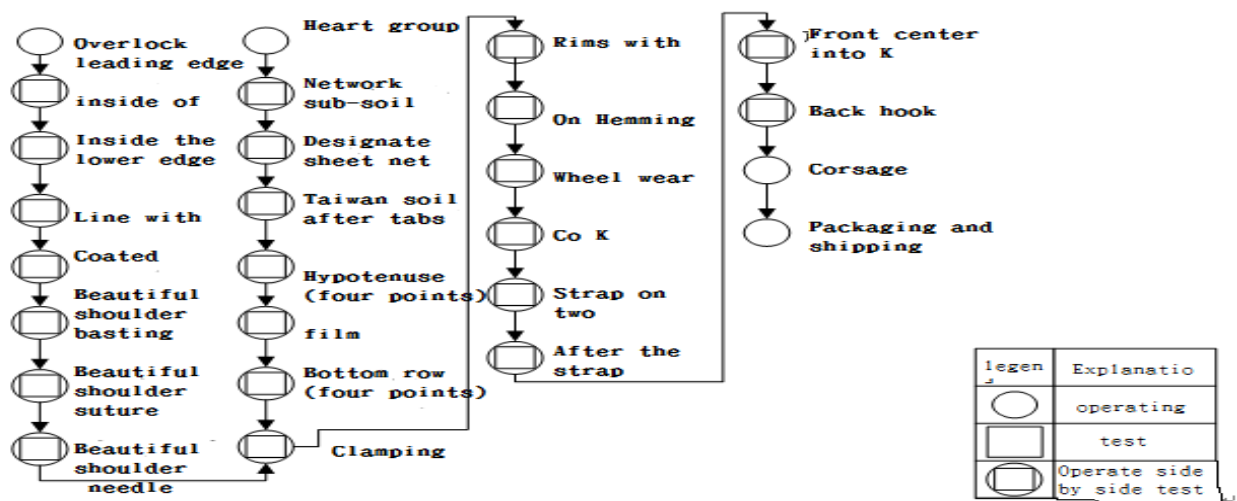


Figure 4.1 Flowchart of Standard Products

4.2.2 Causes and Methods

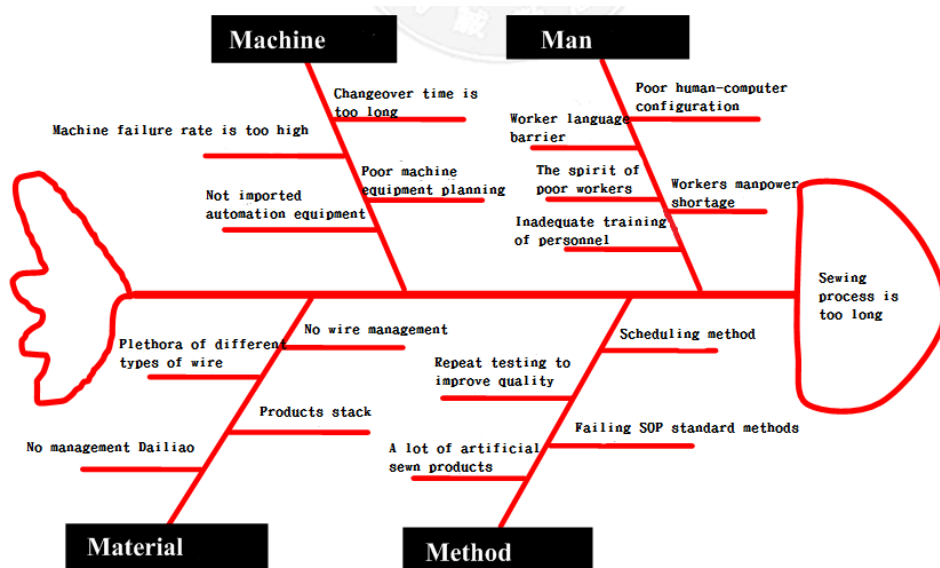


Figure 4.2 Process time characteristic fishbone diagram

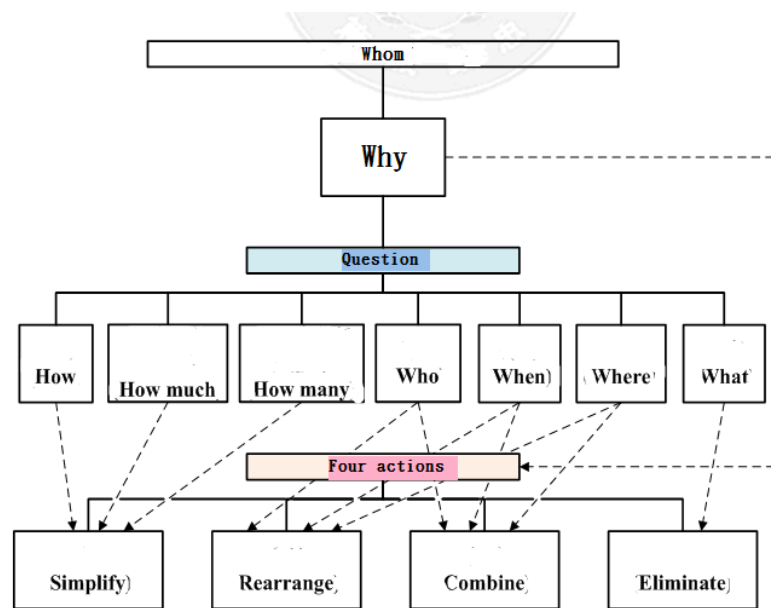


Figure 4.3 IE's seven tools and 6W3H-ECRS

4.2.3 After Improvement

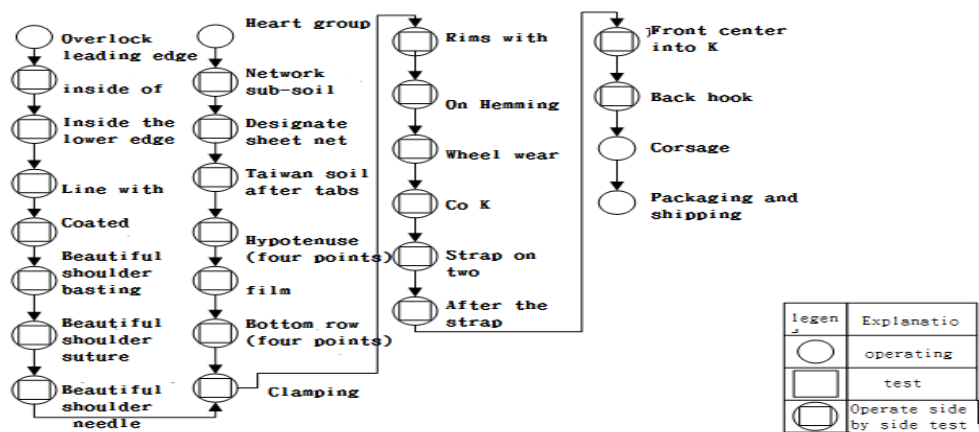


Figure 4.4 Pictures of improved operating procedures

4.3 Summary

This study will improve the target set for the production of the maximum number of products using program analysis to find out the case company's problem, determine the desired characteristics because of FIG rendering problems, measure the flow of work through the code table method along with the use of 7S management improvement, and finally, use the operation FIG procedures and processes to improve the program chart, comparing the difference between the front and rear to give the following results:

1. Improve underwear production performance.
2. Reduce the sewing machine to replace the wire operating time.
3. Improve the effectiveness of \$1,023,225 to \$1,909,425, quantify the benefits, costs \$106,200 investment, and enhance the rate of adverse cost to \$780,000.
4. Strengthen the concepts of the traditional industries of industrial engineering and lean management to enable enterprises to successfully implement continuous improvement and improve production performance. Related industries will want to study this model, which can be applied to other products to ensure smooth production.

Based on the above analysis, internal management attaches importance to management efficiency and stability, and it matches base type. Product service needs to attach importance to product quality and service diversity at the same time, and so it is suitable to

adopt follow-up type. External management is suitable for innovation type to cope with a rapidly changing market.

CONCLUSION AND SUGGESTION

5.1 Analysis Conclusion

The results of this study show that introducing the lean management system successfully reduced production time for the enterprise products, eliminated inventory waste, and improved corporate reputation while increasing the competitiveness of enterprises. The conclusions are summarized below:

1. The program can be used as a result of analysis with a characteristic diagram clearly showing the manufacturing process and waste issues, which suggests improvements and solutions.
2. The present study confirms that the company is introducing lean management cases successfully to resolve the problem and reduce changeover time for sewing machines; sewing machine changeover time reduced working time by 1296.60 seconds.
