

LEAN PRODUCTION SYSTEM KNOWLEDGE IMPROVEMENT BY  
IMPLEMENTING LEAN PRODUCTION SYSTEM SIMULATION GAME AT WSA  
ENGINEERING SDN BHD

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## ABSTRACT

This final year project is about Lean Production System (LPS) Simulation Game that had been applied at WSA Engineering Sdn Bhd. LPS simulation game is a tool for education and training purpose for the employees at WSA Engineering Sdn Bhd in improving their knowledge in Lean Production System. As LPS will be widely used in Malaysia, so there is need a tool in smoothing the LPS implementation. Before implement this LPS, the industry need to develop the LPS skills among the employees. So this step are taken by WSA Engineering Sdn Bhd by implementing this LPS Simulation Game in their company. Therefore, objectives of this project is to train all of the employees to achieve standard in doing work, follow the standard operation procedure (SOP). Besides, to acquire the skills to build optimal quality in the manufacturing processes, secure required volume and pursue cost reduction. The problem statement of this project is LPS or Kaizen team at WSA Engineering Sdn Bhd had difficulties to implement and develop the LPS knowledge among the employees. For the previous condition, the Production team had been run the training but it is the theory only not expose with the simulation game. Through teory, the the employees not really understand and cannot relate with the real condition at the work environment. Then, WSA LPS team had been setup one simulation games which are Kanban Simulation Game. After running the training, the achievement of the employees is increase which are the percentage of rejection is decrease. So, for the current condition the training had been run but with the difference strategies where the idea of this project is come out, which is lump sum the three simulation game which are Kanban Simulation Game, Majaico Tower Simulation Game and Restaurant Game to become LPS Simulation Game. In order to reinforce the learning process and measure the effectiveness of this game in teaching items of LPS, surveys to test pre-game knowledge and post-game knowledge are administered before and after the game to the WSA employees. So, from this the level of LPS knowledge between pre-training and post-training can be evaluated. Besides, during the simulation game running, each group will be evaluated based on the parameters measured through them. That parameters are shipped quantity, cost per piece, profit and customer satisfaction and through that, they will realized about the relationship between shipped quantity, company profit and customer satisfaction, and for the other side is between processing cost and cost per piece. Through the finding of this project, this simulation game enhanced the learning and understanding of basic concepts of lean because of during the simulation game all of the participants have been exposed with all of the LPS items.

