THE TOYOTA PRODUCTION SYSTEM'S FUNDAMENTAL NATURE IN SELECTED SOUTH AFRICAN ORGANISATIONS – A LEARNING PERSPECTIVE

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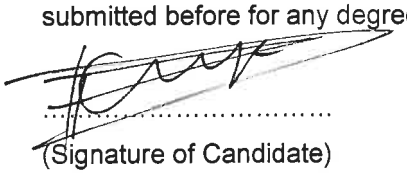
Candidate's declaration

I declare that this dissertation is my own unaided work. It is being submitted to the Degree of Master of Science to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.



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Abstract

The Toyota Production System (TPS) has been cited as being the pinnacle of continuous improvement approaches at manufacturing organisations, and it may be that the majority of elements comprising this system are found in local organisations. Therefore, the purpose of this study is to examine the prevalence of the fundamental nature of the TPS at selected South African organisations. The major goals of the study are to build a model of the fundamental nature of the TPS, establish a protocol to compare selected organisations with this model, and inform future studies into implementing the TPS. Bateson's theory of learning is used as a framework to generate the model. A qualitative multiple case study, using seven organisations, gathers data. The analysis follows a clustering and cross-case approach combined with pattern matching. This study concludes that the evidence does not support the main hypothesis, i.e., the fundamental nature of the TPS is not found at selected local manufacturing organisations.

To my grandmother, Yvonne Hose, who taught me about 'gifts from the heart'.

Acknowledgements

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Nomenclature

Andon: A tool that highlights operational status visually (Marwinski and Shook, 2006:3).

Autonomation: See Jidoka

CEO: Chief Executive Officer (Oxford University Press, 2001).

DNA: Deoxyribonucleic Acid, but used in this dissertation by some authors to indicate the core or most basic nature of a system, e.g. Spear and Bowen (1999) or Watanabe (2007).

'Double Bind': Where communication is such that an individual or group cannot respond successfully to a given message because doing so would mean being unsuccessful in response to another or more messages received with the former message. 'Double Bind' theory is concerned with the 'experiential component in the genesis of tangles in the rules of premise of habit' (Bateson, 1972:276), as an example 'putting a mammal in the wrong regarding its rules for making sense of an important relationship with another mammal' (Bateson, 1972:278).

EPE: Every Product Every... The frequency at which different products are produced in a production process or system (Marchwinski and Shook, 2006:18).

Gemba: The actual place of work (Liker, 2004:224).

Genchi Genbutsu: A value of the TPS, summarised as 'going to the source'; related to the term 'Gemba' (Toyota, 2006d: 46).

Heijunka: Levelling out the work schedule by product and volume mix (Liker, 2004:115,116).

HOOMA: Hierarchical Object Oriented Manufacturing Systems Analysis and Definition (Wu, 1994:152).

Jidoka: Providing resources the ability to detect when an abnormality occurs and immediately stop work (Marchwinski and Shook, 2006:35).

Just-in-Time: The right parts arrive where they are needed, only when they are needed and in the quantity they are needed (Ohno 1988:4).

Kaizen: Continuous incremental improvement of organisation processes (Toyota, 2008b:61).

Lean: See Lean Manufacturing

Lean or Lean Production: A Synonym for the Toyota Production System. The popular term for the TPS - became known after research conducted by MIT and subsequent publication of The

Machine That Changed the World in 1990 by Womack, Jones and Roos. (Marchwinski and Shook, 2006:95).

Lean Manufacturing: A set of techniques pioneered by Toyota, also known as the Toyota Production System (Womack and Jones, 2003:242).

Lean Thinking: The thought process that ties all the tools and techniques of the Toyota Production System together (Womack and Jones, 2003:10).

Metacommunication: Communication that conveys context and simultaneous interaction with normal content and interaction (Tosey, 2008:455).

MIFA: Material and Information Flow Analysis, also called Value-stream Mapping (Liker, 2004:303; Bicheno, 2004:6).

Milk runs: A method to speed the flow of materials delivery and pick up between facilities (Marchwinski and Shook, 2006:53).

Monozukuri: Japanese for Art of Manufacturing (Ito, 2007:4).

MSSD: Manufacturing System Design Decomposition, a manufacturing system design model that aims to distinguish between means and objective and correlate activities to outcomes taking interdependencies and information design into account (Cochran et al, 2002:371).

Muda: Non Value Added (Liker, 2004:114).

Mura: Unevenness (Liker, 2004:114).

Muri: Overburdening people or equipment (Liker, 2004:114).

QCDSM: Typical organisation rudiments – Quality, Cost, Delivery, Safety, Morale (Dennis, 2006:52).

PDCA or Plan Do Check Act: An improvement cycle based on the scientific method, i.e. propose a change, implement, determine results, and take appropriate corrective actions (Marchwinski and Shook, 2006:64).

Poka Yoke: Avoiding (yokeru) unintended errors (poka). Older name – Baka Yoke which meant fool proofing, or devices with the intention of preventing defects through 100% inspection (Ohno, 1988:122).

OEE: Overall Equipment Effectiveness - A measure of the how effectively equipment is used which takes downtime, process efficiency and quality into account (Marchwinski and Shook, 2006:61).

QFD or Quality Function Deployment: A visual decision making methodology for cross functional product teams translating customer requirements into engineering specifications (Marchwinski and Shook, 2006:79).

Sensei: An experienced mentor or guide that fulfils the role of a coach, often with regards to improvement initiatives (Liker and Hoseus, 2008:24).

SOP or Standard Operating Procedure: Precise procedures for an operator's work in a process (Marchwinski and Shook, 2006:85).

SMED: Single Minute Exchange of Dies, a process of changing over from one part number to another in the shortest amount of time possible. The Toyota standard is SMED, i.e. less than ten minutes (Marchwinski and Shook, 2006:83).

TAKT: A number obtained by dividing the average daily production time with number of parts needed by customers for that day (Ballé and Ballé, 2005:77).

TPS: The Toyota Production System (Ohno, 1988).
TMS: The Toyota Management System (Tanaka, 2008)

Tsurube system: A method for maintaining flow between non-linked processes (Marchwinski and Shook, 2006:95).

USA: United States of America (Oxford University Press, 2001).

Value-stream: All actions required to bring a product from concept to launch and order to delivery (Marchwinski and Shook, 2006:97).

Waste: The opposite of customer value add, consuming resources but not creating customer value (Marchwinski and Shook, 2006:100).

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1 Introduction and Background

Improvement initiatives based on Japanese manufacturing methodology is not a new phenomenon. However, the recent global economic recession has placed renewed emphasis on the importance of continuous improvement and models of implementation. This study focuses on one such model, the Toyota Production System, and compares it with selected South African organisations.

1.1 Problem statement

Improvement philosophies like the Toyota Production System (the TPS) may offer South African organisations ways to improve competitiveness if implemented successfully. This study aims to understand the fundamental nature of the TPS and its implementation in South Africa.

The aim of the research, therefore, is to explore the question: How prevalent is the fundamental nature of the TPS in selected South African organisations? The main hypothesis is that the fundamental nature of the TPS will be found in all selected manufacturing organisations.

Given that the fundamental nature may be described on different levels, a set of sub-descriptions may be studied, translating into secondary research questions. Each secondary research question may have a hypothesis that states that the sub-description will be found at selected manufacturing organisations.

1.2 Significance of the study

This study may be significant as it attempts to

- clarify the fundamental nature of the TPS and common terms used;
- provide the first study that uses Bateson's theory of learning as a framework to summarise the fundamental nature of the TPS;
- expand the TPS beyond implementation in the South African automotive industry;
- add to the knowledge of the application of the TPS in South African organisations; and,
- look for similarities and differences between the selected South African organisations and the fundamental nature of the TPS.

