Faculty of Manufacturing Engineering

IMPROVEMENT OF CHANGE GLUE SCHEDULE DOWN TIME AT LID ATTACHMENT PROCESS FOR SEMICONDUCTOR DEVICES

Rozeana Abd Rahman

Master of Manufacturing Engineering

2017

IMPROVEMENT OF CHANGE GLUE SCHEDULE DOWN TIME AT LID ATTACHMENT PROCESS FOR SEMICONDUCTOR DEVICES

ROZEANA ABD RAHMAN

A thesis submitted
in fulfilment of the requirements for the degree of
Master of Manufacturing Engineering

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: **Improvement of Change Glue Schedule Down Time at Lid Attachment Process For Semiconductor Devices**

SESI PENGAJIAN: **2016/2017**

Saya ROZEANA ABD RAHMAN

mengaku membenarkan Laporan Projek Sarjana ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan Projek Sarjana adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan Projek Sarjana ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☑	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	TIDAK TERHAD	

Disahkan oleh:

Alamat Tetap:
NO.94 Block 4 Peringkat 1
Felda Palong 6
Gemas, Negeri Sembilan

Tarikh: 16.08.2017

Cop Rasmi:
PROF DR BASHIR MOHAMAD BIN BALI MOHAMAD
Professor
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Tarikh: 16/8/2017

** Jika Laporan Projek Sarjana ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan Projek Sarjana ini perlu dikelaskan sebagai SULIT atau TERHAD.

EMENTERIAN PENDIDIKAN TINGGI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya,
76100 Durian Tunggal,
Melaka, Malaysia.

Tel : +606 555 2000
Faks : +606 331 6247
www.utem.edu.my

FAKULTI KEJURUTERAAN PEMBUATAN
Tel : +606 331 6429/6019 | Faks : +606 331 6431/6411

Ruj. Kami (Our Ref.) :
Ruj. Tuan (Your Ref.) :

29 Julai 2017

Pustakawan
Perpustakaan UTeM
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya,
76100 Durian Tunggal,
Melaka.

Tuan/Puan,

PENGKELASAN LAPORAN PROJEK SARJANA SEBAGAI ~~SULIT~~/TERHAD LAPORAN PROJEK SARJANA KEJURUTERAAN PEMBUATAN (KEJURUTERAAN SISTEM PEMBUATAN): ROZEANA ABD RAHMAN

Sukacita dimaklumkan bahawa Laporan Projek Sarjana yang tersebut di atas bertajuk **"Improvement of Change Glue Schedule Down Time at Lid Attachment Process for Semiconductor Devices"** mohon dikelaskan sebagai *~~SULIT~~ / TERHAD untuk tempoh LIMA (5) tahun dari tarikh surat ini.

2. Hal ini adalah kerana IANYA MERUPAKAN PROJEK YANG DITAJA OLEH SYARIKAT LUAR DAN HASIL KAJIANNYA ADALAH SULIT.

Sekian dimaklumkan. Terima kasih.

Yang benar,

Tandatangan dan Cop Penyelia

PROF DR BASHIR MOHAMAD BIN BALI MOHAMAD
Professor
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

NOTA: BORANG INI HANYA DIISI JIKA DIKLASIFIKASIKAN SEBAGAI SULIT DAN TERHAD. JIKA LAPORAN DIKELASKAN SEBAGAI **TIDAK TERHAD**, MAKA BORANG INI **TIDAK PERLU DISERTAKAN** DALAM LAPORAN SARJANA.

DECLARATION

I declare that this thesis entitle "Improvement of Change Glue Schedule Down Time at Lid Attachment Process for Semiconductor Devices" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : ROZEANA ABD RAHMAN

Date : 16.08.2017

APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in term of scope and quality as a partial fulfilment of Master of Manufacturing Engineering (Manufacturing System Engineering)

Signature : .....

Name : PROF. DR. BASHIR MOHAMAD

Date : 16/8/2017

DEDICATION

To my beloved father, mother and husband.