## ABSTRAK

Projek tahun akhir ini adalah mengenai *Lean Production System* (LPS) Permainan Simulasi yang telah digunakan pada WSA Engineering Sdn Bhd. Simulasi permainan LPS adalah alat untuk tujuan pendidikan dan latihan untuk pekerja di WSA Engineering Sdn Bhd dalam mempertingkatkan pengetahuan mereka dalam LPS. LPS akan digunakan secara meluas di Malaysia, jadi satu alat diperlukan dalam melicinkan pelaksanaan LPS. Sebelum melaksanakan LPS ini, industri perlu mengambil satu inisiatif untuk membangunkan kemahiran LPS di kalangan kakitangan. Jadi langkah ini diambil oleh WSA Engineering Sdn Bhd dengan melaksanakan Permainan Simulasi LPS dalam syarikat mereka. Oleh itu, objektif projek ini adalah untuk melatih semua pekerja untuk mencapai standard dalam melakukan kerja, mengikut *Standard Operation Procedure* (SOP). Selain itu, untuk memperoleh kemahiran untuk membina kualiti optimum dalam proses pembuatan, dan pengurangan kos. Pernyataan masalah projek ini adalah LPS atau pasukan Kaizen di WSA Engineering Sdn Bhd menghadapi kesukaran untuk melaksanakan dan membangunkan pengetahuan LPS di kalangan pekerja. Bagi keadaan sebelumnya, *Production team* telah menjalankan latihan tetapi ia adalah teori sahaja tidak didedahkan dengan permainan simulasi. Melalui teori, pekerja tidak benar-benar memahami dan tidak boleh dikaitkan dengan keadaan sebenar di persekitaran kerja. Kemudian, pasukan LPS WSA telah menjalankan satu permainan simulasi iaitu Permainan Simulasi Kanban. Selepas menjalankan latihan, pencapaian pekerja adalah meningkat dengan peratusan *rejection* adalah menurun. Jadi, untuk keadaan semasa latihan telah dijalankan tetapi dengan strategi perbezaan di mana idea projek ini terhasil, iaitu menggabungkan tiga permainan simulasi iaitu Permainan Simulasi Kanban, Permainan Simulasi MAJAICO Menara dan Permainan Restoran untuk dijadikan sebagai Permainan Simulasi LPS. Dalam usaha untuk mengukuhkan proses pembelajaran dan mengukur keberkesanan permainan ini dalam pengajaran item LPS, kaji selidik untuk menguji sebelum permainan pengetahuan dan selepas permainan pengetahuan dijalankan sebelum dan selepas permainan kepada pekerja WSA. Jadi, dari tahap ini pengetahuan LPS antara latihan pra-dan pasca-latihan boleh dinilai. Selain itu, semasa berjalan dengan permainan simulasi, setiap kumpulan akan dinilai berdasarkan parameter yang diukur melalui mereka. Antara parameter yang diukur ialah *shipped quantity*, *cost per piece*, *profit* dan *customer satisfaction* dan melalui itu, mereka akan menyedari tentang hubungan antara parameter – parameter tersebut. Melalui kaji selidik yang dijalankan, permainan simulasi ini dapat mempertingkatkan pembelajaran dan pemahaman mengenai konsep-konsep asas LPS kerana semasa permainan simulasi para peserta telah didedahkan dengan item - item LPS.

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**LIST OF ABBREVIATION**

<b>FIFO</b>	First In First Out
<b>JIT</b>	Just in Time
<b>LPS</b>	Lean Production System
<b>NG</b>	No Good
<b>SMED</b>	Single Minutes Exchange Die
<b>SOP</b>	Standard Operation Procedure
<b>TPS</b>	Toyota Production System
<b>VSM</b>	Value Stream Mapping
<b>WIP</b>	Work in Progress

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 BACKGROUND OF PROJECT**

The evolution of production system is start from continuous production, mass production, batch and jobbing production. Then Lean Production System (LPS) was developed in Japan to eliminate the waste of materials, machines, labour, money and stocks. Nowadays, lots of manufacturing sector especially automotive industries are rapidly adopting lean techniques and use the Toyota as the benchmark because of Toyota Motor pioneered lean practices and success in developing this techniques over the past few decades (Stephen Corbett, 2007). Lean Principles were originally developed in industrial operations as a set of tools and practices that managers and workers could use to eliminate waste and inefficiency from production system in reducing costs, improving quality and speeding up cycle times.

Recently, lean techniques have moved from manufacturing plants to operations of all kinds include insurance companies, hospitals, government agencies, airline maintenance organizations, high-tech product development units and so on. In each case the goal is to improve the organization's performance on the operating metrics that make a competitive difference, by drawing employees into the hunt to eliminate unneeded activities and other forms of operational waste.

As Lean Production System (LPS) will be widely used in Malaysia, so there is need a tool in smoothing the LPS implementation. Before implement this lean production system, the industry need to develop the LPS skills among the employees or workers that is from operators until managers included engineers. Therefore in this

project is about LPS simulation game in developing and improving the knowledge of LPS among the WSA employees.

