

Methodology Proposal for the Implementation of Lean Manufacturing System in Selected Mexican Industrial Plants

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Abstract

The purpose of the paper, methodology and approach:

This paper presents a methodology proposal for the implementation of lean manufacturing system adapted to the particular characteristics of Mexican SMEs.

The findings of this research are the following:

1. Methodology proposal
2. Basic concepts for its practical validation

The conclusions and limitations presented in this research are the following:

- a) A lack of knowledge about the concept and about the objectives of lean manufacturing by Mexican SMEs
- b) The results obtained during validation process will allow to develop a general methodology of implementation of lean manufacturing in Mexican industrial plants

Keywords

Lean, SMEs, Manufacturing

Introduction

Methodology design is based on analysis of several models proposed by different authors. Moreover, some of the required input information is compiled into:

- Current situation of industrial companies in Mexico,
- General problems faced by enterprises in México
- Obstacles existent while trying to implement a lean manufacturing system by the enterprises in México.

In order to develop the methodology presented the lean manufacturing systems implemented in several companies located in México were analyzed, too.

Lean Manufacturing System Elements

The figure number 1 shows the elements included in the lean manufacturing system.

	TOOLS	AUTHORS											
		[18] Ohno	[19] Shingo	[15] Monden	[21] Womack	[11] Jordan	[1] Allen	[9] Feld	[10] Hobbs	[8] Dennis	[7] Conner	[12] Liker	[20] Strategos
1	Just in Time	X	X	X		X	X	X		X	X	X	
2	Kanban	X	X	X		X	X	X	X	X			X
3	Autonomation	X	X	X				X		X			X
4	Production Stability	X	X	X	X	X	X	X	X	X	X	X	X
5	Time Reduction of Work in Process		X	X			X		X	X	X	X	
6	Shojinka (Adjust capacity to demand)		X	X			X		X	X	X		
7	Work Cells			X			X	X		X	X		X
8	Jidoka (Includes Poka Yoke and Andon)	X	X	X	X	X	X	X		X	X		X
9	Cost Planning	X	X	X			X	X		X			
10	Pull Systems	X	X	X	X	X	X	X	X	X	X	X	X
11	Single Minute Exchange Dies (SMED)		X	X			X	X		X	X		X
12	Total Quality Control (TQC)		X	X						X	X	X	X
13	Statistical Process Control (SPC)			X				X		X	X		
14	Human Factor	X	X	X	X	X	X	X	X	X	X		X
15	Total productivity Maintenance (TPM)						X	X		X	X		X
16	Suppliers Relationships		X		X		X	X		X			X
17	Value Stream Mapping				X	X	X	X		X	X		X
18	One Piece – Flow	X		X	X	X	X	X	X	X	X	X	X
19	Takt Time					X	X	X	X	X	X		X
20	Visual Factory (Includes 5S's)	X			X		X	X	X	X	X	X	X
21	Policy Management						X	X		X			
22	Work Teams	X	X		X	X	X	X	X	X	X		X
23	Lean Metrics			X	X	X	X	X	X		X		X
24	Systems Thinking						X	X		X	X	X	X
25	Standardized Work		X	X		X	X		X	X	X	X	X
26	Kaizen			X	X	X		X		X		X	X

Figure 1. Elements included in Lean Manufacturing System by the most quoted authors in the topic.

The “X” means that the mentioned author has explained the numbered element.

In the above table the most frequently quoted elements are the following:

- Pull System
- Tact Time
- Production Stability
- Human Factor
- One Piece Flow
- Work Teams

Human Factor and Work Teams are the elements common for many improvement methodologies as they are not exclusive for lean manufacturing.

