A 'Lean' Study using the Soft Systems Methodology

Ifechukwude K. Dibia
School of Engineering
University of Portsmouth
Anglesea Building, Anglesea Road
Portsmouth PO1 3DJ, United Kingdom.

Hom Nath Dhakal, PhD.
School of Engineering
University of Portsmouth
Anglesea Building, Anglesea Road
Portsmouth PO1 3DJ, United Kingdom.

Spencer Onuh, PhD., MIET FHEA (UK) CEng
The Director/CE office
Centre for Satellite Technology Development
National Space Research & Development Agency
PMB 593, Garki, Abuja, Nigeria.

Abstract

Lean Production System as a concept emphasizes the elimination of waste in order to ensure optimum utilization of all available resources for the realization of optimum benefit which is doing more with less. This paper looks at the optimization and waste elimination concept of lean from the human perspective using a case study of a biscuit manufacturing company. The Soft Systems Methodology was used for the study and the findings showed that the 'Leanness' in production can only be guaranteed if the Human resources, the one resource that manages every other resource within the production process is well organised, motivated and adequately managed.

Keywords: Lean Production, Waste, Human Resources, Optimisation.

Introduction

Lean production is an operations management philosophy pioneered by Henry Ford but developed and made popular in the way it is used today by Eiji Toyoda and Taiichi Ohno Toyota's chief Engineer. It was and is still being used as the core of Toyota production system. By definition, "Lean production is an integrated management system that emphasizes to a great extent the elimination of waste and the continuous improvement of operations for the optimization of the benefits derived from its immediate use of scarce resources" (Dibia and Onuh, 2010a). Simply put, Lean is less time, less inventory, less space, less labour and less money or cost for achieving more. This is of course directly in line with the definition of productivity in terms of outputs and inputs but, could be interpreted more widely as doing good with less resources, materials and energy to achieve ultimate sustainability. Lean production focuses on reducing waste in a production system. Waste is anything that adds cost, but adds no extra value to a product. While products may differ, typical, the wastes found in a production environment are quite similar. After years of working to eliminate waste, Toyota, the Japanese automobile manufacturer, identified Overproduction, Waiting, Transportation, Unnecessary Inventory, Inappropriate Processing, Excess Motion and Defects as the seven wastes which adversely affect profitability (Ohno, 1988).

Waste must be eliminated to ensure optimisation of all resources for efficiency and profitability. In terms of resources management in production, Taiichi Ohno's Lean philosophy has focused more on the material resources with less emphasis on the Human resources, the unpredictable soft system part of production, but there is a growing realisation that there is much more to the human resource aspect to waste and doing more with less in terms of optimisation in lean production philosophy than was originally thought.

Lean and the Human Resource

In 1996, Womack and Jones in their classical 'Lean Thinking: Banish Waste and Create Wealth', identified an eighth waste, the waste of the underutilized employees with respect to their ideas and mind. In 1995, Forrester in her article 'Implications of lean manufacturing for human resource strategy' looked at the opportunities provided by Lean Production System for potential synergy between the lean processes and the organization's people policies. It examined the implications of lean production philosophy on the human resource strategy and policies within processes and highlighted the major areas of transition. Transition areas identified include scheduling so that the labour requirement is evened out, organizational style and structure, role and selection in job style and flexibility, training and finally problem solving and innovation which is the expected utilization of employees' ideas and minds as stated by Womack and Jones (1996). Alony and Jones (2008) emphasised that the adoption of Lean manufacturing requires a major change in mindset. From production of large quantities, the organisation must shift to small batches. Rather than having large safety inventories which act buffer on demand, organisations must retain low levels of 'in-process' material. Processes must be efficient and reliable to avoid defects. Movements of people, parts and materials must be minimised. These actions thus assist in eliminating the waiting time of material, people, and equipment.

Adoption of Lean Production system from an organisational perspective involves many changes. This changes include structural changes since work need to be organised around product families instead of functional areas. The workforce has to shift from functional divisions into 'cells'. Each cell though in parts, is responsible for the entire manufacturing of a product in a systems based philosophy which lean is. Thus, it requires a workforce that has the skill to do more than one specialised task. It requires a Multi-skilled workforce. Moreover, this Multi-skilled workforce would have to work in cells as a team. The team should be ideally self-directed. The workers need to focus towards achieving goals, meeting targets and continuously improving the process, constantly striving for perfection.

Alony and Jones (2008) explained that these changes can be difficult to implement. Shifting into work teams means organisational restricting, which often invokes fear and resistance. Shifting into multi-skilled can also create resistance in the work place from the workers. Although most advocates of Lean Production system claim these changes result in an enriched and engaging working environment, studies show the process can be challenging to organisations (Boyer, 1996; Boyer et al., 1997; Nakamura et al., 1998; Power and Sohal, 1997). The case of DIB Ltd shows the human side that needs to be ultimately looked into during the implementation of Lean to ensure customer satisfaction, stakeholders' profitability and the sustenance of the Lean philosophy.

