Enhancing the Service Efficiency of Non-profit Organizations Through Lean Thinking and VSM Analysis: A Case Study of Assistive Device Resource Centers

Abstract
The objective of Non-Profit Organizations (NPO) is to support matters of public concerns. As the social environment has developed, the resources of NPOs have proved to be inefficient to meet their needs, the creation of the “social enterprise” began. This paper presents a case study of applying Lean tools and principles to reduce waste in providing physical disabilities services. The preliminary improvements were made for six months, when the reusable space was increased by 89 % and the transport distance was reduced by 66 %. Finally, the benefits, experience, and extensions of the Lean applied on NPO are discussed.

Keywords
Non-profit organizations, social enterprise, lean thinking, value stream mapping

1. Introduction
Non-profit organizations (NPOs) have a long history of development; but as the social environment has developed, the resources of NPOs have proved to be inefficient to meet their needs. Many social enterprises have demonstrated their social value, and they can ensure their financial autonomy better than traditional NPOs can. O’Neill (2002) indicated that the main income of NPOs comes from service charges and donations from the government and private citizens, of which service charges account for the highest percentage of income, at 40 %[1]. Using transnational data from more than 32 countries in 2003, Salamom et al. showed that service charges made up the highest percentage (53 %), and that charitable donations only made up 12 % [2]. This shows us that service charges are the main source of income. Therefore, if they can be appropriately managed, they could definitely help the organization achieve greater social value.

The case organization used in this study is a type of social enterprise established in 2003 by the Maria Social Welfare Foundation to assist the Ministry of the Interior in promoting social service work in the “Assistive Device Resource Center for the Disabled.” This center has a specialized team to evaluate, recycle, loan, repair, and customize special assistive devices, or provide diverse assistive device services to the physically and mentally disabled and members of the general public who have a need for such devices. The biggest source of income for the center is government subsidies (50 %), followed by charitable donations (30 %) and services charge (20%). Because the government subsidies are a fixed annual amount, faced with the rising costs of materials and the reduction in the amount of charitable donations due to a poor economy, the center will face operations difficulties if they cannot raise service charges to become more self-sustaining.

In these circumstances, though the operations team of the assistive device resource center for the disabled can proactively improve internal operations, the social enterprise is a hybrid organization, where the improvement measures used in traditional NPOs or corporations are not effective. Only by forming a “quality” social enterprise can the social mission effectively be achieved and the social problem addressed to facilitate social progress and transformation. Therefore, the center began to introduce lean thinking based on the concepts of lean manufacturing and lean services, to eliminate waste that cannot create value, to enhance process efficiency and quality, and to reduce costs[3].

We explain lean manufacturing and lean services in the second section of this paper, and then explain our methodology in the third section. In the fourth section, we detail the steps used in our methodology. Finally, our conclusion includes our findings and possible directions for future study.

2. Literature Review
Lean methods originated with the Toyota Motor Corporation. Lean production methods extend throughout the value chain, including production management, product development, supply chain management, and customer service. Lean methods are not merely a tool for improvement, but are also a complete paradigm for corporate management, creating the greatest value for customers using the smallest investment possible[4]. Tools used in lean methods
include value stream mapping, 5S (Sort, Segregate, Shine, Strengthen, and Standardize), kanban systems, just-in-time (JIT), standardization, the 5 whys, automation, and production leveling [5-7]. Production efficiency is increased and costs are decreased by excising waste that does not create value from the period spanning the receipt of customer orders to product delivery [5, 8, 9].

Womack (2005) proposed the idea of lean manufacturing and lean services for the sake of enhancing industrial competitiveness in the study of the process from production to consumption[10]. By showing how eliminating waste in the production and service process creates profit, it allowed more non-manufacturing corporations to be willing to take the road of lean operations. The main goal of lean service is to eliminate waste at the level of the service industry, and the secondary goal is to provide the services required by the customer at the appropriate time and location. The method of people-friendly management includes stable wages, a joint sense of mission between employees and management, a supplier network, a grassroots management mode made up of a committee, and an employee quality control circle.

