PRODUCTIVITY IMPROVEMENT THROUGH VALUE STREAM MAPPING IN JARVY'S FOOTWEAR COMPANY

Engr. Leilani A. Gonzales, Engr. Teresita B. Gonzales

and Engr. Nancy P. Mercado

College of Engineering

ABSTRACT

Reductions in manufacturing cycle time can be vital to the survival and profitability of numerous firms. The focus of the study is the use of Value Stream Mapping as a tool of Lean Manufacturing in measuring productivity in Jarvy's Footwear. The existing lean manufacturing waste present in Jarvy's footwear company are transportation and motion waste. The causes of transportation wastes are the large distance between stations, the need of stairs to reach the next process and the production layout is multilevel. The motion waste factors are poor work station, poor method design and unnecessary movements done by the worker. New process and new layout was proposed in order to improve the productivity of the production line. Also the idea of balancing the manpower of the new layout is used in order to have the smooth flow in the production process. Value Stream Mapping would benefit the company in terms of reduction in manpower and electricity thus a saving of P 1,132,320.00 yearly for manpower and P 35, 579.18 yearly for the electricity.

Keywords: Productivity Improvement, Value Stream Mapping

INTRODUCTION

Reductions in manufacturing cycle time can generate numerous benefits, including lower work-in-process and finished goods inventory levels, improved quality, lower costs, and less forecasting error. More importantly, reductions in manufacturing cycle time increase flexibility and reduce the time required to respond to customer orders. This can be vital to the survival and profitability of numerous firms, especially those experiencing increased market pressures for shorter delivery lead times of customized product.

The world is changing quickly, consumer expectations are high, and companies must be quick to adapt if they are to survive and thrive. Organizations need proven concepts for reducing lead time and the tools to do so if they are to remain competitive. Lean development is one such tool (Samad et al., 2013).

Lean Manufacturing is a systematic methodology of Toyota Motor Corporation, pioneer of lean manufacturing that identifies and eliminates all types of waste or non-value-added activities. Whether the business is manufacturing a product or providing a service, there are components that are considered “waste”. Lean concepts are purely about creating more value for customers by eliminating activities that are considered waste.

Lean concepts improve operating performance by focusing on the continuous flow of products, materials or services through the value stream. Waste can include any activity, step or process that does not add value for the customer (industrialtimestudy.com).

What lean manufacturing wants to obtain is effectiveness. Although producing more is good, lean manufacturing teaches us that producing exactly how much we need is better because producing more means more effort wasted (Mike Nemat, 2013).

The focus of the study is the use of Value Stream Mapping as a tool of Lean Manufacturing in measuring productivity. Value Stream Mapping uses the techniques of lean manufacturing to analyze and evaluate certain work processes in a manufacturing operation (Wolfgang Apel, 2009).

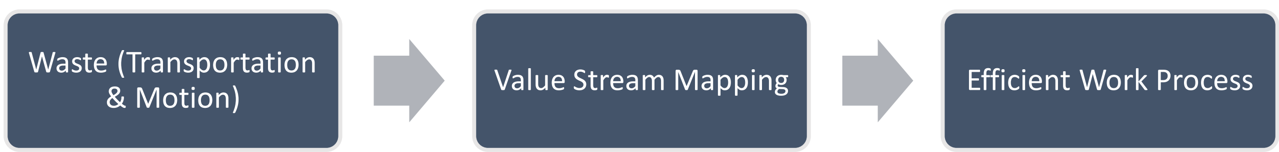
Background of the study

The pioneer owners of the footwear business were a couple. In 1993, they perceived of setting up a manufacturing business for footwear products which they themselves manage. A room located at the house of the owners was considered as the first plant of the manufacturing business. As the business grows, the owners bought a place/plant nearby their house. Upon purchasing, they started collecting the equipment and other machines they needed and then soon got into business. The number of employees increased as well. However, different products was created and manufactured by the business. Jarvy Footwear is producing slippers and sandals. The business regularly supplies SM Department Store and some shoe boutiques such as Sole mate (former Parisian) and Chelsea.

The process of the production of sandals has four (4) divisions namely: Strap Sub-assembly, Insole Sub-assembly, Tope Sub-assembly, and Outsole Sub-assembly. Refer to Appendix (Figures 1-5) for the Current Process Flowchart, Vicinity Map, and Layout of Locations A, B and C.

The study aims to: Identify the two most occurring lean manufacturing waste in the production line; Identify the causes and effects of the two most occurring lean manufacturing waste in the production line; Improve productivity of the production line with Value Stream Mapping; and Determine the cost benefits of Value Stream Mapping on Jarvy's Footwear Company.

Conceptual framework



Waste are identified through Value Stream Mapping, if these waste are reduced or eliminated it will result to efficient Work Process thus Productivity will increase.

Growth of business world these days created tighter market competition, because the existing industrial market become more global and have penetrated the inter-states boundary. In competition which progressively tightens like this, every company claimed to own the excellence and competitiveness so that probabilities to win the competition become greater. Those conditions forced manufacturing operations to continually striving to reduce lead time of their operations. Their goal is to satisfy the customer with the exact product, quality, quantity, and price in the shortest amount of time. It can only be achieved if the company is able to create and to implement effective and efficient processes in each of its line of their business. For this purpose lean tools are used because lean focus on the continuous improvement of a company towards the ideal through the relentless reduction of waste (Samad et al., 2013).

Value stream mapping (VSM) is a lean manufacturing tool that uses pencil and paper to seek to map your process from supplier to customer, highlighting the flows of product and information and identifying delays and non-value adding processes (leanmanufacturingtools.org).

VSM approached the entire process flow in three-step methods in which first producing a diagram showing the actual material and information flows or Current State on how the actual process operates. This is created while walking down the production line. Secondly, a Future State map is produced to identify the root causes of waste and through process improvements that could give great financial impact to the process, a lean process flow. Lastly, is the implementation plan and execution (Rahani& Al-ashraf, 2012).

Mapping out the activities in the business process with cycle times, down times, in-process inventory, material moves, and information flow paths will help visualize the current state of the process activities and guide towards the future desired state (dwassoc.com).

According to Monden (1993), there are three types of operation that are undertaken in an internal manufacturing context. These can be categorized into three (3). First, Non-Value Adding (NVA) which is pure waste and involves unnecessary actions which should be eliminated completely. Examples would include waiting time, stacking intermediate products and double handling.

Secondly, Necessary but Non-Value Adding (NNVA) operations maybe wasteful but are necessary under the current operating procedures. Examples would include walking long distances to pick up parts; unpacking deliveries; and transferring a tool from one hand to another.

Lastly, Value-adding operations involve the conversion or processing of raw materials or semi-finished products through the use of manual labour. This would involve activities such as; sub-assembly of parts, forging raw materials and painting body work (Rahman, 2010).

The influence of value stream is in identifying waste throughout the stream and eliminating it in order to shorten the lead time and improve the value added percentage. In other word, to transform the production system from a batch and push system into a one piece flow and pull system. The only way to understand waste is to understand the elements like overproduction, inventory, transportation, waiting, motion, over processing, and rework that do not contribute value of the product (Samad et al., 2013).

This visual technique of mapping is divided into two sections, flow of information and flow of material and it describes how a business currently operates and could operate. This vision provides the ability to eliminate the process that add no value, eliminate redundant and unnecessary information flows, and combine or streamline those that do. Value stream mapping provides both a picture of the current state of affairs as well as a vision of how we would like to see things work. Identifying the differences in the current and future state yields a roadmap for continuous improvement activities (Angeles, 2011).

Value Stream Mapping: Case Study in a Water Heater Manufacturer, established in 1975 and started to production, Ihlas Domestic Appliances Production Industry and Trade Incorporated Company (IHEVA) presented its small appliances, which takes human health as a priority and facilitates the domestic life from the very beginning, to the consumers. Situated with its energetic coaching staff in Beylikduzu Organised Industrial Zone (BOSB) in a closed area of 21175 m^2 which employs 300 personnel composed of 220 assembly staff and 80 administrative staff, the Company continues its production in Cleaning Robots Factory, Water Heaters and RO Water Purifiers Factory, Carpet Washing Machine Factory and Plastic Injection Printing Plant.