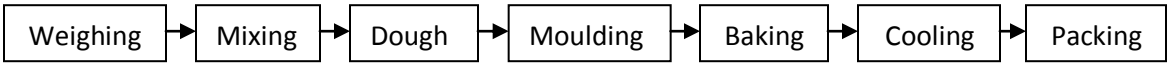
The Case Study

DIB Ltd is a Biscuit manufacturing company. The factory occupies an area of $100m^2$ which includes the production plant area and the general administrative block. DIB manufactures branded processed biscuits in two major forms, Soft Biscuits and Hard Biscuits. The Company operates its own distribution centre to facilitate the shipment of its products directly to retailers although sometimes it sells in larger bulk quantity to whole sellers. DIB has four major suppliers for its raw materials used for its production.The Company has a total of seventy staff of which fifty five of them are in the production department which has two daily shifts of eight hours each making up to a total of sixteen hours daily for production. The Soft Biscuit Machine design capacity is 8,000kgs/16hrs while the Hard Biscuit Machine design capacity is 6,400kgs/16hrs.

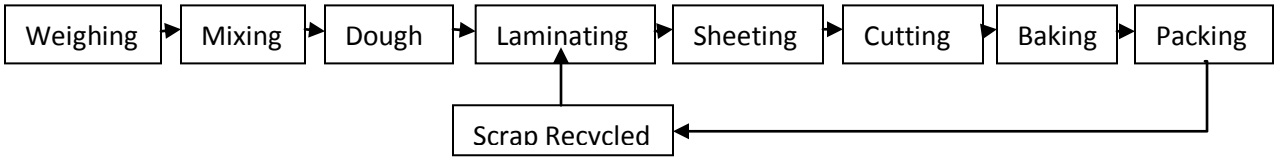
General Process Information

Flow Chart:

Soft Biscuit



Hard Biscuit



Process Description

Each and every ingredient is weighed in accordance with the mixing standard, prior to mixing. However, the quantity of sugar to be used may be varied. The sugar should be liquefied prior to mixing with the other ingredients in the mixer. The flour is sifted and the water put through the water chiller. All materials are then placed in the mixing bowl of the universal mixer for mixing.

The dough will then be placed in the dough tab box.

(A) When making soft biscuits, the dough is put into the rotary machine and moulded into round shaped biscuits. (B) When making hard biscuits, the dough is put into the laminator to be stretched and folded in the form of a belt. It is then sent through the cutting machine to be cut into rectangular shaped biscuits.

This formed and shaped dough is then sent through the band oven for baking.

The baked biscuits then go down the cooling conveyor.

The cooled biscuits are automatically sent down the working conveyor and packed by the operators manually. The packages of biscuits are sealed by the heat sealer and the process is thus completed.

Table 1: Manpower Distribution for the Production Process:

Process	**Person**
Weighing of ingredients (including sugar liquefaction and flour sifting)	2
Mixing (universal mixer) (including water measurement and the handing of dough tab box)	2
Moulding (rotary machine) or laminating and sheeting (laminator) and cutting (cutter)	2
Baking (oven)	2
Cooling (cooling conveyor)	2
Packing (work conveyor)	12
Sealing (heat sealer)	3
Total	25

It takes fifteen minutes for two supervisors to set up the production line which must start production by 8.00am every morning and shot down by 24.00pm every day. Weighing for the first batch takes 15minutes, Mixing 10minutes, Moulding 15minutes, Baking 35minutes, Cooling 10minutes, Packing 25minutes and Sealing 10minutes. After this it becomes a continuous process until the system is shot down. Each pack of biscuit produced weigh 125g and at full capacity, 64,000 packs of Soft Biscuit and 51,200 packs of Hard Biscuit is produced in a day but due to the fluctuation of demand, only 80% of the production capacity is utilised.

It is a standard production practice in the factory that for every 10,000 packs of Biscuit produced, a sample size of 100 packs of Biscuit is randomly tested for possible defects with records of test results kept for traceability.
The business year of the company ends on the 30th of June at the end of which all staff are appraised and promotions made from the appraisal by the end of July every year. New staffs are also employed by the first week of August to fill in areas where the management team perceive some short coming or areas that need improvement.

It has been observed in the past four years that although sales is generally at its highest in December, production tend to improve in the last quarter (April, May and June) of its business year. The rate of defective products reduces while the rate of absenteeism and lateness also reduces. The waiting time at each area or section of the production process also reduces drastically during this time. One major development which has also been observed is the overproduction that occurs within this period. The total production during this period tends to always be more than the expected demand. During this period, excessive movement within the production area is also noticed constantly. There is also an increase in the inventory level at the store for both raw materials and finished goods which do sometimes get into some other spaces meant for other sections and department of the company.

The management is currently thinking of expanding and increasing the store area while also carefully looking at and studying all other production and administrative issues in the production department to ensure the optimum use of both the human and material resources while ensuring that all sort of waste is eliminated. There are also regular training and development programmes which are also regularly planned and executed to meet the need of the organisation.

Below are the monthly administrative and production records for the past four years.