1.3 Summary of the theoretical framework

This dissertation takes note of various ways to understand the TPS, e.g., a basic process view of Cachon and Terwiesch (2009:15), HOOMA of Wu (1994), and MSSD of Cochran et al (2002). It considers various authors who associate learning with the nature of the TPS, e.g.,

Holweg (2007), Spear and Bowen (1999), Liker (2004), Liker (2008) Cavaleri (2008), Ballé and Régnier (2007); and notes some authors who state Bateson (1972) as being the only way to fully understand learning at Toyota, e.g. Ballé et al (2006), Johnson (2006). Accordingly, it proceeds to build a model of Toyota using Bredo (1989), Tosey (2005; 2006; 2008) and Dilts' (1998) application of Bateson's theory of learning (1972). This model describes the TPS on four levels (Zero, One, Two and Three), and positions TPS Level One (*strategies*) as the fundamental nature of the TPS. It explains how the TPS Level Zero (*activities*) inform TPS Level One (*strategies*). Descriptions of each activity of TPS Level Zero are given for later comparison with selected organisations.

1.4 Research methodology

This dissertation tests a model built on the fundamental nature of the TPS at selected South African organisations. Specifically, it investigates whether the strategies that define the fundamental nature of the TPS are present in these organisations. The method of gathering data is through a qualitative multiple case study. Analyses use clustering, cross-case analysis and pattern matching. Data is presented in a linear-analytic composition. The research methodology and analysis techniques are discussed in more detail in chapter three.

1.5 Assumptions and limitations

Some assumptions and limitations apply, with additional limitations mentioned in chapters five and six:

- This study is limited to the selected cases, and excludes their customers and suppliers.
- The fundamental nature of the TPS is described by studying a selection from the body of knowledge that is written about Lean Manufacturing and Toyota.
- The study assumes limited interdependencies when searching for evidence of the fundamental nature of the TPS.
- Searching for evidence of the fundamental nature of the TPS at selected cases assumes these strategies are useful to the selected organisations.
- Selection criteria for participating cases include organisation type, competitive dimensions, and product-process combinations.
- No historical or time series analysis was conducted to obtain a view over time.
- The study limited its scope to the fundamental nature of the TPS.

1.6 Overview of chapter layout

The document is structured in a linear-analytic sequence of the subtopics:

- Chapter one presents a summary of the research question, motivation for the study, research approach and the theoretical framework.
- Chapter two presents a discussion on the TPS, approaches to understand its fundamental nature, how others have approached it, e.g., Cochran et al (2002) and Wu (1994), and, after selecting Bateson's (1972) theory of learning, builds a model of the TPS. It concludes with the impact of product-process combinations as presented by Hayes and Wheelwright (1979) and Schmenner (1987), and the impact of culture, as presented by Hofstede (2003).
- Chapter three presents research methodology; including strategy, design, analysis techniques, validation and case study preparation.
- Chapter four presents individual and cross-case results summarised according to the strategies that comprise the fundamental nature of the TPS.
- Chapter five discusses results from a cross-case perspective, and presents an answer to the main research question by answering secondary questions. It proceeds with an overall results discussion and addresses limitations found.
- Chapter six suggests further research to address deficiencies, and concludes with the overall answer to the main research question.

2 Literature Review

Chapter two starts with background to the TPS system and then follows with some authors' views on the TPS. It finds that a number of authors describe the fundamental nature of the TPS as a *learning* system. Bateson's theory of learning may describe learning at organisations, including the phenomenon of the TPS, and a brief description of Bateson's theory of learning is given and its application studied. The chapter proceeds to describe the TPS using Bateson's learning levels 1, 2, and 3, and concludes with cultural and product influences that need to be taken into account when comparing organisations with Toyota. The theoretical framework to be used concludes the chapter.

How to read this section

Throughout the text certain sections are given a sub-title 'Application'. This indicates proposed use of the theory and allows the reader to easily navigate between theory and application.

2.1 Background to Toyota's Line Flow production system

The following section briefly discusses the development of the Toyota Production System over the last century:

Development of the Toyota Production System[i]

Ohno credits Sakichi Toyoda, the founder of Toyota, with the main concepts that formed the 'foundation' or dictum of Toyota, which is regarded as the elimination of waste[ii] and respect for humanity. He calls him a 'master of inventions'. Ohno reveres Toyoda as someone who 'discovered things to study in real life'. He explains Toyoda's mission in life: to 'cultivate and train the natural intellect of the Japanese people' (Ohno, 1988:89).

Sakichi Toyoda first visited the United States in 1910, and encouraged his son, Kiichiro, to enter the automobile market after visiting Ford and other manufacturers' plants and grasping the opportunity it presented. After Kiichiro Toyoda's subsequent visits to the USA and European plants in 1930, Toyoda's automatic loom works set aside a part of their factory to develop their first automobile. This led to the completion of their first model, Toyota AA, in 1936 (Toyota, 2002a).

Traditionally, the TPS is said to have two pillars: Just-in-Time and Autonomation. Autonomation started with Toyoda's development of the automatic loom in the late 19th century. From this concept of the loom, came the concept of error prevention, or Jidoka/Autonomation as it is

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[i] The sudden acceleration phenomenon which made headlines around in the world in 2008 / 2009 is briefly discussed in Appendix J.

[ii] For a definition of this TPS concept please refer to the 'Nomenclature' section in the document.

known today (1988:88). Just-in-Time was developed in the 1930s by Kiichiro Toyoda, with the idea of carrying no unnecessary inventory and having strong partnerships with suppliers (Ohno, 1988:5-6; Liker, 2004:18).

During World War II, Toyota had focused mostly on manufacturing trucks for the Japanese Government. However, after the end of the war Toyota had to re-evaluate their organisation critically. In addition, Japanese labour productivity was nine times less than that of the USA (Ohno, 1988:3). The differences between Japanese and USA markets required Toyota to move away from Ford's focus of a mass production system to develop a larger variety of models at smaller quantities (Ohno, 1988:37; Cachon and Terwiesch, 2009:203).

Excluding carrying significantly less inventory through application of Just-in-Time and installing rapid tool changeovers to allow small lot quantities, another big differentiator between Toyota and Ford is Toyota's pull system where, instead of forcing production downstream, downstream operations authorise production by upstream ones (Ohno, 1988:100; Levinson, 2002:15).

Ohno developed these concepts into a full manufacturing system that prevents overproduction through control of material and information flows, borrowing further concepts from Toyota's history in weaving and loom manufacture, Ford's system and USA supermarkets (Liker, 2004:23; Ohno, 1988:25).

Application

- Despite Kiichiro Toyoda and Ohno changing Ford's and European manufacturing systems to be more applicable to smaller batch production, a question remains if and how the TPS can be compared with organisations of a smaller size and/or different manufacturing models.
- Akio Toyoda's mention of the impact of culture may highlight the importance of taking cultural differences into account when comparing organisations with Toyota.

The TPS in context to Toyota's Management System (TMS)

The Toyota Production System should of course be seen as part of Toyota's overall Management System (TMS). The picture below (Tanaka, 2008:5) shows how the TPS fits in context of the TMS. Toyota manages their business through a closed loop system of product design (Toyota Development system or TDS), sales (Toyota Marketing and Sales) and production (Toyota Production System).

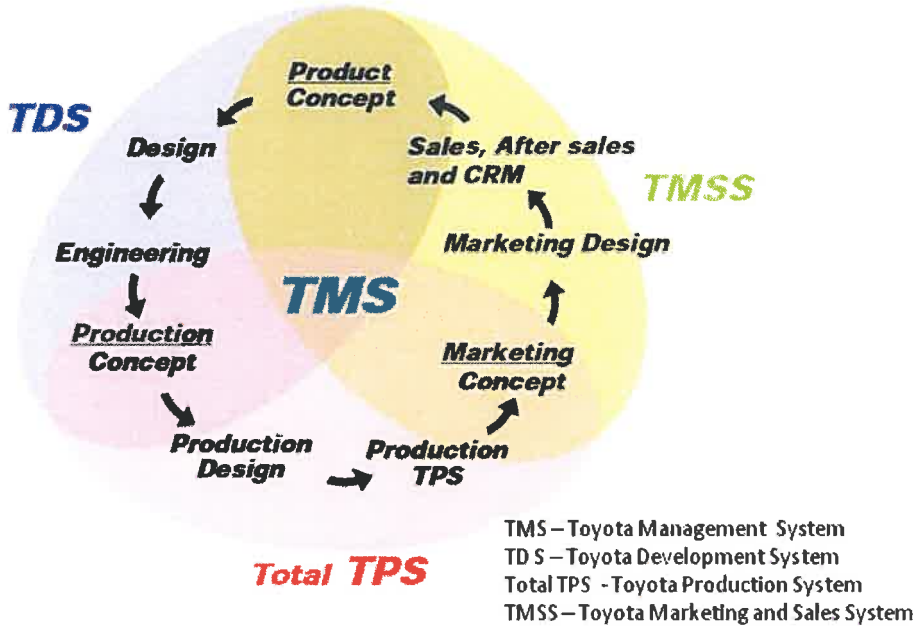

Figure 2-1: The TPS within the context of the Toyota Management System (Tanaka, 2008:5)

Application

- This dissertation will focus on the Toyota Production System (manufacturing system) and its fundamental nature specifically. However, in studying the TPS, it is understood that a mutually exclusive description may not be possible, as there might be some overlap between strategies Toyota employs in each of these systems.

