



**IMPROVING DIE EXCHANGE PROCESS IN TEXTILE
MANUFACTURING COMPANY WITH SINGLE MINUTE
EXCHANGE OF DIE (SMED)**

MUHAMMAD HAZWAN BIN ARZMI

MASTER OF MANUFACTURING ENGINEERING (INDUSTRIAL ENGINEERING)

2014



Faculty of Manufacturing Engineering

**IMPROVING DIE EXCHANGE PROCESS IN
TEXTILE MANUFACTURING COMPANY
WITH SINGLE MINUTE EXCHANGE OF DIE
(SMED)**

Muhammad Hazwan bin Arzmi

Master of Manufacturing Engineering (Industrial Engineering)

2014

**IMPROVING DIE EXCHANGE PROCESS IN TEXTILE MANUFACTURING
COMPANY WITH SINGLE MINUTE EXCHANGE OF DIE (SMED)**

MUHAMMAD HAZWAN BIN ARZMI

**A report submitted in fulfilment of the requirement for the degree of Master of
Manufacturing Engineering (Industrial Engineering)**

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014

DECLARATION

I declare that this project entitled “Improving Die Exchange Process in Textile Manufacturing Company with Single Minute Exchange of Die (SMED)” is the result of my own work except as cited in the references. The project has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Muhammad Hazwan bin Arzmi

Date :

APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfilment of Master of Manufacturing Engineering (Industrial Engineering).

Signature :
Supervisor Name : Dr. Effendi Bin Mohamad
Date :

DEDICATION

For my beloved parent who were always supported me,

Arzmi Bin Mansor

Safiah Binti Abd. Aziz

For my supervisor,

Dr. Effendi Bin Mohamad

For my families and my friend, thanks for their loves and care

ABSTRAK

Kajian ini membentangkan kerjasama antara syarikat tekstil pembuatan di Malaysia dan Universiti Teknikal Malaysia Melaka. Dalam Kerjasama Syarikat-Universiti (CUC), Single Minute Exchange of Die (SMED) diperkenalkan pada syarikat untuk memperbaiki proses pertukaran memakan masa mesin yang stamping. Projek ini telah dilaksanakan pada akhbar mesin sendiri oleh syarikat ini. Sejak mesin ini sedang melaksanakan proses pengeluaran kritikal, ia adalah penting bahawa mesin ini boleh digunakan seberapa banyak yang boleh. Masalah mengenai mesin ini kini pertukaran langkah-langkah yang jelas menyebabkan langkah-langkah ke arah yang lebih rumit wujud selama prosedur pertukaran. Dalam kes ini ia adalah penting untuk mengenal pasti dan mengelaskan antara aktiviti-aktiviti dalaman dan luaran di antara mereka semua. Oleh itu aktiviti-aktiviti yang kemudiannya boleh dipermudahkan dan dari prosedur pertukaran baru boleh dibangunkan. Kerangka teori kajian ini melibatkan mengenal pasti keadaan semasa prosedur pertukaran, mengenal pasti dan memisahkan aktiviti dalaman dan luaran, menukar dalaman ke dalam aktiviti-aktiviti luar dan akhir sekali memperkemas semua aktiviti pertukaran. Sebelum ini, masa pertukaran mesin stamping purata adalah 5.19 jam. Selepas pelaksanaan SMED, masa pertukaran mesin stamping telah dikurangkan kepada 3.23 jam atau purata (25.82%) pengurangan dari semasa pertukaran sebelumnya. Penambahbaikan yang dibuat adalah menukar tiga aktiviti dalaman untuk aktiviti luar. Aktiviti-aktiviti adalah alat mengumpul, mengumpul acuan dan acuan cek cepat. Dengan menukar tiga aktiviti ke luar, masa pertukaran boleh dikurangkan sehingga 11.18 minit. Bagi memudahkan, dua aktiviti pertukaran dipermudahkan yang penjajaran acuan dan tekanan menetapkan dengan itu mengurangkan masa untuk 34.01 minit dan 49.56 minit masing-masing. Kesimpulannya, kerjasama yang ditunjukkan untuk menjadi dilaksanakan dalam menyokong pelaksanaan SMED dalam syarikat tekstil pembuatan.