In the factory, parts produced by the Company and the pieces such as cables screws coming from the subsidiary industry is combined together and packed after quality control and served to the market. There are 31 workers in the production line of the electrical water heaters. The working hours for them are from 08:05 to 18:25. All the works under the production process is labor intensive. In the workplace, there are three control machines and U-shape assembly line. Currently, the total area of the workplace is 100 m2. The 25.6 m2 part of this area is for the assembly line and the remaining 74.4 m2 part is for workers and buffer stocks. The production of a water heater occurs in 31 steps and each step is taken by a different operator. The Company determines the number of water heaters to be produced on a monthly base. The range of output is between 9,000 to 31,000 water heaters. The line of Electrical water heater produces according to the demand. Generally, it produces on alternate days and workers produce different products when not producing water heaters. This is the first and the most important problem. For this reason, sometimes producing on time becomes a problem. While sometimes there is overproduction leading the excess product to wait, in other days there is overtime because the product produced is inadequate. In addition, the company is not able to have production breaks in order to decrease its financial expenses and make the maintenance for the assembly line.

In order to create an organized, clean and high efficiency work environment, they have utilized 5S which is a work process and work method. The materials that are disorderly and occupy unnecessary space are removed. Chairs and junks are removed, too. The places and the sizes are the desks are changed. By creating an evaluation measure, the materials used in the production are rearranged. Only the materials necessary in a day or an hour are allowed to be present in the work area. The unnecessary space usage in the production area is prevented. As a result, the initial $100m^2$ work environments composed of a line of $25.6m^2$ and a remaining part of $74.4m^2$ is decreased to a $60.5\ m^2$ area, composed of a $25.6m^2$ line and a $34.9\ m^2$ remaining part, as a result of the improvements made.

According to the past research entitled Enhancement of Current Layout of the Production Area at Gardo Lande Footwear, the efficiency of the production depend on how well the various machines, production facilities and employees amenities are located in the plant. Only the properly laid out plan can ensure the smooth rapid movement of materials. From the raw materials stage to end product stage, Plant layout emphasis new layout as well as the improvement in the existing layout.

It may be defined as a technique locating machines, process and plant within the factory so as achieve the right quantity and quality of output as the lowest cost of manufacturing. It involves judicious arrangement of production facilities, so that the workflow is directed. An efficient facility layout is that can be instrumental in achieving the following objectives: Reduced material handling cost; Provide enough production; Proper and efficient utilization of available spaces; To ensure that the work proceeds from one point to another point without any delay; Utilize labor efficiently; Reduce accident; and Improve productivity.

METHODS

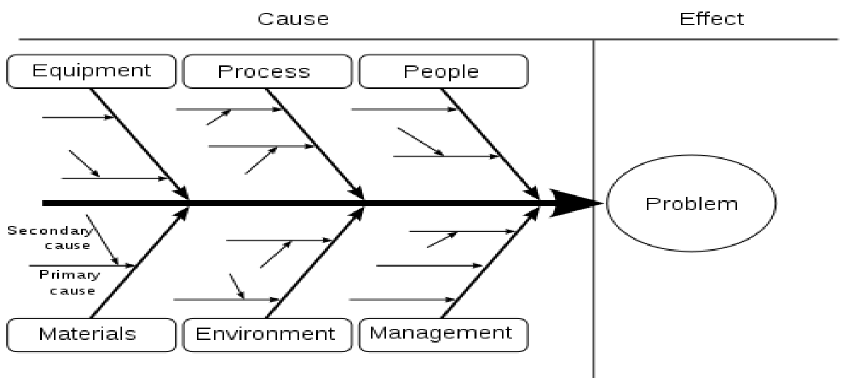
The major purpose of the study is to identify the two (2) most occurring lean manufacturing wastes present in the company and recommend ways on how to reduce if not eliminate these wastes.

The researchers observed and measured various processes that may contain non-value added activities that are present in the production process and are contributing to the existence of lean manufacturing wastes.

The researchers utilized the descriptive method of research with observation as the main source of data. The descriptive method is viable since the purpose of the study is to generate the prevailing conditions. The main subject of the research is the processes in the manufacturing of sandals in the production line of Jarvy's footwear.

In the gathering of data actual observations in Jarvy's Footwear were conducted to determine the waste present in the production process. The researchers observed the actual scenario and the different process performed inside the company. The production supervisor serves as our guide in determining the different process in making the product. She explained and answered the questions that the researchers asked. She also provided the information that the researchers needed in solving the problem.

Other instrument used in the study are the following: Time Study is used to determine the actual cycle time of each activity regardless whether the activity is a value added or a non value added activity (operation, transportation, inspect, storage and time) involved in the study. Measuring Distance is used to determine the distance travelled of the worker / product. Process Activity Mapping is a Value Stream Mapping tool used to determine the physical process in the production line. It includes the sequential list of activities from the first process to the last process. This instrument will be used in determining the wastes present in the process of making the product. Ishikawa Diagram is used to determine and illustrate the flow of factors between the causes, main problem and the effects of the study. The researchers will used to determine the causes and effect of the existing manufacturing wastes present in making the product.



Line Balancing is used to match the production rate after all wastes have been removed to the tact time at each process of the value stream. This value stream tool will guide the researchers in making the improvement in the process.

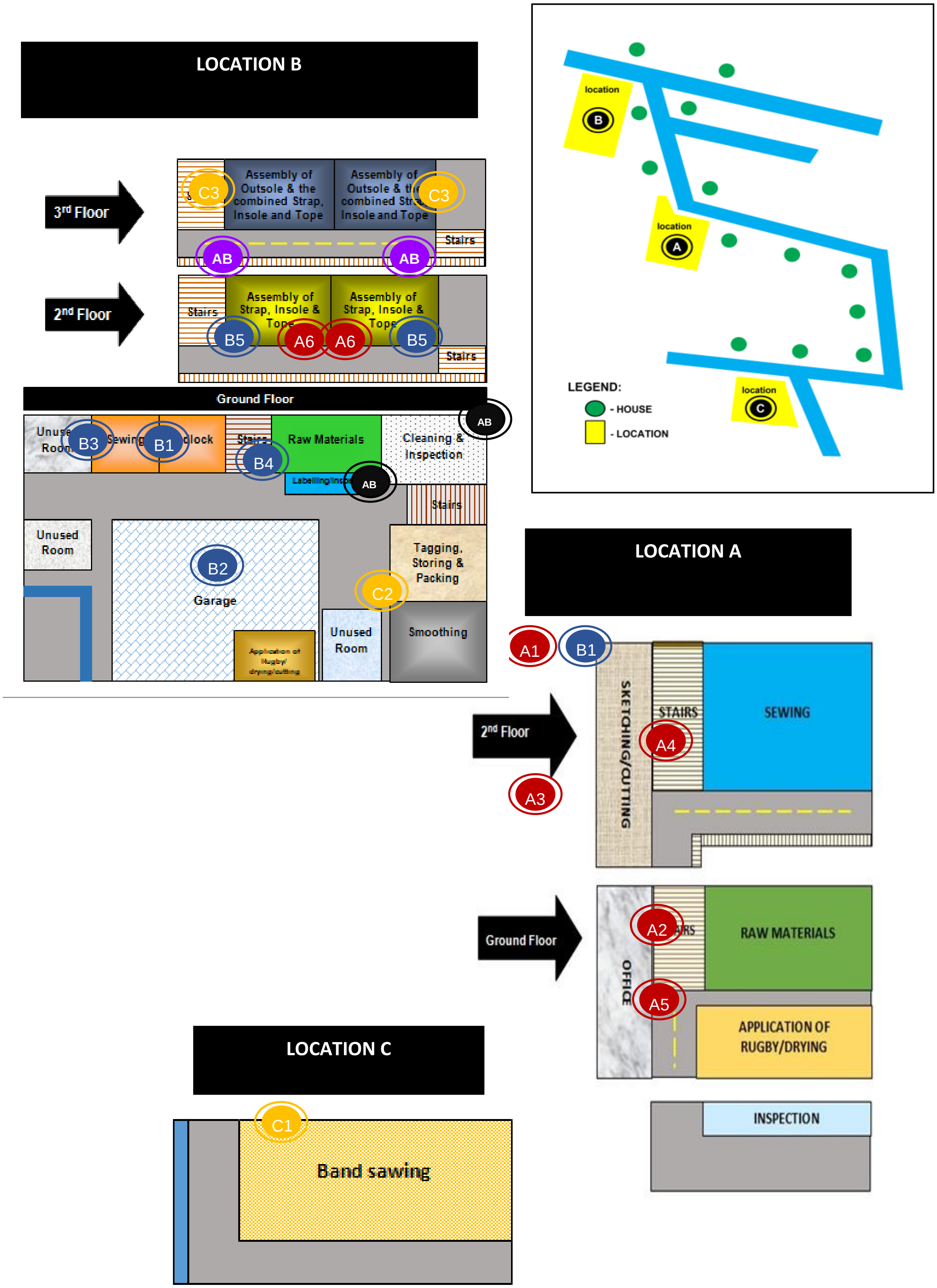
RESULTS AND DISCUSSION

The most occurring lean manufacturing wastes in the production layout at Jarvy's footwear company were observed and discussed below:

TRANSPORTATION

Strap Sub-assembly. Fabric will be sketched at the 2nd floor of Location A (see figure 6, page 9). After sketching is done, it will be transferred to the Ground floor of location A for rugby application. The location of rugby application is in front of the Ground floor of location A. This area is open for workers health and safety consideration. The distance between sketching and rugby application is quite far since the workers used stairs in going from 2nd floor to ground floor. After the rugby is applied, it will be dried in same location. After the fabrics get dry, they will be transferred back to the 2nd floor for cutting. It will be cut manually by the workers. After cutting, they will be transferred to the sewing area. After sewing is done, the assembled straps will be transferred for inspection at the ground floor in front of rugby application. The items should reach at least 120 pairs of assembled strap before it transfer to location B (see figure 6, page 9).