Subsequent to the background of the TPS, the discussion moves to various views on manufacturing production systems and the possible implications for this dissertation.

2.2 A traditional view on production systems: input, process and output

The following section starts with a description of the traditional view on production systems, then studies two advanced applications of this description and concludes with a discussion on the approach this dissertation will follow.

Basic traditional view of a manufacturing system

Chase et al (2001:8) and Cachon and Terwiesch (2009:15) give a basic description of a production system as utilising resources to convert inputs into a desired output.

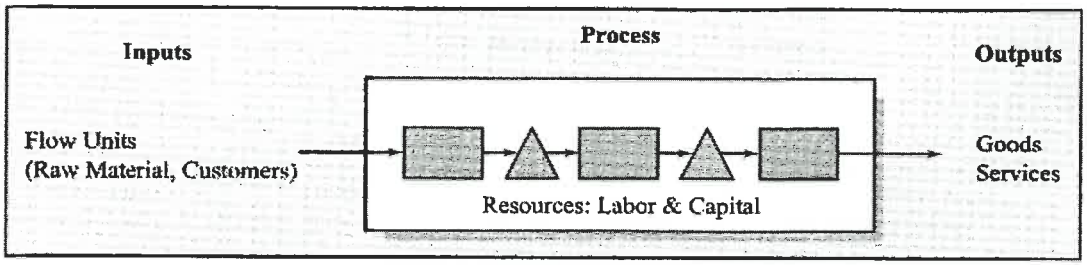

Figure 2-2: Basic process view of an organisation (a manufacturing system?) (Cachon and Terwiesch, 2009:15)

Two advanced applications of the traditional model are that of Wu (1994) and Cochran et al (2002). Both place emphasis on how value-add is achieved in their description of a production system, but use different approaches to capture their views in a model. Wu argues a systems view is more appropriate and suggests an object-oriented mapping approach, whereas Cochran argues that means and objectives need to be separated to understand and maximise value creation.

Wu's object-oriented mapping approach

Wu suggests the systems approach of his Hierarchical Object Oriented Manufacturing Systems Analysis and Definition (HOOMA) model fulfils the need of analysis of hierarchical based manufacturing organisations (1994:141,152). This model uses an object-oriented approach (1994:154), with some of its benefits creating the ability to realistically and accurately describe complex systems (1994:143,147); reusability and extendibility without duplication (1994:144,172) and the ability to capture and use temporary information into 'objects' and dynamically present the relationships between such objects (1994:154).

Cochran et al's separation of means and objectives

Cochran et al (2002)'s model is called the Manufacturing System Design Decomposition approach (MSSD), developed by MIT's Production System Design Laboratory. Whilst this approach aims to separate the objectives and means of a production system and associate shop floor behaviours with outcomes, it does not regard systems theory, e.g. as presented by Wu (1994). They define a manufacturing system design as 'all aspects of creating and operating a manufacturing system' and suggest that this includes the interaction of humans with the system (2002:372). The focus of the decomposition of MSSD is on the behaviours of engineers, managers, and operators; hence it is mainly applicable to model shop floor activities. Axiomatic design is used as an approach for the model (2002:375). They define the outcome of MSSD as maximising long-term return on investment (2002:377). They suggest their model applies to various manufacturing systems, but is highly applicable to accurately map and maximise value-add for medium or high volume repetitive manufacturing (2002:386).

Application

- Both MSSD and HOOMA seem to present a systemic view of production systems such as the TPS, but do not capture cultural precepts, what Watanabe (2007), Toyota's current vice-chairman and former president, describes as the 'DNA' and 'spiritual support' of the Toyota group. These precepts were passed down from Sakichi Toyoda, and formally promulgated in 1935 (Toyota, 2008c:50). The precepts discuss values of contribution, creativity, improvement, practicality, generosity, respect, and gratitude, etc. (Toyota, 2003a:4). It may therefore be useful to find another way of modelling the TPS, to enable the capturing of its cultural principles and values.
- Watanabe (2007) also points to the importance of labour in understanding the TPS. Some economists understand that labour is dominant in output of a supply chain or economy, where the sum of all wages may be seen as indicative of total output. With labour being the core, a technical systemic view may be subordinate to a view associated with labour, and this dissertation next concentrates on this dimension to better understand the TPS.

Given the importance of labour, the next section will start with views that associate the Toyota Production System with labour and an organisation's culture in general.

2.3 Existing views on the Toyota Production System

Authors vary in their description of the TPS. Some refer to resource efficiency; some describe it as an integrated system permeating the culture, some associate it with learning, whilst yet others describe it as a multifaceted system functioning simultaneously on various levels. Existing models of the TPS are also in place. Some of these are explained before attempting a fundamental view of the TPS.

Existing models that may explain the TPS

Many models exist that may be used to explain the functioning of the TPS. These include the Shingo Prize, Liker's (2004) fourteen management principles of the Toyota Way and Womack and Jones' (1996, 2003) five Lean principles, etc.

The Shingo Prize (2010, version four) is a model that aims to help organisations achieve results when implementing lean / TPS concepts through addressing cultural enablers, facilitating continuous process improvement and aligning the enterprise behind proposed changes.