ABSTRACT

This study presents collaboration between a textile manufacturing company in Malaysia and Universiti Teknikal Malaysia Melaka. In this Company-University Collaboration (CUC), Single Minute Exchange of Die (SMED) was introduced in the company to improve the time-consuming changeover process of its stamping machine. This project were implemented on press machine own by this company. Since this machine are currently performing critical production process, it is important that this machine could be utilized as much as it can be. The problem regarding these machine are currently changeover steps are ambiguous resulting towards a more complicated steps exist during changeover procedures. In this case it is important to identify and classify between the internal and external activities between all of them. Hence those activities later could be simplified and from that a new changeover procedure could be developed. The framework of this study involves identifying current condition of changeover procedures, identifying and separating internal and external activities, converting internal into external activities and lastly streamlining all changeover activities. Previously, the changeover time of the stamping machine in average is 5.19 hours. After the implementation of SMED, the changeover time of the stamping machine was reduced to 3.23 hours in average or (25.82%) reduction from previous changeover time. The improvements made are converting three of internal activities in to external activities. Those activities are collecting tools, collecting moulds and mould quick check. By converting these three activities into external, the changeover time could be reduced up to 11.18 minutes. As for simplifying, two of changeover activities were simplified which are mould alignment and pressure setting hence reducing time for 34.01 minutes and 49.56 minutes respectively. In conclusion, the collaboration is shown to be feasible in supporting SMED implementation in the textile manufacturing company.

ACKNOWLEDGEMENT

Alhamdulillah and Thank to Allah S.W.T. with all gracious and merciful for giving me strength and the ability to accomplish this study successfully. I would like to express my gratitude to all those who gave me the possibility to complete this study. I am deeply indebted to my supervisor Dr. Effendi Bin Mohamad whose help, stimulating suggestions, encouragement and guidance helped me in all the time of research for and writing of this thesis.

Also, I am very grateful towards the company personnel's involved whose willing to sacrifice their time and energy in assisting with the completion of this study especially to Mr. Loh and En. Zaini from maintenance department.

Finally, I would like to thanks to all my colleagues. I want to thank them especially Nor Asmaa Alyaa Binti Nor Azlan for all their help, support, interest and valuable hints in completing this thesis. In addition, I would like to give my special thanks to my father, Arzmi Bin Mansor, my mother Safiah Binti Abd. Aziz and my brother Mohd Hafiz Bin Arzmi whose always provides me with love and keep encouraging me all the time in order for me to complete this work.

TABLE OF CONTENT

DECLARATION	
APPROVAL	
DEDICATION	
ABSTRAK	i
ABSTRACT	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENT	iv
LIST OF FIGURES	vi
LIST OF TABLES	Viii
LIST OF ABBREVIATIONS	ix
1.0 INTRODUCTION	
1.1 Introduction	1
1.2 Problem Statement	2
1.3 Objectives of The Study	4
1.4 Scope of The Study	4
2.0 STUDY BACKGROUND	
2.1 Collaboration of University and Industry	5
2.2 Lean Manufacturing (LM)	7
2.2.1 Seven Waste in LM	7
2.2.2 LM Tools	11
2.3 Stopwatch Time Study	12
2.4 Single Minute Exchange of Die (SMED)	16
2.4.1 Purpose of SMED	18
2.4.2 SMED Concepts. Principles and Basic Procedures	19
2.4.3 Traditional Approach Vs SMED	22
2.5 Critical Success Factor (CSF)	24
2.5.1 SMED CSF	25