LPS simulation game is a tool for the education and training purpose for the employees at WSA Engineering Sdn Bhd in improving their knowledge in Lean Production System or Lean Manufacturing . Actually for the current situation is this simulation game is running one by one. Its means that, Kanban Simulation Game is for the learning of the real flow of kanban only, then Majaico Tower Simulation Game is only for the standardized work, Kaizen activity, and identify the MUDA, MURA and MURI and the third one is Restaurant Simulation Game is for the lot sizing learning only. Therefore, from the observation of these three simulation games, the idea of this project which is Lean Production System Simulation Game is come out. The reason why the name of Lean Production System Simulation Game is chosen because all of the items that will be learned and exposed to the WSA Employees is about the Lean Production System or Lean Manufacturing. The items are from the three simulation games and in this LPS simulation Game, it is combined to become one. So, the simulation game for Lean Production System (LPS) is combination from the Kanban Simulation Game, Majaico Tower simulation Game and Restaurant Game. In this LPS Simulation Game, the employees will learn about kanban, kaizen (continuous improvement), Standardized Work, identify the MUDA, MURA and MURI, and lastly is about the lot sizing.

## **1.2 PROBLEM STATEMENT**

Lean Production System (LPS) or Kaizen team at WSA Engineering Sdn Bhd had difficulties to implement and develop the LPS knowledge among the employees at WSA Engineering Sdn Bhd. For the previous condition, the Production Team had been run the training but it is the theory only not expose with the simulation game. Through theory, the the employees not really understand and cannot relate with the real condition at the work environment. But with the simulation Game, they will be expose and know what they do. Then, the WSA LPS team have been setup one simulation games which are Kanban Simulation Game. After running the training, the achievement of the employees is increase which are the number or the percentage of the rejection is decrease. It is one of the best achievement in company. It is because it will increase the profit and the customer satisfaction. So, for the current situation the training had been

run with the difference strategies, which is lump sum the three simulation game which is Kanban Simulation Game, Majaico Tower Simulation Game and Restaurant Game to become one (LPS Simulation Game). When lump sum or combine the simulation game training, it will save cost and save time. With the combination of the simulation game, hopefully the achievement of the employees better than previous and they will perform well with their task. The company will be success when the employees are well perform. So the employees need to improve their knowledge in Lean Production System. Lean Production System is one of the way to the company to be a success and to maintain it as the model company.

### **1.3 OBJECTIVES OF PROJECT**

To train all of the employees in Automotive Industry (WSA Engineering Sdn Bhd) to achieve standard in doing work, follow the standard operation procedure (SOP). Besides it also give easier to the new operators to perform their work. They can use SOP as their references and guidance in performing their works. So, it will reduce or eliminate the mistakes during doing works, hence can reduce reworks and defects. Reworks and defects is one of the seven wastes. Eliminating the waste is one of the lean principles.

To develop creative and critical thinking of each employees during think of Kaizen or doing continuous improvement for each tasks. Means, the employees will realize the important of employee involvement in all of the kaizen activities in company because of doing the improvement; it will increase the company profits, although in small changes. For example, when doing improvement at production line, the efficiency of the production will increase. Means, the process flow become smooth. Automatically the quality of the product increase and customer satisfaction will increase.

To expose the employees about the real flow of kanban. To illustrate how a kanban system works and controls the work in progress (WIP) inventory. In achieving the pull production towards the Just in Time, the employees need to understand the flow of kanban and distinguish between pull production and push production. Kanban is a tool of pull production. Through pull system, it will eliminates under or overproduction to those parts demanded by the next downstream process.



To acquire the skills to build optimal quality in the manufacturing processes, secure required volume and pursue cost reduction. When, employees are trained with understanding of standardized work, know the benefits of continuous improvement, and exposed with the real flow of Kanban, automatically the higher quality of product and cost reduction will be achieved. Then, the quantity of product produced will follow the customer demand, so the accuracy is high.