Figure 6. Current Production Layout of Jarvy's Footwear Company



Insole and Tope Sub-assembly. The sketching for insole is done in location A together with the straps. After insoles are sketched, they will be transferred to Ground floor of location B for rugby application and drying. Location B is quite far from location A, it takes about 5-8 minutes of walking before a worker reaches the location.

While the insoles are drying up, the tope are being processed into padlock. Padlock is a machine where the tope will be shaped according to the feet sizes. The location of raw tope and process of padlock is quite good since the materials and machine are in one location. The padlock area is beside the stairs.

As the insoles are dried, they will be cut at the location where rugby application and drying processes are done. After the tope was processed in the padlock, it will be transfer to the application of rugby/drying/cutting to be process. The cut insole will be transfer to sewing and will be combined to tope as well as the tope was done from the application of rugby/drying/cutting section. After sewing, the combined insole and tope will be transfer to labelling section for the labels/names of the product. The distance of sewing area and labelling area is quite far, the worker will pass the padlock area and stairs to reach the labelling area. Inspection is done at labelling area. The combined insole and tope should be at least 120 pairs before it will be transfer to the 2nd floor , for the assembly of strap and the combined insole and tope using rugby. After this process the assembled strap, insoles and tope will be transfer to 3rd floor for the overall assembly.

Outsole. The area of band sawing (see figure 6, page 12) for outsole is far from location A and location B. It takes 15 minutes for the workers to reach the plant when walking and 5-7 minutes when vehicle is used. Outsoles should be at least 120 pairs before it will be transferred to location B for the next process, the smoothing process. As the smoothing process is done, the outsole will be transferred to 3rd floor of location B for the assembly of outsole and the combined strap, insole and tope. The distance of smoothing and assembly area is quite far since smoothing area is in the 1st floor while the over-all assembly area is in the 3rd floor.

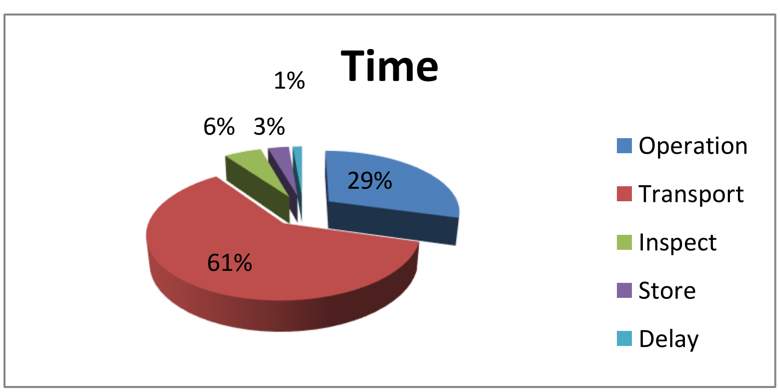
When the products were finished, they will be transferred to Ground floor again. After transferring, the product will be process in cleaning area and final inspection. The area of cleaning and final inspection is the same. After inspection it will be transferred into the next room for tagging, packaging and storing. The company has three location A, B, and C that is very far from the each other. After the products are completely done, it will now be delivered to the customers.

Table 1. Time and Motion Study of the Current Process

Process	Total time consumed	Percentage	Rank
Operation	5.65	29%	2
Transport	**11.69**	**61%**	**1**
Inspect	1.05	5%	3
Store	0.59	3%	4
Delay	0.26	1%	5
Total	19.24	100%	

Table 1 shows the summary of time and motion study conducted by the researchers in determining the cycle time needed to finish the product (see appendix A for the breakdown). Total time is computed based on Time Study of Current Process (Appendix A). Transportation were computed by adding Element 2 of sub-assembly, element 5 and the rest of the transportation activity in all assembly processes. Operation, Inspection, Storage and Delay were computed in the same way. As illustrated in Table 1, majority of the time is consumed by transportation numbering to 11.69 minutes out of 19.24 minutes composing 61% of the total time. 5.65minutes out of 19.24 minutes of the time were operation and are composed of 29% of the entire time. 1% was composed by the delay in a day. Consequently, 5% came from inspection whereas 3% of the time is come from storing the sandals.

Figure7. Distribution of Time and Motion Study Result of the Current Process



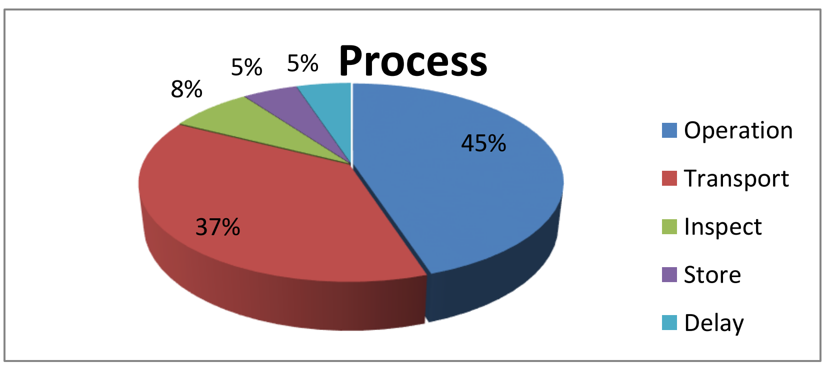
After conducting time study the researchers found out that transportation is one of the most existing lean manufacturing wastes present in the company (Figure 7).

Table 2. Frequency and Distribution of Process Activity Map

Process	Frequency	Percentage	Rank
Operation	18	45%	1
Transport	15	37%	2
Inspect	3	8%	3
Store	2	5%	4
Delay	2	5%	5
Total Time	40	100%	

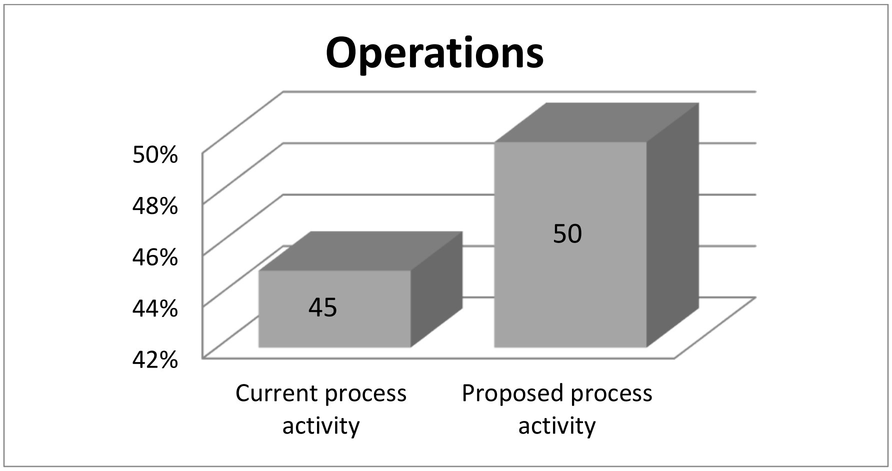
Table2 shows the summary of process activity map conducted by the researchers in determining the frequency and distribution of the process (see appendix B for the breakdown). As shown in Table 2 majority of the activity accounted for operation, 18 out of 40 or 45%; 15 out of 40 or 37% accounted for transportation; 3 out of 40 or 7.5% accounted for inspection and 2 out of 40 or 5% were storage and delay

Figure 8. Present the time and motion percentage distribution of processes in the production line



The researchers conducted time and motion study to determine the time and elements involve in the process (Figure 8). After determining the elements the researchers found out that major operation was only 45% of the total process. This means that the remaining 55% in the process activity is considered as non-value added (store, inspect, transport and delay). With the data gathered the researchers found out that motion waste is present in the company.