2.6	Implementation of SMED	28
2.7	Current Condition of Studied Machine	31
3.0	METHODOLOGY	
3.1	Project Overview	32
3.2	Project Flowchart	34
3.3	Observation	35
3.4	Design and Dimensioning Jig	36
3.4.1	Dimensioning	37
3.4.2	Designing Jig	39
3.4.3	Fabricating Jig	41
3.5	Experiment	43
3.5.1	Alignment Setting	43
3.5.2	Pressure Setting	45
4.0	RESULTS AND DISCUSSION	
4.1	Observation Results	47
4.2	Stopwatch Time Study	58
4.3	Improvements	61
4.4	Results	64
5.0	CONCLUSION AND RECOMMENDATION	
5.1	Conclusion	69
5.2	Recommendation	71
REFERENCES		72
APPENDICES		
A	Gantt Chart MP1	78
B	Gantt Chart MP2	79
C	Turn It In Report	80
D	Raw Data Stopwatch Time Study	81

LIST OF FIGURES

2.1	Over production	8
2.2	Waste of transportation	9
2.3	Production line integrated with conveyor belting	10
2.4	Stopwatch time study sheet	14
2.5	Traditional changeover procedures	19
2.6	SMED procedures	21
2.7	Traditional approach and SMED	23
3.1	Product produce from the press machine	32
3.2	Framework of SMED	33
3.3	Flowchart of study	35
3.4	Flowchart of jig development	37
3.5	Machine dimensioning	38
3.6	Jig attachment	39
3.7	Isometric view	39
3.8(a)	Side view	40
3.8(b)	Front view	40
3.8(c)	Top view	41
3.9	Raw material	41
3.10	Laser cutting process	42
3.11	Laser cutting product	42
3.12	MIG welding process	43
3.12(a)	Mould side point	44
3.12(b)	Mould top point	45
3.12(c)	Marking	45
4.1(a)	Machine prep (before)	48

4.1(b) Machine prep (after)	48
4.2 Technician collecting tools	49
4.3 Technician pulling out mould from machine	50
4.4 Mould rack	50
4.5 Machine clean-up	51
4.6 Mould quick check	52
4.7 Aligning the mould	53
4.8 Pressure setting	54
4.9 Benchmarking strips from previous production	54
4.10 Feeding rate setting	55
4.11(a) Carrier clamping setting	56
4.11(b) Product being clamped	56
4.12 Folding pressure	57
4.13(a) Puller setting (guide)	58
4.13(b) Puller setting (feeder)	58
4.14 Mould rack (improved)	62
4.15 Jig	63
4.16 Jig marking	63
4.17 Pressure setting gap	64
4.18 Changeover reduction time graph	68

LIST OF TABLES

2.1	Type of Activities in University and Industry Collaboration	6
2.2	Number of recommended cycle for time study	15
2.3	Key event and publication on SMED	17
2.4	Advantages of SMED	24
2.5	SMED implementation	29
4.1	Conversion procedure and time	60
4.2	Stamping machine changeover time before and after SMED	66

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, in an increasingly competitive world market, the trend of business globalization pushes the companies to face challenges from both national and international competitors. The main purpose of being competitive is to win customer's satisfaction since they play a very important role in every successful company (Matzler & Hinterhuber, 1998). In facing these challenges, companies need to be well prepared in many aspects including in production strategies. Production strategies or also called manufacturing strategies can be defined as a pattern of decisions, both structural and infrastructural that will define the capability of a manufacturing system and at the same time illustrating the operation behaviour, in order to meet a set of manufacturing objectives which are parallel with the overall business objectives. (Platts *et al.*, 1998).

According to Hallgren (2007), production strategy can be related to the capabilities and the performance of a particular production line. In determining the performance of certain production, several aspects can be used as guidelines. One of them is the ability of being flexible in production line. Based on Kaschel (2006), flexibility can be defined as the ability of a manufacturing system to respond cost effectively and rapidly to changing production needs and requirements. This capability is becoming increasingly important for the design and operation of manufacturing systems, as these systems do operate in highly variable and unpredictable environments.

