

Appendix A

Table A.1 Lean operations: usage and satisfaction [32]

Region	2006 Usage %	2006 Satisfaction (out of 5)
Global	54	3.73
North America	59	3.87
Europe	52	3.85
Asia-Pacific	56	3.51
Latin America	33	4.11
Large companies (\$2 B+)	62	3.88
Medium companies (\$600 M - 2 B)	59	3.73
Small companies (<\$600 M)	49	3.66

□ Significantly higher rate than other regions/ company size

○ Significantly lower rate

Table A.2 Lean scores for 65 manufacturing plants in China [40]

Rank	Plant number	Industry	Inventory	Team approach	Process	Maintenance	Layout/handling	Supplier	Setups	Quality	Scheduling/control	Total score	Score from 100
1	22	Food/beverage	3.00	3.00	3.33	3.20	2.80	2.20	4.00	3.00	3.33	27.87	77
2	7	Electronics	2.33	3.67	1.83	3.60	3.20	2.60	3.23	3.50	3.67	27.73	77
3	2	Electronics	2.33	3.50	1.83	3.60	3.20	2.60	3.67	2.75	3.67	27.15	75
4	41	Telecom.	3.00	3.00	2.17	3.20	3.00	2.20	3.33	3.25	3.67	26.82	74
5	9	Electronics	2.33	3.17	3.50	3.60	3.50	2.60	1.33	3.00	3.33	26.97	74
6	10	Telecom.	2.00	3.50	2.83	2.80	2.80	2.60	3.67	3.00	3.00	26.20	73
7	13	Telecom.	4.00	3.50	2.17	2.40	1.80	1.40	3.67	3.50	3.67	26.10	73
8	3	Electronics	3.00	2.67	2.50	2.60	3.00	2.80	3.33	3.00	3.00	25.90	72
9	28	Petroleum	2.00	3.33	2.83	3.00	1.80	2.40	3.67	3.50	3.33	25.87	72
10	63	Automotive	2.33	3.50	1.50	2.60	3.20	2.60	2.33	3.00	4.00	25.07	70
11	53	Computer	2.67	2.47	2.00	3.40	3.20	2.20	3.67	2.75	3.00	25.05	70
12	30	Petroleum	2.33	3.17	2.67	3.00	1.50	2.40	3.67	3.50	2.67	25.00	69
13	37	Chemical	2.33	3.50	1.17	3.40	2.80	2.40	2.67	3.75	3.67	24.68	69
14	61	Railway	2.00	3.67	3.00	3.40	2.80	1.80	2.67	2.50	2.67	24.50	68
15	29	Petroleum	1.67	2.67	2.50	3.60	3.20	0.40	2.67	3.75	4.00	24.45	68
16	52	Computer	1.00	1.83	3.50	3.60	2.20	3.40	1.67	3.50	3.67	23.70	66
17	14	Telecom.	2.33	2.50	2.33	2.60	3.40	1.80	3.00	2.75	2.33	23.05	64
18	19	Garment	3.00	2.17	3.00	3.00	3.40	1.60	2.67	0.75	3.00	22.58	63
19	46	Kitchen cabinet	2.00	2.00	1.83	3.40	2.20	1.60	3.67	2.50	3.33	22.53	63
20	20	Garment	2.33	3.00	2.50	2.60	1.80	0.80	3.00	3.75	2.67	22.45	62
21	54	Computer	1.33	2.83	2.53	2.00	2.40	2.40	3.00	3.00	2.33	22.13	61
22	43	Glass	2.67	1.67	2.33	3.40	1.20	0.80	4.00	2.75	3.00	21.82	61
23	12	Telecom.	3.00	2.00	2.33	1.80	2.20	3.60	1.67	2.50	2.67	21.77	60
24	4	Electronics	2.00	1.83	3.00	3.00	3.00	1.40	2.33	2.50	2.67	21.73	60
25	50	Water processing	2.33	2.33	1.83	2.60	2.20	2.60	3.00	2.50	1.67	21.07	59
26	35	Chemical	0.33	2.83	2.00	3.00	2.80	2.00	2.00	2.00	3.33	20.30	56
27	21	Garment	1.67	2.17	2.17	2.60	2.00	2.00	3.33	2.25	2.00	20.18	56
28	64	Elevator	1.67	2.17	2.17	2.40	3.20	1.20	2.33	2.25	2.67	20.05	56
29	33	Chemical	1.00	2.33	1.67	3.00	2.40	2.40	2.00	2.50	2.67	19.97	55
30	45	Plastic	1.67	2.83	2.00	2.80	1.00	1.60	2.67	2.25	3.33	19.95	55
31	60	Biotechnology	0.67	2.50	1.50	2.80	2.60	1.20	3.00	3.00	2.67	19.93	55
32	38	Chemical	1.33	2.50	1.33	2.40	2.40	2.20	2.67	2.00	3.00	19.83	55

(continued)