To train the employees to identify and eliminate MUDA (wastes) for each process in production activities. There are seven types of waste. Lean production is aimed at the elimination of waste in every area of production, including customer relations, product design and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products, and less space to become highly responsive to customer demand while producing top quality products in the most efficient and economical manner possible.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 DEFINITION OF SIMULATION GAME**

Simulation game is the combination between simulation and game. Simulation and game is related to each other. It is supported by (McKenney, 1967), simulation is the series of rules to manipulate of a model while game is a set of rules which conduct the activity of the participants in relation to the simulation. According to (Fripp, 1993) “simulation purpose is to help to understand and solve complex real-life problems by constructing a small, simplified version of the problem, often called a model and users have a set of goals, implicit or explicit, which they seek to achieve, either in the short or long term. Participants have to pursue these goals by taking action or making a set of decisions.” Then, (Crookal & Saunders, 1989; Forsen-Nyberg & Haramaki, 1998) define simulation as “representations of some real-world phenomenon or imitations of a system, process, or environment that can also take on some aspects of reality for players or participants. Simulation is real world representation systems that needs rules and strategies in developing simulation activity. It also low and free risk learning environment that protects participants from the consequences of mistakes (Connoly & Stansfield, 2007). Simulation and game is two different things, games do not represent any real world phenomenon or systems; the game is the end in itself. The similarities between the simulation and game is contain rules and strategies. According to (Garris et al., 2002), a game is an “activity that is voluntary and enjoyable, separate from the real world, uncertain, unproductive in that the activity does not produce any goods of external value, and governed by rules.” (Elgood, 1997) said that “Game is human opponent, actions have an effect upon each other and environment; emphasis on

competitiveness and winning; emphasis on humour and enjoyment; repetitive cycle of making decisions and encountering result, allowing hope of improvement and doing better next time.” The good combination between simulation and game will give the good impact to people. Combination with the real world situation and enjoyable situation, will encourage to the positive impact. It is supported by (Kiili, 2005), “Simulation game are designed to generate a positive effect to participant and are most successful and engaging when they facilitate the flow experience”. Flow describes a state of complete absorption or engagement in an activity and refers to the optimal experience (Csikszentmihalyi, 1991). When in the flow state, people become absorbed in their activities, automatically it can lead to increased learning.