Flexibility can be seen in many aspects which is in term of process, product, volume, operation or routine (Parker & Wirth, 1999). By achieving high flexibility, as stated by Ngamsirijit (2008), production in an organization could be customized, have short lead

times, able to cope with high uncertainty and also changing customer preferences from time to time without having issues regarding the cost ineffectiveness in production.

In order to achieve high flexibility, one of the alternatives that could be taken by companies is implementing lean manufacturing teaching in their organization. One of the lean methods in reducing waste, the Single Minute Exchange of Die (SMED) is designed for the purpose of optimizing machine utilization by reducing the downtime due to the changeover processes. There are ample of companies that already been practising SMED since the effectiveness of this method are already proven (Ferradás & Salonitis, 2013). In addition, Ferradás and Salonitis (2013) also stated that the ability of this method to be adapted in many different fields makes it even more useful and beneficial to the companies.

In this study a collaboration between university and industry has been established. Students from universities are required to propose solution to several issues in a particular industry. In this study, the issues are related to downtime due to changeover process. One of the press machines used in the factory was producing several different sizes of the same product, hence requiring the mould to be changed from time to time. Thus, reducing changeover time is important to the company.

1.2 Problem Statement

A variety of product exists in the current market. Although they are basically of the same kind, they still exist in many different shapes, colour and sizes which make each of them very interesting and attracting in their own ways. Hence emphasizing the importance of having high flexibility to be one of the speciality in companies. Flexibility are mostly related to the ability of producing many different products in a small time frame without sacrificing too much machine utilization rates while having a longer downtime (Goyal & Netessine, 2011).

Usually, changeovers would result in downtime (Shingo, 1985). This is due to the requirement for the machine to be stopped from any production in order for any part of them to be removed or replaced either because of safety issues or constraint issues. In spite of that, reducing downtime due to changeover procedure is proven to be difficult due to

ambiguous steps and procedure during each changeover procedure. In addition, usually when the changeover procedure is started, the machine would be turned off until all of the changeover steps are completed hence requiring more time (Shingo, 1985).

Furthermore, a complicated step in the changeover procedure will definitely increase the time taken especially involving machines that fully operate mechanically. This is due to the need of the operator to do their work slower than they should be in order for them to do it right at the first time and avoiding any error in the changeover procedure. Any error in the changeover procedure result in operator redoing them all over again if especially when it involve realigning and resetting the machines. In mechanical machines, most of the settings were done manually, hence usually, most of the activities involve in the changeover procedure are done based solely on operators' experience and intuition.

Nevertheless, although changeover time can be reduced, the effectiveness of the reduction process are sometime is undefined. The knowledge of the reduction time achieved could be used as a guide for the improvement in that particular process which could be crucial in improving quality, capacity and capability of the process. Besides that, it is important to determine the effectiveness since there are possibility that the same methods can be implemented in other areas which could improve them as well. Hence it would help to improve other process existed in the manufacturing as well.

In this study, SMED implementation involving press machines in a textile industry is discussed. The textile company needs to produce many different types of product in a short time period and in order to do so, the utilization of the machine must be at the maximum rates hence enabling them to achieve cost effectiveness in production. Currently, it requires 5.19 hours to be completed provided that everything is proceeding according to plan. Due to the trial and error concept being used, it may increased the time tremendously. Hence increasing downtime due to changeover procedures while in the same time reducing machine utilization.

1.3 Objectives of The Study

The objectives of this study are as follows:

- a) To identify activities exist in the changeover procedure involving the machine studied and classify them into external and internal processes
- b) To analyse and simplify certain steps in the changeover procedure by designing jig and creating standards
- c) To propose new changeover procedure which consume less time than currently are

1.4 Scope of The Study

In this study, problem detected in the textile manufacturing company is the time consuming process of changeover procedure involving press machine. The reason which lead to studying this particular machines are due to this machine were performing critical task rather than the others. Currently, the company only own this one machine which could produce the required products. Hence, any delay due to changeover cannot be back up by any other machines. As a consequences, the company experiencing low machine utilization and low cost-effectiveness in their production. Due to a confidentiality, the basic information of the company is not stated.