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The elements that differentiate the Lean Production System from others are:

- Pull System
- Tact Time
- Production Stability
- One Piece Floor
- Value Stream Mapping

After some researches carried out in Mexican industry plants, it was found that there are also some other elements that compose their lean manufacturing systems: [6, 16]

- Quality Systems (ISO 9000, ISO/TS 16949)
- Six sigma
- Group Technology
- Inventory Management
- Manufacturing Resources Planning (MRP II)
- Enterprise Resources Planning (ERP)

Problems faced by Mexican SMEs

In the Figure number 2 there are several problems frequently related to Mexican SMEs being presented; as a result of several research. [13, 14, 17, 3, 6]

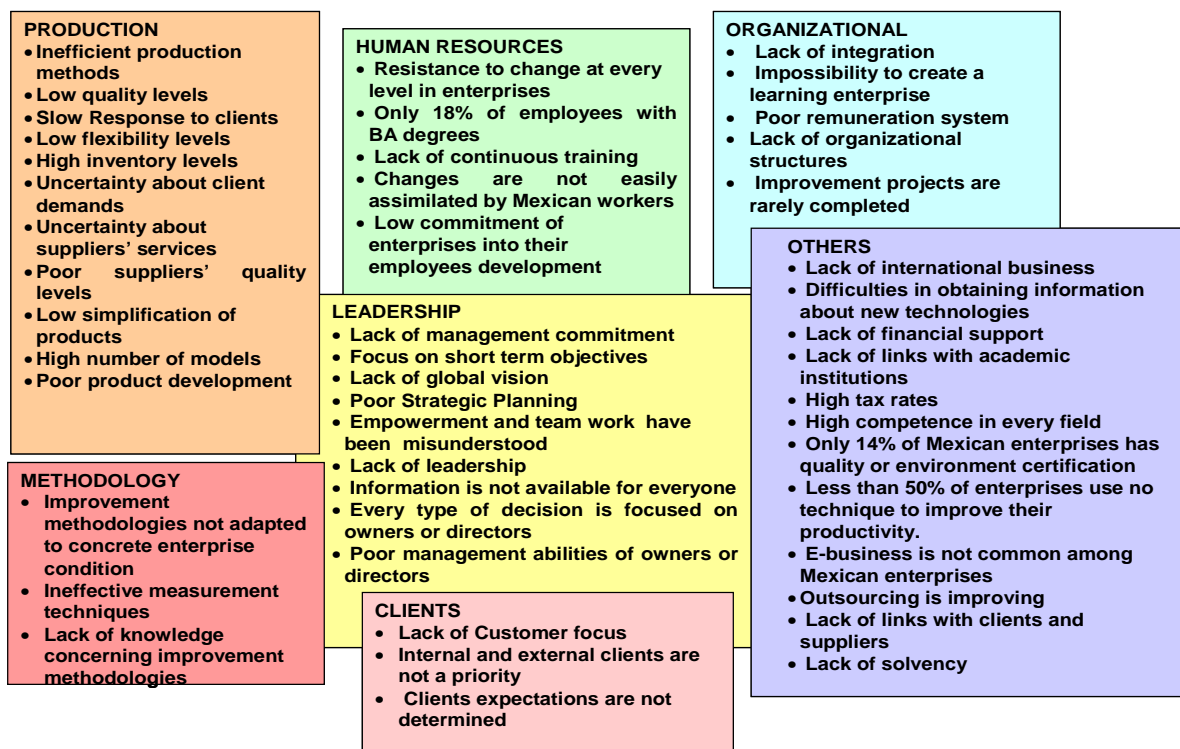


Figure 2. A compilation of several problems frequently present in Mexican SMEs

The problems registered in the figure number 2 define an information input for designing the Methodology Proposal for the Implementation of Lean Manufacturing in the SMEs in México.

Lean Manufacturing System Elements versus Challenging Situation of Mexican Industrial SMEs.

The Figure number 3 presents the relationship between the elements of lean manufacturing and the problems of Mexican SMEs solvable while using the elements mentioned.