Rank	Plant number	Industry	Inventory	Team approach	Process	Maintenance	Layout/handling	Supplier	Setups	Quality	Scheduling/control	Total score	Score from 100
33	51	Computer	1.33	2.83	2.50	1.60	2.20	2.20	2.67	2.75	1.67	19.75	56
34	39	Coal	2.00	3.33	2.50	2.20	1.20	1.40	2.67	1.75	2.67	19.72	55
35	8	Electronics	1.33	3.00	1.83	2.80	2.80	0.60	3.00	2.25	3.00	19.62	54
36	57	Printing	1.67	2.33	2.50	2.60	1.60	2.00	1.33	2.60	3.33	19.37	54
37	11	Telecom.	1.67	2.17	1.33	3.60	2.00	0.60	2.67	2.25	3.00	19.28	54
38	24	Food/beverage	1.67	1.00	3.33	2.40	3.20	2.50	1.33	0.75	2.67	19.15	53
39	48	A/C and heating	1.33	1.67	3.00	1.60	2.20	1.40	2.00	2.50	3.00	18.70	52
40	18	Garment	1.67	0.67	2.17	2.40	2.20	1.40	4.00	1.75	2.00	18.25	51
41	16	Telecom.	2.00	1.67	1.83	3.00	2.40	1.80	1.67	1.50	2.33	18.20	51
42	27	Food/beverage	0.67	2.17	1.83	2.60	1.60	2.00	3.00	2.00	2.33	18.20	51
43	58	Printing	2.33	2.33	2.17	2.60	2.00	0.20	2.67	2.50	1.33	18.13	50
44	62	Sport equipments	1.67	1.00	2.00	2.40	2.60	2.40	1.67	2.25	2.00	17.98	50
45	40	Coal	1.67	2.50	2.00	3.00	1.60	2.40	1.00	0.75	3.00	17.92	50
46	56	Printing	2.33	1.00	2.67	1.80	2.40	1.80	1.33	1.25	3.33	17.92	50
47	34	Chemical	1.33	1.83	1.67	2.20	2.30	1.80	2.67	1.25	2.33	17.48	49
48	23	Food/beverage	2.00	1.50	2.50	2.20	2.40	1.20	1.33	1.50	2.67	17.30	48
49	25	Food/beverage	2.33	2.83	2.00	1.00	2.60	1.80	2.00	1.50	1.00	17.07	47
50	49	A/C and heating	2.00	2.33	1.17	2.00	1.60	1.60	2.00	2.00	2.00	16.70	46
51	44	Plastic	2.00	1.33	1.33	2.20	1.80	2.00	1.67	2.00	2.33	16.67	46
52	15	Telecom.	1.33	2.17	1.83	1.60	2.00	1.40	2.33	2.25	1.33	16.45	46
53	47	A/C and heating	0.33	2.17	1.67	1.60	2.40	2.20	1.33	2.00	2.33	16.23	45
54	5	Electronics	1.33	1.83	1.67	2.60	2.20	1.00	2.33	2.25	1.00	16.22	45
56	76	Printing	1.33	1.50	2.33	1.80	2.00	1.60	2.00	1.25	2.00	15.82	44
56	26	Food/beverage	1.67	2.17	2.50	0.60	1.80	1.00	1.67	1.25	2.33	14.38	40
57	9	Electronics	1.33	1.67	1.50	2.60	1.80	1.40	1.00	1.75	1.67	14.12	39
58	59	Aviation	0.67	2.50	2.50	2.40	2.40	1.00	0.33	1.25	1.00	14.05	39
59	32	Pharmaceutical	2.00	2.00	3.00	2.00	1.80	0.60	0.33	0.75	1.33	13.82	38
60	36	Chemical	1.67	2.50	1.83	0.80	1.80	2.00	1.33	0.50	0.67	13.10	36
61	31	Pharmaceutical	2.00	1.17	2.17	2.40	2.00	0.60	1.60	0.75	1.00	13.08	36
62	1	Electronics	0.33	1.00	0.33	1.60	2.00	1.40	2.67	1.75	1.67	12.75	35
63	42	Cement	0.67	1.83	1.83	2.00	1.60	0.20	1.00	1.25	1.00	11.38	32
64	17	Garment	1.33	1.50	2.50	1.60	1.60	1.60	0.67	0.75	0.33	11.28	31
65	65	Shipbuilding	0.33	2.17	0.33	2.00	0.80	0.80	1.67	1.25	1.67	11.02	31
		Average	1.80	2.31	2.15	2.51	2.20	1.74	2.35	2.22	2.51	19.90	55

Table A.3 Survey result for the question; "Which of the following Lean Manufacturing tools/ techniques have been most beneficial for your business?" [47]

Lean tool	Have not used %	Not beneficial %	Somewhat beneficial %	Very Beneficial %
5S	26.19	1.19	17.86	54.76
Kaizen	34.52	0.00	27.38	38.10
JIT	23.81	0.00	40.48	35.71
Standardized work	34.52	0.00	29.76	35.71
VSM	44.05	2.38	17.86	35.71
SMED	48.81	1.19	17.86	32.14
TPM	54.76	2.38	16.67	26.19
Cellular manufacturing	58.33	3.57	16.67	21.43
Kanban	54.76	1.19	23.81	20.24
Pull system	60.71	2.38	20.24	16.67
OEE	59.92	1.19	28.57	10.71
Value stream costing	73.81	2.38	13.10	10.71
Takt time	73.81	1.19	15.48	9.52

Table A.4 Score worksheet for electronics industry (n=9) – average score [48]

Section	Section points	Number of quest	Section average	Section (%)	Strategic impact factor (%)	Section target (%)
Inventory	5.44	3	1.81	45	11.1	100
Teams	14.89	6	2.48	62	11.1	100
Process	12.00	6	2.00	50	11.1	100
Maintenance	14.11	5	2.82	71	11.1	100
Layout	13.89	5	2.78	69	11.1	100
Supplier	9.11	5	1.82	46	11.1	100
Setup	7.33	3	2.44	61	11.1	100
Quality	10.11	4	2.53	63	11.1	100
Scheduling	7.89	3	2.63	66	11.1	100

Table A.5 Mapping of Lean Manufacturing practices to six impact areas [50]

Impact Area	Lean Manufacturing Principles and Practices
Manufacturing Equipment and Processes	Setup time reduction
	Work standardization
	Cellular manufacturing
	Mistake proofing
	Value identification
	TPM
	Shop floor organization
Shop Floor Management	Production scheduling
	Lot size reduction
	Pull flow control
New Product Development	Parts standardization
	Concurrent engineering
	Design for manufacturability
Supplier Relationships	Supplier evaluation
	Total cost evaluation
	Information exchange
	Long term relationships
Customer Relationships	Delivery performance improvement
	Demand stabilization
	Services to enhance value
	Customer requirements analysis
	Product customization
Workforce Management	Multifunctional workforce
	Work delegation
	Employee evaluation
	Pay for performance
	Formal reward system

Table A.6 Average implementation score for printed circuit and assembly (n=4), equipment (n=4) and wafer or semiconductor (n=5) manufacturers [52]

Impact Area	Printed Circuit & Assembly	Equipment Manufacturers	Wafer & Semiconductor Manufacturers	p-value
Manufacturing Equipment and Processes	3.41	3.44	4.15	0.089
Shop Floor Management	3.14	3.74	3.61	0.493
New Product Development	2.53	3.34	3.31	0.137
Supplier Relationships	2.86	3.80	3.53	0.205
Customer Relationships	3.25	3.85	3.94	0.180
Workforce Management	3.30	3.43	3.72	0.291