Table 2: Total Days of Production for each month from 2005 – 2008

	2005	2006	2007	2008
January	21days	22days	22days	22days
February	20days	20days	20days	21days
March	22days	23days	22days	20days
April	21days	19days	20days	22days
May	20days	21days	21days	20days
June	22days	22days	21days	21days
July	21days	21days	22days	22days
August	22days	22days	22days	20days
September	22days	21days	20days	22days
October	21days	22days	23days	23days
November	22days	22days	22days	20days
December	21days	19days	19days	20days

Table 3: Total Available Man-hours for Production for each month from 2005 – 2008

	2005	2006	2007	2008
January	9240	9680	9680	9680
February	8800	8800	8800	9240
March	9680	10120	9680	8800
April	9240	8360	8800	9680
May	8800	9240	9240	8800
June	9680	9680	9240	9240
July	9240	9240	9680	9680
August	9680	9680	9680	8800
September	9680	9240	8800	9680
October	9240	9680	10120	10120
November	9680	9680	9680	8800
December	9240	8360	8360	8800

Table 4: Total Number of Staff Absent at the production department for each month from 2005 – 2008

	2005	2006	2007	2008
January	3	5	4	2
February	1	2	1	1
March	2	1	4	5
April	-	1	1	1
May	1	-	1	-
June	-	1	-	-
July	2	-	1	2
August	3	4	3	5
September	8	7	7	6
October	6	9	4	5
November	4	5	6	5
December	6	4	5	6

Table 5: Lateness in hours for each month from 2005 – 2008

	2005	2006	2007	2008
January	2hours	1.5hours	1hour	0.5hours
February	1hour	2.25hours	2hours	2.5hours
March	2hours	1hour	1.5hours	1hour
April	0.5hours	-	0.25hours	-
May	0.25hours	-	-	-
June	-	0.25hours	-	-
July	1hour	0.25hours	0.25hours	0.5hours
August	2.5hours	2hours	1.5hours	1hour
September	0.5hours	1.5hours	0.5hours	0.5hours
October	2hours	0.5hours	1hour	0.25hours
November	2hours	3hours	1.5hours	0.25hours
December	3hours	2hours	3hours	1.5hour

Table 6: Demand for the Soft and Hard Biscuit is in ratio 5:4 and so the Machines are set up for production in ratio 5:4. The Combine Total Demand for the Product for each month from 2005 – 2008

	2005	2006	2007	2008
January	1891000	1980000	1988000	2020000
February	1803000	1807000	1800000	2000800
March	1986000	2008000	1982000	1990000
April	2050000	2006000	2013000	2050000
May	1907000	1909000	2002000	2001000
June	1900000	1902000	2008000	2003000
July	1891000	1894000	1987000	1970000
August	1990000	1980000	1981000	1990000
September	1983000	1895000	1802000	1980000
October	1892000	1986000	2077000	2110500
November	2101000	2202000	2294000	2301000
December	2308000	2292000	2311000	2313000

Table 7: The Combine Total Production for each month from 2005 -2008

	2005	2006	2007	2008
January	1890000	1980000	1980000	2019000
February	1800000	1800000	1800000	2000000
March	1980000	2010000	1980000	1980000
April	2100000	2090000	2000000	2068000
May	2000000	2100000	2100000	2000000
June	1980000	1980000	2100000	2100000
July	1890000	1890000	1980000	1980000
August	1980000	1980000	1980000	1980000
September	1980000	1890000	1800000	1980000
October	1890000	1980000	2070000	2100000
November	2090000	2200000	2200000	2255000
December	2268000	2268000	2310000	2310000

Table 8: Average percentage of defects for each 10,000 packs produced for each month from 2005 – 2008

	2005	2006	2007	2008
January	0.015	0.015	0.002	0.002
February	0.010	0.008	0.004	0.005
March	0.015	0.004	0.015	0.003
April	0.003	0.001	0.002	0.001
May	0.001	0.002	0.001	0.002
June	0.001	0.001	0.001	0.001
July	0.004	0.001	0.004	0.004
August	0.002	0.008	0.005	0.002
September	0.010	0.012	0.002	0.001
October	0.020	0.020	0.010	0.008
November	0.010	0.008	0.008	0.002
December	0.008	0.004	0.015	0.002

Methodology

For the purpose of this study, the Root Cause Analysis was done using the Fishbone diagram while Peter Checkland's (1981) Soft Systems methodology a systems approach to organisational process modelling was used in the exploratory study.

Peter Checkland's (1981) Soft Systems Methodology is a seven step process which involves;

1. Considering the Problematic Situation,
2. Expressing the problem situation (using a rich picture),
3. Generating the root definition of the relevant systems based on systems thinking,
4. Developing a conceptual model of the systems described in the root definitions,
5. Compare the model with the real world (reality),
6. Identify feasible and desirable changes,
7. Action is continuously taken to improve the problem situation.

Considering the Problem Situation

From the case study and the data given, the problem situations include;

Overproduction- As can be seen from the four years production records provided; there has always been a massive overproduction from April to June every year.

Excess Inventory- There is also increase in the inventory level at the store for both raw materials and finished goods which do sometimes get into some other spaces meant for other section and department.

Excess Movement- There is an observable excessive movement of staff within and around the production area during certain periods within the year.

Absenteeism- There is a consistency in the relative increasing level of absenteeism observed from the month of August to December annually.

Defective Products- Though the percentage of defects observed may not be high but in numbers they are relatively high and from observation, the percentage defect is always highest in the month of October from the four years records at our disposal.

The Key players within the company from my findings are the production staff and the Top Management. They practically own the system and directly or indirectly drive the processes and plays determinant roles in the fortunes of the company.

The process of production is well defined. There are fifty five (55) production staff which includes One Manager, Four Supervisors and Fifty other staff. There are Two daily shifts of Eight hours each making a total of Sixteen hours daily from 8.00am to 24.00pm. Only about 80% of production capacity is being currently utilised.