	LEAN MANUFACTURING ELEMENTS	PROBLEMS IN MEXICAN SME'S
1	Just in Time	A lot of competence in every market Responses to clients are slow Low flexibility levels
2	Kanban	Responses to clients are slow High inventory levels
3	Autonomation	Low flexibility levels Inefficient production methods
4	Production Stability	High inventory levels Inefficient production methods
5	Time Reduction of Work in Process	Low flexibility levels High inventory levels High number of models Inefficient production methods
6	Shojinka (Adjust capacity to demand)	Low flexibility levels Inefficient production methods High number of models Uncertain on clients demands
7	Work Cells	Low flexibility levels High inventory levels High number of models Inefficient production methods
8	Jidoka (Includes Poka Yoke and Andon)	Low quality levels Poor quality levels in suppliers
9	Cost Planning	Poor Strategic Planning
10	Pull Systems	Responses to clients are slow Low flexibility levels High number of models High inventory levels
11	Single Minute Exchange Dies (SMED)	Inefficient production methods Low flexibility levels Responses to clients are slow
12	Total Quality Control (TQC)	Low quality levels Clients expectations are not determined Internal and external clients are not a priority Low commitment with employees development
13	Statistical Process Control (SPC)	Low quality levels Poor quality levels in suppliers
14	Human Factor	Change resistance on every level of enterprises Only 18% of employees has gotten bachelors degree Lack of continuous training Lack of knowledge about improving methodologies Change is not easy assimilated in Mexican workers
15	Total productivity Maintenance (TPM)	Inefficient production methods Low flexibility levels Responses to clients are slow
16	Suppliers Relationships	Uncertain on suppliers services Lack of links with suppliers
17	Value Stream Mapping	Poor Strategic Planning Lack of global vision
18	One Piece – Flow	Low flexibility levels High inventory levels
19	Takt Time	Uncertain on clients demands
20	Visual Factory (Includes 5S's)	Responses to clients are slow High inventory levels Low quality levels High number of models Information is not available for everyone
21	Policy Management	Poor Strategic Planning Lack of management commitment Focus on short term objectives Lack of global vision
22	Work Teams	Empowerment and team work have been misunderstood
23	Lean Metrics	Ineffective measurements techniques
24	Systems Thinking	Lack of global vision Lack of integration
25	Standardized Work	Inefficient production methods High number of models Low simplification on products
26	Kaizen	Improving projects rarely are finished

Figure 3. Lean Manufacturing Elements versus the problems of Mexican SMEs

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Lean Manufacturing system can represent an integral solution to the challenging situation of Mexican industries.

Problems Arising in Lean Manufacturing System Implementations in Several Mexican Plants.

As a part of research, there was a survey sent to 300 enterprises in the end of 2005 and in the beginning of 2006 and 96 answers were collect from the enterprises. Lean manufacturing works were started in approximately 30% of them. The survey asked about the problems present during the implementation of lean manufacturing system.

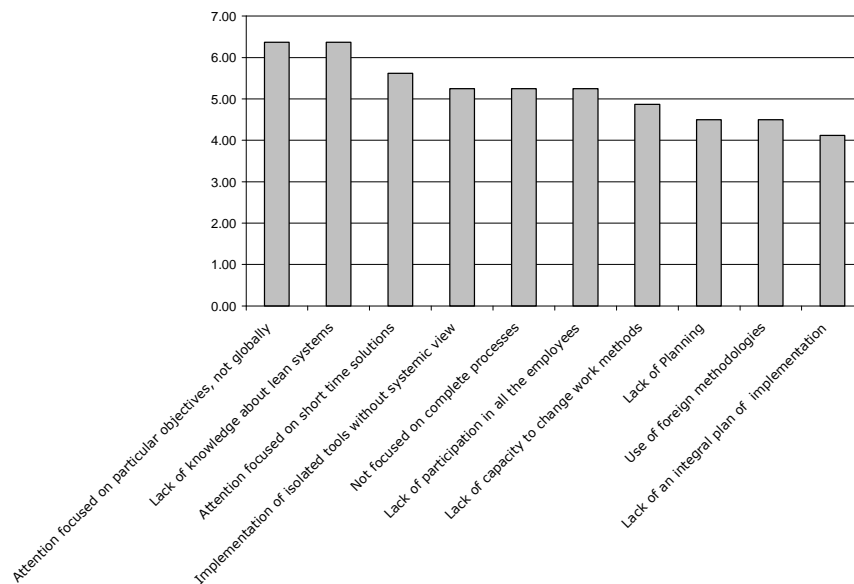


Figure 4. The most frequent problems arising during lean manufacturing system implementation in México

