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LEAN MANUFACTURING IN TWO SERBIAN FOOD COMPANIES – CASE STUDIES

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Abstract: *This paper gives an overview of a 9 month experience in implementing lean manufacturing tools in two Serbian food companies. Both companies have certified quality and food safety management systems and are food exporters. One of them is a big producer with more than 1000 employees with a three shift serial production while the other is a small producer with one shift and batch oriented production. Results showed that six tools were chosen by both companies – Total productive maintenance, Poka yoke, batch reduction, layout improvement, standardization of work and visual management. The big company implemented also cellular and flow, Jidoka, quick changeovers and 5S. None of the companies expressed interest at implementing Just-In-Time, Kanban, Self-inspection and Value stream mapping at this stage of the project.*
Keywords: *Lean manufacturing, food industry, lean tools*

1. INTRODUCTION

The objective of the food industry should be to produce its products in a sustainable way. Spoiling nature's resources and using more resources than needed means an inefficient way of transformation of raw materials into final products, resulting in large amounts of waste, (Omurgonulsen, 2009). Roughly, 20% of this amount can be attributed to the food, drink and tobacco industries (Somsen et al., 2004). This draws attention to the significant level of waste in the food industry not only all over the world, but also in Serbia as a result of all types of nonconformities (product, process and system nonconformities) where increase of implementation of lean manufacturing and decrease of quality costs may have a significant impact on the food industry.

The birth of lean was in Japan within Toyota in the 1940s: The Toyota Production System was based around the desire to produce in a continuous flow which did not rely on long production runs to be efficient; it was based around the recognition that only a small fraction of the total time and effort is to process a product added value to the end customer, (Melton, 2005). There are various lean tools and techniques and they are often presented as "lean bricks" in a Lean house, (Alukal G. and Manos A., 2006; Đekić I., 2010).

Key tools and techniques within the 'lean' system include, (Alukal G. and Manos A., 2006; Holweg, 2007; Melton, 2005; Rooney S. and Rooney J., 2005; Rubio and Corominas, 2008; Shah and Ward, 2003):

- Total productive maintenance which covers practices primarily designed to maximize equipment effectiveness through planned predictive and preventive maintenance of the equipment and use of maintenance optimization techniques.
- JIT philosophy related to 'zero inventories' or 'stockless production so batches should always be as small as possible, in order to achieve one-piece flow with batches sizes of one.
- Cellular and flow – physically linking and arranging manual and machine process steps into the most efficient combination.
- Kanban – a visual signal to support flow by 'pulling' product through the manufacturing process as required by the internal / external customer.
- Poke yoke – an 'error-proofing' technique - a process used to prevent errors from occurring or to immediately point out a defect as it occurs.
- Self-inspection – inspection and process control by competent employees so they understand if the product passed to next operation is of acceptable quality.
- 'jidoka' or 'autonomous machine' - form of automation in which equipment automatically inspects each item after producing it, ceases production and notifies humans if a defect is detected.
- Point Of Use Storage – raw materials, parts, information, tooling, work standards, supplies and procedures are stored where needed.
- Batch size reduction is a technique in reducing batches to the smallest possible size to enable single and continuous flow.
- SMED (single minute exchange of dies)—a changeover reduction technique defined as a

time between the last good piece off the current run and the first good piece off the next run.
- Layout – a layout designed according to optimum operational sequence.
- Standard work – consistent performance of a task according to defined methods with no waste.
- Visual control – a visual method of measuring performance at the 'shop floor'. Use of this technique enables a fast check of all information – toolings, parts, production activities and indicators at a glance
- 5 S's – a visual housekeeping technique which devolved control to the shopfloor.
- Value stream mapping (VSM) a method of mapping current and future value flow of the entire production process.

Any activity in a process which does not add value to the customer is called 'waste', (Alukal G. and Manos A., 2006; Melton, 2005). There are seven (by some authors eight) main types of waste as outlined in the Japanese concept: defects, over-production, waiting, transport, inventory, over-processing and motion. The eight types of wastes are presented with the acronym downtime (**D**efects, **O**verproduction, **W**aiting, **N**on Value Added Processing, **T**ransportation, **I**nventory, **M**otion and **E**mployee knowledge and skills).