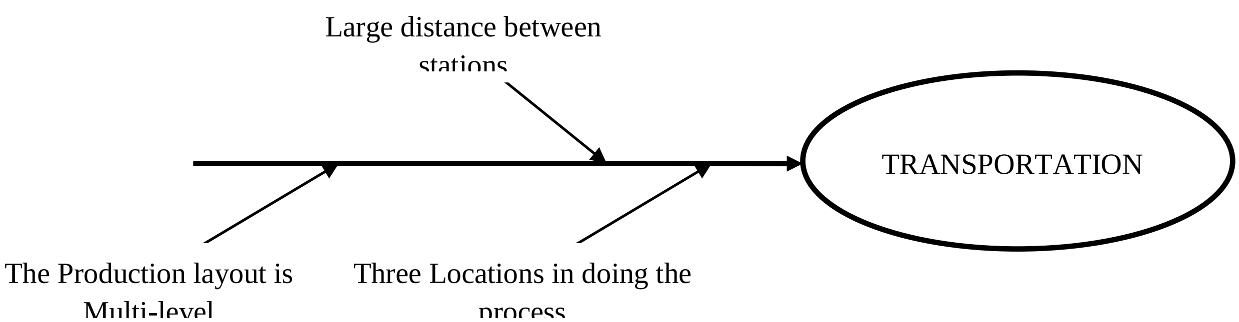
Figure 9. Comparison of percent operations



Represented in Figure 9 is the comparison of percent operations of the current process activity (see appendix B) and the proposed process activity (Appendix, Table 4). It was observed that the proposed process activity increased the percent of operation from 45% to 50% by reducing the present non-value added activity in the current process activity.

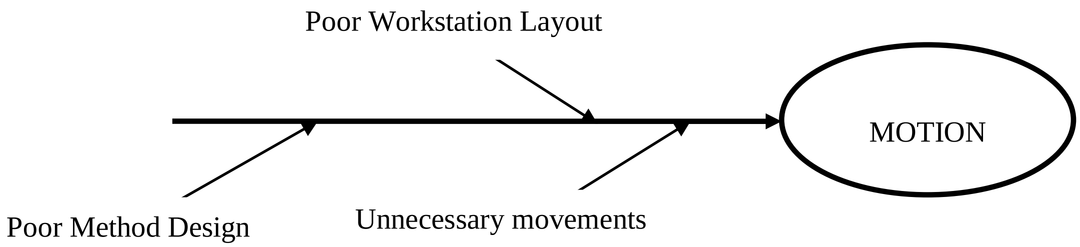
Ishikawa diagram. The causes of the two most existing lean manufacturing waste present (transportation and motion) is summarized through the Ishikawa Diagram presented below:

Figure 10.1 Transportation Ishikawa Diagram



The researchers observed that transportation is a lean manufacturing waste that is present in the production line. A factor contributing to transportation waste is the large distance between stations. It is observed that the distance between stations in proportional to time. As the distance increase, so is the time. It was also observed in the company that each plant has no elevators. Furthermore, the company has different locations in processing their product.

Figure 10.2 Motion Ishikawa Diagram



As observed by the researchers, having a poor workstation layout contributed in the existence of motion waste. Results of poor workstation layout are excessive walking to each process, bending and reaching. Factors that also contribute in the existence of motion waste are the unnecessary movements of the workers in doing their job. It produces extra effort to finish the required output they need in a day. Extra and unnecessary motions are lean manufacturing waste that does not contribute to the value of the product and should be reduced if not eliminated completely.

The future layout proposed by the researchers is convenient compared to the current layout of the Jarvy's footwear. The researchers took into consideration the reduction of transportation since it is the waste the researchers determined using Value Stream Mapping. In addition the researchers combined the processes which they know that can be possible to combine. Also the idea of balancing the manpower of the new layout is used by the researchers in order to have the smooth flow in the production process.

With the proposed layout (Figure 11), the researchers reduce the distance travel of the materials to reach the other process.

Figure 11. Proposed Layout

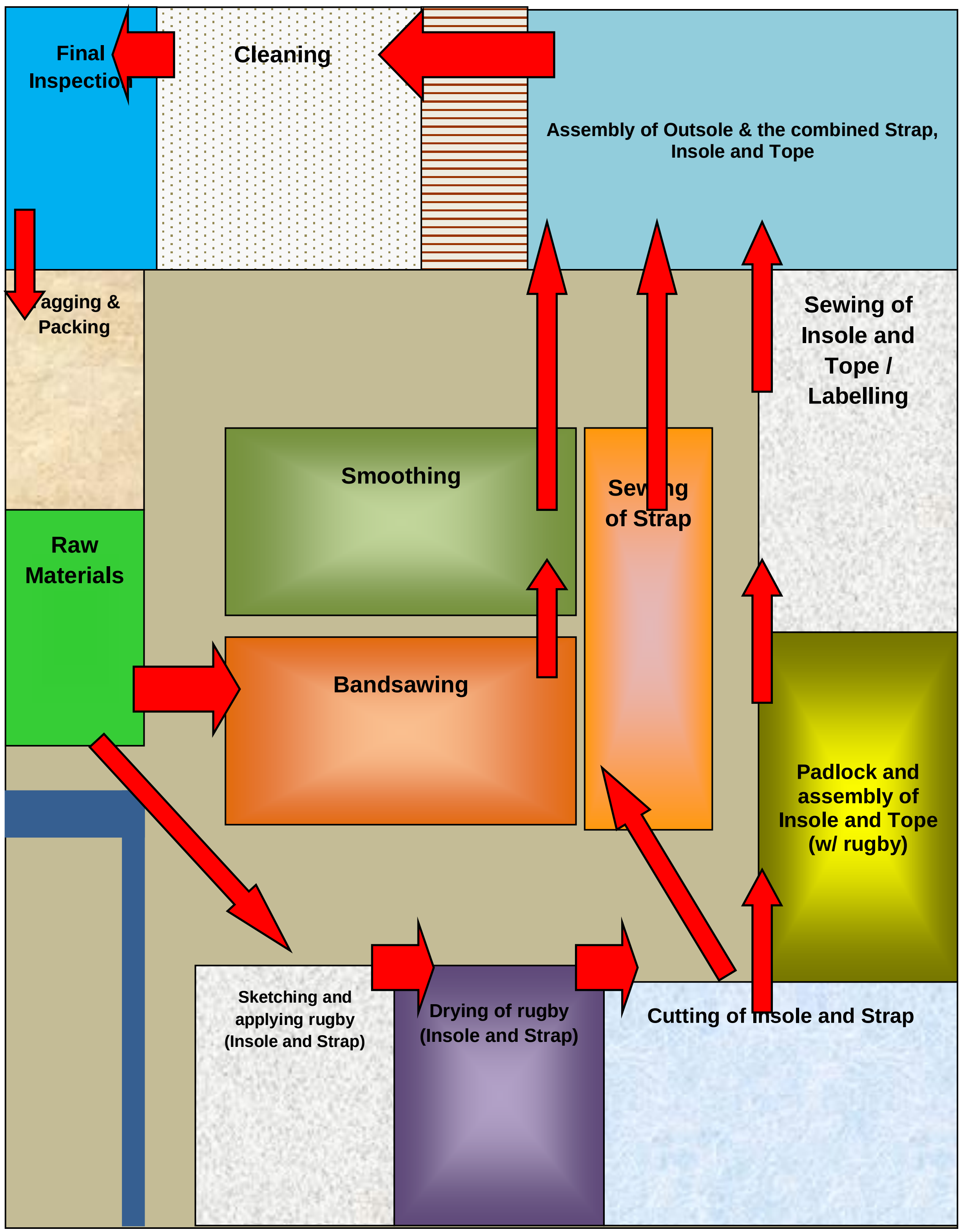


Figure12. Illustrate the proposed space of each process.