ABSTRACT

This research report presents the work done on the improvement of change glue schedule down time at lid attachment process for semiconductor devices. Lid attachment is the end of line process for Plastic Dual Small Outline Flat (PDSOF) package which is one of the semiconductor devices. The process is started with pick and places the lid onto the package, then proceeds to glue dispensing with dosage on four corners of the lids to completely seal the package by using capillary effect. There is a change of glue activity in this process which is counted under schedule down time. Based on the Overall Equipment Effectiveness (OEE), it was found that the change of glue activity give impact on the machine performance. The increasing of change glue time will result in the production did not achieve the target productivity. In this research, the hidden losses were defined on the equipment setup which is changed of glue in the lid attachment process. There is plan to increase the amount of glue lid attach to reduce the schedule down time in order to improve overall equipment effectiveness toward achieving good productivity. The study for glue pot life is required since increasing the amount of glue will extend the glue pot life and it is suspected will increase the glue viscosity. In general, all the project objective are managed to be achieved using the developed research methodology. For future work, this research should be enhance further to achieve better result and to make use of the increasing glue amount and pot life extended time enhancement in other perspective field and also to carry out further study to improve on the whitish on lid surface.

ABSTRAK

Laporan penyelidikan ini membentangkan kerja yang dilakukan pada peningkatan perubahan jadual turun masa penukaran gam pada proses lekatan tudung penutup untuk peranti semikonduktor. Lekatan tudung penutup adalah proses talian terakhir bagi Plastic Dual Kecil Rangka Flat (PDSOF) pakej yang merupakan salah satu daripada peranti semikonduktor. Proses ini bermula dengan pengambilan dan meletakkan tudung ke pakej, kemudian meneruskan untuk pemancutan gam dengan dos yang betul pada empat penjuru tudung untuk melekatkan pakej sepenuhnya dengan menggunakan kesan kapilari. Terdapat aktiviti penukaran gam dalam proses ini yang dikira di bawah jadual turun masa (SDT). Berdasarkan Keberkesanan keseluruhan peralatan (OEE), didapati bahawa aktiviti penukaran gam memberi kesan ke atas prestasi mesin. Peningkatan masa penukaran gam menyebabkan pengeluaran tidak mencapai sasaran produktiviti. Dalam kajian ini kerugian tersembunyi telah ditakrifkan pada persediaan peralatan yang merupakan penukaran gam dalam proses lekatan tudung penutup . Terdapat rancangan untuk menambah jumlah gam untuk mengurangkan jadual turun masa (SDT) untuk memperbaiki keseluruhan keberkesanan peralatan (OEE) ke arah untuk mencapai produktiviti yang baik. Kajian terhadap kehidupan gam periuk diperlukan bagi peningkatan jumlah gam yang akan memanjangkan jangka hayat gam periuk dan disyaki akan meningkatkan kelikatan gam itu. Secara umum, semua objektif projek ini berjaya dicapai dengan menggunakan kaedah penyelidikan yang telah ditetapkan. Untuk kerja-kerja masa depan, penyelidikan ini perlu diperbaiki lagi untuk mencapai keputusan yang lebih baik dan untuk menggunakan jumlah gam dengan periuk peningkatan masa hidup dilanjutkan bagi diaplikasikan dalam bidang perspektif lain dan juga untuk menjalankan kajian lanjut untuk mengatasi masalah keputihan di permukaan tudung.

ACKNOWLEDGEMENTS

First and foremost, i would like to take this opportunity to express my sincere acknowlegement to my supervisor Professor Dr. Bashir Mohamad Bin Bali Mohamad form Falcuty of Manufacturing Engineering University Technical Malaysia Melaka (UteM) for his essential supervison, support and encouragement and support towards the completion of this master project.

I would also like to express my grestest gratitute to Dr Nur Izan Shahriah bt Hussein from Faculty of Manufacturing Engineering Universiti Teknikal Malaysia Melaka (UteM) for suggestions and advice to me for the master project accomplishment.

Special thanks to all my beloved father, mother and couse mate for their moral support in completing this master. Lastly thanks to you everyone who had been to the crucial parts of realization of this project.

TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	**i**
ABSTRAK	**ii**
ACKNOWLADGEMENT	**iii**
TABLE OF CONTENTS	**iv**
LIST OF TABLES	**vi**
LIST OF FIGURES	**vii**
LIST OF ABBREVIATIONS	**ix**
CHAPTER 1	
1. INTRODUCTION	**1**
1.1 Background	1
1.2 Problem statement	3
1.3 Objectives	4
1.4 Scope	5
1.5 Significant of Project	5
2 LITERATURE REVIEW	**6**
2.1 Introduction of Overall Equipment Effectiveness (OEE)	6
2.1.1 Lid attachment process down Time (SDT)	9
2.2 General Glue Pot Life and Working Life	10
2.3 Liquid Dispensing Element	
2.3.1 Dispensing working principle and process parameter	14
2.4 PDSOF Lid Attachment Glue Dispensing Element	16
2.5 Summary of the Glue Pot Life vs Glue Dispensing Performance	18
3 METHODOLOGY	**19**
3.1 Introduction	19
3.2 Methodology Flowchart	20

3.3 Method Analyse and Project Decision 21
3.4 Analyse Current Procedure and Material 22
3.5 Proposal on New glue Amount and Experimental 25
3.6 Experimental for Data Collection 26
3.7 Process Ability 26
3.6.1Pareto chart analysis 27
3.6.2 Quality Check for 0 hour 31
3.6.3 Reliability (Moisture sensitivity level (MSL1)) 34
3.6.4 Pressure Leakage Test 36
3.8 Implementation and Performance Assessment 38

4 RESULT AND DISCUSSION 39
4.1 Result 39
4.1.1 Process Ability monitoring 39
4.1.2 Experimental Result after change Syringe size to 30cc/20g 42
42 4.1.3 Experimental result for the glue expiry assessment for 0 hour 44
4.1.4 Experimental result for the glue expiry assessment after (MSL1) 45
4.1.5 SDT improvements after increase the amount of syringe size 45
4.1.6 Glue waste monitoring of 10cc/10g vs 30cc/20g syringe size 46
4.1.7 Summary of implementation and lid Attachment process performance result 48
4.2 Discussion 50

5 CONCLUSION AND SUGGESTION FOR FUTURE WORK 55
5.1 Conclusion 55
5.2 Suggestion for Future Work 56

REFERENCES 57

LIST OF TABLE

TABLE	TITLE	PAGE
1.1	Lid Attach weekly machine performance	4
1.2	Breakdown of Schedule downtime of lid attachment process	4
3.1	Comparison between to method for SDT reduction	21
3.2	Experiment Plan	25
3.3	Performance assessment	38
4.1	Experiment Plan	41
4.2	Lid pull result vs expiry time	44
4.3	Lid Pull test result after MSL1	45
4.4	Overall process ability result	49
4.5	SDT change glue monitoring result	50
4.6	Design of Experiment for Whitish on lid surface	54

LIST OF FIGURE

FIGURE	TITLE	PAGE
1.1	Lid attachment process	2
1.2	Lid attachment process flow	2
2.1	OEE computation and procedure	7
2.1	Lid attachment changing glue activity vs time	9
2.3	Viscosity vs Time	10
2.4	EPO-TEK H70E Viscosity vs Time	11
2.5	EPO-TEK H70E Viscosity vs Time	12
2.6	Overall dispenser system overview	16
2.7	Liquidyn glue dispensing controller	17
2.8	Heater block of dispenser system	17
3.1	Research Methodology Flowchart	20
3.2	The new glue packaging amount	22
3.3	Current spec of lid attachment glue.	23
3.4	The location of glue lid attach syringe at the dispenser system	24
3.5	Glue dot offset calibration	26
3.6	Expectation yield based on Pareto analysis	29
3.7	E-Recording data for lid Attachment Process	30
3.8	Box Plot data for lid pull test	32

3.9	Good UV glue refection	33
3.10	Bad UV glue refection	33
3.11	Example lid pull test result after MSL1	35
3.12	BDC test to check any leakage current	37
4.1	E-Recording Checklist	40
4.2	SPC lid pull test data	41
4.3	Lid pull result for 10cc/10g vs 30cc20g of lid attachment process	43
4.4	Yield performance after changes to 30cc/20g	44
4.5	SDT glue change	45
4.6	Comparison of glue waster between syringe size 10cc/10g and syringe size 30cc/20g.	46
4.7	The balanced glue weight is kept under controlled	47
4.8	Lid Pull trend vs expiry time	51
4.9	Glue staging time vs adhesion reading	51
4.10	Yield of lid attach after changes	52
4.11	Improvement of output and reducing of change glue activity	53