In general, the practical application of lean service follows the core concept of lean operations, and its primary purpose is explore the pursuit of continuous improvement to meet customer needs. However, because of the differences in characteristics of the manufacturing and service industries, many scholars have proposed that the tools and methods used by lean services are different from those of lean manufacturing. Levitt highlighted that compared to the production line used in mass production, the supply process of the service industry is more likely to lack efficiency[11]. This is because the quality of the service industry is influenced by the service culture over the long term, and thus it is greatly influenced by individual employees. In contrast, the quality level of the manufacturing industry is mainly influenced by its production techniques. In a situation in which the service industry uses a low cost strategy, the concept of mass production can be beneficial to creating a competitive advantage [12]. Lean operations is a mode of thinking that can allow a corporation to pursue continuous improvement, in addition to achieving the goal of adhering more closely to the value required by the customer by following specific management principles.

3. Implementation case Study
The subject of this study was the Taichung Assistive Device Resource Center for the Disabled, which mainly research, develops, and manufactures rehabilitative assistive devices for the disabled, and also customizes products according to special cases. The products include all types of wheelchairs, walkers, rehabilitative assistive devices, kinesiotherapy, and assistive equipment for the disabled, members of the general public, special needs classes at schools, and other organizations and groups. The assistive device resource center is composed of an iron works, a fabric factory, and a counseling center. The production and repair of assistive devices at the iron works and fabric factory are supervised by assistive device technicians, and the counseling center is staffed by physiotherapists, occupational therapists, speech therapists, and social workers. These staff provide medical advice such as counseling, evaluation, and advice as needed by the clients.

The assistive device resource center has diverse services. When clients go to the center for a service, they usually have special customized needs or financial difficulties, and most of their needs are urgent. However, because of inefficiencies in the service process or too heavy a work load, the repair and manufacture of devices is rarely punctual, which causes the clients to be unable to get assistance right away. Some of the items to be repaired or manufactured have to be sent to for-profit companies to meet the client’s needs after client approval. Because the assistive device resource center desires to serve the needs of the public rapidly and with the highest quality, they formed an improvement team led by the managers of the resource center that holds regular meetings and invites lecturers to provide regular counseling and educational training.

3.1 Selection of Improvement Activities
As an NPO, the assisted device resource center does not prioritize profit generation, and mainly wishes to provide perfect services to clients. Therefore, our study did not involve the issue of the time involved in the evaluation, counseling, and advice-proffering services of the therapists, which may make the clients feel that time was rushed when they received the service, thereby lowering service quality. This approach is similar to that of improvement work in hospitals, in which the focus is placed on the improvement of logistical support, instead of the efficiency with which physicians spend time treating patients. Therefore, we defined the lean operations of an NPO as being the improvement of logistics support and resource improvement to achieve higher efficiency, so that the social workers and therapists could have more time and resources to serve their clients. There was not a great quantity of manufacturing requirements, but the average time spent was very long, as much as 30 days. Therefore, we decided that the first priority for improvement was the manufacturing process of assistive devices, because the longest average amount of time was spent on this.
3.2 Value Stream Mapping

McDonald et al. (2002) used VSM to confirm the value stream of VA and NVA activities needed for the production of specific products and/or services in the supply chain or internal operations. Because VSM can only be established by understanding the manufacturing steps, this is the first task required for completion. Therefore, in the lean activities meeting, the VA and the NVA activities in the service procedures of manufactured assistive devices were defined from the client’s perspective.