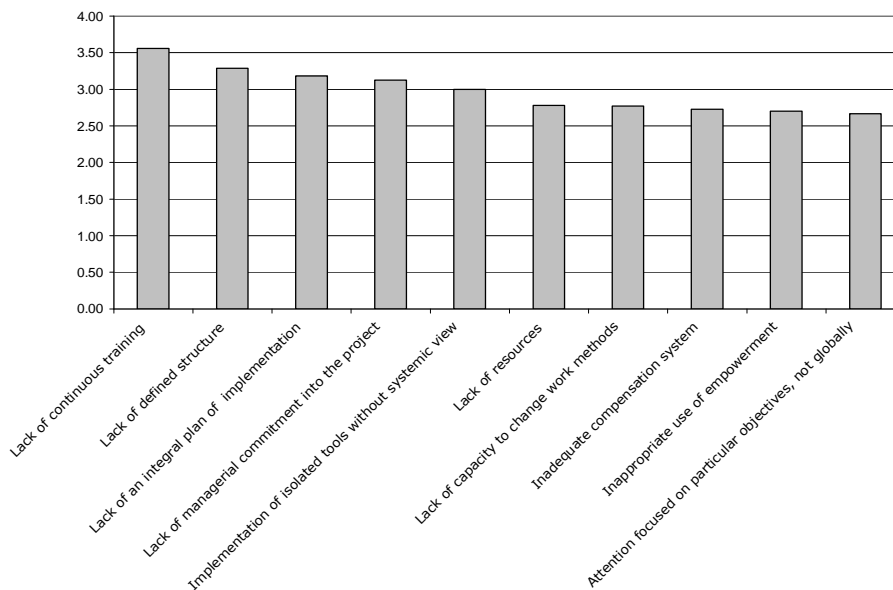


Figure 5. The most important problems arising during the lean manufacturing system implementation in México

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It can be observed that the following problems considered as the most important are very frequently present during the lean manufacturing implementations:

- Lack of an integral plan for the improvement of tools implementation
- Implanting of an isolated element of lean concepts
- Lack of planning
- The attention focused on the short-term or temporary solutions

The main reason for this situation is that Mexican enterprises are not using a standardized methodology to implement a lean manufacturing system.

At following this methodology is being designed in order to be adapted to Mexican plant characteristics.

Implementation methodology has to include the following characteristics:

- Focus on short-term goals
- Logical sequence structure
- Systemic View
- Long-term planning
- Elements for continuous improvement
- Entire personnel participation
- Be focused on top management commitment

