AN INVESTIGATION INTO KEY ENABLING FACTORS FOR THE SUCCESSFUL IMPLEMENTATION OF KANBAN SYSTEMS IN SOUTH AFRICA: A CASE STUDY

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ABSTRACT

The manufacturing sector, considered to be a significant industry in any country, is often plagued with delivering measurable benefits in terms of efficiency and quality in manufacturing and the degree of competition has greatly increased due to global marketing. In order to cope with this challenge, organisations attempt to improve their manufacturing operations by using different tools and techniques to reduce costs while remaining profitable. This study investigated the existing applications of Kanban systems of two different manufacturing organisations in South Africa. The objective of the study was to identify the strengths and weaknesses of the Kanban system in an attempt to improve quality and productivity. An empirical study was conducted using quantitative methodology. A survey questionnaire was distributed to the shop floor workers and engineers of two chosen organisations. The results of the study showed that in both organisations there are similar and contributing factors that enable effective application of Kanban systems.

Keywords
Industrial engineering applications, Kanban systems, quality, productivity

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1 INTRODUCTION AND BACKGROUND

The success of the Toyota Production System (TPS) enabled Japanese manufacturers to improve productivity and reduce costs three decades ago. With manufacturing costs escalating on a regular basis due to various reasons, manufacturing organisations that are unable to compete eventually file for bankruptcy. An integral feature of just in-time (JIT) systems is the use of pull shop floor control systems which is commonly known as Kanban. The kanban system was introduced by the Japanese to complement the JIT system. This system was introduced to do away with the push system which was and is still used by many industries, the concept initially originated from US supermarkets where customers get (a) what is needed, (b) at the time it is needed, and (3) at the correct amount needed [1]. The idea of tangible and touchable food items in a supermarket was applied by Taiichi Ohno in Toyota around 1952 to: (a) reduce inventory and production time, (b) increase the speed of information exchange, and (c) improve efficiencies [1]. After the gains demonstrated by Kanban, many industries adopted the system. The Kanban Concept was introduced by the Japanese through the Toyota Production System Concept. The Kanban system was introduced to work hand in hand with the Just-in-Time concept and the practise of standardised work. This system was later recognised by a number of manufacturing industries worldwide due to the impact it had in the Toyota manufacturing plants. Kanban Systems efficiently control repetitive manufacturing environments and offer simplicity. However, they are not suitable for non-repetitive manufacturing systems.

2 METHODOLOGY

[2] define methodology as the study of procedures or methods used in research to create new knowledge. On further examination, [3] and [4] advocate that qualitative and quantitative techniques are commonly used to conduct research. In most cases, qualitative research is focused on understanding and interpreting data while providing a detailed description of events, situations and interaction between people and things, thus providing depth and detail. The views of [2] and [5] concur with [4] in that qualitative research aims to study human interaction from the insider’s perspective as they identify, examine and reflect on perceptions. In summary, qualitative techniques are used to study phenomena that do not fit into particular theories.

[4] articulate that quantitative research is often used for testing a theory and focuses on describing, explaining and predicting data with the use of statistical and mathematical methods. In essence, quantitative research is most commonly encountered as part of formal or conclusive research and the aim of this technique is to determine the relationship between an independent variable and a dependent or outcome variable in a population. Principally quantitative approach was adopted as it enables the researcher to focus in a particular area and gather information through various means. In this case study, data was collected through the review of existing literature and triangulated with face to face discussions and telephonic discussions using shop floor workers and supervisors as primary participants.

3 LITERATURE REVIEW

The famous inventor of the cotton gin, Eli Whitney, perfected the concept of interchangeable parts in 1799. For the next 100 years, manufacturers concerned themselves primarily with developing systems of engineering drawings, perfecting modern machine tools and developing large scale processes [6]. The works of early industrial engineers such as Frederick Taylor, Frank Gilbert and Lillian Gilbert in the late 1890’s, introduced the era of scientific management [7]. They developed concepts such as “time study”, “standardised work”, “motion study”, “process charting” and workplace psychology. Following the aforementioned information, it can be suggested that these specialists originally introduced the concept of what is today referred to as “waste elimination”.

[4207]-2
3.1 The toyota production system

Early in the 1940’s, Taichi Ohno and Shigeo Shingo began to incorporate Ford production, Statistical Process Control and other techniques into the TPS. They recognised the central role of inventory and the importance of respect to employees from the contradictions and shortcomings they identified in the Ford system [6]. Ohno visualised an ideal production system in terms of a sequential workflow that produced goods Just In Time (JIT) with little or no inventory between workstations [8]. This prompted a shift from the traditional “batch and queue” mass production philosophy to “one piece flow” pull production. In order to maintain the sequential workflow and keep inventory to a minimum, Shingo worked on reducing machine set-up times by developing the Single Minute Exchange of Dies (SMED) system [8].