After the client asks for help from the assisted device resource center, the administrator interacts with the client and fills out the record of basic information and counseling needs, and then looks up the previous service record. If it is a new case, then the therapist or assisted device technician evaluates the needs of the client for the manufacture of an assistive device. If it is not a new case, then only the technician evaluates the manufacturing requirements. After the evaluation, the technician estimates the manufacturing expenses, and asks the manager to approve the price. If the manager cannot approve the price, then it is sent up to the director for approval. After the price is confirmed, the administrator asks the client if they can accept the price. If they cannot accept it, then a loan or referral service is provided. If the client accepts and signs off on it, then the administrator enters it on the schedule board, and the assistive device technician begins manufacturing operations. When the manufacture is completed, the administrator contacts the client. When the client comes to the center, the therapist helps the client to use and adjust the device. If the client is satisfied, they pay, and the case is concluded. If the client is not satisfied, the therapist and technician communicate to see if an adjustment can be made, and then adjust it until the client is satisfied.

The improvement team took all the service procedures and used current state VSM (Figure 1) to clearly present the case company’s VA and NVA time, distance, and inventory quantities. They also used the seven manufacturing site wastes proposed by Taiichi Ohno to confirm the facts, and the 5 Why’s through brainstorming and the 5W1H (What, Where, When, Who, Why and How) to unearth the root causes and find the problems that need improvement.

The seven manufacturing site wastes (Muda) proposed by Taiichi Ohno are: (1) Waste in the form of waiting time; (2) transportation waste; (3) waste from product defects; (4) wasted motion; (5) processing waste; (6) inventory waste; and (7) waste from overproduction (or early production).

After analyzing the manufacturing process, they summarized four types of problems from the service end to the manufacturing end:

- The service subject (client) waiting too long on site: When the client calls or visits the assisted device resource center and receives services, the administrator always has to look up the paper records of past services, and passes the paper files to the therapist or the assisted device technician for evaluation. After trial use or manufacture, the information is then filed in paper form. Finally, the service charge is determined using this information. All of this time spent searching, reproducing, and passing on records is waste in the form of waiting time. In addition, the information in the paper records and case records is often incomplete, so the service subject must repeatedly fill out or be asked this information; and sometimes, important information required for a specific service subject is omitted, leading to waste from product defects.
• Excessive numbers of items awaiting manufacture or repair: The average time for the assistive device resource center to manufacture a device is 30 days; but most of the time on the schedule board (29 days) is designated as waiting for the item to be manufactured, while the actual manufacturing time only takes about five hours. The reason for this is that after the administrator writes the delivery date on the schedule board, the assistive device technician can decide the day on which manufacturing operations are to take place. This causes the situation in which the device is manufactured too early or too late, which produces more waste in the form of waiting time.

• Overstocking of raw materials at the fabric factory: Two sources of raw materials exist. The first are materials purchased by the assistive device resource center every month, using the funds provided by the government or through charitable donations. The second type is fabric that is donated to the center. The fabric donated by charitable persons is not necessarily suitable for the needs in making assistive devices, causing inventory waste.

• Long NVA time when manufacturing assistive devices: Of the 268.75 min required for manufacturing cycle time, NVA makes up 75.67 min, which constitutes 28%. This includes moving the raw material around several times and over a long distance by the assistive device technician in the fabric factory, causing transportation waste and wasted motion produced when searching for the raw material. When the staff cannot find the raw material in the factory, then they have to make a special trip to go purchase it, which produces double waste. When collecting the raw material, sewing machines often block the passage, so they have to go around or over the equipment, causing wasted motion. The time spent during these transport and motion waste activities is seen as NVA time.

After analyzing the problem points using VSM, they were organized together with improvement methods and expected improvement, and the VSM Future State Map (Figure 2) was drawn so that they could conveniently see the improvement activities of the entire value stream; such as IT, Kanban, visual control, and the 5 S’s. This allowed for a reconfigured layout of the improvement methods.

3.3 Implementation of Lean Activities

After completing the VSM Future State Map, the assistive device resource center began to plan measures for implementation, which began with improvements to the fabric factory manufacturing site, and then continued with improvements on the service end. They thoroughly implemented the basic concepts of lean operations, which is to eliminate waste and create value for the customer.