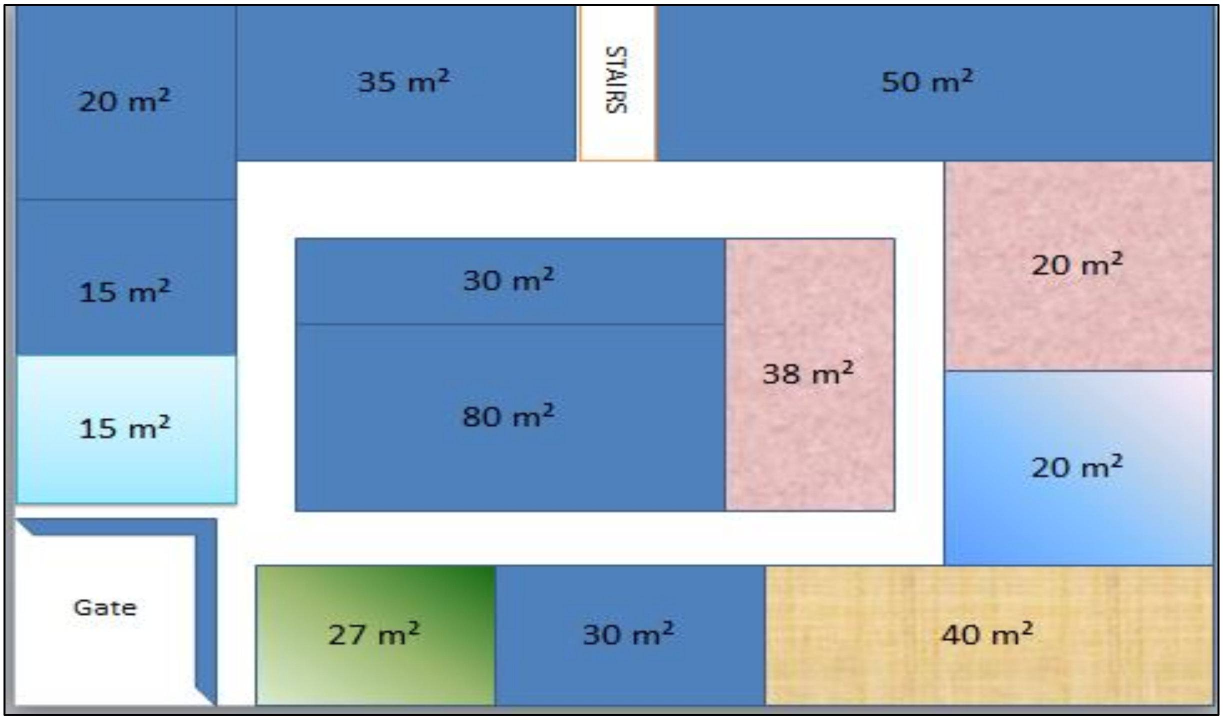


Figure13. Illustrate the proposed manpower of each process.

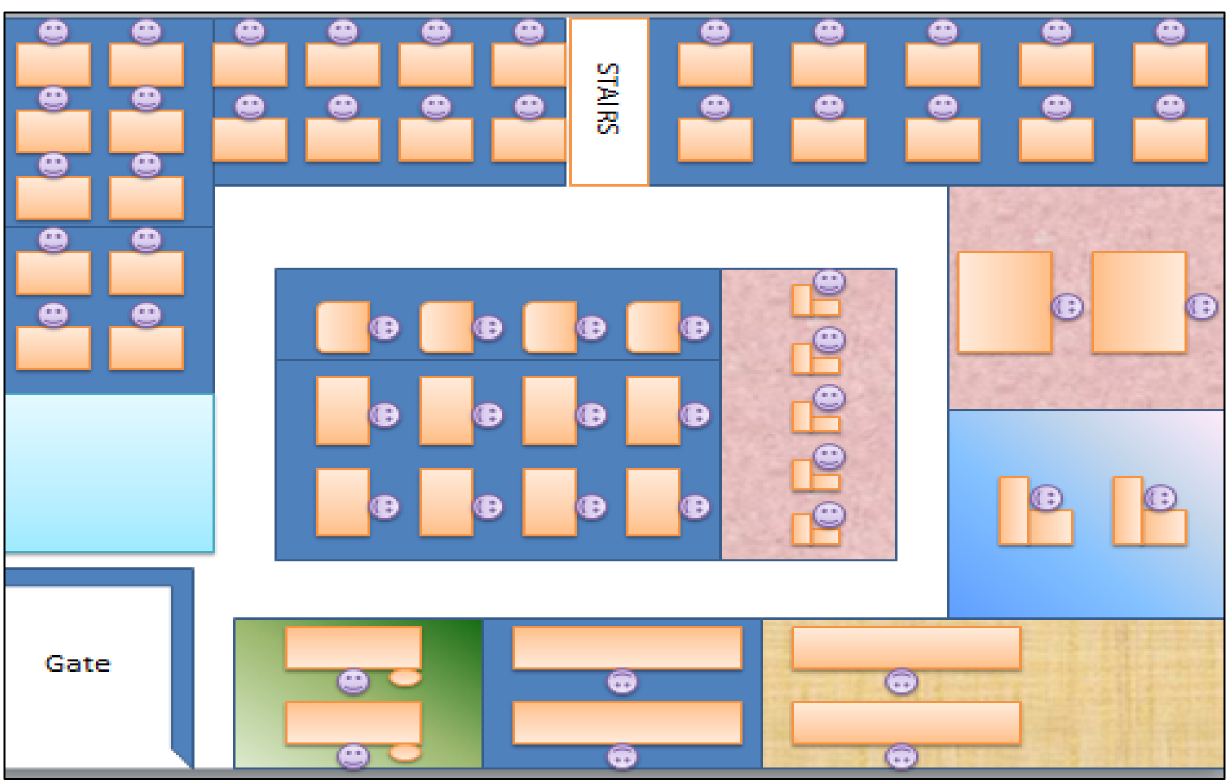
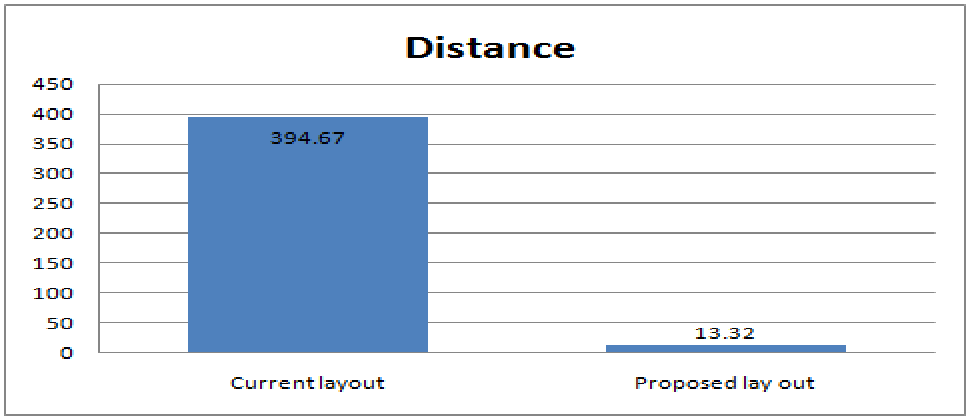


Figure14. Comparison distance



Represented in Figure 14 is the comparison of distance of the current process activity (see appendix A) and the proposed process activity (Table 4, Appendix). It was observed that the proposed process activity decreased the distance from 394.67m to 13.32m by using the ground floor of the location B only unlike using the 3 locations in doing the product.

For the Cost Benefit, Manpower savings is computed based on number of manpower reduced multiplied by the workers daily rate. As a result the company can save P 94,000.00 monthly or P 1,132,320.00 yearly. For the electricity savings, it is computed based on the proposed and current layout difference in total KW/day multiplied by the number of days multiplied by the rate/KW. As a result the company can save P 35, 579.18 yearly.

- Electricity Consumption

	CURRENT			PROPOSED		
	Kilowatt (KW)	Quantity	Total (KW/day)	Kilowatt (KW)	Quantity	Total (KW/day)
Lightings	0.04	21	6.7	0.04	14	4.48
Electric Fans	0.1	19	15.2	0.1	12	9.6
Machines (padlock, bulihan, sewing, machine and bandsawing)	1.4	21	29.4	1.4	20	28
Total			51.32			42.08

Current

Total wattage used per year = Total Kilowatt used per day X No. of working Days = 51.32X 288

= 14,780.16 KW

Total cost of electricity per year = Total KW used per year X cost per kilowatt

= 14,780.16 KW X Php13.37 **= P 197,610.74**

Proposed

Total wattage used per year = 12,119.04 KW

Total cost of electricity per year = **P 162, 031.56**

SAVINGS: P 197, 610.74 – P 162, 031.56 = **P 35, 579.18**

- Manpower Consumption

Current manpower	67
Proposed manpower	53
Reduction of manpower	14
Daily rate	P 337
Manpower savings (daily) =no. of manpower reduced x daily rate	P 4,718
Number of working days	24
Monthly savings	P 94,360
Yearly savings	**P 1,132,320**

CONCLUSION

The following conclusions are established based on the following findings of the study: The existing lean manufacturing waste present in Jarvy's footwear company are transportation and motion waste. The causes of transportation wastes are the large distance between stations, the need of stairs to reach the next process and the production layout is multilevel. The motion waste factors that contribute are poor work station, poor method design and unnecessary movements done by the worker. New process and new layout was proposed in order to improve the productivity of the production line. The researchers proposed a more convenient layout, reducing the transportation waste and merge together processes that can be technically combined. Also the idea of balancing the manpower of the new layout is used by the researchers in order to have the smooth flow in the production process. Value Stream Mapping would benefit the company in terms of reduction in manpower and electricity, The company can save P 94,000.00 monthly or P 1,132,320.00 yearly for manpower and P 35, 579.18 yearly for the electricity.