In this study, SMED is implemented to reduce changeover time and downtime. Every steps of SMED will be done one by one on the machine. Initially, each step in changeover procedures is identified followed by separation of internal or external processes before proceeding to conversion and improvement phase. In conversion phase, each possible internal step will be converted to external step and use for improvement. While in simplification process, all steps will be simplified as best as it can by using any aiding tools such as jigs or using marking as a guide during the changeover process. In this study, stopwatch time study also will be implemented in determining the time consumption of each activity in the changeover procedure. In addition, each activity is studied in order to determine either they can be performed at the same time without affecting other activity or not.

CHAPTER 2

STUDY BACKGROUND

This chapter contains the literature reviews on lean manufacturing practices including its tools, focusing on SMED and how the SMED could help reduce changeover time of a manufacturing process. The literatures include journals, thesis, technical documents, books, case studies, reports and electronic-media.

2.1 Collaboration of University and Industry

First of all, this study were executed as part of a collaboration between Universiti Teknikal Malaysia Melaka (UTeM) and one of manufacturing company in Malaysia. The purpose of this collaboration is two-pronged. From the university perspectives, the collaboration could provide students with real life knowledge regarding the actual situation in industries and at the same time enabling them to experience the true nature of manufacturing problems that usually occur in the industry (Mohamad & Ito, 2011). Besides that, this collaboration could enable students to build their technical skills and improve the growth of entrepreneurial factors (Pecas & Henriques, 2006). Via this collaboration, university can gain benefit in terms of knowledge and experience (Mohamad & Ito, 2011).

From the industries perspectives, this collaboration may assist them in defining and solving manufacturing problems with the help from academician and the problems could be tackled in more effective ways. Besides problem solving, the collaboration would help the company in term of their innovation process (Pecas & Henriques, 2006) since university tend to explore new technology from time to time. Related to that, according to Mohammad and Ito (2011), there is a need of expertise in the rapid evolving technology which forces industry to perform collaboration with universities hence keeping them in the loop of surroundings technologies.

According to Mohamad and Ito (2011), there are three different groups which would be involved in a university-industry collaboration. The groups are the company employees (CE), engineering student (ES) and university staff (US). Table 2.1 below shows the activities between the three groups mentioned earlier.

Table 2.1: Type of activities in university and industry collaboration (Mohamad and Ito, 2011)

Activity	Description of Activity	Involved group
Company Employees- Engineering Students Collaboration (CEESC)	Involve more on students internship in the industries which includes a small projects that are based on the needs of that particular company	CE & ES
Engineering Student- University Staff Collaboration (ESUSC)	Includes all groups but mostly are between students and supervisor from the university since it is involving the student final projects. As for the company will only be assisting in providing information and data required for student's project.	ES, CE & US
Company Employees- University Staff Collaboration (CEUSC)	Basically involving performance and knowledge enhancement of university staff which includes training, seminars and workshops. This collaboration usually last between one to three years and all the activities were conducted by the company.	US & CE

Nonetheless, in university-industry collaboration, certain aspects need to be considered such as the culture, organization and management characteristics between the two joined partners (Liyanage & Mitchell, 1994). In order to have an effective relationship, both parties must have a same goal and at the same time working together to achieve it. Furthermore, certain aspect can be improved such as company efficiency, reducing waste, process capabilities and so on.

2.2 Lean Manufacturing (LM)

Lean manufacturing or sometimes referred as Toyota Production System (TPS) (Abdullah, 2003) was invented by a Japanese named Taiichi Ohno in 1945 to 1970 and still being improved continuously until these days (Liker, 2004). Lean manufacturing (LM) is considered as a performance-based process that is being used in manufacturing organizations to increase competitiveness with other companies. According to Abdullah (2003), lean manufacturing is not about implementing new tools and techniques towards building a product, but actually improving the thinking perspectives on how to run the manufacturing lines.