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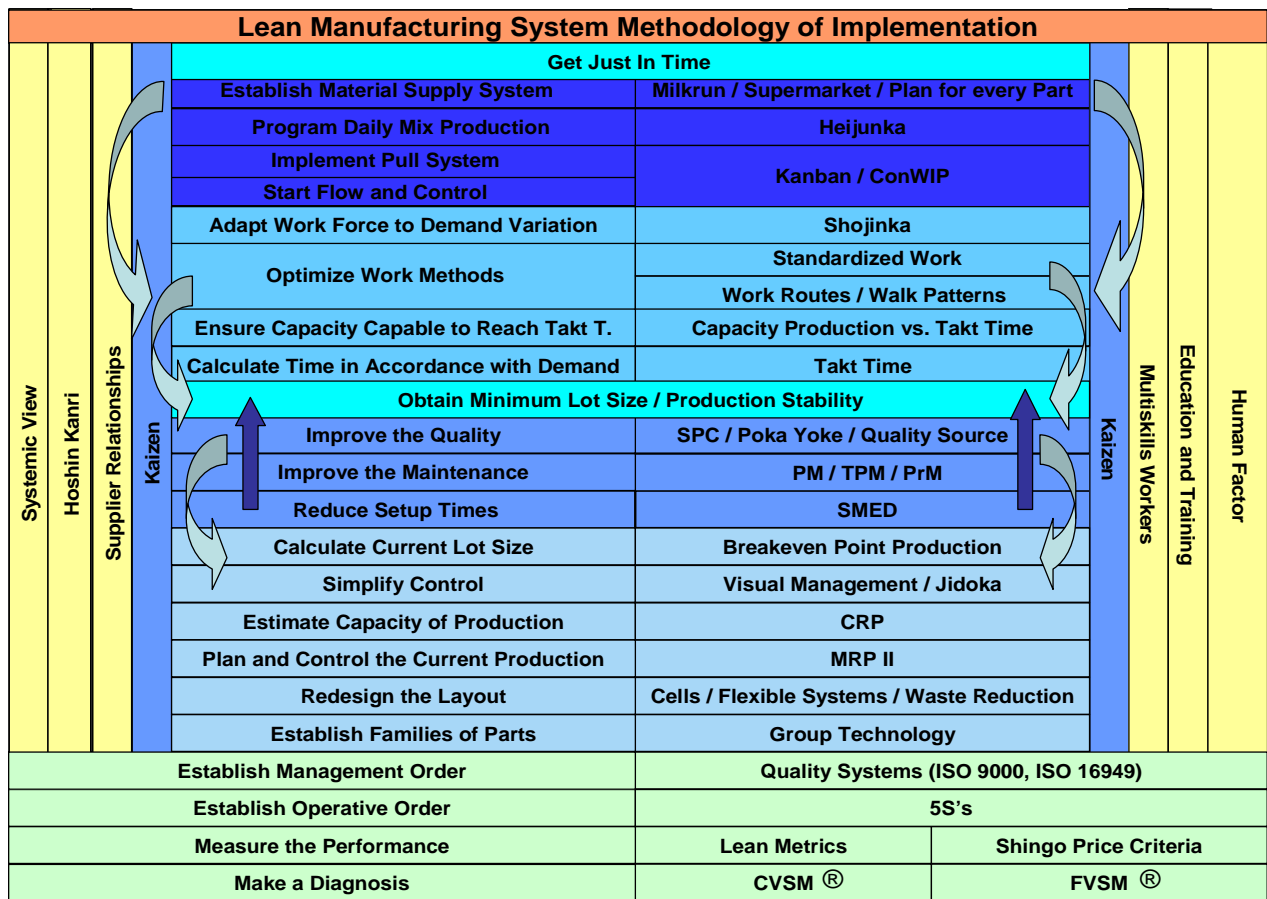
The designed methodology is a logical sequence of elements related to the lean manufacturing system to be implemented. The following elements were taken under the consideration during its development:

- Theory Models
- The relationship between Mexican SMEs common problems and lean manufacturing elements that could eliminate these problems.
- The characteristics of Mexican enterprises.

The methodology consists of 5 large technical stages which will be detailed in this paper, as follow:

1. Diagnosis and Preparation
2. Launch
3. Stabilization
4. Standardization
5. Flow

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- CVSM ®=Current Value Stream Mapping
- FVSM ®=Future Value Stream Mapping
- MRP II= Manufacturing Resources Planning

- CRP=Capacity Requirements Planning
- SMED=Single Minute Exchange Dies
- PM=Preventive Maintenance
- TPM=Total Productive Maintenance

- PrM=Predictive Maintenance
- SPC=Statistical Process Control
- ConVIP=Constant Work in Process

Figure 6. The methodology to implement the Lean Manufacturing System in selected Mexican plants

In the methodology model there is a visible incremental evolution from bottom to top and from right and left side to the center.

Personal Participation (right) and the Top Management Commitment (left) are shown in the sidelines of the model because they have to begin to be active in the early stages of the model implementation and continue to be working through all stages described in the methodology in order to achieve a successful result in the implementation of the methodology.