They first created a reconfigured layout and the 5 S’s at the site of manufacturing for Problem No. 4: long NVA time when manufacturing assistive devices. After basic improvements were made, the improvement team then implemented visual control for Problem No. 3: overstocking of raw materials at the fabric factory. Following that, they implemented standard work and kanban improvements for Problem No. 2: excessive numbers of items awaiting manufacture or repair. Finally, they used IT improvements to solve Problem No. 1: the service subject waiting too long on site.
No Author 1, 2, or 3 Last Name Yet

No one step in the sequence of implementing improvement methods could be ignored or skipped in this case. The team first took consideration of the original flow of operations, and eliminated transportation waste through a reconfigured layout. Then they implemented the 5 S’s to clearly separate the items that were necessary from those that were not, and the latter items were eliminated. After putting this in order, the necessary items were placed in locations where they could be collected and used at any time, and a category chart was made so that people could easily be able to determine which items were to be placed where. They used visual control for the inventory to control inventory quantity.

After using these three methods, the original operations flow was improved, so they needed to make new procedures for manufacturing all products in the fabric factory. However, more than 50 % of the products manufactured in the fabric factory were customized assistive devices, so there were no repeated operations. Therefore, the improvement team made operation standards for the items that were in repeat demand; such as arch supports, insoles, safety helmets, corrective shoes, and restraint straps. For the custom-made parts, they found similarities in the operations among the types of custom-made products that had been made previously, and they formulated basic operating standards. The team then separately formulated special operating standards based on the different special requirements for the types of custom-made products. After standard work, they calculated the kanban amounts required for the manufacturing schedule according to the standard times that were set. Finally, the team made overall improvements for the service end, including the operating procedures of the administrators, and the process of passing information between therapists and assisted device technicians. They used the IT system to correctly enter the information to be shared and to shorten the waiting time.

- Detailed analysis: The improvement team first analyzed the problem points in detail for Problem No. 4: the long NVA time when manufacturing assistive devices. This included the transportation waste in the form of the long moving distance, and the wasted motion when searching for raw materials. These are respectively described below:
  - Moving waste: By drawing up a spaghetti chart, the team analyzed the flow of the manufacturing of assistive devices. Taking the flow of the manufacture of safety helmets as an example, as shown in Figure 3, the assistive device technician’s work area is on the left side of the work station, and the most often used sewing machine F is located to the right. However, employees have to regularly collect raw material from material shelves A and B on the right, causing the assistive device technician to constantly have to go back and forth from left to right, which creates a total transport distance of 36 m.

![Figure 3 As-is spaghetti diagram for manufacture process](image)

- Wasted motion: This included waste in the action of searching for and collecting raw material. This can be analyzed from the two aspects of raw materials placement and equipment placement.
  - Raw materials placement: There are no signs posted in the fabric factory, and the materials are placed in a disorderly fashion, making it difficult to find and collect raw material. For example, the fabric is randomly piled vertically in front of the shelves, causing the assistive device technician to have to move the fabric to another place before he can see if the material needed is
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on the shelf or not. This includes waste of motion in terms of searching for and collecting material. If the needed material is placed further back, making the technician unable to locate it, then employees have to go out and purchase it, which creates double waste.

- Equipment placement: By analyzing the factory layout and shelf diagram shown in Figure 4, it can be seen that sewing machine A and sewing machine F are located in front of raw material shelf C, meaning that the bottom of shelf C is blocked by the two sewing machines. As shown in Figure 5, it is difficult to reach items placed on the lower section; and because the sewing machines are in front of the shelf and have supports that stick out, it is also difficult to obtain items on the upper part of the shelf. In addition, sewing machine D is located in the aisle of the factory, blocking the movement of those going to use the other sewing machines, so people have to go around it. These are all considered wasted motion.