Root Cause Analysis

Root Cause Analysis is a class of problem solving method aimed at identifying the root cause of the problems or events. The practise of Root Cause Analysis is predicated on the belief that problems are best solved by attempting to correct or eliminate root causes, as opposed to merely addressing the immediately obvious systems. By directing corrective measures at root causes, it is hoped that the likelihood of problem recurrence will be minimized since a complete prevention of recurrence by a single intervention is not always possible. Thus Root Cause Analysis is often considered to be an iterative process, and is frequently viewed as a tool of continuous improvement.

Root Cause Analysis is not a single, sharply defined methodology; there are different techniques, tools, processes and philosophies of Root Cause Analysis in existence. For this study, the Root Cause Analysis will be carried out using one of the most novel techniques the cause and effect diagram known as the "Fishbone" diagram (see figure 1).

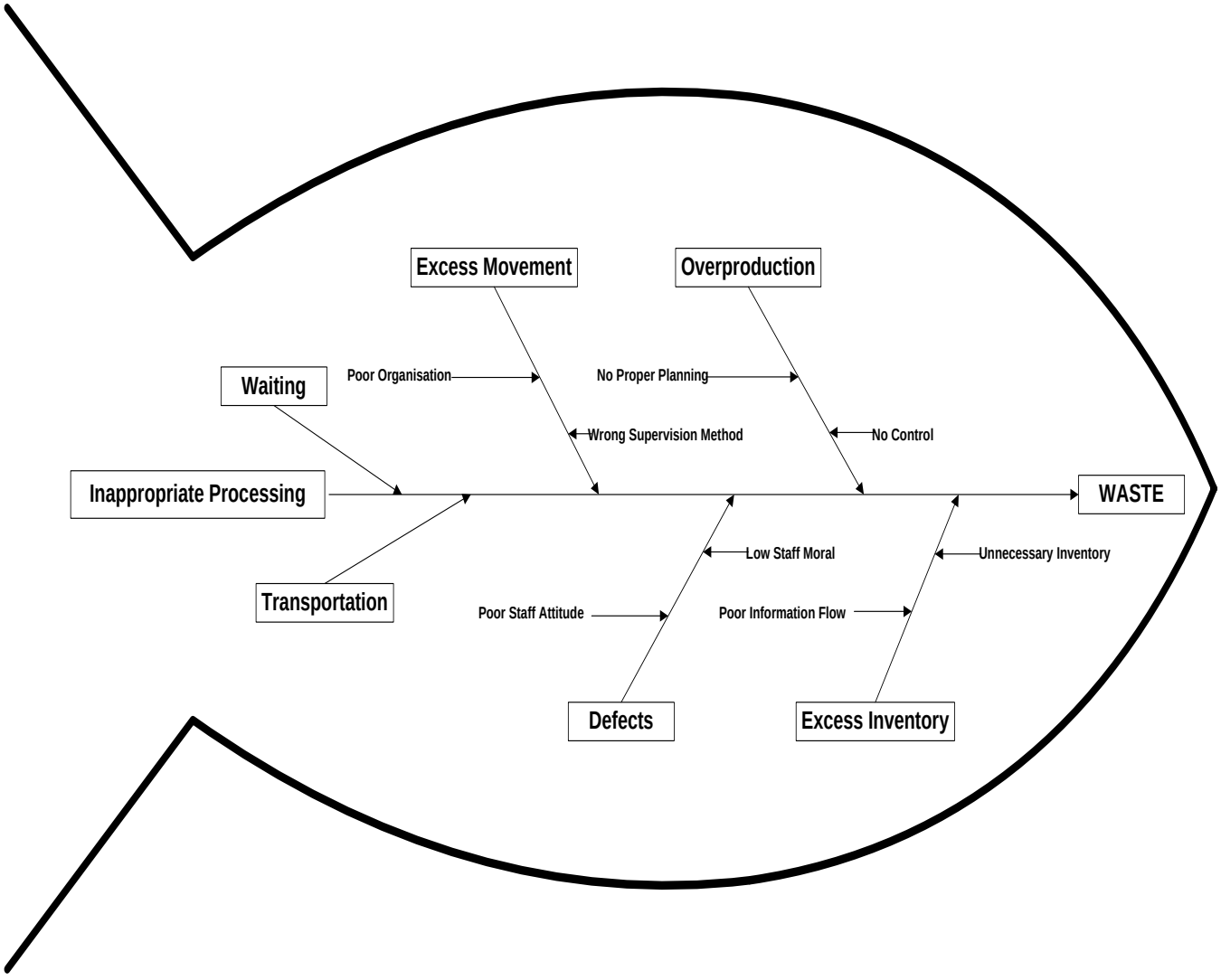


Figure 1: Fishbone Diagram

Expressing the problem situation: Current State Soft Systems Rich Picture

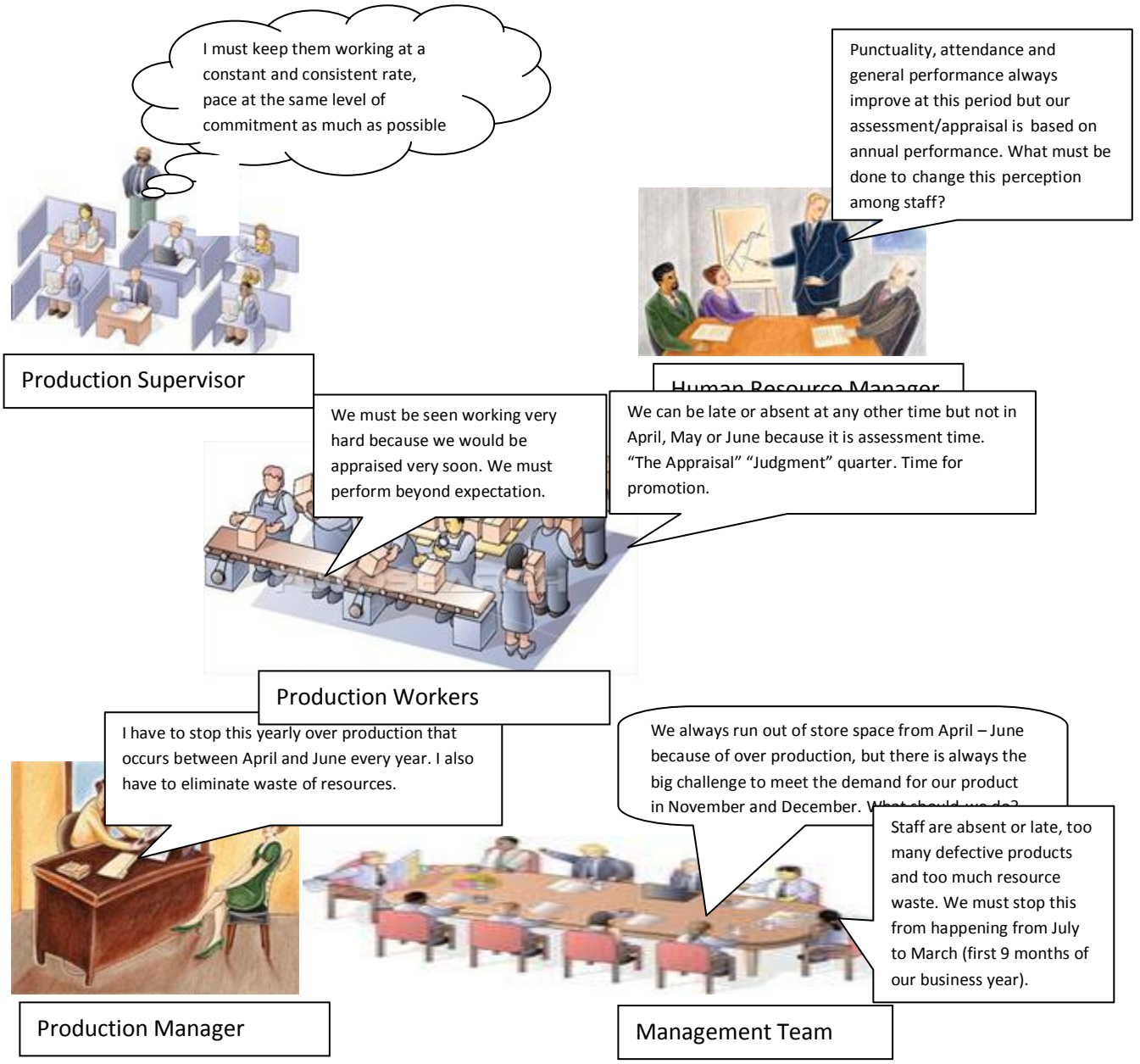


Figure 2: The Current State Soft Systems Rich Picture

Selecting how to View the Situation and Producing Root Definition

In considering the different perspective (see figure 2) from which the situation can be viewed we have the following;

- Staffs believe they have to do more at the end of the business year to be promoted.
- Staffs have to be seen to be putting more effort to be well appraised at the end of the business year.
- There is individual push without control for success at the end of the business year.
- Morales are down after appraisal and most staffs are not motivated to put in their best.
- There is poor information flow.
- Wrong supervisory method currently being used.
- No proper checks which in the long run ends up to being counterproductive.
- Poor Organisational Structure.