Table A.7 Summary of statistics and percentage of organizations implementing specific practices by item [53]

Lean Practice	Percentage	Average	Standard Deviation
Supplier evaluation	100	3.21	1.02
Delivery performance improvement	100	3.96	0.70
Multifunctional workforce	100	3.69	0.53
Work standardization	92	4.70	0.58
Value identification	92	3.39	0.41
Cycle time reduction	92	3.68	0.97
Product customization	92	3.01	0.68
Employee evaluation	92	N/A	N/A
Setup time reduction	85	3.76	0.53
TQM	85	3.44	0.99
Product scheduling improvement	85	3.54	0.81
Information exchange with suppliers	85	3.53	0.71
Long term relationships with suppliers	85	3.76	0.80
Customer requirements analysis	85	3.61	1.05
Pay for performance	83	N/A	N/A
Lot size reduction	77	3.34	0.83
Pull flow control	77	3.70	1.08
Work delegation	77	3.37	0.53
TPM	69	4.04	0.89
Parts standardization	69	3.18	0.88
Formal reward system	69	N/A	N/A
Concurrent engineering	62	3.40	0.65
Demand stabilization	62	3.54	0.85
Services to enhance product value	62	3.58	0.76
Shop floor organization (5S)	58	4.24	0.66
Cellular manufacturing	54	3.39	1.02
Design for manufacturability	38	2.67	0.85
Total cost evaluation	31	3.12	0.64
Mistake proofing	27	2.67	0.29

Appendix B

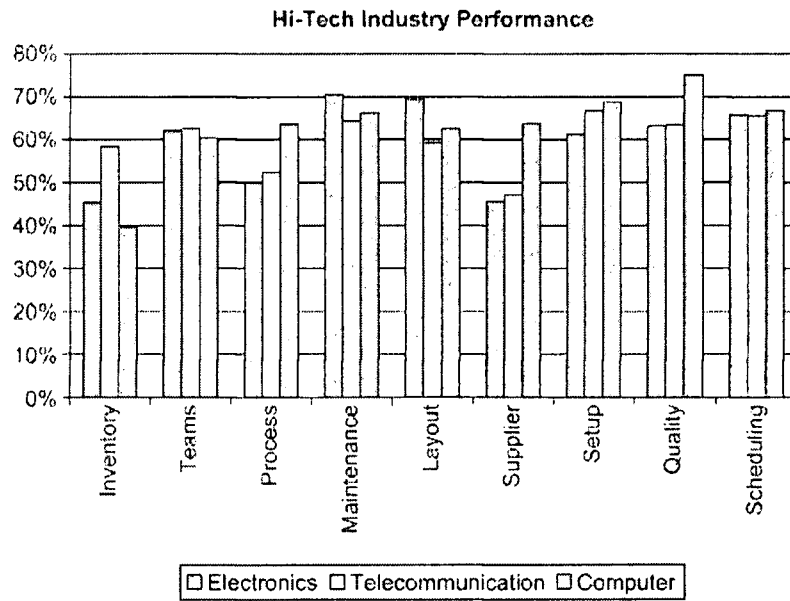


Figure B.1 Performance in key manufacturing areas in hi-tech industries (n=20) [49]

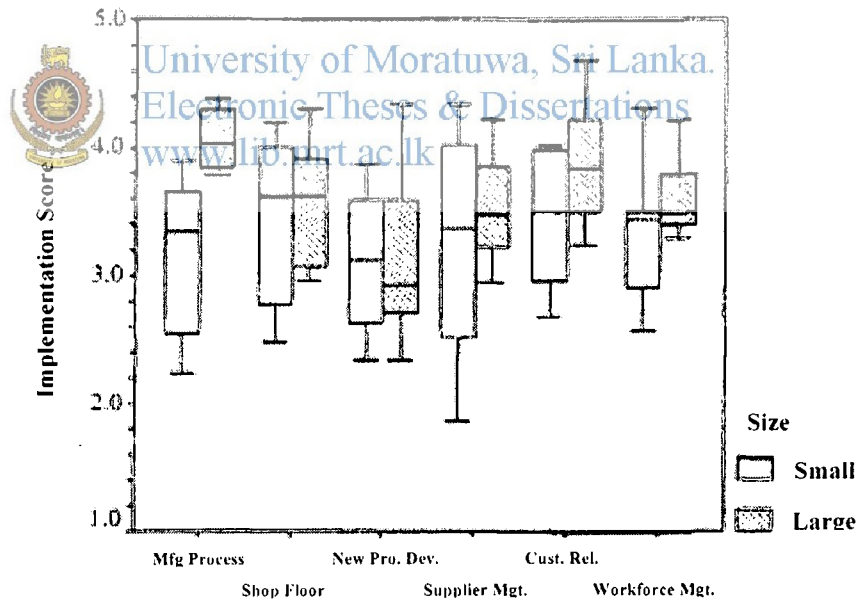


Figure B.2 Comparison of average implementation scores for small and large companies (Lines on/ in box represent upper quartile, median and lower quartile.) [51]

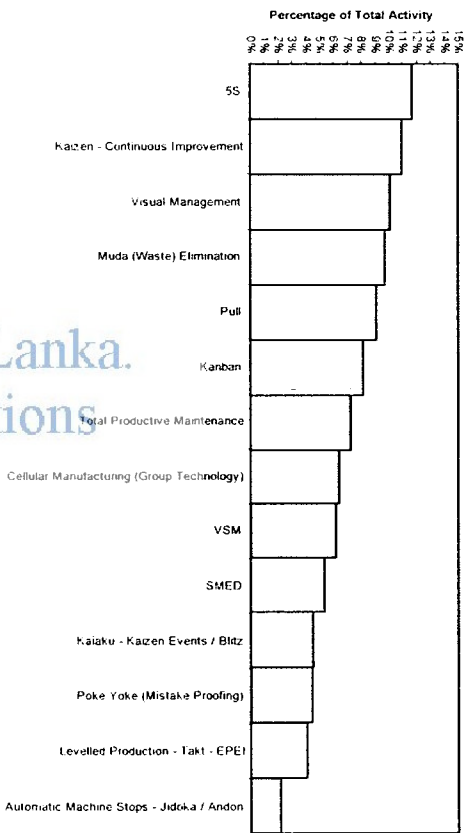


Figure B.3 Most used Lean tools and techniques [54]