2. MATERIALS AND METHODS

This paper analyses experience with lean tools and techniques used in two Serbian companies. The chosen companies have the following characteristics:
- Both companies are in the food sector;
- Both companies have implemented ISO 9001 and HACCP / FSMS for more than 3 years;
- Both companies are exporters;
- In both companies analysis of the production process has been performed to identify typical lean wastes;
- Implementation of lean tools and techniques is on-going for more than 9 months;
- Implementation process is a combination of training and consulting activities;
- The reason for implementing lean tools and techniques in both companies is initiated from top management and is not a customer driven decision;
- One company is a big food manufacturer (more than 1000 employees);
- The big company has serial production in more than one shift;
- The other food company is a small manufacturer (less than 50 employees);
- The small company has small batch production focused on customer requirements operating in one shift.
- Reason for choosing these companies was to analyze how size of the company impacts implementing lean manufacturing. By some authors, large organizations suffer from structural inertial forces that negatively affect the implementation of lean manufacturing practices. However, large size also implies the availability of both capital and human resources that facilitate adoption and implementation of lean practices as well as returns to scale for investments associated with lean practices. The influence of size is pervasive and has been identified in relation to technology practices so choice of tools was of interest for this study (Shah and Ward, 2003).

3. RESULTS AND DISCUSSION

Results will be divided in two categories, presenting identified typical wastes in both companies and analysis of possibilities of implementing lean tools in techniques in two types of companies.

Table 1 presents identified typical wastes in both companies, modified from, (Melton, 2005; Rooney S. and Rooney J., 2005).

Table 1 – typical wastes in the two companies

Waste type	Description	Within big food company	Within small food company
Over - production	Producing more than the next process needs, before the next process needs and faster than the next process needs	When two or more machines in a row are used for the entire production process	During days when production planning is flexible
Waiting	Waiting for people, equipment, (semi)products	Waiting for work instructions, raw materials and maintenance Changeovers between products	Cleaning and sanitation Preparation of raw materials

Waste type	Description	Within big food company	Within small food company
Transportation	Unnecessary transport of materials	Due to the layout of the production area (old plant)	Due to the layout of the production area and movable machines
Inventory	Inventories more than the absolute minimum (products, intermediates, raw materials)	When work orders have small quantities; when production requires many ingredients	When suppliers goods are in big batches
Over-processing	Over-processing due to poor tool and product / process design	Administration and double recording	Lack of competence of supervisors
Motion	Unnecessary movement of people, data, decisions and information	Due to long production lines Bad working habits	Due to the layout of the production area and movable machines
Defects	Any error during the process — requiring re-work or additional work	Defects from unequal quality of raw materials	When design samples differ from final product

3.1 Big company wastes

In the big company, overproduction was observed during production with at least two machines in a row (production and packaging). In some situations production was faster and prior than the possibilities and need of packaging.

Waiting was observed in the following situations: (i) when changeovers lasted longer than planned, (ii) concerning further work instructions, (iii) waiting for raw materials / semi-products and (iv) waiting for maintenance staff.

Due to the layout of the production area (old plant) unnecessary transportation is seen in moving raw materials from the storage area to the production line and semi-products within the entire production area to the packaging machines.

When work orders have small series (in quantities) inventory as remains of packaging and raw materials was seen within the entire production area. Other case with inventory was when products require many different ingredients.

Over-processing was seen in administration and double recording with both hard and soft copies.

Unnecessary motions were observed in two dimensions. Long unnecessary motion occurs since production lines are long in length. Second, on a micro level near movable machines such as the packaging machines due to the fact that placement of the movable machines is not designated. Finally bad working habits cause unnecessary motion.

Due to unequal quality of raw materials from several suppliers, defects occur in the production process.

3.2 Small company wastes

Over-production occurs when production plan is not strict so the flexibility causes this waste.

In the small company, main waiting activities are after cleaning and sanitation of the production line if the cleaning process lasts longer so the changeover is postponed. Sometimes, preparation of raw materials for specific products causes waiting.

Due to the layout of the production area (new plant with movable production and packaging machines) unnecessary transportation is seen since there are no visually designated signs on the floor for pallets. For the same reason unnecessary motion was observed.

Since all work orders are different from capacity point of view, due to small series (in quantities) inventory as remains of packaging and raw materials was seen within the entire production cycle. Other occasion is with big batches coming from suppliers.

Supervisors have inadequate training for recording all production / process parameters so this results in double recording.

Defect was observed in cases when the design sample accepted by customer differs from final product after trial production.