3. Regarding the company's production line, in terms of re-examination process improvement, production of each standard pair of underwear was reduced by 15.01 seconds, and the product production time was reduced by 3.3%.
4. The data will improve the results of cost-benefit, for which the quantization efficiency of \$1,909,425, \$1,023,225 to improve efficiency, input costs \$106,200, \$780,000 non-performing rate increased cost.

5.2 Study Suggestion

1. To improve the results in order to reduce the inventory, take line operator operating time, product testing time, and waste that may occur in other processes, further research can be conducted.
2. This study will improve the standard set underwear products. In the case that there are still many other products that have not improved, future researchers can explore different types of products.
3. The labor shortage has been the company's problem; the future of the company may involve the introduction of automated machines and auxiliary staff to manufacture products while lowering the rate of human action, improving production efficiency in order to cope with market changes.
4. It is recommended that the company involve computer and software companies to facilitate the management and use computer management for raw materials inventory, real-time inventory updates, inventory control, and reducing the waste of raw materials.
5. Visual management and board management can be used to enable staff to track the real-time status of the statistical production line, and production line staff can prepare the site in advance in order to promptly to solve problems.

REFERENCES

- [1] Chung, T.T. (2015). Use Lean Management to Improve the Production Process Performance. (Master Thesis, Feng Chia University, Taichung, Taiwan).
- [2] Katayama, H., and Bennett, D (1996), Lean production in a changing competitive world: a Japanese perspective, *International Journal of Operations and Production Management*, 16 (2), 8-23.
- [3] Ohno, T. (1998). *Toyota Production System: Beyond Large-Scale Production*. Portland, Oregon: Productivity Press.
- [4] Taiwan Textile Foundation, (2015). Clothing Textile Process Diagram, Retrieved from <http://www.textiles.org.tw> (June 25, 2015)
- [5] Taylor, F.W. (1911). *The Principles of Scientific Management*. New York: Harper Bros: 5-29.
- [6] Womack, J.P., Daniel, T. J., (2004). *A máquina que mudou o mundo*, Elsevier Editora, Gulf Professional Publishing.