The methodology proposal aims at reaching:

- A logical sequence of stages and elements in order to implement a lean manufacturing system
- Waste reduction
- Lead times reduction
- Flexibility improvement
- System evolution according to the time invested in its development.
- Adjustment to the challenging situation of Mexican enterprises.
- Milestones being established for every stage or element

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- Short-term results
- A systemic view of elements required for an implementation of a lean manufacturing system
- Decreasing learning curve for lean manufacturing implementations
- A possibility to estimate the degree of development of companies interested in implementing a lean manufacturing system
- A possibility to apply the concepts of continuous improvement

The stages of the proposal are the following:

Stage One. The Diagnosis and Preparation.

The objectives are:

- To define the current situation in the enterprise
- To define the lean elements used in the enterprise
- To define the success indicators being used
- To propose the indicators
- To establish operational and managerial structure to implement a lean manufacturing system

Diagnosis and Preparation

Establish Management Order	Quality Systems (ISO 9000, ISO 16949)	
Establish Operative Order	5S's	
Measure the Performance	Lean Metrics	Shingo Price Criteria
Make a Diagnosis	CVSM	FVSM

Figure 7. Stage 1. Diagnosis and Preparation

In the diagnosis current and future Value Stream Mapping will be used; Shingo prize criteria are included too. A quality system as ISO9000 or ISO/TS 16949 with 5S's methodology can create the operative and managerial order required.

Stage Two. The Launch.

The objectives are:

- To define and measure a production capacity of the current system
- To determinate the economic size of a lot
- To redesign a plant layout to eliminate the waste
- To introduce changes needed to facilitate the lean manufacturing system keeping the plant in operation.

Launch

Kaizen	Calculate Current Lot Size	Breakeven Point Production	Kaizen
	Simplify Control	Visual Management / Jidoka	
	Estimate Capacity of Production	CRP	
	Plan and Control the Current Production	MRP II	
	Redesign the Layout	Cells / Flexible Systems / Waste Reduction	
	Establish Families of Parts	Group Technology	

Figure 8. Stage 2. The Launch

At this stage, the elements as Jidoka or manufacturing cells shall be included.

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Kaizen workshops have to be carried out at all organizational levels. The elements such as MRP II are used. It's essential to calculate a production breakeven point in order to define the economic size of production lots.

Stage Three. The Stabilization.

The objectives are:

- To decrease the waste for the activities related to preparation, maintenance and quality.
- To stabilize the production process
- To decrease the size on production lots to possible minimum.

Stabilization

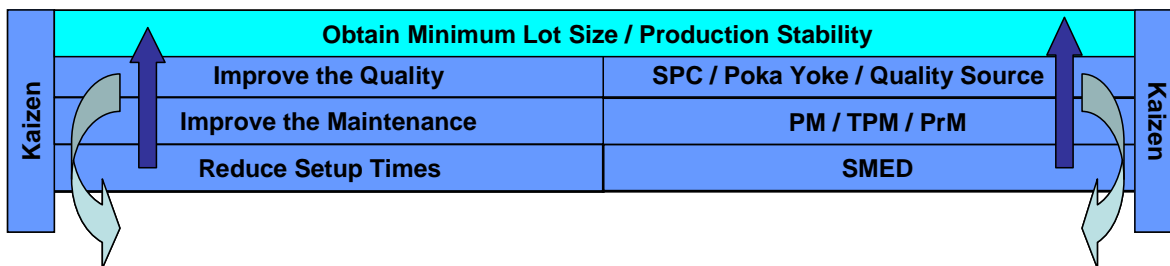


Figure 9. Stage 3. The Stabilization.

In this phase the improvements of preparations, maintenance and quality have to be developed in order to obtain a minimum lot size. The quality levels and an overall effectiveness of the equipment are suitable indicators. Kaizen workshops are still carried out in order to increase the stability of the process. The application of particular tools must be done in accordance with every improvement progress.

Stage Four. The Standardization.

The objectives are:

- To improve the working methods
- To design the working methods adaptable to demand variations
- To calculate the tact time suitable to follow the client demand
- To modify the production system to follow the client demand.