It was during the 1950’s that Ohno developed the concept of “one piece flow” by merging the knowledge and skill of master craftsmen [9]. During this era, many other concepts such as JIT, Kanban, Quality Circles, Kaizen and Cell Manufacturing emerged within the TPS. When the popularity of productivity and quality gains in the TPS became known globally, American executives travelled to Japan to study these concepts. The American executives adopted mainly the superficial concepts like JIT, Kanban and Quality Circles which proved to be successful over time [10].

3.2 Lean manufacturing

Toyota captured the world’s attention in the 1980’s, when it was perceived that their vehicles were lasting longer and required much less repairs than American vehicles. The most remarkable aspect was that the vehicles were designed much faster, with more reliability, and at a more competitive cost than the Americans. According to [11] it was a mystery for a number of years that the Japanese were able to produce automobiles at such high quality and low cost. This, however, lead to the largest and most thorough study ever undertaken in any industry. A research group at the Massachusetts Institute of Technology took five years in the late 1980’s to explore the difference between American mass production and the TPS in the automotive industry [12].

In 1990, James Womack’s book titled “The machine that changed the world” provided an account of the history of automobile manufacturing combined with a study of Japanese, American, and European automotive assembly plants. His objective was to demonstrate to organisations, managers, employees and investors that there was a better way to organise and manage customer relations, the supply chain, product development and production operations. This approach, which was pioneered by Toyota and named the TPS after World War 2, was labelled Lean Manufacturing [13].

The term “lean manufacturing” focuses on producing value-added features while identifying and eliminating non-value-added activities in the production environment. In essence, lean manufacturing aims to reduce wasteful practices while providing increased customer value. The central focus of value, according to [13], should be on providing products with specific capabilities, offered at predetermined prices, through a dialogue with predefined customers. To understand how this concept applies to industry, [14] distinguishes “value-added” as an activity that makes a product more complete from “non-value-added” as an activity which does not advance the product to a finished state.

In order to focus on all activities that create value, [15] propose that it is essential to have an alignment between strategic goals and operational activities. From a more specific point of view, [16] contends that traditional organisations grow both value-added and non-value-added operations in order to increase production and profits. However, lean organisations should focus on reducing non-value-added activities by transferring efforts to those operations which add value, thus growing both production and profits without added resources. Therefore, to demonstrate this idea, Mekong [17]) cites the following key implications of Lean manufacturing compared to traditional batch manufacturing.
The main principles for the implementation of Kanban systems are as follows:

- Level production (balance the schedule) in order to achieve low variability of the number of parts from one-time period to the next.
- Avoid complex information and hierarchical control systems on a factory floor.
- Do not withdraw parts without a Kanban.
- Withdraw only the parts needed at each stage.
- Do not send defective parts to the succeeding stages.
- Produce the exact quantity of parts withdrawn.

The Kanban system is a means to control just-in-time supply and "autonomation" (automation with a human touch). The Kanban system works hand-in-hand with the "order-point method."

The order-point method is a control technique used to carry out optimum ordering in repetitive production processes. It is a technique/formula used to lower inventories using smaller and smaller lots, thereby increasing the frequency of delivery of materials. Because materials are delivered more often, new strategies are needed to deal with the amount of increased transport, in order to ensure that excessive transport waste is not created.

Kanban is a means of visual control, used to keep the supply system going. The theory behind Kanban is that only what is used is replenished. By only creating what was taken, it creates a "pull" of inventory through the system, rather than "pushing" material through that was created without need.

The key objective of a Kanban system was to deliver the material just-in-time to the manufacturing workstations, and to pass information to the preceding stage regarding what and how much to produce.

A Kanban full fills the following functions:

- Visibility function
  The information and material flow are combined together as Kanban’s move with their parts (WIP - work-in-progress).

- Production function
  The Kanban detached from the succeeding stage full fills a production control function which indicates the time, quantity, and the part types to be produced.

- Inventory function
  The number of Kanban’s actually measures the amount of inventory. Hence, controlling the number of Kanban’s is equivalent to controlling the amount of inventory; i.e. increasing (decreasing) the number of Kanban’s corresponds to increasing (decreasing) the amount of inventory. Controlling the number of Kanban’s is much simpler than controlling the amount of inventory itself [18][19].
According to Figure 1, the “man” group indicates unnecessary motions during operations, employees waiting for preceding processes and over-production; the “machine” group represents inappropriate processing of products and the “material” group identifies waste resulting from transportation, excess inventory and defects. On closer examination, [19] maintains that over-production overlaps man and machine while defects overlap machine and material. The figure reveals that the main sources of waste overlap each other. Indeed, by removing one source of waste it can lead to the reduction or elimination of others.

It is evident that lean manufacturing aims to lower product costs through the constant elimination of waste. Identifying waste is not easy due to the large number of parameters and overlap between different processes that may cause waste activities to be concealed between other activities. Therefore, in order to accomplish the methodical classification of waste in production, this study explores the different sources of lean manufacturing waste in existing and past literature.

4 RESULTS AND DISCUSSION

Critical success factors were identified and the aim was to compare the two organisations and identify key enabling factors for an effective Kanban system and if they share those five common critical factors. The sections are as follows: cultural transformation, creating a visual workplace, focus on WIP- inventory, to focus on good housekeeping and elimination of waste (Muda).