LIST OF ABBREVIATIONS

PDSOF	-	Plastic (Green) Dual Small Outline Flat
SDT	-	Schedule Down Time
OEE	-	Overall Equipment Effectiveness
TPM	-	Total Productive Maintenance
MSL	-	Moisture sensitivity level
FTIR	-	Fourier Transform Infrared Spectroscopy
DOE	-	Design of Experiment
UV	-	Ultra-Violation

CHAPTER 1

INTRODUCTION

1.1 Background

Lid attachment is the end of line process for Plastic (Green) Dual Small Outline Flat (PDSOF) package which is one of the semiconductor devices. The process is started with pick and places the lid onto the package, then proceeds to glue dispensing with dosage on four corners of the lids to completely seal the package by using capillary effect. Subsequently the package is cured in the oven at 150 °C for one hour. However during production running, the glue needs to be changed in the middle of production lot. The amount of glue is not sufficient for one lot production which is consisted of 13,440 units. Due to this issue, it has indirectly increase the schedule down time (SDT) and affect the overall machine performance. Figure 1.1 shows how the lid attachment process is look like. In Figure 1.2 described the lid attachment process flow in detail. Form the lid attachment process flow, it can be seen that the problematic area is on the glue dispensing. Therefore this project is focusing on that area in order to improve the SDT of lid attachment process.