Direction for future use

The researchers recommend the redesign of the process activity by eliminating some of the non-value added processes such as transportation, inspection, storage and delay. Table 4 (Appendix), is the proposed process activity of the researchers, the storage process is removed and the operation, the transportation and the storage are reduced. Therefore, increasing the percentage of operations or the value-adding activity. In order to reduce the transportation waste, the researchers recommend the re-layout of the production line. Another proposal of the researchers is the implementation of 5S in the production. The implementation of 5S can be helpful in sustaining a smooth work flow, lessen the workers to be idle and to maintain cleanliness in the workplace. This study will serve as a reference or supplementary information if the same or related study will be conducted.

References

Agrigar, N.K., Gerardo, A. A., Pabalan, M.A.C., Patorfide, J.M. (2009). Enhancement of the current layout of the production area at Gardo Lande footwear manufacturing. Retrieved February 19, 2014 from UPHSL Library Thesis Section. 2nd Sem S.Y. 2008-2009

Angeles, K.A.A., Dicayanan, M.M.,Garcia, D.R., Javana, G.G., Pamatiga, M.J.G., (2011) Redesign of Production Line in Santa Rosa Aluminum Products through Value Stream Mapping: A lean manufacturing tool. Retrieved September 25, 2013 from UPHSL Library Thesis Section. 2nd Sem 2011-2012

Apel, W., Li, J.Y., & Walton, V. (2007). Value Stream Mapping for Lean Manufacturing Implementation. Retrieved September 21, 2013, from www.wpi.edu

Ar, R & Al-Ashraf, M. (2012). Production Flow Analysis through Value Stream Mapping: A Lean Manufacturing Process Case Study. Retrieved September 21, 2013, from www.academia.edu

Balanced Scorecard Institute, (n.d). Basic tools for process improvement, Module 5 – Cause and Effect diagram. Retrieved January 20, 2014 from www.balancedscorecard.org/files/c-ediag.pdf

Developing Winner Associates (n.d). Value Stream Mapping. Retrieved September 21, 2013, from www.dwassoc.com

Industrial Time Study Institute (n.d). Lean Concepts. Retrieved September 20, 2013, from Industrial Time Study Institute: www. industrialtimestudy.com

Locher, D. A (n.d). Value Stream Mapping for Lean Development: A How-To Guide for Streamlining. Retrieved September 17, 2013, from www. books.google.com.ph

Nemat, M. (2013). The Importance of Lean Manufacturing Strategy. Retrieved September 21, 2013), from Nemat Management Group: nematinc.blogspot.com

Rahman, S.R.B (2010). Application of Value Stream Mapping (VSM) in Manufacturing Industry. Retrieved September 24, 2013, from eprints2.utem.edu.my

Samad, M.A., SaifulAlam ,M.D., & Tusnim, N. (2013). Value Stream Mapping to reduce manufacturing lead time a semi-automated factory. Retrieved September 20, 2013, from www.asian-transactions.org

Turkyilmaz, A., Gorener, A., & Baser, H. (2013). Value Stream Mapping: Case Study in a Water Heater Manufacturer. Retrieved January 8, 2014 from www. ojs.excelingtech.co.uk

APPENDIX

Figure 1. Current Process Flowchart of Making Sandal

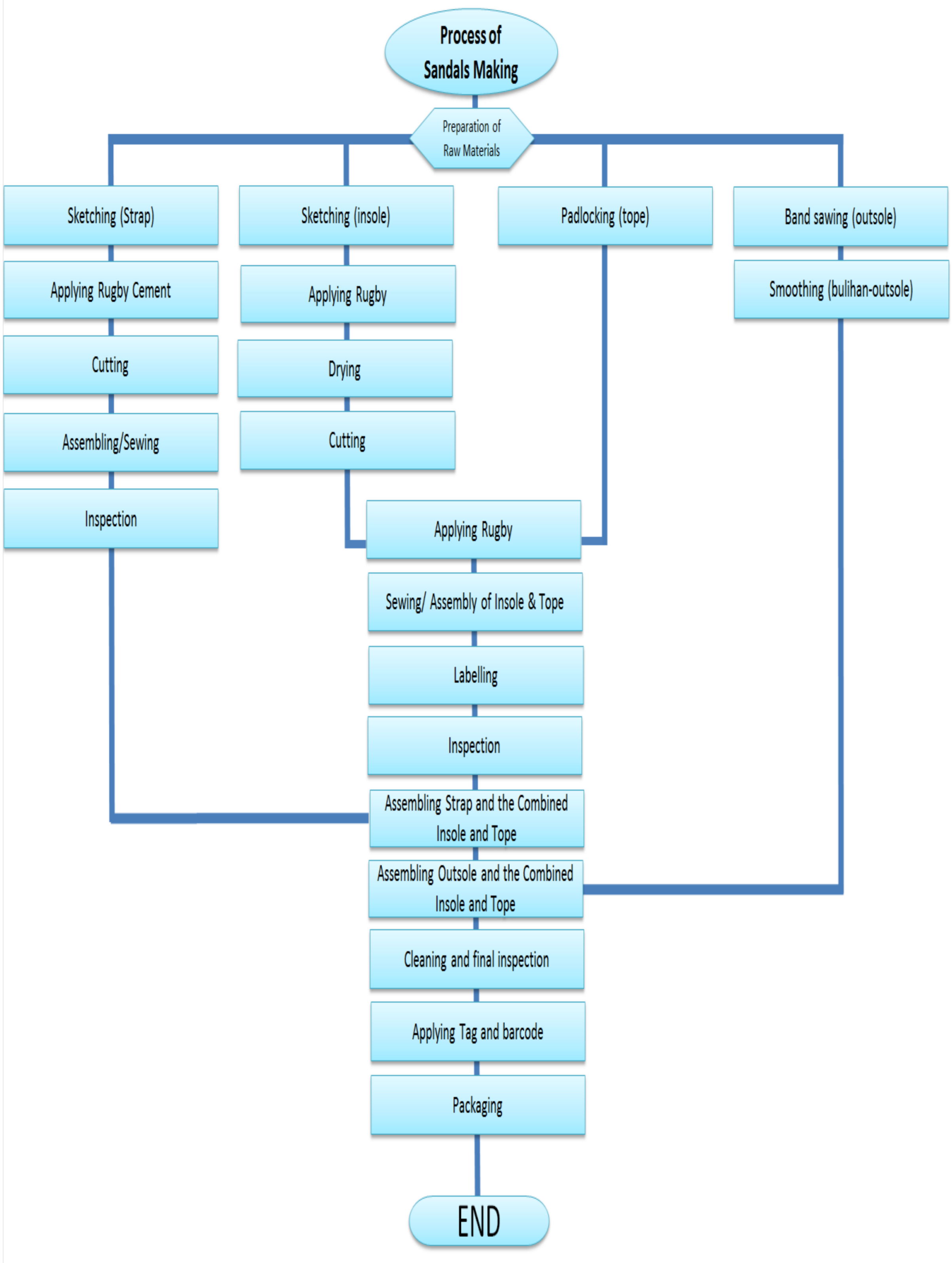


Figure 2. Vicinity Map of Jarvy's Footwear at Almeda St. in Dela Paz, Binan City, Laguna