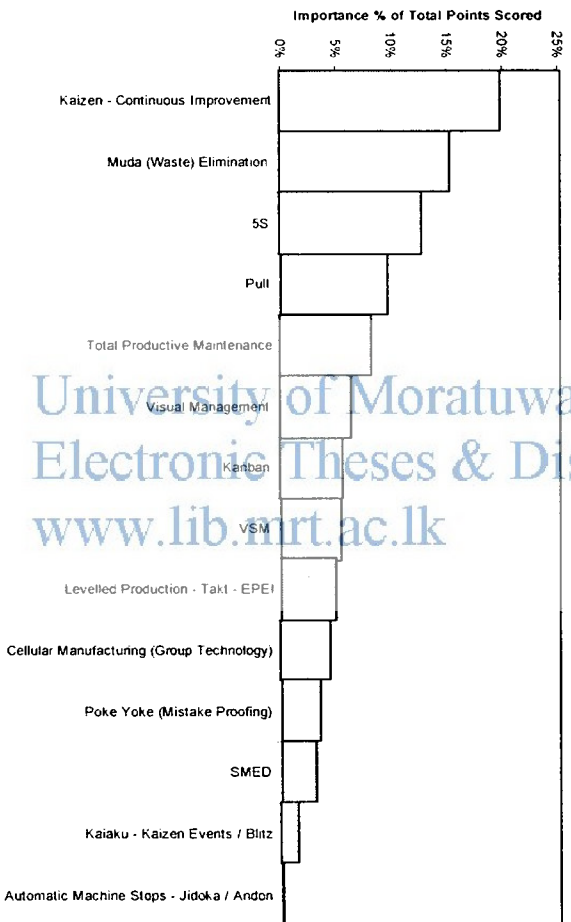


Figure B.4 Most important tools and techniques for Lean production [55]



University of Moratuwa, Sri Lanka.
 Electronic Theses & Dissertations
www.lib.mrt.ac.lk

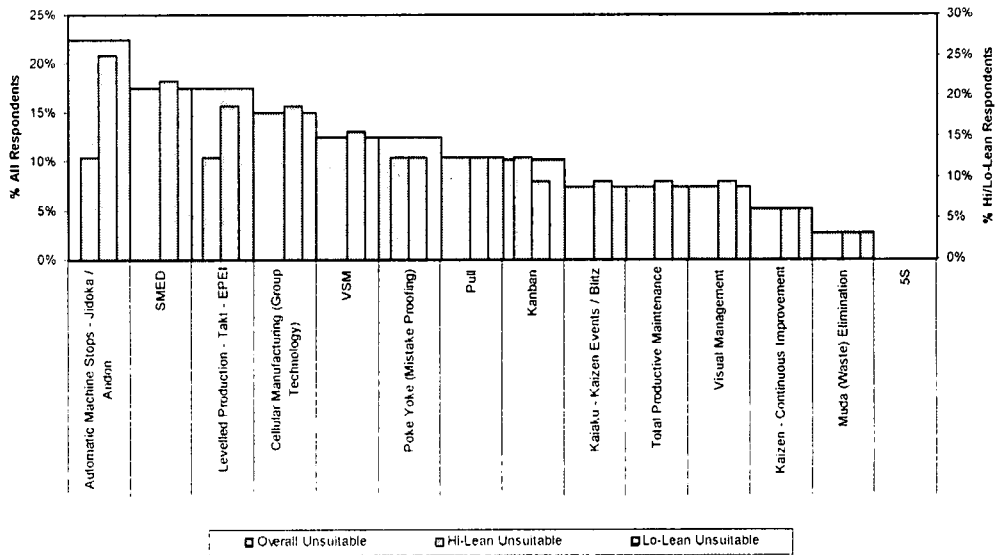


Figure B.5 Unsuitable techniques [56]



University of Moratuwa, Sri Lanka.
 Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Appendix C

Viability of Lean Manufacturing Tools and Techniques in Apparel Industry in Sri Lanka Questionnaire

This survey is conducted by S.K.P.N. Silva as part of M. Eng. research project at University of Moratuwa and it is expected to answer the following research questions.

- What are the tools and techniques introduced to the company?
- Reasons to choose line wise, section wise, department wise and company wise the above mentioned tools?
- What is the order of implementation and sustainability of Lean tools and techniques?
- What are the implementation strategies that suits Sri Lanka?
- What are the challenges in implementing Lean?
- How to overcome those challenges?
- What are the benefits achieved after implementing Lean?

Thank you,

S.K.P.N. Silva,

Department of Mechanical Engineering,

University of Moratuwa,

Moratuwa.

06. 10. 2010.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Company Information

Name of the Company: _____

Date: _____

Personal Information

Providing the following information is optional.

First Name: _____ Last Name: _____

Occupation: _____

Gender: _____ Age: _____

Address: _____

City: _____ Province: _____ ZIP Code: _____

Telephone: _____ Email: _____

Company Overview

1. The capacity of the organization (by the number of employees)

- a) Small scale (less than 100 employees)
- b) Medium scale (100 – 500 employees)
- c) Large scale (500 – 1000 employees)
- d) Extra large scale (more than 1000 employees)

2. What type of product mix does the company produce?

- a) Single product with a single production line
- b) Single product with multiple production lines
- c) Variety of similar products with same production line
- d) Different products with multiple production lines

3. The customer base of the organization

- a) Fixed customers
- b) Variety of customers
- c) Highly volatile customers
- d) Other- Please specify