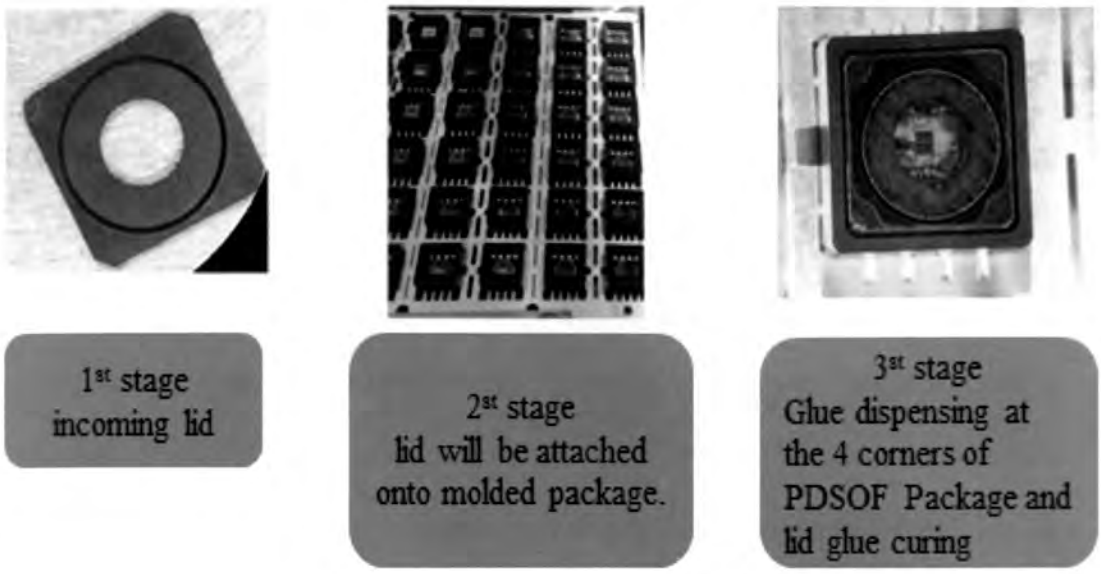

Figure1.1: Lid attachment process

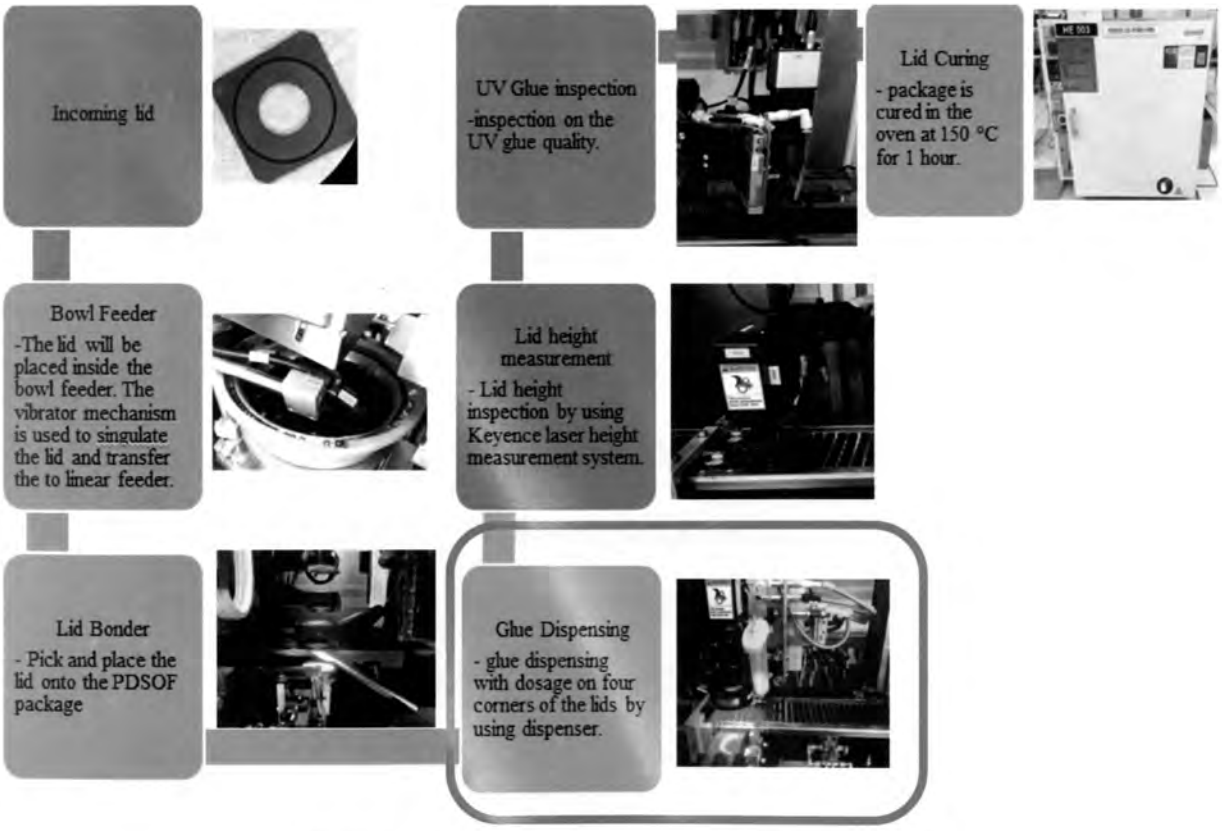

Figure 1.2: lid attachment process flow.

1.2 Problem Statement

Infineon Sensor segment is producing semiconductor devices mainly for automotive industry. The demand of semiconductor devices is increasing towards the growth of automotive demand. Due to increasing of PDSOF package form one million per week to 1.6 million per week, production planner found that lid attachment is a bottleneck process and have a potential to cope with the future demand.

Based on weekly machine performance monitoring, it was observed that there is high schedule down time (SDT) for lids attachment process. Table 1.1 shows the figure of Lid attachment weekly machine performance and Table 1.2 shows the breakdown of schedule down time activity at lid attachment process. The current amount of glue lid attachment is not sufficient to support for 13,444 units in one lot production. The machine needs to stop for changing glue activity. In this situation, the machine will stop 15 minutes for this activity. In one day, the machine will be stopped for 10 times for this purpose. This will give huge impact on the productivity losses.

To overcome the high schedule down time (SDT) issues, there is a proposal to increase the amount of glue which is sufficient for one lot of production and can reduce the change glue activities from 10 times per day to 5 times per day. The increasing of the glue amount will extend the glue expired or glue pot life. For current practice, the glue expired limit is 8 hours. However, according to Nagase glue supplier, glue expired limit can be extended for more than 8 hours. In response to this problem, this project is propose to study the glue pot life and to measure how the change glue activity can reduce the schedule down time (SDT) of lid attach process.