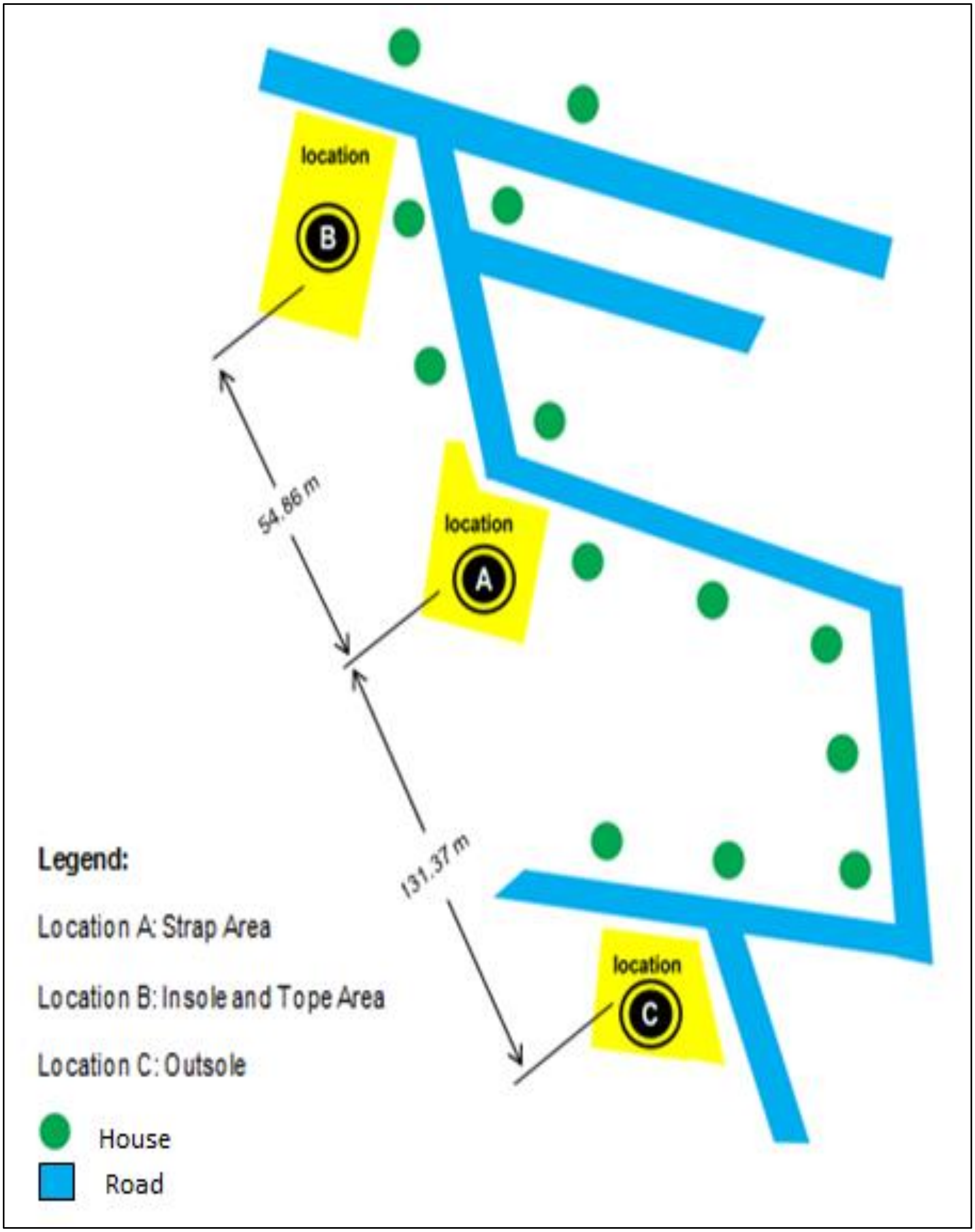


Figure 3. Current Production Layout for Straps (Location A)

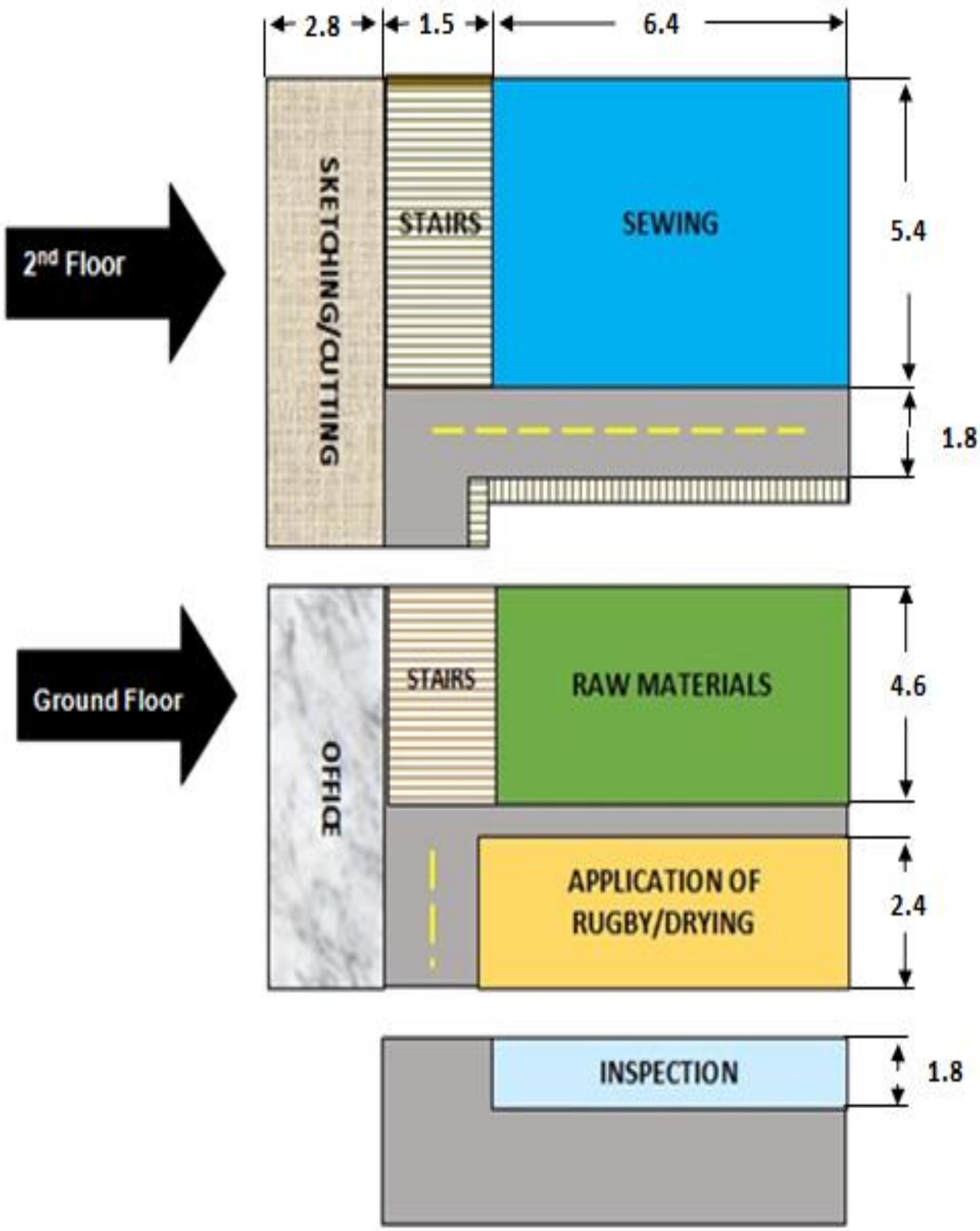


Figure 4. Current Production Layout for Insole and Tope (Location B)