All these are perfectly valid purposeful perspective, but the basis of Soft System Methodology is the intension to address all perspectives in a complex whole. Clarity is gained by addressing key perspective separately, understanding their implications and then using those understanding when seeking to reintegrate these perspectives into a set of evaluative conclusions and suggestions for future action.

What need to be done next is to select a particular perspective and put it through a very structured and rigorous model development process developed by Peter Checkland using the mnemonic CATWOE. The particular perspective selected is "There is individual push without control for success at the end of the business year." This particular perspective selected will be put through Checkland's (1981) model development process using CATWOE.

- **C** – Customer
- **A** – Actors
- **T** – Transformation
- **W** – Weltanschauung (i.e this transformation is relevant because.....)
- **O** – Owners
- **E** – Environment

The starting point is a Transformation (T). From this particular perspective to know what is actually transformed from what to what; from input to output.

- **Transformation:** "Individual push without control for success at the end of the business year" will be replaced by "Collective push for success with adequate supervision to reduce waste and achieve organisational goal".
- **Weltanschauug:** This transformation is relevant because it will create a sense of belonging and team spirit which will lead to organisational success.
- **Customer:** In this case the beneficiaries of this transformation are the Production staff and the Organisation at large.
- **Actors:** The Facilitators of this transformation are the Top Management, The Production Manager and the Production Team.
- **Owners:** The Organisation.
- **Environment:** Production Sector.

Root Definition

Therefore, a "Root Definition" for the desired transformation will be "A Company owned system of performance appraisal that will encourage collective push for success with adequate supervision, well organised assessment and good control mechanism to achieve organisational goal and reduce all forms of waste".