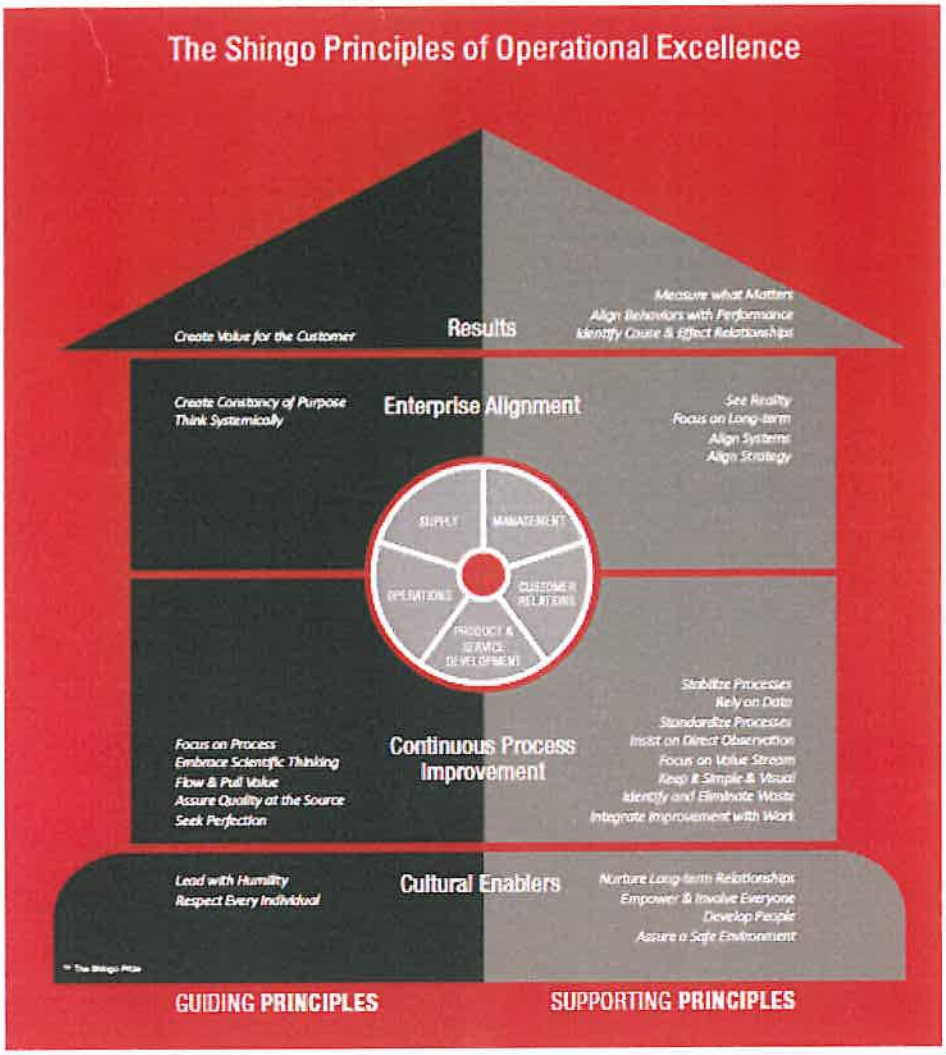

Figure 2-3: The Shingo Principles of Operational Excellence (Version 4, 2010)

Liker (2004) suggests fourteen management principles that summarise the Toyota Way. These principles cover philosophy, process, people and partners and problem solving. Liker suggests these principles form an always-improving way of thinking and management philosophy (Liker, 2004:297).

Womack and Jones (1996, 2003) suggested five Lean Thinking principles. These principles are *specifying value*, *identifying the value stream*, *creating flow*, *pull* and *pursuing perfection*. They position 'lean thinking' as the opposite of waste, or human activity that absorbs resources but creates no value for the Customer (2003:15).

Views using labour efficiency to explain the TPS

Ohno states that the most important outcome of the TPS is 'to increase production efficiency by consistently and thoroughly eliminating waste', (1988: xiii). He calls this the 'starting point' of the TPS (1988: xiv). Dennis also explains that the TPS is all about efficiency, 'doing more with less

- less time, less space, less human effort, less machinery, less materials – while giving customers what they want' (2007:13). Towill (2007) and Bremner and Dawson (2003) agree and tie, in part, Toyota's apparent efficiency and success to the standards that govern labour. Nayebpour and Saito go further and specifically link labour efficiency to the principles of Just-in-Time, Kanban and Kaizen (2007:571).

Views of the TPS as an integrated system permeating the organisation's culture

The TPS 'house' shown in Figure 2-3 is sometimes used to illustrate the TPS as an integrated system (Liker, 2004:33, Marchwinski and Shook, 2006:13; Dennis, 2007:19).

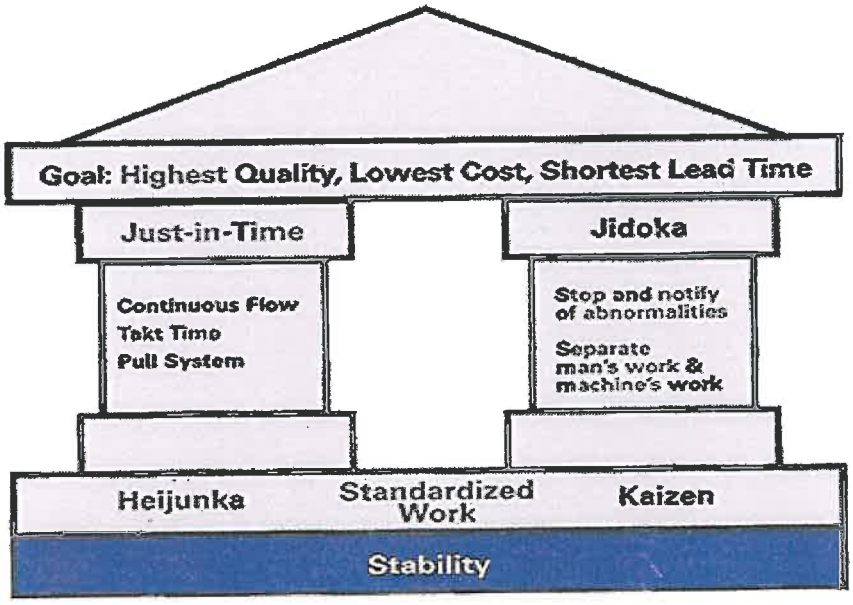

Figure 2-4: The TPS 'House'

Ohno notes that the TPS is not just a production system, but rather a management system 'adapted to today's era of global markets and high-level computerised information systems' (1988: xv). Liker (2004:7) agrees and calls the TPS 'Toyota's unique approach to manufacturing', adding it is 'an entire system that must permeate an organisation's culture'. Liker explains it as a system that attracts, develops, engages, and inspires trainable, able, performing, and committed people. The input into this system is the organisation's philosophy and values, partnerships, principles and human resources, and the outputs are 'quality people working together with shared Toyota values to continuously improve'. He calls this a 'human systems model', with the feedback loop 'respect for people and continuous improvement via Plan-Do-Check-Act' (2008:42).

Views that associate the TPS with learning

Some authors directly link the TPS with learning. Bicheno (2004:5) recalls a conversation with a South African manufacturing director of Toyota, George Davidson. When asked what the TPS was, he said 'the customer first', and when asked how to achieve that, he said 'by creating thinking people'. Minoura (2003), Toyota's managing director of global purchasing at the time and a former student of Ohno, concurs and calls the 'T' in the TPS an abbreviation for thinking. He explains Ohno was not as much interested in his answers when asking a question, but in whether he was learning how to think. Holweg (2007:422) expands and calls the TPS a 'continuously iterating learning cycle that spanned decades' and says Ohno did not as much invent the TPS as hybridise and combine techniques that had already existed. He comments that this 'dynamic learning capability' is at the core of the success of the TPS.

Other authors call Toyota a model learning organisation. Spear and Bowen (1999) state that Toyota practices the 'cornerstone' of what is known today as a learning organisation Cavaleri (2008) suggests Toyota has been able to integrate knowledge management, organisational learning, and quality improvement into a 'fruitful journey towards becoming a pragmatic learning organisation'. Liker (2004:251) notes that Toyota is the best example of a learning organisation he has come across as they view standardisation and innovation as 'two sides of the same coin'.

Some authors mention that the absence of understanding the TPS from a learning perspective leads to failed implementation, with the opposite leading to success. Ohba (2002:2), general manager of Toyota Supplier Support Centre, suggests organisations will not be able to adopt the evolving nature of the TPS if they do not implement the TPS as a system that facilitates learning. Ballé and Régnier (2007:33) also tie successful implementation of the TPS to a learning approach. Studying implementation at a hospital ward, they found a focus on learning became a virtuous cycle that led to increased visibility of problems, appropriate countermeasures and established standards that ultimately led to increased learning (2007:35,38,41).

Views of the TPS as a system that functions with multiple perspectives on different levels

Ballé et al (2006) suggest that the successful and holistic understanding and implementation of the TPS requires viewing the system from different perspectives, enabling a balanced view. Johnson (2006) goes further and argues that when such perspectives, operating on different levels, are confused as organisations fail to implement the TPS successfully. He explains this error of logic as using linear cause-effect relationships to explain a complex social system, e.g., where organisations use financial quantities to explain financial results. Both authors suggest

using Bateson's (1972) approach to framing and contextualisation as an appropriate way to develop a correct understanding of the TPS, e.g. through his theory of learning[iii].