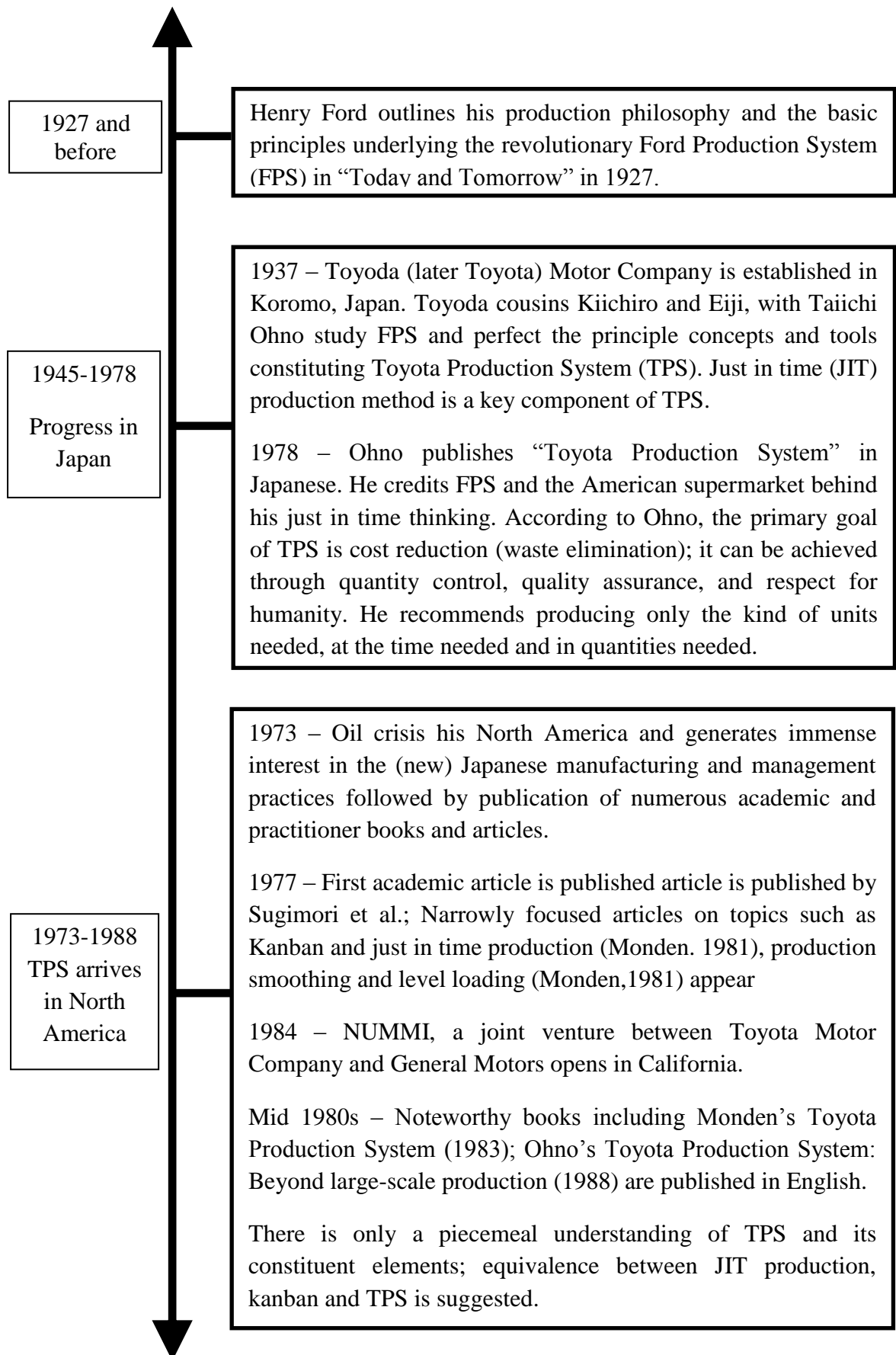
## **2.2 RELATIONSHIP BETWEEN SIMULATION GAME AND KNOWLEDGE IMPROVEMENT**

Simulation Games are one way to acquire knowledge but it is not mean to replace lectures, readings, case studies or other learning methods, with simulation games the learning method will be improve and as an alternatives to other types of problem solving activities to the deep learning. It is according to (van der Zee and Slomp, 2009) assert that simulation games may be used for various purposes, it could help workers find solutions for specific problems, or to familiarize themselves with and ease their acceptance of new work methods or systems. Then, according to the (Fowler, 2006), simulation game and cases are significantly better than traditional lectures for comprehension. Lectures are better for application. No significant difference for the other dimensions. Simulation game also will expose the employees with the real situation of the work environment. It is also supported by (Faria & Dickinson, 1994; Haapasalo & Hyvonen, 2001; Hoberman & Mailick, 1992; Lainema & Hilmola, 2005), they allow participants to develop a global perspective, to connect learning with real-world situations and get close to the realities of a competitive business world. According to (Patrick W.Shannon, Kip R. Krumwiede and Jeffrey N. Street, 2010) from their survey, through feedback on lean simulation exercise, the respondents said that “the hands-on simulation was an excellent learning tool. The tool really helped bring to life the principles of lean operation. It would be difficult to get this concept across without using some type of tools like this.” Through simulation game, learning environment will become more advance because it challenge the learner’s thinking. It