Developing a Conceptual Model

Activities necessary to carry out this transformation as stated in the root definition to have an all encompassing and adequate model include;

- Determine policy change needed.
- Assign teams to shift for collective responsibility.
- Define Criteria for assessment.
- Decide on feasible measures of assessment.
- Identify and evaluate possible measures for job enrichment and job enlargement.
- Ensure adequate training and development within the system.
- Develop good production control mechanism.
- Establish adequate supervision and monitoring within the organisation.
- Develop a good reward system.

Applying the process recommended by Peter Checkland, a "Conceptual Model" of the transformation using the root definition is shown in figure 3.

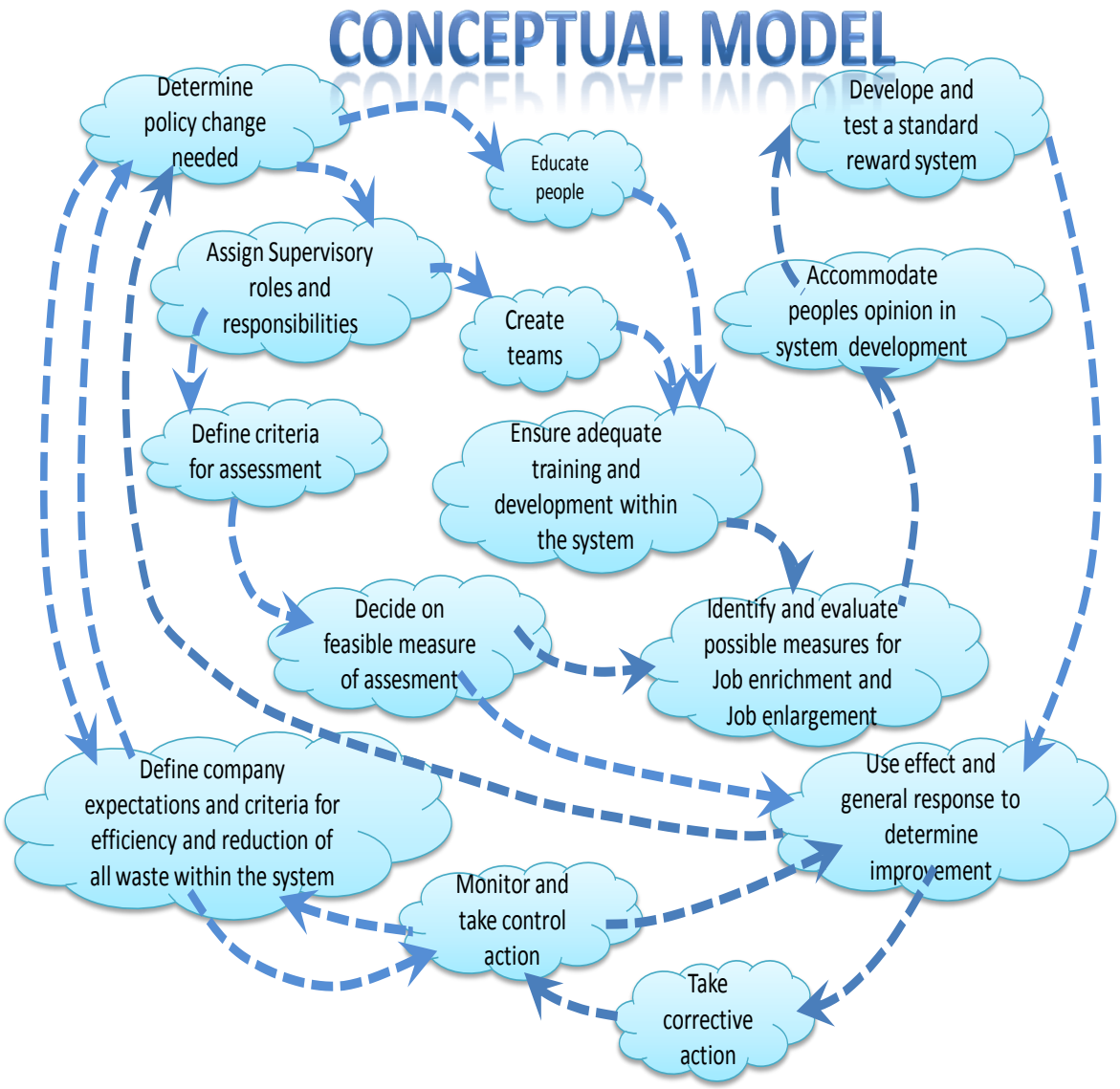


Figure 3: Conceptual Model

Comparing the Model with the reality

Looking at the conceptual model, it could be seen that 'the policy change' needed can be made if the management is determined to meet the new 'definition of company expectation'. Workers' education about the need for this change and the benefit of the change is feasible. If awareness on the benefits of the change and its impact on the company's performance and bottom-line profitability are made known to the staff, there would be a sense of responsibility as all would be carried along. The conceptual model is feasible in the 'real world'.

Feasible and desirable changes; Actions for Continuous improvement

The policy change needed should be determined and implemented by the management. Awareness of these changes and its benefits should be made known to all the staff. They must be carried along to ensure all round success for the company, its customers and all other stake holders. Roles and responsibilities should be clearly assigned with criteria for assessment and feasible measure for assessment defined while teams should be created to create a sense of belonging to the whole. Within these teams adequate training should be carried out to meet the needs of the organization. Possible areas for job enrichment and job enlargement should be identified while people's opinions on the workings of the system should be accommodated so that a standard workable and generally acceptable reward system can be developed.