4. The Supplier base of the organization

- a) Fixed suppliers
- b) Variety of Suppliers



- c) Highly volatile Suppliers
 - d) Other- Please specify
5. What is the nature of the organization culture towards new concepts?
- a) Cooperative towards new concepts
 - b) Aggressive towards new concepts
 - c) Learning organization
 - d) Neutral
6. What is the leadership style of the organization?
- a) Task Oriented Style
 - b) People Oriented Style
 - c) Boss-Centered Leadership
 - d) Subordinate-Centred Leadership
7. What is the type of your organization structure?
- a) Simple (characterized by a low degree of departmentalization, wide spans of management authority centralized in a single person and little formalization)
 - b) Functional (in which departments are identified according to the functional specialty)
 - c) Matrix (in which each employee reports to both a functional (or divisional) manager and to a project (or group) manager)
 - d) Team
8. What is the education level of shopfloor employees?
- a) Grade 8
 - b) Ordinary level
 - c) Advanced level
 - d) Technical training

Company Leanness

1. How long has your company been implementing Lean Manufacturing concepts?
- a) Less than 1 year
 - b) 1 – 2 years
 - c) 2 – 5 years

d) More than 5 years

2. What are the tools and techniques implemented when Lean was introduced?

No.	Tool / Technique	Line wise	Section wise	Department wise	Company wise	Order of implementation
1	5S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
2	Poka – yoke (Mistake proofing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
3	Kaizen (Cts. Improve.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
4	Takt time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
5	One piece flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
6	Pull system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
7	Just – In – Time (JIT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
8	Kanban	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
9	Cellular manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
10	Heijunka (Workload leveling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
11	Quick changeovers (SMED)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
12	Value Stream Mapping (VSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
13	Total Productive Maintenance (TPM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
14	Visual displays and controls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
15	Jidoka (Automation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
16	Problem solving (5 Why, and F. diagram etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
17	Standardized work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

3. Reasons to choose line wise, section wise, department wise and company wise the above mentioned tools in question 2.

4. What is the level of sustainability in following tools in your organization?

No.	Tool / Technique	Sustainability				
		<3 months	3 – 6 months	6 month – 1 year	1-3 years	> 3 years
1	5S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	Poka – yoke (Mistake proofing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	Kaizen (Cis. Improve.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	Takt time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	One piece flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	Pull system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	Just – In – Time (JIT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	Kanban	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	Cellular manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	Heijunka (Workload leveling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	Quick changeovers (SMED)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	Value Stream Mapping (VSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	Total Productive Maintenance (TPM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	Visual displays and ctrl.s	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15	Jidoka (Autonomation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16	Problem solving (5 Why, C and E diagram etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17	Standardized work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. What is the implementation method you used to implement Lean Manufacturing?

No.	Tool / Technique	Method					
		Segmentation method	Lean Team	Lean boot camp	Belt program	Through IE dept.	Other (pls. specify)
1	5S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
2	Poka – yoke (Mistake proofing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
3	Kaizen (Cts. Improve.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
4	Takt time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
5	One piece flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
6	Pull system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
7	Just – In – Time (JIT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
8	Kanban	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
9	Cellular manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
10	Heijunka (Workload leveling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
11	Quick changeovers (SMED)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
12	Value Stream Mapping (VSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
13	Total Productive Maintenance (TPM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
14	Visual displays and ctrl.s	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
15	Jidoka (Automation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
16	Problem solving (5 Why, C and F diagram etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
17	Standardized work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

- Segmentation method (implement Lean Manufacturing segment wise with an outside facilitator)
- Lean boot camp (moulding the top key players of an organization into Lean concept through an intensive training for them)
- Belt program (creating a Lean team in the organization and train them in every aspect of Lean concept such that they become facilitators in implementing Lean)
- Through industrial engineering department

6. What are the challenges faces in implementing Lean Manufacturing in your organization?

No.	Tool / Technique	Challenges														
		Backsliding	Lack of implementation know-how	Senior management resistance	Middle management resistance	Supervisor resistance	Employee resistance	Failure of past projects	Budget constraint	Lean viewed as "flavor of the month"	Financial value of Lean not recognized	Land and buildings which are solid	Lack of multi talented employees	Plant size	Plant age	Unionization
1	5S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	Poka – yoke (Mistake proofing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	Kaizen (Cts. Improve.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	Takt time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	One piece flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	Pull system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	Just – In – Time (JIT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	Kanban	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	Cellular manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	Heijunka (Workload leveling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	Quick changeovers (SMED)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	Value Stream Mapping (VSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	Total Productive Maintenance (TPM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	Visual displays and ctrl.s	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15	Jidoka (Autonomation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16	Problem solving (5 Why, C and E diagram etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17	Standardized work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. What are the ways to overcome those challenges?

No.	Tool / Technique	Workshops	Presentatio -ns	Quality circles	Leaflets/ Banners	Belt program	Get Involvem -ent	Any other Pls. specify
1	5S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
2	Poka – yoke (Mistake proofing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
3	Kaizen (Cts. Improve.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
4	Takt time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
5	One piece flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
6	Pull system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
7	Just – In – Time (JIT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
8	Kanban	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
9	Cellular manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
10	Heijunka (Workload leveling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
11	Quick changeovers (SMED)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
12	Value Stream Mapping (VSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
13	Total Productive Maintenance (TPM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
14	Visual displays and ctrl.s	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
15	Jidoka (Autonomation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
16	Problem solving (5 Why, C and E diagram etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
17	Standardized work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

8. What are the benefits achieved after implementing Lean?

No.	Tool / Technique	Lower lead time	Lower inventory	Lower defects	Lower operational costs	Reduction of space utilization	Reduced machine breakdowns	Better workplace organization	Improved customer satisfaction	Improved employee satisfaction
1	5S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	Poka – yoke (Mistake proofing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	Kaizen (Cts. Improve.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	Takt time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	One piece flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	Pull system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	Just – In – Time (JIT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	Kanban	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	Cellular manufacturing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	Heijunka (Workload leveling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	Quick changeovers (SMED)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	Value Stream Mapping (VSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	Total Productive Maintenance (TPM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	Visual displays and ctrl.s	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15	Jidoka (Autonomation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16	Problem solving (5 Why, C and E diagram etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17	Standardized work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



University of Moratuwa, Sri Lanka.
 Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Additional Feedback

Please share any additional comments.

Thank you for taking the time to fill out the survey. Your input is greatly appreciated.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Appendix D

Viability of Lean Manufacturing Tools and Techniques in Apparel Industry in Sri Lanka

Discussion guide

This discussion is conducted by S.K.P.N. Silva as part of M. Eng. research project at University of Moratuwa and it is expected to answer the following research questions.