Application

- This dissertation notes some existing models that may explain the TPS, i.e. Shingo Prize (2010, version four), Liker's (2004) fourteen management principles or Womack and Jones' (1996, 2003) five principles of Lean Thinking. It also notes the various descriptions of the Toyota Production System associated with labour and culture, firstly as a system focused on efficiency, e.g. Ohno (1988), Towill (2007), Bremner and Dawson (2003), and Dennis (2007), and secondly as an integrated management and cultural system, e.g. Liker (2004), Ohno (1988).
- This dissertation also notes Ballé et al's (2006) and Johnson's (2006) suggested approach, i.e. viewing the TPS from different frames or contexts, made possible by the application of Bateson's theory.
- This dissertation will therefore not directly use any of the existing frameworks as it does not satisfy Ballé et al's (2006) and Johnson's (2006) criticism. The only way to satisfy these criticisms is by using different frames or contexts by applying Bateson (1972).
- This study is therefore approached from a perspective of learning, e.g. Bicheno (2004), Holweg (2007), Spear and Bowen (1999), Cavaleri (2008) and also Liker (2004); specifically following Ballé et al's (2006) and Johnson's (2006) suggested approach to describe the fundamental nature of the TPS through the application of Bateson's (1972) theory on learning. This theory will be used as a way to obtain a theoretical framework for the TPS.
- Respective writings of existing frameworks will however be used to develop an understanding according to Bateson of the fundamental nature of the Toyota Production System.

Given the connection with Bateson and his theory on learning, the following paragraphs discuss important facets of his theory and its implications for this dissertation.

2.4 Bateson's theory

Bateson's theory of learning is explained by first understanding that learning requires the use of different levels, and then defining Bateson's Level Zero, one, two, and three of learning.

[iii] Tosey (2005, 2006) and Tosey et al (2005) also suggest using Bateson to develop an accurate understanding of learning in an organisation (although not explicitly mentioning the TPS). Bateson's theory on learning is specifically suggested as the most appropriate theory to understand learning in an organisation from different perspectives, frames or contexts. For more information, refer to Appendix A.

2.4.1 Understanding *learning* requires the use of levels

Bateson argues that a distinction between a class and its members is necessary when studying behavioural phenomena like learning (1972:282). Using the Theory of Logical Types, 'no class ... can be a member of itself, a class of classes cannot be one of the classes, which are its members ...' and 'a class cannot be one of those items, which are correctly classified as its non-members' (1972:280). He believes this understanding needs to guide behavioural scientists when they try to classify phenomena related to learning (1972:281).

2.4.2 Understanding *learning* requires the use of context

Bateson suggests context may be viewed as 'a collective term for all those events, which tell the organism amongst what set of alternatives he must make his next choice'. He also introduces the idea of content markers, which serves the purpose of classifying contexts (1972:289), best understood through a question 'when a rat starts a sequence of exploratory activities, does he do so in response to a 'stimulus', or in response to a context, or in response to a context marker?' (1972:290).

He argues that 'the notion of repeatable context is a necessary premise for any theory, which defines learning as change, and that the application of this theory relies on the hypothesis that organisms can segment their life experiences or actions into contexts (1972:292).

Given an understanding of 'levels' and 'context', the next section explores Bateson's application of these two principles as it relates to learning.

2.4.3 *Learning Zero* – no change given the same or different contexts

Bateson defines *Learning Zero* as a situation where no learning takes place, 'when an entity shows minimal change in its response to a repeated item of sensory input' (1972:283). Bateson gives some examples to explain *Learning Zero* (1972:284) -

- giving a correct response to a repeating similar question or stimulus;
- stereotype responses; and,
- where responses are hard wired, e.g. genetics, electronic circuits.

Learning Zero therefore includes processing based on the same criteria leading to a similar decision given similar inputs, or when trial and error is impossible, i.e. the set of alternatives amongst which a choice is made remains the same set (1972:285). Bateson proposes that if learning indeed takes place, it should contain components of 'trial and error' (1972:287).

2.4.4 *Learning One* – change given the same context

Bateson describes *Learning One* instances as being when an entity gives a different response at a future point to the same stimulus in a current situation. He provides examples to explain (1972:288) *Learning One* -

- habituation or breaking in e.g. a horse, where it stops overtly responding to each occurrence of a repeated event;
- Pavlovian conditioning, where an entity modifies behaviour to avoid pain and earn reward; and,
- memory by repetition, where one behaviour stimulates another behaviour, e.g. associations.

An important assumption for *Learning One* to take place is that of repeated context (1972:288-289).

2.4.5 *Learning Two* – a correction to Learning One

Bateson depicts *Learning Two* as change in the process of *Learning One*, i.e., 'a corrective change in the set of alternatives from which choice is made ...a change in how the sequence of experience is punctuated' (1972:293). He continues to explain *Learning Two* as the way in which action and experience is segmented into different contexts, and changing the approach in which context markers are applied. Simply put, *Learning Two* takes place when a previous learning, which happened in a specific context, is judged as appropriate and applied in another context. A couple of examples are used to illuminate *Learning Two*:

- Improvement in use of associations – e.g. an experiment showed how participants improved in their ability to reverse sequences of associations. This improvement in ability to use association in different contexts is *Learning Two* (1972:296).
- 'Double Bind' – A double bind occurs when someone is caught between two strong negatives. According to Bateson, *Learning Two* is likely to take place if the person shows 'severe disturbance' (1972:297). As an outcome, habits may be formed which is applied as a solution of classes of problems, i.e. solving a whole class of problems through assumptions or premises. This leads to learning to learn (1972:274), which is *Learning Two*[iv].
- Character traits – Bateson suggests character traits are a good example of *Learning Two*, as certain repeated patterns of behaviour or events are applied in different

[iv] An example is given of the training of a porpoise, which had to overcome a 'Double Bind'. The trainer gave the porpoise reinforcement for new behaviour in a similar context, after having had reinforcement for similar behaviour in a similar context. The porpoise had to 'break that pattern to deal with the class of such episodes' (1972:276). She had to distinguish the 'larger context of contexts' that put her in the wrong. Learning to deal with this context of contexts, or deutero-learning, by offering new behaviour every time she gave a performance led Bateson to conclude that operating in such a 'Double Bind' ('putting a mammal in the wrong regarding its rules for making sense of an important relationship') can be maladjusting, but if overcome, 'may promote creativity' (1972:278)

contexts[v]. This leads to mastery of the context of these contexts, i.e. the context changes but the person understands she needs to apply an adapted version of the character trait in the alternative context (1972:298).

2.4.6 *Learning Three* – a correction to Learning Two

Bateson explains *Learning Three* as a correction in the system of the contexts of *Learning Two*. He suggests *Learning Three* is likely to be difficult and even rare in human beings, as the self-validating nature of *Learning Two* makes it difficult to achieve such a correction, requiring 'profound reorganisation of character' (1972:301). Just as it is possible to find a loophole to avoid a scenario of *Learning Two*, e.g., not improve at the application of *Learning One*; it is possible to avoid *Learning Three*, i.e., avoid an improvement in *Learning Two*. The key here is to look at whether the 'facilitation' of the process of *Learning Two* is taking place. He provides some examples to explain the nature of *Learning Three*

- Improving the approach to *Learning Two* (1972:304) - these includes to 'learn to form more readily those habits the forming of which we call *Learning Two*'; to close loopholes which would allow avoiding *Learning Two*; to change the habits acquired by Learning Two, to learn to limit or direct *Learning Two*, and learn about the 'contexts of contexts' as *Learning Two* is learning about the context of *Learning One.*
- Learning to negate 'self' (1972:304) - Bateson notes that as *Learning Three* takes place the concept of 'self' is negated by those who undergo this learning. *Learning Two* is forms character traits, and hence in *Learning Three*, learning about the contexts of the character traits, "self' will take on a sort of irrelevance'.[vi]
- Solving *Learning Two* contradictions through understanding sequence (1972:305) - Bateson explains how *Learning Three* is about 'the larger sequences within which *Learning Two* paradigms are imbedded'. Asking how such 'larger sequences are generated', unleashes the Learning Two into numerous 'instances'. *Learning Two*, therefore, simplifies such instances into one category, but *Learning Three*, being concerned with the context of these categories, achieves the opposite. Solving 'contraries' that may arise out of *Learning Two* is *Learning Three*, and act as positive reinforcement.