Standardization

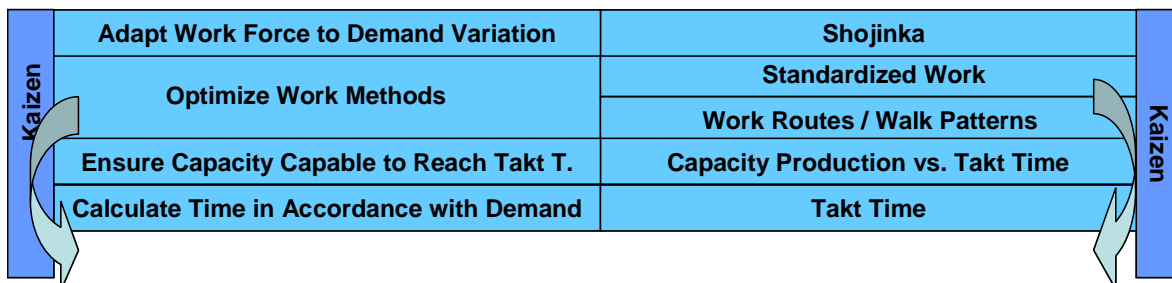


Figure 10. Stage 4. The Standardization

At this stage the working methods have to be standardized. They are to be designed to follow the demand variations.

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Kaizen workshops are used to find solutions to improve the standard methods.

Stage Five. The Flow.

The objectives are:

- To ensure complete shipments with low lead times and with on time warranty
- To continue the waste reduction
- To keep stability and flexibility of the process obtained in the last 2 stages.
- To improve the material handling system in the entire the plant

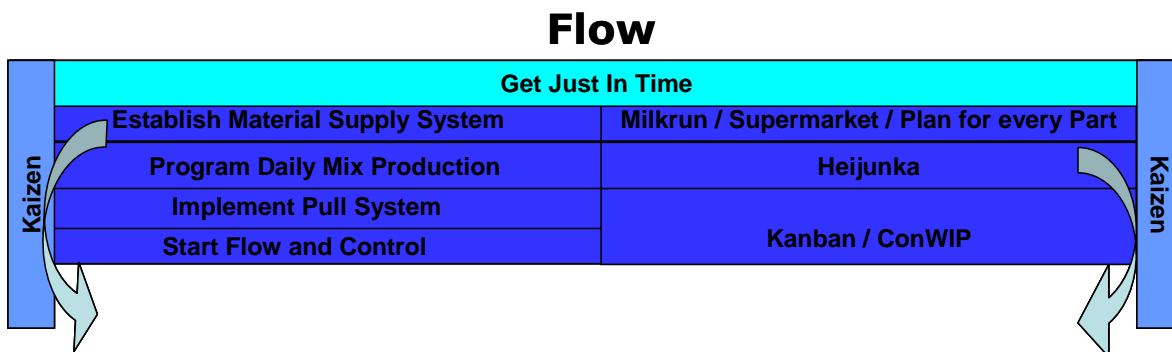


Figure 11. Stage 5. The Flow

At this stage, it is possible to create and control the flow of production materials based on the elements such as kanban, heijunka and material supply systems.

Kaizen workshops must focus on the improvement of the activities related to flow creation and material supply system.

The principal concept of “just in time” is based on the production in quantity, time, and place required with waste levels close to zero. Currently it is possible to obtain the “just in time” concept with the total integration of the lean manufacturing system.

Future Research

The future research will be focus on:

1. Implementation at floor-shop of the methodology in an industrial plant with characteristics in correspondence with Mexican industrial plants.
2. Elaborate interviews with experts
3. Introduce the modifications in the methodology that are required in order to adapt it to the characteristics of the industrial enterprises from México.

Conclusions

This methodology is ready for the validation in practice. The validation will provide the data that will enable to define if the methodology can:

- Help to implement lean manufacturing systems in Mexican enterprises, SMEs especially.
- Present a sequence map to follow in order to obtain a success lean manufacturing implementation
- Present a systemic idea about all elements required for the implementation of lean manufacturing systems

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- Reduce the learning curve in the projects of implementation of lean manufacturing systems
- Reduce the uncertainty of Mexican industrial enterprises which are looking forward to implement a lean manufacturing system.