A feedback mechanism which uses the observations in terms of effect of the policy change and general responses will be use to determine areas for improvement and possible 'policy change'. The circle goes over and over again because of the need for continuous improvement.

Discussions

In most organisations where the Lean Production System is practised and also in over eighty percent (80%) of articles and write-ups on Lean Production System and the seven waste, emphasis is always on 'Lean' or better put 'Less'. Less of everything, in terms of having half the manufacturing space, half the investment in tools, half the inventory, half the engineering hours, half the effort and half or even less than half 'the time'. Everybody talks about achieving 'less of everything' by eliminating waste due to Over production, Over processing of parts, Long wait for the next processing step, Unnecessary transportation, Keeping inventory more than necessary, Unnecessary movement and Waste due to Defective parts from production.

Although most research (Callen et al., 2000; Cua et al., 2001; Eroglu and Hofer, 2011; Fullerton and McWatters, 2001; Fullerton et al., 2003; Inman and Mehra, 1992; Jayaram et al., 2008; Martinez and Perez, 2001; Norris et al., 1994; Shah and Ward, 2003; Shah and Ward, 2007; Womack et al., 1990; White, 1993) which are empirical and functionalist based has considered machines and other constraints as the determinant of leanness, true 'leanness' is mainly achieved by a working system based on the ingenuity of the Human resources although less appreciated by most practitioners. Achieving true leanness is mainly due to the effective and efficient coordination and time management of the Human Resource (the labour force). These are the workers in the organisation, the Human Resources whose technical know-how, work environment, job satisfaction, strength, ability, attitude, motivation, mood, joy, happiness, sadness and general well being or not is the key determining factor in ensuring true 'Leanness'.

In the bestselling book on Lean Production System by Womack et al (1990) 'The Machine That Changed the World' which is based on the Massachusetts Institute of Technology five million dollar, five year, fourteen country International Motor Vehicle Program's study of the Worldwide auto industry, Lean Production System was seen as a complete system that 'welds' all activities to ensure the optimum use of all resource at a high speed, in the shortest of time resulting in the highest and best of output and also the best of returns on investment in terms of profit. 'Man' (The Human Resources) was seen as just another factor of production without full consideration that 'the man' is actually the determining and deciding factor. 'The Man' (Human Resources) causes waste and so he is the Ultimate waste if there is waste. 'The Man', ensures there is no over production, no over processing of parts, no long wait for the next processing step, no unnecessary transportation, no unnecessary inventory, no unnecessary movement and no defective parts from production. 'The Man' is the determining factor, the major factor and so 'The Man' is the Ultimate face of Lean Production System. Without full consideration of this 'Human face' (The Human Resources), Lean Production System if started, cannot be sustained.

Conclusion

Lean production system implementation requires a lot of effort in ensuring that waste in the production system is reduced and possibly eliminated for optimum benefit. Although in real Lean production practise and as can be seen from even most writers and analyst on the Lean production System, there is the tendency to forget that in implementing the Lean production system, the Human Resources 'the face' behind Lean as a 'production system' must be fully considered as the eighth possible source of waste and as the ultimate deciding factor in ensuring the 'Leanness' in a production system.

If the Human Resource is not there to manage and control the system effectively and efficiently, surely nothing will work since the presence of the Human Resource in the Lean production system is what galvanises the system to work to its optimum level.

As can be seen from the case study, if everything in terms of machines, production process, production layout and factory layout seems perfect in a manufacturing organisation, it still does not guarantee 'Leanness' in production or optimisation in production except the Human resource, the one resource that manages every other resources within the production process is well organised, informed, trained, motivated, managed (Sanchez and Perez, 2001; Dibia and Onuh, 2010b) and adequately controlled. Also, workers need to work together as a unit, a team to have a sense of belonging to the 'whole'.

A sense of belonging creates a wonderful atmosphere for achieving anything, and achieving 'Leanness' is no exception and so team work is an integral part and a vital tool in achieving 'Leanness' and optimisation in production.

Finally, it is not all about using the Lean production system to eliminate waste and get the production system to its optimum level for the benefit of all; it is also about sustaining the systems near perfect performance. The most difficult part of the Lean production system is its sustainability and this depends ultimately on the Human Resources and not the machines nor the finance in the production system. If the System must be sustained then the Human Resources must be taken into full consideration at all time.

Taking the human resource factors into consideration at all time in Lean production practice will ensure the reduction and possible elimination of waste in all its forms to achieve optimisation in production and optimum benefit for all stakeholders. To achieve this, the following is recommended;

- Proper organisation and administration
- Constant education and reawakening of the awareness for Lean
- Effective communication mechanism both vertical and horizontal
- Constant and efficient information flow especially within the value stream both internally and externally
- Effective human resource management
- Internal values culturization
- Cooperate team building
- Training and constant retraining of staff to meet daily expectation
- Real motivation that gives the desired effect

Further Work

Further work could be done to look into the role of the human resources in the extended value stream of production in the Lean production system. The impact of Lean activities on performance could also be looked into.