The purpose of the LM is basically to reduce cost and production cycle-time by eliminating all waste or non-value added activities that exist in the production through continuous improvement and at the same time increasing the value-added process along that activities (Leon, 2010; Tinoco, 2004; Abdullah, 2003). According to Marchwinski and Shook (2003), waste can be defined as any activity that consume resources but creates no value for the customer and as for value-added, it is defined as the time spent on activities that add value to an item from the consumer's perspectives. Furthermore, the value-added activities will effectively change the form and function of a raw material into a goods or services that customer are willing to pay. Rawabdeh (2005) stated that it is important to determine and overcome the problem of waste generation because it will not only waste material and labour resources, but it will also create material shortages, hinder meeting schedules, create idle time at subsequent workstations and extend the manufacturing lead time.

2.2.1 Seven Wastes in Lean Manufacturing

According to Leon (2010) and Poppendieck (2002), in lean manufacturing, there were seven elements that has been classified as waste in the manufacturing processes. These waste can be related to each other and sometimes become a chain reaction from one waste to the other. The first type of waste is over production. Producing a product earlier or faster than it should be or more than it should be will result in waste (Leon, 2010; Berlec & Starbek, 2009). This is because the product could become a scrap over time especially if it has a specific expiry dates. Figure 2.1 shows waste due to over production in production lines.

Besides expiry dates, there will also be a possibility in damaging the goods due to material handling in production lines or the warehouses because of the excessive quantity of products. According to Berlec and Starbek (2009), over production is usually happened due to poor production scheduling. This could be relates to the over estimation on the forecasting process.



Figure 2.1: Over production (Berlec & Starbek, 2009)

The second waste in LM is "defect" or "reworks". Defect can be caused by poor processing parameters control, lack of skills and expertise and so on. Defective product cannot be delivered to customer because it will damage the reputation of the organization. Furthermore, whenever there is defects, there will be reworks otherwise the organization have no choice but to scrap the product (El-Nomrouty & Abu-Shaaban, 2013).

Based on Leon, (2010), rework can be define as correcting or repairing a defective product until it can be accepted by the customer. In rework, extra resources is required to fix the defect of a product hence resulting in using more resources to complete a single unit of product. This problem can be reduced by training, supervision and checking (Berlec & Starbek, 2009).

The third waste in LM are excessive inventories. Excessive inventories happens due to product overload. It can also be a consequence of the first waste which is over-production. Besides product overload, raw material and work in progress (WIP) are also counted as inventories (El-Nomrouty & Abu-Shaaban, 2013). Inventories require a space to be kept together either in indoor storage or at the production warehouses. A bigger inventories will require larger space to be stored and a high cost is involved. According to Berlec and Starbek (2009), inventories can cost up to 20% of the production sales value.

In addition, large amount of inventories will lead to a more complex material handling hence creating a possibility for the item to be damaged. Hence contribute to an additional cost. Waste of unnecessary inventory can be minimized by defining optimal, maximum and minimum inventory, as well as exact time when the ordered quantity should arrive at the warehouse (Berlec & Starbek, 2009).

The fourth waste in LM are the "transportation". According to El-Nomrouty and Abu-Shaabab (2013), "transportation" includes any non-value added movement of materials e.g. moving materials between workstations. This type of waste is a consequence of excessively long, intersecting transport paths, temporary storage, load and unload, transport of pallets hither and thither. In order to eliminate this type of waste, optimizing transport paths, by defining exact locations and numbers of intermediate warehouses and also by a transition from large-series to small-series or even individual production are required (Berlec & Starbek, 2009). Figure 2.2 shows the waste of transportation. The product were transported by two forklift rather than only one. Hence needing more resources of manpower and equipments than it should really have.