Table 1.1: Lid Attachment weekly machine performance

Machine	Standby		Engineering		Schedule down time		Unschedule down time	
	Actual	Target	Actual	Target	Actual	Target	Actual	Target
ALA-001	0.10%	3%	1.98%	2%	7.36%	7%	2.45%	4%
ALA-002	1.20%	3%	0.10%	2%	7.49%	7%	2.76%	4%
ALA-003	0.09%	3%	0.18%	2%	6.45%	7%	3.04%	4%

Table 1.2: Breakdown of Schedule downtime of lid attachment process

Average of Schedule down time		
Activity	Actual	Target
Change lot	0.4%	0.5%
Change glue	3.1%	2.5%
Change needle	1.1%	1.5%
Service Dispenser	2.5%	2.5%
Total	7.1%	7.0%

1.3 Objectives

i. To investigate the glue pot life effects in lid attachment performance and process parameter due to increasing of glue amount.

ii. To monitor the change of glue time towards schedule down time (SDT) reductions in lid attachment process.

iii. To improve the schedules down time (SDT) of lid attachment process by increasing the amounts of glue lid attachment.

1.4 Scope

The lid attach machine consists of four modules which is loader, unloader, bond head, and dispenser and inspection system. The scope of study is at glue dispensing process in which focuses on Lid Attach machine's module. The second phase of the methodology in chapter 3 will be using the screening procedure in which the numbers of design and material will be reduce after considering the objectives of the project. This study proposes three main phases of the project as follow:

1) Phase 1 : Investigate the current procedure and material used

2) Phase 2: Design assessment and trial run for data collection.

3) Phase 3: Implementation of new glue amount for performance assessment.

1.5 Significance of Project

Upon the successful of this project, it is hope that it can help to improve the overall machine performance and efficiency with reducing the change glue SDT by 1.5% reduction. With this improvement the new demand can be achieve successfully.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Overall Equipment Effectiveness (OEE)

Due to extreme global competition, all companies are struggling to increase and optimize their productivity in order to stay competitive. This condition has led to the need for more strictly defined productivity metrics that are able to take into important factors, such as equipment availability, performance and quality. In availability factor the measurement is on breakdowns, set-ups time and adjustments required in the process. Performance is measure based on reduced speed, idling time and minor stoppages on one equipment or process. While the example of quality such as defects, rework and yield. OEE is the good tool to do the analysis to know how well the equipment or process in order to get the good productivity. Form the OEE also we will know which element needs to be improved in the process.

As mentioned by Campbell,(1995) OEE commonly used measures of maintenance performance into three categories on the basis of their focus; measures of equipment performance (availability, reliability, overall equipment effectiveness), measures of cost performance (operation & maintenance labour and material costs) and measures of process performance (ratio of planned and unplanned work, schedule compliance). The total productive maintenance concept has provided a quantitative metric, Overall Equipment Effectiveness for measuring the productivity of individual production equipment in a factory.

OEE is a tool developed by S. Nakajima (1988) who proposed this in order to evaluate the progress of Total Productive Maintenance (TPM) that he originally created. While Jeong, (2001) mentioned that OEE is the multiplication of three factors; availability, performance and quality. Its particularity is that the hidden losses are taken into consideration in order to higher the degree of significance regarding equipment utilization. However Ljungberg, (1998) mentioned that before the creation of OEE, availability was the only parameter considered which falsified the final result, and an overestimation of equipment utilization was observed. Figure 2.1 is a representation of how OEE could be defined, gathering all the key functions affecting the final result. Moreover, some other losses could be added to get even more accurate results. Based on Aurelian Narses, (2013), planned maintenance for example can be added or focused maintenance time, where the machine could be turned down while improvements are performed on the system.