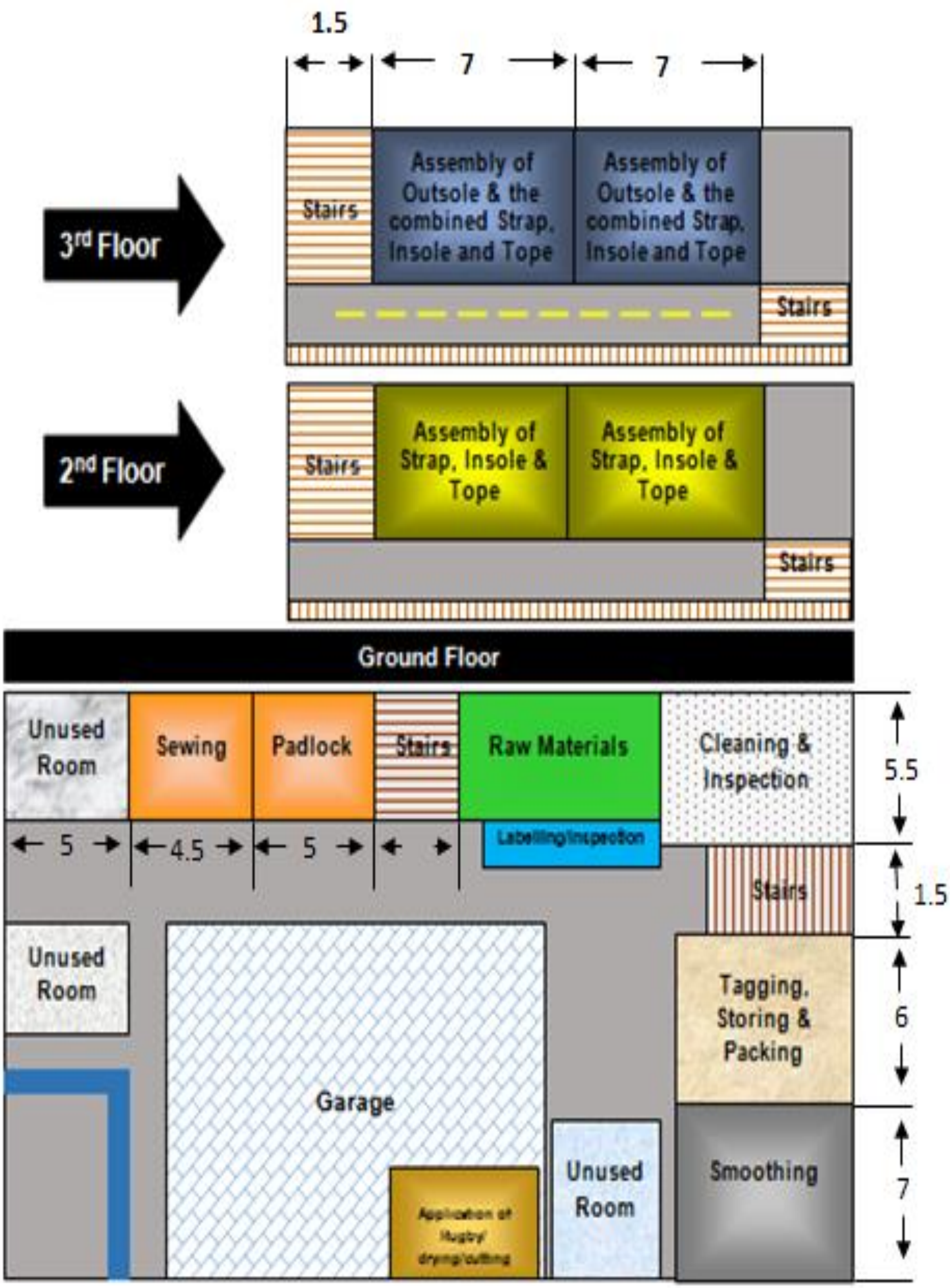
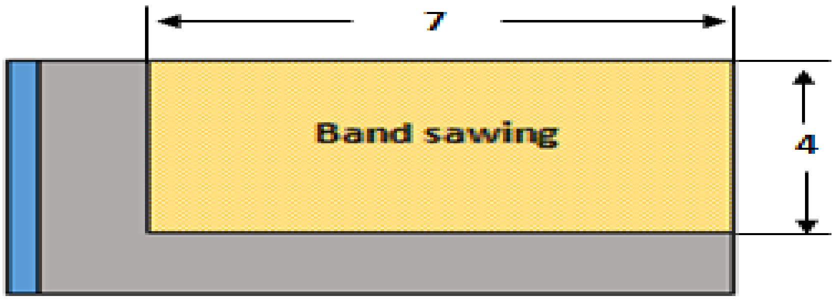


Figure 5. Current Production Layout for Outsole (Location C)



APPENDIX A

Time Study of Current Process

CURRENT PROCESS			
Process	**Time (Minutes)**	**Process+Transportation**	**Distance (Meter)**
Pre Assembling (Strap)			
Sketching (strap and insole)	0.04	0.4	
transfer to 1st floor for applying the rugby	0.36		8.81
Applying rugby cement (strap and insole)	0.03	0.03	
Drying (strap and insole)	0.13	0.49	
Transfer for cutting	0.36		8.81
Cutting(insole and strap)	0.08	0.2	
Transfer for sewing	0.12		3.56
Assembly/Sewing	0.6	0.96	
Transfer 1st floor for inspection	0.36		8.92
Inspection	0.17	0.17	
Store	0.21	1.99	
Transfer to location B	1.78		54.86
Pre Assembling (insole)			
Sketching	0.07	1.85	
Transfer to location B for the next process	1.78		54.86
Applying rugby cement	0.04	0.04	
Drying	0.13	0.13	
Cutting (insole)	0.14	0.14	
Padlocking (Tope)	0.08	0.16	
Transfer for Assembling (insole & tope using rugby)	0.08		2.89
Assembling (insole & Tope) using rugby	0.09	0.17	
Transfer for sewing	0.08		2.89
Sewing	0.15	0.22	
Transfer for labelling	0.07		2.58
Labelling	0.06	0.06	
Inspection	0.18	0.62	
Transfer to 2nd floor for Assembling Strap and Insole	0.44		10.24
Assembling Strap and Insole	0.54	0.98	
Transfer 3rd floor for assembling outsole and combined insole and strap	0.44		10.24
Pre Assembling (Outsole)			
Bandsawing	1.01	6.26	
Store	0.38		
Transfer to Bldg. B for the next process	4.87		186.23
Smoothing (Bulihan)	0.49	0.93	
Transfer 3rd floor for Assembling outsole and combined insole and strap	0.44		10.24
Assembling outsole and combined insole and strap	0.77	1.23	
Transfer 1stfloor for cleaning	0.46		10.24
Cleaning	0.96	0.96	
Final Inspection	0.7	0.75	
Transfer for tag and bar code	0.05		19.3
Applying Tag & barcode	0.22	0.22	
Packaging	0.28	0.28	
	19.24	19.24	**394.67**

Note: The company has assigned a worker to transfer sub-parts to another process.

APPENDIX B

Current Process Activity Map

CURRENT PROCESS						
Process	**manpower**	**O**	**T**	**I**	**S**	**D**
Pre Assembling (Strap)						
Sketching (strap and insole)	1	●				
transfer to 1st floor for applying the rugby			●			
Applying rugby cement (strap and insole)	1	●				
Drying (strap and insole)	1					●
Transfer for cutting			●			
Cutting(insole and strap)	1	●				
Transfer for sewing			●			
Assembly/Sewing	5	●				
Transfer 1st floor for inspection			●			
Inspection	1			●		
Store					●	
Transfer to location B			●			
Pre Assembling (insole)						
Sketching	1	●				
Transfer to location B for the next process			●			
Applying rugby cement	1	●				
Drying						●
Cutting (insole)	1	●				
Padlocking (Tope)	1	●				
Transfer for Assembling (insole & tope using rugby)			●			
Assembling (insole & Tope) using rugby	1	●				
Transfer for sewing			●			
Sewing	3	●				
Transfer for labelling			●			
Labelling	1	●				
Inspection	1			●		
Transfer to 2nd floor for Assembling Strap and Insole			●			
Assembling Strap and Insole	12	●				
Store					●	
Transfer 3rd floor for assembling outsole and combined insole and strap			●			
Pre Assembling (Outsole)						
Bandsawing	8	●				
Transfer to Bldg. B for the next process			●			
Smoothing (Bulihan)	4	●				
Transfer 3rd floor for Assembling outsole and combined insole and strap			●			
Assembling outsole and combined insole and strap	12	●				
Transfer 1stfloor for cleaning			●			
Cleaning	3	●				
Final Inspection	3			●		
Transfer for tag and bar code			●			
Applying Tag & barcode	3	●				
Packaging	3	●				
	67	18	15	3	2	2

Table 4. Proposed Process Activity

PROPOSED LAYOUT									
Process	Time (Minutes)	Manpower	Time (Minutes)	Distance (meter)	O	T	I	S	D
Sketching and applying rugby (strap and insole)	0.22	2	0.11		●				
Transfer for the next process	0.03		0.03	1		●			
Drying (strap and insole)	0.25								●
Cutting(insole and strap)	0.22	2	0.11		●				
Transfer for the next process	0.03		0.03	1.98		●			
assembly/sewing of strap	0.55	5	0.11		●				
Transfer for the next process	0.05		0.05	2.89		●			
Padlock & assembly of insole and tope(rugby)	0.2	2	0.1		●				
Transfer for the next process	0.04		0.04	1		●			
sewing of insole and tope, labelling	0.18	2	0.09		●				
Transfer for the next process	0.05		0.05	1		●			
Bandsawing	1.01	8	0.13		●				
Smoothing (Bulihan)	0.44	4	0.11		●				
Transfer for the next process	0.05		0.05	2.89		●			
Assembling Strap, insole and outsole	1.28	10	0.13		●				
Transfer for the next process	0.03		0.03	1.56		●			
Cleaning	0.92	8	0.12		●				
Transfer for the next process	0.03		0.03	1		●			
Final Inspection	0.72	6	0.12				●		
Packaging, Applying tag and barcode	0.5	4	0.13		●				
	6.81	53	1.55	13.32	10	8	1	0	1