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[v]Bateson explains the nature of character traits as indicative of the nature of *Learning Two,* a way of punctuating events which cannot be 'true or false' (1972:300). Rather, these 'have the general characteristic of being self-validating' and is almost ineradicable (1972:301).

[vi] Bateson does, however, warn that operating on this level could lead to psychosis, but for those who can resolve these successfully, it could lead to a 'collapsing of much that was learnt at Level Two, revealing a simplicity in which hunger leads directly to eating, and the identified self is no longer in charge of organising the behaviour' (1972:306)

Having described Bateson's theory of learning, a discussion on its proposed application in this dissertation follows.

2.4.7 Application

The following section summarises the most important points from Bateson's theory of learning as applicable to this dissertation:

Table 2-1: Application of Bateson's theory of learning

Concept	Main Points	Implication for the theoretical framework:
Levels	▪ A distinction between a class and its members is necessary when studying behavioural phenomena like learning.	▪ Use classes of types, or Levels, to define learning in the TPS.
Context	▪ The notion of repeatable context is a necessary premise for any theory which defines learning as change.	▪ To model the TPS according to Bateson's theory of learning, the framework needs to be defined as sets of contexts that are repeated.
Learning Zero	▪ *Learning Zero* is a situation where no learning takes place, i.e. a similar response given similar stimuli.	▪ The framework will need to differentiate between real change and zero change.
Learning One	▪ *Learning One* is an instance where an entity gives a different response at a future point to the same stimulus in a current situation.	▪ The framework needs to capture as *Learning One* the aspects of the TPS that cause a different future behaviour given a similar stimulus.
Learning Two	▪ *Learning Two* takes place when a previous learning, which happened in a specific context, is judged as appropriate and applied in another context.	▪ The framework needs to capture as *Learning Two* the aspect of the TPS that are not context specific, such as 'character traits'.
Learning Three	▪ *Learning Three* is a correction in the system of the contexts of *Learning Two.*	▪ The framework needs to capture as *Learning Three* those aspects of the TPS that inform the system of contexts of Learning Two.

Given a summary of Bateson's theory on learning, the next section will study its application by some authors.

2.5 Use of Bateson to explain systems where learning takes place

The following paragraphs focus on the theory of learning applied to study behaviour in organisations. Bredo (1989) discusses the impact of higher orders or levels of learning on lower orders, Dilts (1998) comments on how Bateson's theory may explain behaviour inside a system; Tosey (2006) explains Bateson's levels are a suitable framework to describe systems where transformative learning takes place; and later Tosey (2008) explains how Bateson's association between the understanding of changes in context in explaining learning enlighten the phenomenon of organisational learning; and Bredo (1989) suggests Bateson's description of learning in contexts imply that, in systems, higher order learning or processes inform lower order learning or processes

2.5.1 The impact of higher order or levels of learning on lower orders or levels - Bredo

Bredo (1989:27) criticises contemporary learning theory by claiming it does not associate learning with development and separates task learning from social learning. He explains Bateson understands communication as contextual, functioning on different levels and involving interplay of subtleties between messages on different levels (1989:28). He comments on Bateson's view of context: it consists of sequences of events, and meta-contexts consist of sequences of context, with the higher levels possibly containing information that explains the lower levels (1989:29).

Bredo asserts the implications of Bateson's learning theory for a more integrated approach to include that (1989:36-37) -

- higher order learning informs lower level processes, and the lower level processes helps 'compose' higher levels;
- learning is part of the larger development context about which it informs and could increase the ability of application of other tasks in other contexts; and,
- individual learning is connected to social change in that individual learning is part of a social context, therefore, the relationships that inform meaning are important; the teaching of tasks have social implications.

2.5.2 The nature of learning on different levels and the implication of understanding the context of a lower order level - Tosey

Tosey (2006:2) says Bateson's work relates to learning in that he establishes learning as a 'systemic phenomenon' to create a theory explaining the 'classification inherent in all

perceiving, thinking, learning, and communicating'. Implications from using a hierarchy of logical levels or types include the following:

- Learning on various levels takes place simultaneously - Tosey (2006:2) suggests it can be understood that 'one not only learns, but **simultaneously** learns how to learn'.
- Understanding the context of a level allows understanding of a higher level - Tosey comments on how Bateson connects the concepts of context and systemic thinking to learning: '...this hierarchy of types – classes, classes of classes, classes of classes of classes, and so on, provides a **convenient bridge** to the critical notion of **context and the interdependence of wholes and parts**'. Tosey suggests Bateson's levels indicate a **hierarchy** more than recursion or nested loops (2006:4).
- Understanding change in context allows understanding of learning - Tosey claims Bateson's theory on learning 'inverts the common assumption that change in organisational performance will follow from the acquisition of new knowledge and skills' but that learning would rather follow from a '**change in contextual conditions**'. Therefore, alteration of behaviour that constitutes learning will be 'an output of changed contexts', and not something 'crafted through training programmes' (2008:458). Tosey (2006:8) argues people will always adjust their ways based on the metacommunication present – as it is 'partly subject to our conscious influence, is often non-verbal, and is complex because different levels of learning are **simultaneous** and **mutually influencing'.**

2.5.3 Bateson's theory and behaviour inside an organisational system - Dilts

Dilts (1998:194) explains how his theory of 'neuro-logical levels' evolved as a way to 'operationally apply Bateson's concept of logical levels and logical types to human communication and change' inside organisational systems. He explains how the various levels build on each other, 'progressively more encompassing and impactful psychologically'. He describes it as a hierarchy of organisation in which the systems of activities are 'a subsystem embedded inside of another system, which is embedded inside of another system'. Dilts explains how these form hierarchies in our 'brain structure, language, and perceptual systems' and how it seems to be authoritative from the higher to the lower levels, albeit not vice versa. He bases his design of neuro-logical levels on Bateson's levels of learning but creates six neuro-logical levels. These are (from the lowest to the highest) the environment, specific behaviours, capabilities, plans or strategies, belief and value systems, sense of identity or role and the larger system, and may link with Bateson's levels as follows (Dilts, 1998:194-195). Applying Bateson's definitions of what constitutes learning, i.e. *Learning Zero* as a similar response in the same context and *Learning One* as a different response in the same context, *Learning Two* as change to the *Learning One* context and *Learning Three* as change to the

Learning Two context (Bateson, 1972:284,288,293,301), Dilts' definitions may be mapped to Bateson's levels as well:

- *Bateson's Learning Zero* – Dilts' Environment, Behaviour and Capabilities levels
  - Dilts explains the *Environment* Level is about the external context or the 'specific external conditions in which our behaviour takes place' and can be found by asking the questions 'where?' and 'when?'.
  - The next level, '*behaviour*', consists to Dilts of the tasks and actions in response to or inside the milieu and includes habits, rituals, etc. This can be found by asking the question 'what?', however, warns Dilts, if these are not driven by the next level, they will be mere 'knee jerk reactions'
  - *Capabilities,* the subsequent level, 'guide and give direction to behavioural actions through a mental map'
- *Bateson's Learning One – Dilts' plan or strategy level*
  - Dilts suggests the ensuing level, '*plan* or s*trategy',* is where we 'are able to select, alter, and adapt a class of behaviours to a wider set of external situations', i.e. the context of environment, behaviour and capabilities inform the strategies of the organisation.
- *Bateson's Learning Two – Dilts' beliefs and values level*
  - The following level, 'beliefs and values', encourage or discourage capabilities, and will be illuminated by asking the question 'why?'.
- *Bateson's Learning Three* – Dilts's identity and system levels
  - The successive level, '*identity',* is about the question of who we are and 'consolidates whole systems of beliefs and values into a sense of self'. Dilts also says this level is about overall purpose or mission.
  - Dilts calls the ultimate level '*system'* and says this is about vision and answers to the question 'who else?'. He says this level is about connection to a system that is larger than the individual, i.e., 'teams, groups, professional community, and even global systems' (1998:195).

Dilts also institutes the notion that learning on various levels forms a hierarchy, with higher levels informing lower levels (Dilts, 1998:194-195).