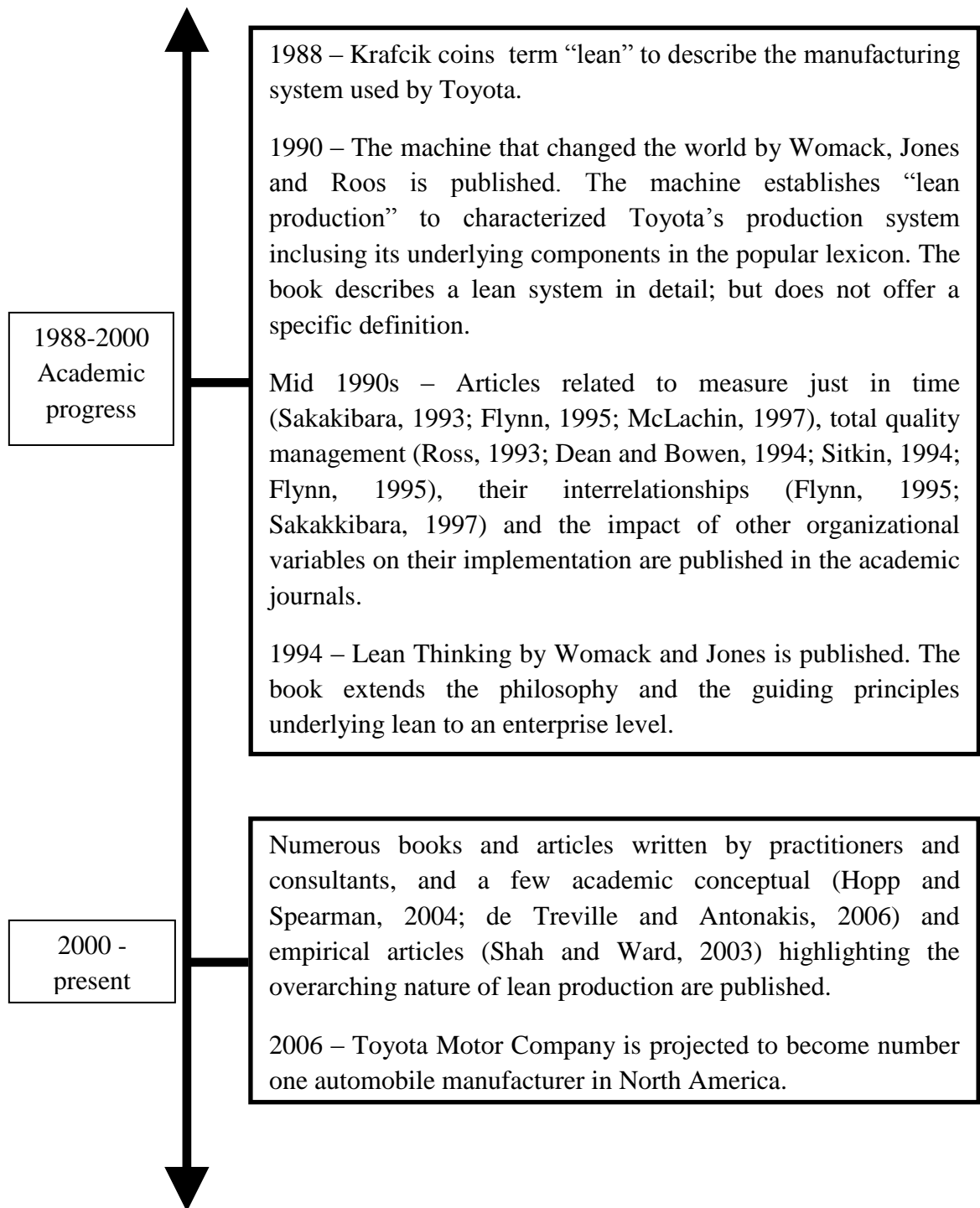
will relate learning activities to a larger task or problem and also provide the participants with opportunities to own the solution development process. Based on (Lisa B. Ncube, 2010), simulation game allowed the development of problem-solving skills, experiential learning was promoted, enhancing the learning environment, also enhancing the learning and understanding of complex concepts of lean. Through (Kiili, 2005) simulation game will approach learning towards an interactive platform that the participants can test their learned concepts through different stages of simulation games. Therefore, simulation game is not just a tool for training, but also a tool for testing the level of lean understanding of participants. Simulation game thus offer the benefits of both experiential and generative learning, and are said to provide an enhanced learning experience. According to (Salas, Wildman, & Piccolo, 2009; Tompson & Dass, 2000), simulation game are superior to other teaching methods for helping participants develop skills such as complex problem-solving, strategic decision making and behavioral skills, including teamwork and organizing.