References

1. Allen, John. Robinson, Charles. Stewart, David and others., 2001, Lean Manufacturing. A Plant Floor Guide. 1st Edition. Society of Manufacturing Engineers SME. USA.
2. Association for the Operations Management APICS, 2006, Manufacturing Resource Planning Training Handbook. APICS, USA.
3. Bednarek M. and Niño L. Fernando, 2005, Study of Manufacturing Situation in Mexican Enterprises, Polytechnic University of San Luis Potosi, México.
4. Bednarek M. and Niño L. Fernando, 2005, The Proposal of the Lean Manufacturing for Mexican SMEs' HAAMAHA, San Diego, USA.
5. Bednarek M. and Niño L. Fernando, 2006, The selected problems of Lean Manufacturing Implementation in Mexican SMEs, Lean Business Systems and Beyond, AMPS 2006 Congress, Wroclaw, Poland.
6. Bednarek M., Niño L. Fernando, 2006, Study of Lean Manufacturing Implementation Process in Mexican Industrial Plants, Polytechnic University of San Luis Potosi, México.
7. Conner, Gary, 2001, Lean Manufacturing for the Small Shop 1st Edition. Society of Manufacturing Engineers SME. USA.
8. Dennis, Pascal, 2002, Lean Production Simplified 1st Edition. Productivity Press. USA
9. Feld, Williams M., 2001, Lean Manufacturing. Tools, Techniques, and How to Use Them. 1st Edition. CRC Press. USA.
10. Hobbs, Dennis P., 2004, Lean Manufacturing Implementation. A Complete Execution Manual for Any Size Manufacturer 1st Edition. J. Ross Publishing Incorporation. USA.
11. Jordan, James A. and Michel, Frederick J., 2001, The Lean Company. Making the Right Choices 1st Edition. Society of Manufacturing Engineers SME. USA.
12. Liker, Jeffrey K., 2003, The Toyota Way. 14 Management Principles from the World's Greatest Manufacturer 1st Edition. McGrawHill. U.S.A.
13. Meade, Daniel., 1997, Barriers on Quality Systems Implementations, Support Material used on Course Quality Process and Norms; Session 15. Masters on Quality Systems, Virtual University of Technological System of Monterrey. México.
14. Moctezuma, Francisco, 2002, A Model for Implementing Manufacturing Integral Systems in Small and Medium Size Mexican Companies Doctoral Dissertation. Orgmasz Institute. Poland.
15. Monden, Yashuhiro, 1993, Toyota production System: An integrated approach to Just in Time. Industrial Engineering and Management Press. USA
16. Niño L. Fernando, 2007, Analysis of Production Systems Models used in Six Medium and Large Automotive Industrial Plants Located in México, Polytechnic University of San Luis Potosi, México.
17. Observatorio PYME, Statistical information about the situation of SMEs in Mexico, 2003, <http://www.cipi.gob.mx/html/observatorio.html>, Secretary of Economy. México.

Metodology Proposal for the Implementation of Lean Manufacturing System in Selected Mexican Industrial Plants

18. Ohno, Taiichi, 1978, Toyota Production System. Beyond Large Scale Production. Productivity Press. USA.
19. Shingo, Shigeo, 1989,. A study of the Toyota Production System from an industrial engineering viewpoint, Productivity, Inc. U.S.A.
20. Strategos. Consultants, Engineers, Strategists. Lean Manufacturing Strategy., <http://www.strategosinc.com/>,. 10/08/2007. K.C. U.S.A.
21. Womack, James P. and Jones, Daniel T., 2003, Lean Thinking. Banish Waste and Create Wealth in Your Corporation. 1st Edition. Free Press. USA.
22. Womack, James P., Jones, Daniel T. and Roos Daniel., 1990, The Machine that Change the World. 1st Edition. Rawson Associates. USA.