Bredo, Tosey and Dilts' implications for this dissertation is discussed in the next section.

2.5.4 Application

This section starts with a summary of the main points from Bredo, Tosey and Dilts' application, and the consequence for this dissertation; followed by a summary of implications for the theoretical framework.

Implications from Bredo, Tosey and Dilts

Table 2-2: Implications from Bredo, Tosey and Dilts

	Bredo	Tosey	Dilts
Main points for this dissertation	▪ Higher levels inform lower levels, and lower levels help compose higher levels. ▪ Learning is part of the larger development context about which it informs. ▪ Individual learning is connected to social change in that individual learning is part of a social context.	▪ Learning on various levels takes place simultaneously. ▪ Understanding the context of a level allows understanding of a higher level, i.e. the class of a lower level set describes the higher level. ▪ Bateson's theory is best used to measure learning.	▪ Dilts' 'neuro-logical levels' provide a way to operationally apply Bateson's concept of logical levels to organisational systems. ▪ Dilts provides commonly used terminology to understand the application of Bateson in organisations, e.g. behaviours, strategy, values and purpose. ▪ Dilts describes the strategy level as 'where we 'are able to select, alter, and adapt a class of behaviours to a wider set of external situations', which points to the fundamental nature of a system.
Implication	▪ Studying lower levels help to compose higher levels. ▪ If a measuring instrument is designed using Bateson, it may gain insight into the larger social context even if measuring only individuals.	▪ If a measuring instrument is designed using Bateson, multiple levels of learning may be measured at the same time. ▪ Understanding the class or context of a lower level informs the higher level of learning, **i.e. measuring the presence or absence of *Learning Zero* will inform the presence or absence of *Learning One.***	▪ In an organisational system, Learning Zero may refer to the environment, behaviours or capabilities; *Learning One* to the strategy of an organisation, *Learning Two* to its values or beliefs and *Learning Three* to its greater purpose or vision. ▪ Given that environment, behaviour, and capabilities are all on the same Bateson learning level, the context of either of the three will inform Learning One. Similarly, the context of 'values' informs both purpose and vision.

Creating a framework of the fundamental nature of the TPS by applying the theory Bateson and drawing on Bredo, Tosey and Dilts

This dissertation creates a framework of the fundamental nature of the TPS by studying literature on Toyota's approach to improving the application of behaviours and capabilities, also referred to as tools and techniques in a specific context. To create this framework, the following approach is suggested:

Table 2-3: Creating a framework of the fundamental nature of the TPS through application of relevant theory

Terminology	Link to Bateson's model	Approach to specify	Questions to ask
TPS Level Zero	▪ *Learning Zero*	▪ List the environment, behaviours or capabilities found in the literature on the TPS, referred to as *activities* of the TPS.	▪ Which ***activities*** are performed by Toyota as found in the literature on TPS
TPS Level One / *strategy*	▪ *Learning One* (change in a similar context)	▪ Name the context of the activities as found in literature on the TPS; i.e. the name of the class of activities to adapt to a wider set of external situations.	▪ What is the context of the ***activities*** of TPS Level Zero? ▪ What is the TPS ***Strategy*** to which the activities should conform when TPS is implemented?
TPS Level Two / *values*	▪ *Learning Two* (a correction to Learning One)	▪ The context of change to the TPS Level One as found in the literature, or the *values* of the TPS.	▪ What is the context of the ***strategies*** of the TPS? ▪ What ***values*** does the TPS promote that aims to improve its *strategies*?
TPS Level Three / *purpose*	▪ *Learning Three* (a correction to Learning Two)	▪ The context of change to the TPS Level Two as found in the literature, or the *purpose* or *vision* that govern the TPS (given that these are on the same Bateson level, this dissertation will refer to purpose only).	▪ What is the context of improvement to the ***values*** of the TPS? ▪ What does the TPS specify as having ***purpose***, when improving its values?

Representing the table visually, the picture in Figure 2-5 may be used to give a visual representation of the various levels of the TPS.

Figure 2-5: Words used to describe the Fundamental Nature of the TPS using Bateson

Using Bateson, Bredo, Tosey and Dilts, the fundamental nature of the TPS is defined as the 'strategies of the TPS', called TPS Level One. TPS Level One, equivalent to Bateson Learning One, is the classes or contexts of the activities that define the TPS Level Zero. The next section discusses literature on the fundamental nature of the TPS, by discussing activities found in literature under the headings of classes or contexts, called strategies. This is followed by a discussion on subsequent levels, i.e. values and purpose of the TPS.

2.6 Creating a theoretical framework of the fundamental nature of the TPS

In the preceding section the TPS Level One or strategies are described as the fundamental nature of the TPS. The following section describes the *strategies* the TPS employs to improve manufacturing automobiles. Strategies may be arranged under twelve headings, namely *Increase customer value, Organise by value stream, Deploy policy, Empower employees, Eliminate waste before it occurs, Promote flow, Increase process effectiveness and efficiency, Standardise, Formalise industrial engineering, Create intelligent processes, Balance resources,* and *Enable visual management. Activities* describing each strategy are listed below each *Strategy* heading.

2.6.1 Increase customer value

Literature on 'Increase customer value' may be summarised into four main activities. These are to understand the customer's perspective of value, re-engineer core products to improve customer value, redefine organisation processes to 'Increase customer value' and add value to the customer throughout the lifecycle of the product.

Understand the customer's perspective of value

The goal of the customer value strategy is to develop an exact grasp of what the customer defines as value, and transform the organisation to achieve and deliver upon this understanding (Bicheno, 2004:10; Womack and Jones, 2003:10,16,19). For this reason, it could be beneficial to set up a value-stream in every major market that the organisation serves, even across continents (Womack and Jones; 2003:228,268); and then define value jointly with the customer for each product family. This value definition should include required specification, quality, speed, intervals of delivery, and cost (Bicheno, 2004:11; Womack and Jones, 2003:71, 72,277; Ballé and Ballé, 2005:78,292). Toyota examples include target costing, where value to a client is specified and the product then engineered backwards to fit within a specific cost structure (Womack and Jones, 2003:236); and door-to-door sales in Japan, where feedback on customer satisfaction comes from a personal relationship between the customer and the salesman (Liker, 2004:177). The TPS starts with the customer and the system revolves around customer satisfaction (Ballé and Ballé, 2005:285; Liker, 2004:73,177).

Re-engineer core products to improve customer value

Rethink core products for core customers and repackage them to improve customer value (Womack and Jones, 2003:32; Ballé and Ballé, 2005:28). Customers should be involved in design from the outset (Womack and Jones, 2003:226; Ballé and Ballé, 2005:75). Do not substitute an engineer's or designer's view of value for that of the customer. Make what customers want, not what the organisation enjoys making (Womack and Jones, 2003:212,215).

Redefine organisation processes to increase customer value

Redefine organisation processes to maximise value production, not waste, from the customer's perspective (Womack and Jones, 2003:97; Ballé and Ballé, 2005:85). Do away with everything that does not exactly contribute to value as specified by the customer. Work on the ability to deliver value fast. Be sure to avoid local optimisation at the expense of global optimisation (Womack and Jones, 2003:244,268). A lean enterprise correctly specifies value for the customer, then identifies all the steps from concept to launch, order to delivery and from raw material to the customer throughout its life, and removes all the actions, which do not create value (Womack and Jones, 2003: 275).

At Toyota, the continuous improvement belief is process orientated, i.e., *the right process will produce the right results* (Womack and Jones, 2003:336). The right process maximises value

adding, is accessible, competent, and sufficient, facilitates flow, is triggered by the customer, and is balanced (Womack, 2002:20). Toyota aims to implement such processes from the beginning of the value-stream, i.e., raw material, in their own manufacturing processes (Toyota, 2004a:26), and ultimately through to the customer (Toyota 2008a:49).