4.1 Cultural transformation

An extensive amount of time was spent with employees particularly shop floor employees who are the day to day operators of the Kanban system in both organisations. Time was also set aside with management to see if employees shared the same sentiments with management. Kanban systems involves a complete cultural change of doing things. It was evident that there are common and contributing factors of effective application of Kanban systems at both organisations.

- Training and education is facilitated to all levels of management and employees
- Employee involvement ‘ownership’ and innovation is encouraged in both organisations
• The strategic level revolves around the customer while the techniques and tools apply to the operational level
• The importance of management support and communication
• The Goal is satisfying customer requirements
• Employee involvement ‘ownership’ and innovation is encouraged in both organisations.

4.2 Visual workplace
Upon investigation of the two workplaces which was part of the research it was found that:
• A place for everything and everything in its place
• Demarcation of work areas and work benches
• Visual Kanban cards were visible
• Labelling of equipment and tools is evident
• Clean working environment
• 15 minutes before close of business, employees clean their work areas
• Identify defects and errors by visual control

Visual controls give the ability to see abnormalities at a glance. This in turns comprise a series of activities for eliminating waste that contribute to errors, defects and safety related issues in the workplace.

4.3 WIP - inventory
The purpose of inventory management is to be able to manage the operation’s inventory in order to satisfy customer demand; that is actual demand in the market regarding products and services, without exposing the organisation to unnecessary costs and risks. Effective inventory management can be one of the toughest tasks in business because the achievement of organisational objectives is linked to the relationship between its functional goals. All organisations should be concerned with inventory management and a particular emphasis should always be put on it. A sound inventory management involves the coordination of an organisation’s strategic functions (production, finance, marketing) in order to achieve organisational objectives. The more inventory a company has, the less likely they will have what they need - Taiichi Ohno [11].

Decades ago Toyota started thinking in terms of pulling inventories based on immediate customer demand. In the Toyota Way “pull” means the ideal state of Just-In-Time manufacturing thereby giving the internal customer (next stage in production line) what they want when they want and in the amount they want [11]. It is 100% on demand and has zero inventories. Toyota tries to keep it this way, but there is always little bit of buffer and when it is used then it will be replenished.

By implementing the ‘pull’ system instead of the ‘push’ system both organisations are carefully monitoring and co-ordinating to replenish thousands of parts and tools internally.

4.4 Housekeeping - 5s
The 5s principles play a major role in both organisations (Seiri, Seiton, Seiso, Seiketsu and Shitsuke) [11] As a part of housekeeping, a senior person regularly evaluates all areas to ensure that all employees adhere to a clean and safe working environment by allocating the person a grade from 1 to 5 (1 very good - 5 very bad). The Toyota way recognizes that visual management complements humans as humans are visually, tactiley and audibly oriented.
4.5 Elimination of waste

The organisation found it can create the leanest possible operation and eventually give better service and production quality by leveling out (Heijunka) its production schedule and not always building to order. There are a total of eight wastes (Muda) but we will discuss here the three M’s which fit together as a system to make an effective Kanban at Toyota. They are; Muda, Muri and Mura (in Japanese terms).

It was also evident for the study that XYZ Plastics endorses the elimination of 8 wastes which was explained in detail in the previous sections.

Below is a representation of the 3M’s that effective Kanban systems try to eliminate by all means.

![Diagram showing the elimination of 3M's for Kanban systems](image_url)

**Figure 2: 3M’s that effective Kanban systems try to eliminate**

Muda: Non-value added; all the wasteful activities in making the final product that lengthen the lead times, such as extra movement to get parts or tools, excess inventory, or in any type of waiting. Everything other than the actual cutting is considering Muda according to this analysis.

Muri: Overburdening People or equipment; this means pushing people and machines beyond their natural limits. Overburdening causes safety and quality problems and in machinery it causes breakdowns and defects.

Mura: Unevenness; this means unevenness due to irregular production schedule or fluctuating production volumes due to internal problems, such as down time or missing parts or defects. Muda will be a result of Mura[11].

Eliminating Muda is only one third of achieving continuous flow, but to achieve complete flow, eliminating Muri and smoothing Mura are equally important.

Results of the study revealed that there are common enabling factors between Toyota and XYZ Plastic for the effective application and implementation of Kanban systems. Study also revealed that both organisations share and live on five critical factors that enable effective Kanban system.

In Conclusion from above were the results of the study, Kanban systems has been broadly embraced to eliminate waste and to improve quality and productivity and these benefits can be affirmed by the employees. Based on the analysis and presentation of the results obtained, the following chapter will present the conclusion and recommendations for the project.

5 RECOMMENDATION AND CONCLUSION

Based on literature review and assessment of XYZ Plastics operations, the conclusions reached are summarized as follows:

The literature presents an in-depth analysis of lean manufacturing which includes Kanban System and details its constituents including its origins.
The paper assesses XYZ Plastics operations with regard to its Kanban system.

XYZ Plastics Kanban System is comparable with that of Toyota Production System.

5. REFERENCES