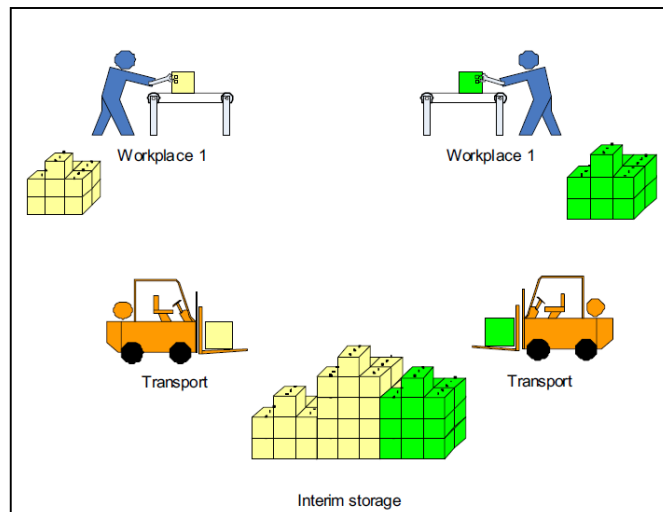


Figure 2.2: Waste of transportation (Berlec & Starbek, 2009)

The fifth waste is waiting. This type of waste refers to idle time of either manpower or machines. According to Berlec and Starbek (2009), waste of waiting can either be visible or invisible. "Waiting" can be seen clearly for example not operating machines or idling worker while hidden waste of waiting can happen due to operator waiting because of

machine defects. El-Nomrouty and Abu-Shaabab (2013) stated that this type of waste can occur due to bottleneck or inefficient product flow in the factory.

The sixth waste is unnecessary motions. Leon (2010) justified that this waste is related to any movement that does not contribute any added value to the product or services. This might include walking around the factory floor to look for a tool, or even unnecessary or difficult physical movements, due to poorly designed ergonomics, which slow down the workers (Capital, 2004). According to Rawabdeh (2005), it involves poor ergonomic of production, where operators have to stretch, bend and pick up when such actions could be avoided. One method proposed by Berlec and Starbek (2009) in order to reduce this waste is by installing transfer device such as conveyor belting to reduce the workers' movement as shown in Figure 2.3.

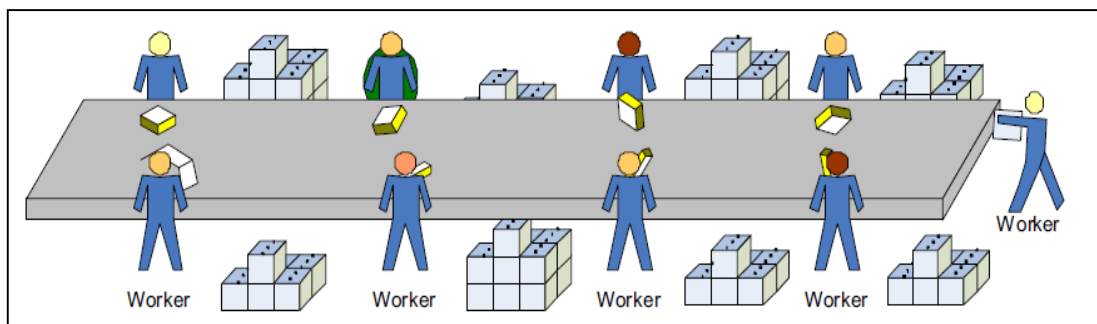


Figure 2.3: Production line integrated with conveyor belting (Berlec & Starbek, 2009)

The seventh and the last type of waste in LM is over-processing. According to El-Nomrouty and Abu-Shaabab (2013), over-processing occur due to producing more than what is required by customer. This can be in terms of quality such as producing earlier than it should be or in terms of specification e.g. equipping the product with more advance features than it should have. Over-processing occur due to product not satisfying the specification required hence needed to be reworked (Berlec and Starbek, 2009). In order to eliminate this waste, a proper analysis toward the process need to be conducted. Furthermore, continuous improvement would also help greatly in preventing this type of waste.