- What are the tools and techniques most popular and most important?
- Reasons to choose line wise, section wise, department wise and company wise the above mentioned tools?
- What is the order of implementation and sustainability of Lean tools and techniques?
- What are the implementation strategies that suits Sri Lanka?
- What are the challenges in implementing Lean?
- How to overcome those challenges?
- What are the benefits achieved after implementing Lean?

Thank you,

S.K.P.N. Silva,

Department of Mechanical Engineering,

University of Moratuwa,

Moratuwa.

06. 10. 2010.

Appendix E

Lean Key Performance Indicators

1. Dock-to-Dock (DTD)

DTD is a measure of the speed which the product flows within the factory. It is the time between unloading of raw materials and the release of the finished goods for shipping. This is measured in time scale or in cost of inventory (dollars)

DTD has three sub categories.

a) Dock-to-Dock Raw Material (DTD-RM) in days = $\frac{\text{RM stock value at the month-end}}{\text{Average RM consumption per day}}$

b) Dock-to-Dock Work in Progress (DTD-WIP) in days
= $\frac{\text{WIP stock value for the current month}}{\text{Average RM consumption per day}}$

c) Dock-to-Dock Finish Goods (DTD-FG) in days
= $\frac{\text{FG stock value at the end of month}}{\text{Average cost of sales per day}}$



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

2. Raw Material On Time Delivery (RM-OTD)

The percentage of deliveries completed on time, with respect to the total no. of deliveries planned for the month.

3. Floor space saving

Area of factory floor space saved after implementing Lean Manufacturing.

4. First Time Through (FTT)

$\text{FTT} = \frac{\text{\# of units produced} - \text{\# of defects}}{\text{Total number of units produced}}$

5. Cut-to-Ship Ratio (CTSR)

The percentage of shipped quantity vs. cut quantity

6. Cost per Standard Hour (CPSH)

This is the cost spends on a standard hour sold during a given month

7. Delivered In Full, On-Time (DIFOT)

This has two sub categories.

a) On Time Delivery – Finish Goods (OTD-FG)

$$= \frac{\text{\# of deliveries completed on time}}{\text{Total \# of deliveries planned for the month}} \times 100\%$$

b) Order Fulfillment (OF) = $\frac{\text{\# of garments delivered during the month} \times 100\%}{\text{Total \# of garments planned to deliver during the month}}$

8. Plant efficiency



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Appendix F

Table F.1 Challenges (n=5)

Tool / Technique	Backsliding	Lack of implementation know-how	Senior management resistance	Middle management resistance	Supervisor resistance	Employee resistance	Failure of past projects	Budget constraint	Lean viewed as "flavor of the month"	Financial value of lean not recognized	Land and buildings which are solid	Lack of multi talented employees	Plant size	Plant age	Unionization	Lack of training / awareness
5S	4	1	2	3	3	1	3	1	2	1	0	2	1	1	0	1
Poka - yoke	1	2	1	1	1	1	0	1	0	1	0	0	0	0	0	2
Kaizen	4	3	1	3	2	1	3	2	1	1	0	1	0	1	0	3
Takt time	3	2	2	3	2	2	1	0	0	2	0	2	0	0	0	1
One piece flow	4	2	2	3	3	3	1	1	0	2	1	2	1	0	0	1
Pull system	4	2	2	3	3	3	1	0	0	1	1	1	1	0	0	1
JIT	1	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0
Kanban	4	3	2	2	3	2	2	0	0	2	0	0	1	0	0	2
Cellular manufacturing	1	3	1	2	2	3	1	1	0	1	2	3	2	1	0	2
Heijunka	0	2	1	1	1	0	1	1	0	1	0	1	0	0	0	1
Quick changeovers	3	3	1	1	1	1	2	3	0	1	0	1	0	0	0	2
VSM	2	2	1	1	1	1	1	0	0	1	0	0	0	0	0	3
TPM	3	3	1	1	3	3	2	3	0	2	0	3	0	0	0	2
Visual displays & ctrls	2	2	1	2	5	2	1	2	0	3	1	0	1	0	0	3
Jidoka	3	3	1	1	2	1	3	0	0	1	0	2	0	0	0	1
Problem solving	4	3	2	1	2	2	2	1	0	1	0	1	0	0	0	3
Standardized work	3	2	1	1	2	1	1	0	0	1	0	3	0	0	0	2
Supplier integration	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Work groups & team work	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

102540



University of Moratuwa, Sri Lanka.
 Electronic Theses & Dissertations
www.lib.mrt.ac.lk


UNIVERSITY LIBRARY
 MORATI MORATI
 MORATUWA SRI LANKA

References

- [1] P.P.G. Vilasini, "Challenges and common failures in implementing Lean Manufacturing", 15th ERU Symposium, Faculty of Engineering, University of Moratuwa, pp. 2, 2009
- [2] Craft Production [Online]. Available: http://en.wikipedia.org/wiki/Craft_production [2010, May, 04]
- [3] T. Degirmenci. Standardization and Certification in Lean Manufacturing [Online]. Available: <http://uwspace.uwaterloo.ca/bitstream/10012/4000/1/Thesis%20revised-Tamer%20Degirmenci.pdf>, pp. 3. [2010, May, 04]
- [4] J. K Liker. The Toyota Way. 14 Management Principles. Tata McGraw-Hill Edition, New Delhi. 2004, pp. 4-5.
- [5] T. Ohno, Toyota Production System, Productivity Press, New York, 1988, pp. ix
- [6] S. Shingo, A Study of the TPS, Revised Edition, CRC Press, New York, 1989, pp. 69.
- [7] D. McBride. The 7 Manufacturing Wastes [Online]. Available: <http://www.emsstrategies.com/dm090203article2.html> [2010, May, 05]
- [8] J. P Womack, D.T Jones, Lean Thinking. 1st Free Press ed., New York: Free Press, 2003, pp. 16-26.
- [9] J. K.Liker, D. Meier, The Toyota Way, Field Book, Tata McGraw-Hill Edition, New Delhi. 2007. pp. 186.
- [10] J. K Liker. The Toyota Way. 14 Management Principles, Tata McGraw-Hill Edition, New Delhi, 2004, pp. 24.
- [11] If this sounds like your company..... Maybe now is a good time to look at Lean Manufacturing [Online]. Available: www.beyondlean.com [2010, May, 05]
- [12] J. K. Liker, The Toyota Way, 14 Management Principles, Tata McGraw-Hill Edition, New Delhi, 2004, pp. 94.
- [13] J. K Liker, D. Meier, The Toyota Way, Field Book, Tata McGraw-Hill Edition, New Delhi, 2007, pp. 9.
- [14] D. McBride, Toyota and Total Productive Maintenance [Online]. Available: <http://www.reliableplant.com/Read/8417/toyota-total-productive-maintenance> [2010, May 07]
- [15] J. Kilpatrick, Lean Principles [Online]. Available: <http://supplychain.tamu.edu/academics/444/LeanPrinciples.pdf>, pp. 2 [2010, May, 08]
- [16] J.K. Liker, D. Meier, The Toyota Way, Field Book, Tata McGraw-Hill Edition, New Delhi. 2007, pp. 103.