- Activities implemented for problem points: After analyzing Problem No. 4, the improvement team reduced the transportation waste and wasted motion by reconfiguring the layout and following the 5 S’s.
  - Reconfigured layout: The improvement team measured the dimensions of the fabric factory, raw material shelves, sewing machines, and work stations, and then created a proportional model. By simulating actual locations and sizes, they judged whether improvements were feasible. After several attempts, discussions, and brainstorming sessions, they decided to adopt the following changes (Figure 6):
    - The assistive device technician regularly uses raw material shelves C and B, which are located on the right side of the fabric factory, so the work station was moved 1 m to the left. Sewing machine F, which is the most regularly used sewing machine, was moved to beside the technician’s work area; and the technician’s work area was moved to the right side of the work station, reducing the distance over which the technician needed to move the raw material.
    - Sewing machines F and A have the same functions, but there is only one assistive device technician, who would not be able to use both of them simultaneously. Therefore, sewing machine A was removed from the fabric factory so that the technician could reach the raw material shelves more easily without being blocked by the sewing machine, thus reducing wasted motion.
    - The divider between the two spaces of the bottom part of raw material shelf C was removed so that sewing machine E, which is operated while the technician is standing, could be placed in the bottom part of material shelf C. As shown in Figure 7, this change allowed the placement of all
sewing machines of different functions inside the factory with no blockage of access, reducing wasted motion.

Figure 6 To-be Layout

Figure 7 The design of combine storage rack with sewing machine

Following the 5 S’s: The 5 S’s are Seiri (sorting), Seiton (systematic arrangement), Seiso (cleaning), Sheiketsu (standard work), and Shitsuke (self-discipline). Seiri is the sorting of necessary and unnecessary items, and the removal of the latter. Seiton is the systematic arrangement of items so that everyone can quickly and conveniently find anything. Seiso is the maintenance of an area so that any cause of waste will become apparent. Sheiketsu is the repeated use of Seiri, Seiton, and Seiso. Shitsuke makes them become habitual. The Seiri and Seiton implemented in the fabric factory are described as follows:

- **Seri:** PQ Analysis was conducted for raw material use to sort it by usage rate. The items in the factory were divided according to usage rate into necessary and unnecessary items, and the raw material was divided into categories A, B, and C. Their placement on the raw material shelves was correctly planned. Type-A material has a usage rate of 10% or higher; type-B material has usage rate of 2% to 10%; and type-C material has a usage rate of less than 2%. Type-A materials were placed on the shelves closest to the work station, and type-C materials were placed in shelves the furthest away from the work station because they were less often used.

- **Seiton:** To allow the assistive device technician to be able to collect raw material quickly and conveniently while working, the following three arrangements were made when planning the raw materials:
  - By analyzing human factors, the most often used raw material should be placed in an area from knee-height to eye-level, which is the height that the average person could most
easily and quickly collect material (Figure 8). Therefore, in terms of shelf design, the most often used material was placed in the second and third shelves down from the top, to meet ergonomic requirements and to reduce wasted motion.

Figure 8 Design of improved component shelf

- Planning the placement of material on the shelves: The placement location was planned according to material usage rate and size, as shown in Figure 9. The most often used raw materials (type-A) were placed closest to the work area, and the type-C materials were placed furthest away from the work area, to reduce transport distance.

Figure 9 To-be arrangement of storage racks

4.4 Analysis of Performance of Lean Thinking Promotion

After reconfiguring the layout and following the 5 S’s, the average operations time and distance for manufacturing safety helmets were measured to evaluate the difference before and after improvement. As displayed in Table 1, the measurement results show that the distance over which material was moved had been shortened from 24.6 to 8.4 m, a reduction of 66%. This saved the technician time when looking for raw material. It also allowed for the easier collection of material, which reduced wasted motion. In addition, this improvement benefited the factory by creating 89% more usable space, so more space became available for manufacturing or repairing large assistive devices in the fabric factory, and the technician had a larger and more flexible work space.