3.3 Implemented tools and techniques

After analysis of symptoms of wastes, several lean tools and techniques have been implemented. Table 2 gives an overview of lean tools and techniques used in the two companies. Reasons for choosing and not choosing a specific tool and techniques are given further in text.

Total productive maintenance has been identified as a very important tool in the big company. Due to big number of production lines, OEE indicator (Overall equipment effectiveness) is monitored on a shift basis and autonomous maintenance has been deployed to production workers in two dimensions – cleaning and hygiene of the machine and audio / visual inspection of machines. Lubrication was not included since hazard analysis within existing HACCP identified risk of contamination of food product. Troubleshooting was deployed by several work instructions.

The small company doesn't have serial production, sometimes capacities are not fully exploited so OEE doesn't give adequate benefit, although it is monitored on a daily basis. Maintenance is outsourced by external company and machinery is not very complex so at the moment this tool does not show adequate effect.

Table 2 – Overview of lean tools and techniques in two companies

	Within big food company	**Within small food company**
Total productive maintenance	✓	✓
JIT	×	×
Cellular and flow	✓	×
Kanban	×	×
Poke yoke	✓	✓
Self-inspection	×	×
Jidoka	✓	×
Batch size reduction	✓	✓
Quick changeovers	✓	×
Layout	✓	✓
Standard work	✓	✓
Visual control	✓	✓
5S	✓	×
Value stream mapping	×	×

JIT concept was observed as hard for both companies since the flow of materials / pallets is not uniform and the key problem is with the suppliers. Both companies have a small number of suppliers for their key raw materials and the suppliers do not have the possibility to deliver raw materials in different quantities on a daily basis. This tools is planned for the future as a project of supplier development and improvement of the supply chain.

Cellular and flow was not able to be applied in the big company due to its fixed layout since this tool requires resources within cells to be arranged to easily facilitate all operations, (Abdulmalek and Rajgopal, 2007). The small company with batch production also rejected this tool. Kanban was rejected by both companies. In the big company, main reason was unsynchronized cycle time (the time required to complete one cycle of an operation) and unequal takt time and since new investments were planned concerning new machines with higher capacity, improving takt time is planned in the future. In the small company that is batch oriented with simple production, this tool was not recognized as interesting.

Although poke yoke was not identified as a tool, both companies use some variety of this tool in avoiding human mistakes, particularly in the hygiene process. In the big company, all doors with access to the outdoor have automatic closing mechanism to avoid the door being open and possible pest infestation. Some tooling also has only one way to be fixed. In the small company, access to the production area is protected by a "poka yoke" device, i.e. access is denied unless the machine disinfects workers hand so there is no possibility for the worker to enter production area without clean hands. Self-inspection has not been recognized as an easy tool for implementing since in the big company, large portfolio would require reengineering of the control process and deeper analysis of the technology. Food industry has its constraints (large varieties in quality of raw materials due to weather conditions, season, supplier and its level of quality) so control is kept on a higher hierarchical level. The small company's technology is designed to have only several process controls and these activities are performed by shift leaders and self-inspection is not cascaded to the workers' level.

Jidoka concept is implemented in the big company. New equipment purchased in the last few years have integrated some modalities of the autonomation concept justified for the food industry (audio / visual alarms and stopping the line automatically when any defect occurs like inadequate temperature, failure on the transportation conveyer, etc.). The financial assets of the small company do not allow investing in autonomation at the moment. Batch size reduction in the big company was a challenge since the entire production process was reengineered from production towards market to production towards customer. Effects of this change were overseen in decrease of inventory waste. In the small company since their production orientation was customer driven; their entire production process was already designed towards batch reduction.

Quick changeover in the big company was identified as the leading tools to show big improvements in a short period of time. Due to big capacities, time savings in any mean bring big financial savings. On the other side, the small company working in one shift and with smaller capacities didn't identify big benefits in measuring changeovers. In the small company, following time for cleaning and sanitation was identified as an area for improvement. Implementation of HACCP concept and food safety management system, layout has been reorganized to avoid any kind of cross – contamination as defined in food safety standards, (CAC, 2003; ISO, 2005).

As previously stated, both companies have implemented and certified their quality management system. Within their QMS, a large number of procedures and work instructions have been developed.

However, the new lean philosophy highlighted the necessity of standardizing work in the aim of improving takt time. Since kanban was rejected, at this moment, new modified and simplified but more precise work instructions are being developed. Visual control is implemented in both companies. However, level of implementation differs. In the big company, floor signalization is posted joint with OHSAS program, there are visual labels on the walls but some are obsolete. In the small company, visual management is at the beginning.