### 2.3 HISTORY OF LEAN PRODUCTION SYSTEM

Lean production system concept is begin after World War II, Japanese manufactures were faced with the dilemma because of shortages of material, financial and human resource. Its happen in all of sudden. The problems that Japanese mahufacturers were faced with differed from those of their Western Counterparts. Then, Toyota Motor Company, led by its president Toyoda recognized that American automakers of that era were out-producing their Japanese counterparts. In making improvement in early system, Toyoda Kiichiro, Shigeo Shingo and Taiichi Ohno create a new, disciplined, process-oriented system, which known until today as the “Toyota Production System” or “Lean Production System.” Taiichi Ohno is most important person in developing the system to enhance productivity at Toyota. During developing this system, he mostly refer some ideas from the west which is particularly from Henry Ford’s book “Today and Tomorrow.” Ford’s moving assembly line of continuously flowing material formed the basis for the Toyota Production System (Abdullah, F, 2003). Then, “Toyota’s production organization adopted various elements of the Ford system selectively and in unbundled forms, and hybridized them with their ingenious system and original ideas. Its also learnt from experiences with other industries which is textiles. It is thus a myth that the Toyota Production System was a pure invention of genius Japanese Automobile practitioners. However, we should not underestimate the entrepreneurial imagination of Toyota’s production managers, who integrated elements of the ford system in a domestic environment quite different from that of the United States. Thus, the Toyota-style system has been neither purely original nor totally imitative. It is essentially a hybrid (Fujimoto, 1999).” After some experimentation done, the Toyota Production System finally successful developed. The system is developed and refined between 1945 and 1970 and is still growing today all over the world. The main objective of this system is to minimize the consumption of resources that add no value to a product. Then, its enhance the successful of this system (Abdullah, F, 2003 ).



**Figure 2.1** The critical phases in the lean production evolution



**Figure 2.1** Continue

Source : Gutowski (2009)

## 2.4 DEFINITION OF LEAN PRODUCTION SYSTEM

Lean production system is “a systematic approach to identify and eliminate waste or non-value added activities through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection”(Taiichi Ohno). In other words, lean production system is always find way to eliminate waste during produce product and increase worth of product or service to a customer, customer is willing to pay for it (value added activity). Most of the company avoid to have non value added activity in production. It will increases time spent on product or service but does not increase worth, means unnecessary from customer perspective. It can be reduced, redesign or eliminated without affecting market value or quality. Besides, a lean organization understands customer value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste. Eliminating waste by creates processes that need less human effort, less space, less capital, and less time to make products and services at far less costs and with much fewer defects. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Also, information management becomes much simpler and more accurate. According to (S. R. Maike, A. B. Todd, D. Patricia, 2009), “to be lean manufacturer requires a way of thinking that focuses on making the product flow through value adding processes without interruption (one piece flow), a pull system that cascade back from customer demand by replenishing only what the next operation takes away at short intervals, and a culture to improve.” Similarly, (Shah and Ward, 2007) define lean as “an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability.” A popular misconception is that lean is suited only for manufacturing. Not true. Lean applies in every business and every process. It is not a tactic or a cost reduction program, but a way of thinking and acting for an entire organization (B. Sanjay, B. Peter, 2004).

The concept of “lean” is based on the principles of the Toyota Production System (TPS). TPS was developed with the objective of identifying and reducing wasteful activities in manufacturing processes through education and involvement of the employee and top management. While originally created for use in Toyota’s