<table>
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<tr>
<th>Table 1 Assessment of efficiency comparing the manufacture process before and after improvement</th>
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<td>Distance (meter)</td>
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<td>Time (minute)</td>
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<td>Use Space (meter$^2$)</td>
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5. Discussion

Only a small number of people work for the assistive device resource center for the disabled, with a fixed full-time staff of five people: including one manager, one administrative assistant, one social worker, and two assistive device technicians (one for the iron works and one for the fabric factory). They were all members of the improvement team, and when they became involved in the lean thinking activities, it increased their already heavy workloads. Therefore, when the improvement schedule was arranged, it was set over a longer time and at a slower pace, without the expectation that improvement results would instantly occur. They planned to continuously improve and constantly consider solutions to root problems to thoroughly eliminate waste, shorten service time, and enhance service quality.

However, the improvement team was very satisfied with the preliminary improvements, especially with the unexpected benefit of an 89% increase in extra space. The additional usable space provided the technician with room to repair and manufacture large-sized assistive devices in the empty space behind the sewing machine, as shown in Figure 11. Before the improvement, the fabric factory (Figure 10) was relatively disorganized, so much so...
that it was even difficult to walk around. There was no space at all to place large assistive devices being manufactured or repaired; the technician had to work outside the factory and keep going back and forth to and from the factory, increasing operations time.

Figure 10 As-is cloth factory

Figure 11 To-be cloth factory

6. Conclusions

As a social enterprise, the assistive device resource center for the disabled is a hybrid of a for-profit enterprise and an NPO. With support from the government, it uses a commercial strategy and implements its organizational mission of social service for the disabled. Of its income sources, 50% comes from government subsidies, 30% from charitable donations, and 20% comes from service charges. Because of a weak economy, the staff began to realize that they needed to raise the proportion of their income constituted by service charges, to prevent their operations from being restricted by the smaller amounts of donations as in traditional NPOs [14]. Therefore, the operations team of the center proactively improved internal operations. However, because a social enterprise is a hybrid entity, traditional improvement methods cannot be completely applied. To introduce lean thinking, they had to combine the concepts of lean manufacturing and lean service, and distill it down to the essential concept of lean operations: enhancing workflow efficiency and quality, and reducing costs by eliminating waste that cannot create value; thereby creating a social enterprise with rapid and high quality service to effectively achieve its social mission.

This study introduced lean operations through the five steps of lean thinking, and used VSM analysis to understand current conditions from the service end to the manufacturing end, and to determine the problems. After establishing the goals, we drew a future state VSM to set the relevant improvement measures. We listed the four main problems and the methods for approaching them. Each detail of every step in the improvement measures had to be closely followed in sequence from the manufacturing end to the service end. To prevent taking excessive measures, we did not consider looking for a perfect overall solution, which might lead to improvement costs that are too high. Therefore, we began by seeking to improve the problem of excessive NVA time in the manufacturing of assistive devices. By reconfiguring the layout and following the 5 S’s, we reduced transport and action risk, achieving the preliminary improvement of reducing the NVA time in manufacturing.

The preliminary improvements were made for just six months, when the reusable space was increased by 89% and the transport distance was reduced by 66%. Though the overall manufacturing time was not greatly reduced, when comparing the situations before and after improvement, the clients could clearly feel that improvements were made in the time that they needed to wait for the manufacturing of assistive devices. The assistive device technicians can find the related parts more quickly, and the distance over which they have to transport them is shorter. Because of the improved production efficiency, they have become more proactive about completing the repair and manufacturing work on schedule. Therefore, the therapists can provide the clients with faster service, enhancing the resource utilization rate within the time available, and enhancing client satisfaction. Additionally, we are sure that the improvement team will continue to improve, and that this improvement plan will result in even greater benefits in the future.

References