Another area that could be looked into is how to measure the alignment of the organizational culture with Lean principles since as with any other change initiative, Lean implementations differ greatly from one company to the next. Some of the problems and discrepancies can be attributed to differences in market segment, production processes and competitive and regulatory environment. However, it seems reasonable to suspect that changes as big as a Lean implementation are greatly influenced by the culture of the company, its values and traditions.
It would be of great value to investigate which aspects of organisational culture are more important than others for a Lean implementation and how to measure them to develop a change management plan based on culture.
Also, considerable effort should be made to research on possible methods that can be used effectively to establish harmonious work teams in organisations adopting lean production system. The effect and influence of Labour Unionization status on the adoption of lean production system practices in a company or organisation can also be look into in terms of further research.

Finally a more system based research methodology for the study of lean, its implementation and a benefit which combines the advantages of the functionalist and interpretive paradigms (Burrell and Morgan, 1979) should be looked into.

References

1. Alony, I. and Jones, M. (2008). Lean supply chains, JIT and Cellular manufacturing – The Human Side. Journal of Issues in Informing Science and Information Technology, Vol. 5, Page 165-175.
2. Boyer, K.K. (1996). An Assessment of Managerial Commitment to Lean Production. International Journal of Operation & Production Management, Vol. 16, Issue 9, Page 48-59.
3. Boyer, K.K., Leong, G.K., Ward, P.T., & Krajewski, L.J. (1997). Unlocking the potential of advanced manufacturing technologies. Journal of Operations Management, 15(4), 331-347.
4. Burrell, G. and Morgan, G. (1979). Sociological Paradigms and Organizational Analysis. Heinemann Education, London.
5. Callen, J.L., Fader, C. and Krinsky, I. (2000). Just-in-time: a cross-sectional plant analysis. International Journal of Production Economics Vol. 63, No. 3, Page 277-301.
6. Checkland, P.B. (1981). Systems Thinking, Systems Practice, John Wiley, Chichester.
7. Cua, K.O., McKone, K.E. and Schroeder, R.G. (2001). Relationships between implementation of TQM, JIT and TPM and manufacturing performance. Journal of Operations Management, Vol. 19, No. 6, Page 675-694.
8. Dibia, I.K. and Onuh, S. (2010a). Lean culturerization: a long term philosophy for full optimization of the human resource. Proceedings of the World Congress on Engineering and Computer Science (WCECS), USA, Page 1087-1091.
9. Dibia, I.K. and Onuh, S. (2010b). Lean Revolution and Human Resource Aspects. Proceedings of the World Congress on Engineering (WCE), London, Vol. 3, Page 2347-2350.
10. Eroglu, C. and Hofer, C. (2011). Lean, leaner, too lean? The inventory performance link revisited. Journal of Operations Management, Vol. 29, Page 356-369.
11. Forrester, R. (1995). Implication of lean manufacturing for human resource strategy. Work Study, Vol. 44, Issue: 3, Page 20-24.
12. Fullerton, R.R. and McWatters, C.S. (2001). The production performance benefits from JIT implementation. Journal of Operations Management Vol. 19, Page 81-96.
13. Fullerton, R.R., McWatters, C.S. and Fawson, C. (2003). An examination of the relationships between JIT and financial performance. Journal of Operations Management, Vol. 21, No. 4, Page 383-404.
14. Inman, R.A. and Mehra, S. (1992). Financial justification of JIT implementation. International Journal of Operations & Production Management, Vol. 13, No. 4, Page 32-39.
15. Jayaram, J., Vickery, S. and Droge, C. (2008). Relationship building, lean strategy and firm performance: an exploratory study in the automotive supplier industry. International Journal of Production Research Vol. 46, No. 20, Page 5633-5649.
16. Nakamura, M., Sakakibara, S. and Schroeder, R. (1998). Adoption of Just-in-Time Manufacturing Methods at U.S. and Japanese Owned Plants: Some Empirical Evidence. IEEE Transactions on Engineering Management, Vol. 45, No. 3, Page 230-240.
17. Norris, D.M., Swanson, R.D. and Chu, Y. (1994). Just-in-time production systems: a survey of managers. Production and Inventory Management Journal, Vol. 35, No. 2, Page 63-66.
18. Ohno, T. (1988). Toyota Production System: Beyond Large-Scale Productivity. Production Press, Cambridge, MA.
19. Power, D.J. and Sohal, A.S. (1997). An examination of the literature relating to issues affecting the human variable in just-in-time environments. Technovation Vol.17 (11/12), Page 649-666.
20. Sanchez, A.M. and Perez, M.P. (2001). Lean indicators and manufacturing strategies. International Journal of Operations & Production Management, Vol. 21, Issue 11, Page 1433-1452.
21. Shah, R. and Ward, P.T. (2003). Lean manufacturing: Context, practice bundles, and performance. Journal of Operations Management, 21(2), 129-149.
22. Shah, R. and Ward, P.T. (2007). Defining and developing measures of lean production. Journal of Operations Management, Vol. 25, Pages 785-805.
23. White, R.E. (1993). An empirical assessment of JIT in US manufacturers. Production and Inventory Management Journal, Vol. 34, No. 1, Page 38-42.
24. Womack, J., Jones, D. (2003). Lean Thinking, Banish Waste and Create Wealth in your Corporation, Revised, Free Press, pp 351-352
25. Womack, J., Jones, D. (1996). Lean Thinking, Banish Waste and Create Wealth in your Corporation. New York: Simon & Schuster.
26. Womack, J., Jones, D., Roos, D. (1990). The Machine that Changed the World, Rowson Associates, New York, USA