- [17] T. Ohno, Toyota Production System, Productivity Press, New York, 1988, pp. 62, 63.
- [18] T. Ohno, Toyota Production System, Productivity Press, New York, 1988, pp. 126.
- [19] J.K. Liker, D. Meier, The Toyota Way, Field Book, Tata McGraw-Hill Edition, New Delhi. 2007, pp. 41.
- [20] J. Kilpatrick, Lean Principles [Online]. Available:
<http://supplychain.tamu.edu/academics/444/LeanPrinciples.pdf>, pp. 2 [2010, May, 08]
- [21] J.K. Liker, The Toyota Way, 14 Management Principles, Tata McGraw-Hill Edition, New Delhi, 2004, pp. 152.
- [22] J.K. Liker, D. Meier, The Toyota Way, Field Book, Tata McGraw-Hill Edition, New Delhi, 2004, pp. 139.
- [23] J.K. Liker, The Toyota Way, 14 Management Principles, Tata McGraw-Hill Edition, New Delhi, 2004, pp. 130.
- [24] T. Ohno, Toyota Production System, Productivity Press, New York, 1988, pp. 121.
- [25] D.H. Besterfield, Total Quality Management, 3rd Edition, Prentice-Hall India, New Delhi, 2003, pp. 464.
- [26] J.K. Liker, The Toyota Way, 14 Management Principles, Tata McGraw-Hill Edition, New Delhi, 2004, pp. 255.
- [27] Diagram Pareto [Online]. Available: http://pl.wikipedia.org/wiki/Diagram_Pareto, [2010, May, 09]
- [28] D.H. Besterfield, Total Quality Management, 3rd Edition, Prentice Hall India, New Delhi, 2003, pp. 462.
- [29] T. Ohno, Toyota Production System, Productivity Press, New York, 1988, pp. 98.
- [30] T. Ohno, Toyota Production System, Productivity Press, New York, 1988, pp. 21.
- [31] T. Ohno, Toyota Production System, Productivity Press, New York, 1988, pp. 127.
- [32] D. Rigby, B. Bilodeau. Management Tools and Trends 2007, Bain and Company [Online]. Available:
http://www.bain.com/management_tools/Management_Tools_and_Trends_2009_Global_Res ults.pdf, pp. 91. [2010, May, 10]
- [33] A.S. Sohal, A. Egglestone, "Lean Production – Experience among Australian Organizations", International Journal of Operations and Production Management, Vol.14, no. 11, pp. 39, 1994.
- [34] J. Womack. (2005). LEI State of Lean Survey Summary [Online]. Available:
<http://www.lean.org/common/display/?o=728#> [2010, May, 17]

- [35] G. Thornton. (2006-2007). CME Management Issues Survey [Online]. Available: <http://www.highperformancesolutions.builderspot.com>, pp. 22 [2010, May, 18]
- [36] G. Thornton. (2006-2007). CME Management Issues Survey [Online]. Available: <http://www.highperformancesolutions.builderspot.com>, pp. 23 [2010, May, 18]
- [37] G. Thornton. (2006-2007). CME Management Issues Survey [Online]. Available: <http://www.highperformancesolutions.builderspot.com>, pp. 23 [2010, May, 18]
- [38] A.S. Sohal, A. Egglestone, "Lean Production – Experience among Australian Organizations", International Journal of Operations and Production Management, Vol. 14, no. 11, pp. 38, 1994.
- [39] A.S. Sohal, A. Egglestone, "Lean Production – Experience among Australian Organizations", International Journal of Operations and Production Management, Vol. 14, No. 11, pp. 39, 1994.
- [40] T. Shahram, "Lean Manufacturing Performance in China: Assessment of 65 Manufacturing Plants". Journal of Manufacturing Technology Management, Vol. 19 Iss: 2, pp.222, 223, 2005.
- [41] J. Womack. (2005). LEI State of Lean Survey Summary [Online]. Available: <http://www.lean.org/common/display/?o=728#> [2010, May, 17]
- [42] G. Thornton. (2006-2007). CME Management Issues Survey [Online]. Available: <http://www.highperformancesolutions.builderspot.com>, pp. 23 [2010, May, 18]
- [43] Pinder. (2005). Interpreting Lean Survey Results Lean Survey [Online]. Available: <http://elsmar.com/Forums/showthread.php?t=20566>
- [44] A.S. Sohal, A. Egglestone, "Lean Production – Experience among Australian Organizations", International Journal of Operations and Production Management, Vol. 14, no. 11, pp. 40, 1994.
- [45] D. Dodd, K. Rizzo, J. Workman, How Lean Is Print? , Management Portfolio, pp. 6, 2008.
- [46] D. Dodd, K. Rizzo, J. Workman, How Lean Is Print? , Management Portfolio, pp. 6, 2008.
- [47] D. Dodd, K. Rizzo, J. Workman, How Lean Is Print? , Management Portfolio, pp. 7, 2008.
- [48] T. Shahram, "Applying Lean Assessment Tools in Chinese Hi-tech Industries", Management Decision, Vol. 43 Iss: 4, pp.633, 2005.
- [49] T. Shahram, "Applying Lean Assessment Tools in Chinese Hi-tech Industries", Management Decision, Vol. 43 Iss: 4, pp.635, 2005.