5S as a concept is used in the big company. In the first stage it is used in maintenance sector in the workshops and storage of spare parts. Perspective of using 5S in production is in the near future. In the small company, 5S is not identified as necessary since the layout is new and the production is simple. The area where there is a potential for 5S is in the area where the plant lab and development sector operate.Value stream mapping was not included in both companies for different reasons. In the big company, since there are a lot of production lines and a big portfolio of products their labor capacity was unable to analyze all production lines and their product flow using VSM. On the other side, in the small company the production flow is simple so flow chart from HACCP plan and the quality plan were used as basis for improving product flow.

4. CONCLUSION

After initial readiness for implementing lean tools and techniques, as time went by, organizational culture became predominant factor for success. Some authors point organizational characteristics as the most influential factor in developing commitment and highlight the weight of decentralization and participation in decision-making, (Losonci et al., 2011; Wim et al., 1998). In both companies, change of organizational climate has been identified as slow and unequal not depending on the age of employees, their educational and hierarchical position. The lean production philosophy considers inventory a form of waste that should be minimized. In recent decades, as lean production has gained widespread adoption, lean inventory management has become synonymous with good inventory management, (Eroglu and Hofer, 2011).

From 14 tools, in the big company 10 tools have some level of implementation. On the other side, in the small company 6 tools have been recognized. In both companies, the same tools are implemented - TPM, Poka yoke, batch reduction, layout improvement, standardization of work and visual management which raises a conclusion that these tools cover better coordination between production and maintenance (TPM), batch reduction as a result of customer driven production and pull strategy, poka yoke as a tool to avoid human errors where possible and micro – organizational improvements – layout, standard work and visual management.

The aim of chosen tools is to enhance benefits of implementing lean, (Melton, 2005) through reduced inventory and lead time, less process waste and rework and financial savings.

REFERENCES:

[1] Abdulmalek, F.A., Rajgopal, J., (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. International Journal of Production Economics 107(1), 223-236.

[2] Alukal G., Manos A., (2006). *Lean Kaizen - A Simplified Approach to Process Improvements*. ASQ Quality Press, Milwaukee, Wisconsin.

[3] CAC, (2003). CAC/RCP 1-1969, Rev.4- 2003 Recommended International code of Practice - General principles of food hygiene Codex Alimentarius Commission.

[4] Đekić I., (2010). *Metode poboljšanja sistema upravljanja bezbednošću i kvalitetom u proizvodnji hrane*. Poljoprivredni fakultet Univerziteta u Beogradu, Beograd.

[5] Eroglu, C., Hofer, C., (2011). Lean, leaner, too lean? The inventory-performance link revisited. Journal of Operations Management 29(4), 356-369.

[6] Holweg, M., (2007). The genealogy of lean production. Journal of Operations Management 25(2), 420-437.

[7] ISO, (2005). ISO 22000:2005 Food safety management systems -- Requirements for any organization in the food chain

[8] Losonci, D., Demeter, K., Jenei, I., (2011). Factors influencing employee perceptions in lean transformations. International Journal of Production Economics 131(1), 30-43.

[9] Melton, T., (2005). The Benefits of Lean Manufacturing: What Lean Thinking has to Offer the Process Industries. Chemical Engineering Research and Design 83(6), 662-673.

[10] Omurgonulsen, M., (2009). A research on the measurement of quality costs in the Turkish food manufacturing industry. Total Quality Management & Business Excellence 20(5), 547-562.
[11] Rooney S., Rooney J., (2005). Lean Glossary. Quality Progress.
[12] Rubio, S., Corominas, A., (2008). Optimal manufacturing-remanufacturing policies in a lean production environment. Computers & Industrial Engineering 55(1), 234-242.
[13] Shah, R., Ward, P.T., (2003). Lean manufacturing: context, practice bundles, and performance. Journal of Operations Management 21(2), 129-149.
[14] Somsen, D., Capelle, A., Tramper, J., (2004). Production yield analysis--a new systematic method for improvement of raw material yield. Trends in Food Science & Technology 15(5), 267-275.
[15] Wim, J.N., Margriet, J.d.J., Gijs, B., (1998). Employee commitment in changing organizations: an exploration. Journal of European Industrial Training 22(6), 243-248.

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