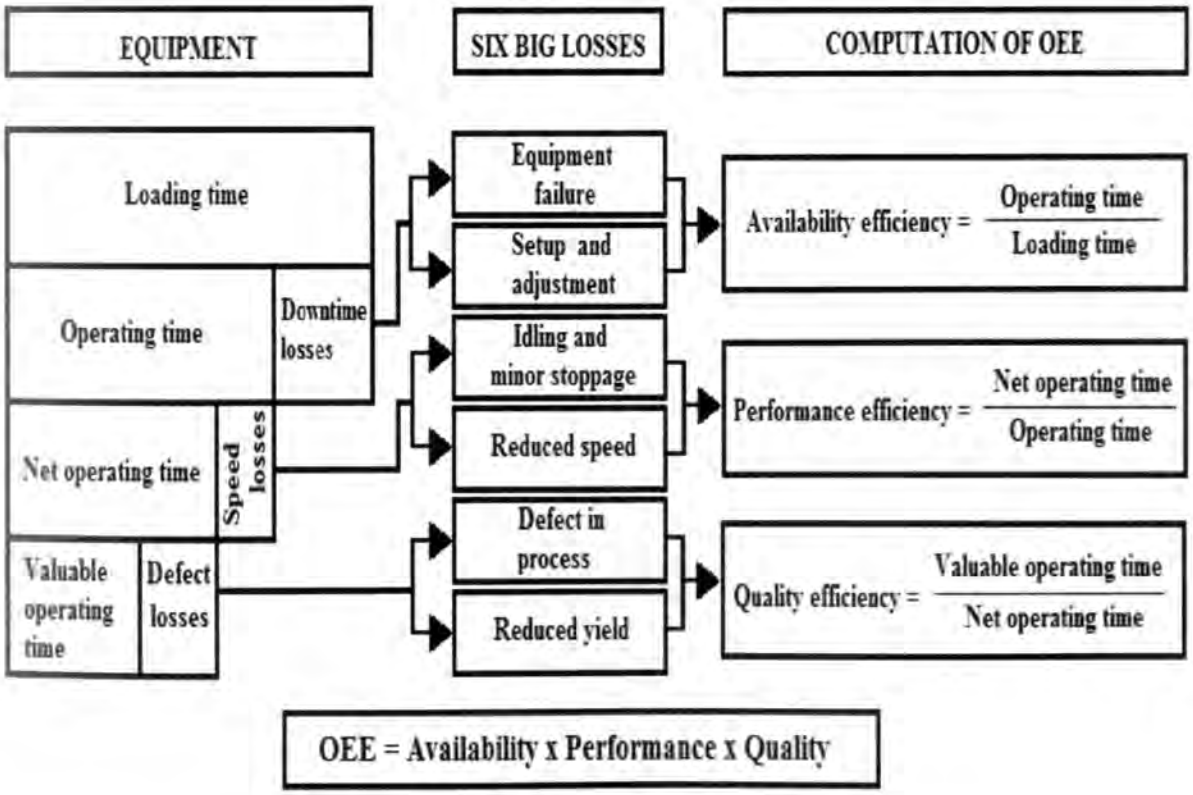

Figure 2.1: OEE computation and procedure (Nakajima, 1988)

OEE can be defined as "A bottom-up approach where an integrated workforce strives to achieve overall equipment effectiveness by eliminating the six big losses" (Nakajima 1988). Six Big Losses describes the most common causes for efficiency loss that almost always found in today's manufacturing environment. Vorne Industries, (2002) also mentioned about six root causes of loss are presented, each directly related to an OEE Factor.

"Six big losses" are defined as follows:

1. Equipment failure/breakdown losses are categorized as time losses when productivity is reduced, and quantity losses caused by defective products.
2. Set-up/adjustment time losses result from downtime and defective products that occur when production of one item ends and the equipment is adjusted to meet the requirements of another item.
3. Idling and minor stop losses occur when the production is interrupted by a temporary malfunction or when a machine is idling.
4. Reduced speed losses refer to the difference between equipment design speed and actual operating speed.
5. Reduced yield occurs during the early stages of production from machine start up to stabilization.
6. Quality defects and rework are losses in quality caused by malfunctioning production equipment. The first two big losses are known as downtime losses and are used to help calculate a true value for the availability of a machine. The third and fourth big losses are speed losses that determine the performance efficiency of a machine such the losses which occur as a consequence operating at less than the optimum conditions. The final two losses are considered to be losses due to defects,