- [50] T. Doolen T., Hacker M., "A review of Lean Assessment in Organizations: An Exploratory Study of Lean Practices by Electronics Manufacturers," Journal of Manufacturing System, Vol.24, No.1, pp. 60, 2005.
- [51] T. Doolen, M. Hacker, "A review of Lean Assessment in Organizations: An Exploratory Study of Lean Practices by Electronics Manufacturers," Journal of Manufacturing System, Vol.24, No.1, pp. 62, 2005.
- [52] T. Doolen, M. Hacker, "A review of Lean Assessment in Organizations: An Exploratory Study of Lean Practices by Electronics Manufacturers," Journal of Manufacturing System, Vol.24, No.1, pp. 63, 2005.
- [53] T. Doolen, M. Hacker, "A review of Lean Assessment in Organizations: An Exploratory Study of Lean Practices by Electronics Manufacturers," Journal of Manufacturing System, Vol.24, No.1, pp. 64, 2005.
- [54] Bets practices for introducing Lean tools and techniques to the furniture manufacturing industry [Online]. Available:
<http://www.leanproductionforum.co.uk/dissertation/introduction.php> [2010, June, 15]
- [55] Bets practices for introducing Lean tools and techniques to the furniture manufacturing industry [Online]. Available:
<http://www.leanproductionforum.co.uk/dissertation/introduction.php> [2010, June, 15]
- [56] Bets practices for introducing Lean tools and techniques to the furniture manufacturing industry [Online]. Available:

www.lib.mrt.ac.lk
<http://www.leanproductionforum.co.uk/dissertation/introduction.php> [2010, June, 15]
- [57] J. Womack. (2005). LEI State of Lean Survey Summary [Online] Available:
<http://www.lean.org/common/display/?o=728#> [2010, May, 17]
- [58] J. Womack. (2004). LEI State of Lean Survey Summary [Online]. Available:
<http://www.lean.org/common/display/?o=728#> [2010, May, 17]
- [59] G. Thornton. (2006-2007). CME Management Issues Survey [Online]. Available:
<http://www.highperformancesolutions.builderspot.com>, pp. 24 [2010, May, 18]
- [60] Pinder. (2005). Interpreting Lean Survey Results Lean Survey [Online]. Available:
<http://elsmar.com/Forums/showthread.php?t=20566>
- [61] J. R. Galbraith. Organization Design, Addison-Wesley, Philippines, 1977.
- [62] Y. Mudunkotuwa, R. Jayatilaka, M. de Silva, "Lean Manufacturing Decision Support Model for the Garment Industry of Sri Lanka", 15th ERU Symposium, Faculty of Engineering, University of Moratuwa, 2009, pp. 45.

- [63] J. Womack. (2004). LEI State of Lean Survey Summary [Online]. Available: <http://www.lean.org/common/display/?o=728#> [2010, May, 17]
- [64] G. Thornton. (2006-2007). CME Management Issues Survey [Online]. Available: <http://www.highperformancesolutions.builderspot.com>, pp. 24 [2010, May, 18]
- [65] J. R. Galbraith, Organization Design, Addison-Wesley, Philippines, 1977.
- [66] Pinder. (2005). Interpreting Lean Survey Results Lean Survey [Online]. Available: <http://elsmar.com/Forums/showthread.php?t=20566>
- [67] Y. Mudunkotuwa, R. Jayatilaka, M. de Silva, "Lean Manufacturing Decision Support Model for the Garment Industry of Sri Lanka", 15th ERU Symposium, Faculty of Engineering, University of Moratuwa, 2009, pp. 47.
- [68] Y. Mudunkotuwa, R. Jayatilaka, M. de Silva M., "Lean Manufacturing Decision Support Model for the Garment Industry of Sri Lanka", 15th ERU Symposium, Faculty of Engineering, University of Moratuwa, 2009, pp. 41.
- [69] W.M.K. Trochim. Qualitative validity [Online]. Available: <http://www.socialresearchmethods.net/kb/qualval.php>, (2010, Oct.. 12)



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Bibliography

- o T. Doolen, M. Hacker, "A review of Lean Assessment in Organizations: An Exploratory Study of Lean Practices by Electronics Manufacturers," Journal of Manufacturing System, Vol.24, No.1, 2005.
- o B. Carreira, Lean Manufacturing That Works, Eastern Economy Edition, Prentice-Hall of India, New Delhi, 2007.
- o R. Shah, P.T. Ward, "Lean Manufacturing: context, practice bundles, and performance", Journal of Operations Management, Vol. 21, Iss. 2, March 2003, pp. 129-149, 2000.
- o J. Womack. (2005). LEI State of Lean Survey Summary [Online]. Available: <http://www.lean.org/common/display/?o=728#> [2010, May, 17]
- o J. P Womack, D.T Jones, Lean Thinking. 1st Free Press ed., New York: Free Press, 2003.
- o T. Shahram, "Applying Lean Assessment Tools in Chinese Hi-tech Industries", Management Decision, Vol. 43 Iss: 4, 2005.
- o S. Shingo, A Study of the TPS, Revised Edition, CRC Press, New York, 1989.
- o A.S. Sohal, A. Egglestone, "Lean Production – Experience among Australian Organizations", International Journal of Operations and Production Management, Vol. 14, No. 11, 1994.
- o T. Ohno, TPS, Beyond Large Scale Production, Productivity Press, Portland, OR, 1988.
- o J.P. Womack, D.T. Jones, D. Roos, The Machine That Changed the World, First Free Press Trade Paperback Edition, Free Press, New York, 2007.
- o G. Thornton. (2006-2007). CME Management Issues Survey [Online]. Available: <http://www.highperformancesolutions.builderspot.com> [2010, May, 18]
- o D.H. Besterfield, Total Quality Management, 3rd Edition, Prentice-Hall India, New Delhi, 2003.
- o J.K. Liker, D. Meier, The Toyota Way, Field Book, Tata McGraw-Hill Edition, New Delhi, 2007.
- o J.K. Liker, The Toyota Way, 14 Management Principles, Tata McGraw-Hill Edition, New Delhi, 2004.