Add value to the customer throughout the lifecycle of the product

Toyota's focus on building customer satisfaction is not limited to the 'drive' or initial experience of the end customer. Rather, they focus on the customer experience throughout the lifecycle of the vehicle, from sale to service to re-sale, aiming to build customers for life (Liker and Hoseus, 2008:497). Customers are both internal and external. According to Toyota Motor Sales, their focus on customer satisfaction is first and foremost about service delivery to their dealers, before assessing the way the dealers provide service to the end-customers (Liker and Hoseus, 2008:498)

Application

Table 2-4 shows a summary from the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-4: Application of 'Increase customer value'

Main activity	Definitions considered for the main activity
Understand the customer's perspective of value	▪ Set up a value-stream in every major market. ▪ Define value jointly with the customer around cost, quality, delivery and overall specification. ▪ Ensure a general sensitivity and awareness regarding customer needs and satisfaction throughout the organisation. ▪ Use personal relationships as an approach to understand what the customer really values.
Re-engineer core products to improve customer value	▪ Rethink core products after obtaining an improved understanding of customer requirements. ▪ Involve customers in design from the outset. ▪ Test whether end-designs meet customer requirements.
Redefine organisation processes to increase customer value	▪ Ensure the right processes are in place, producing the right results (e.g., maximise value add, accessible, competent, sufficient, facilitates flow, triggered by the customer, balanced) ▪ Find ways to deliver such value faster ▪ Include the extend supply chain in redefining processes.
Add value to the customer throughout the lifecycle of the product	▪ Focus on the customer experience throughout the lifecycle of the product. ▪ Focus on internal (e.g. dealers) and external (e.g. motorists) customers when optimising for lifecycle value add.

2.6.2 Organise by value stream

'Organise by value stream' is a strategy to reconfigure organisation units to facilitate the flow of value. Toyota is organised into product platforms of front-drive, rear-drive, and light trucks, with strong horizontal (project) management, and these teams are located together for periods of time (Womack and Jones, 2003:238; Liker, 2004:178; Toyota, 2006a:20). 'Organise by value stream' may be explained as three activities, namely reconfigure teams to let value flow, install horizontal accountability and leadership, and realign vertical roles.

Reconfigure teams to let value flow

In such a work-by-value-stream approach teams include marketing, sales, product development, scheduling, production, and purchasing. All day-to-day operations are shared horizontally[vii] in an integrated function. Although team members report to the vertical functions, there is a strong team focus and accountability to the horizontal product families, often being

[vii] 'Horizontal' is borrowed from concepts used to describe a matrix organisation, i.e. viewed horizontally from a product's perspective as it travels through various 'functions' whilst moving from launch to production.

co-located. Co-location includes organising the shopfloor around product lines, and not grouping stations functionally (Womack and Jones, 2003:256; Liker, 2004:178; Bicheno, 2004:11). Such a team would be responsible for specification, general design, detailed engineering, purchasing, tooling, and production planning, using Quality Function Deployment to facilitate decision making in a standardised approach (Womack and Jones, 2003:54; Bicheno, 2004:173; Hsiao and Liu, 2004:27).

Install horizontal accountability and leadership

At Toyota a programme (horizontal) management function is performed by strong leaders with a focus to streamline flow through alignment of dedicated resources to product platforms. There is strong informal accountability to the horizontal function of almost the entire organisation for delivering results, as these managers also fulfil an engineering function and have to prove their competence in engineering and leadership (Womack and Jones, 2003:238; Dennis, 2007:91; Liker, 2004:63-64, 304). Standard Tasks are spread horizontally (multi-skilling), not vertically, i.e., not working on more than one product family (Womack and Jones, 2003:279-280). Toyota claims cross-functional integration as the reason why the development of the Prius model was possible in a short amount of time (Toyota, 2003a:25; Liker, 2004:64).

Realign vertical roles

The role of the vertical organisation changes to act as houses of technology, knowledge management, and suppliers of core services, as directed by the needs of the Chief Engineer, albeit in informal accountability (Liker, 2004:179,304; Womack and Jones, 2003:280). The following quote from *Lean Thinking* may be a useful summary '*what functions should do, is think about the future. Product engineering should work on new products… to do new things for the user and develop new materials and methods…. Tool engineering should work on 'right- sized devices' … to create value in continuous flow and rapidly shift over between product variants. Purchasing should identify the set of suppliers an organisation will work with in the long term and develop a plan for each... Quality should develop a standard set of methods that the product teams can apply... The traditional functions should be combined with a productivity (or 'lean') function to create an 'improvement' function able to eliminate Muda of all sorts'* (Womack and Jones, 2003:280).

Application

Table 2-5 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-5: Application of 'Organise by value stream'

Main activity	Definitions considered for the main activity
Reconfigure teams to let value flow	▪ Multi-skill employees with skills that span the value-stream. ▪ Use Multi-disciplinary teams when designing or solving problems. ▪ Multi-task teams with responsibilities that span sections of the value-stream, i.e. horizontally across the group (along the value-stream) to balance work. ▪ Co-Locate programme (value-stream) teams where possible.
Install horizontal accountability and leadership	▪ Ensure strong horizontal or programme leadership is in place. ▪ Create client or product teams that focus on one product family or client group. ▪ Spread tasks horizontally across the group (i.e. along the value-stream) to balance work.
Re-align vertical roles	▪ Redefine the roles of the vertical or functional organisation to act as houses of technology, knowledge management, and suppliers of core services. ▪ Ensure the needs of the horizontal organisation gives primary direction to the daily activities of vertical functions.

2.6.3 Deploy policy

Toyota has longer term visions in place called its 'Global Vision' (See appendix E for more information). Two versions are currently applicable, the Global Vision 2010 (Toyota, 2003a:5) and the Global Vision 2020 (Toyota, 2008c:4). This is cascaded down into improvement plans for specific product families, with project selection criteria traceable to organisation goals (Liker, 2004:218-219,260). Toyota also helps non-performing suppliers install policy deployment in their organisations, for the entire supply chain to perform optimally (Liker, 2004:213). Five activities may be used to explain Deploy policy, namely set targets for the broader organisation, set specific management goals, create supporting plans to achieve management goals, check progress to plan on a regular basis and continue to set stretching goals.

Set targets for the broader organisation

Hoshin Kanri or policy deployment at Toyota starts with executive management reaffirming Toyota's purpose through defining customer need and setting long-term goals to achieve this (Liker, 2004:219,262, Dennis, 2006:37). They avoid setting grand complex strategies with difficult application in practise; rather they focus on simple but achievable goals (Dennis, 2006:9). Toyota, therefore, places a greater emphasis on deployment than on selection of

performance criteria (Dennis, 2006:27), i.e., the quality of the management system achieving targets (Dennis, 2006:37).

Set specific management goals

The organisational target-setting process continues to cascade objectives associated with this purpose and need down to more junior positions and specifies the meeting structure where targets are discussed (Dennis, 2006:43; Toyota, 2007b:57). It also includes translating into rudiments, e.g., balanced scorecard models (Dennis, 2006:55), and drawing up A3-sized dashboards that capture these (Dennis, 2006:57). These deployment dashboards show measurable objectives, the indicator being measured, and who is responsible to achieve the objective (Liker, 2004:219). A central connecting theme for these Dashboards is Deming's PDCA (Plan-Do-Check-Act) cycle (Dennis, 2006:69; Liker, 2004:263), *'Plan'* represents the hypothesis connected with addressing the need or realising the purpose (Dennis, 2006:69), *'Do'* is about translating goals and implementing action plans (Dennis, 2006:71), *'Check'* is about measuring the results against the target at the source (Dennis, 2006:71,72) and *'Act* or *Adjust'* is about reflecting on the results and implementing successes as standards in the organisation or if not successful reformulating the hypothesis (Dennis, 2006:72).

Create supporting plans to achieve management goals

A deployment leader is in place for each focus area (Dennis, 2006:92-93). These leaders use A3 dashboards as tools to plan, measure, and attain the goals set out by senior and executive management (Dennis, 2006:93). They start with further cascading down the longer term strategy to practical targets, regular Kaizen events and daily problem solving (Dennis 2006:129; Liker, 2004:219). In return, there is a commitment by team members to make problems visible, using the tools of policy deployment, solving opportunities for improvement that are highlighted at the source (Dennis, 2006:20, 25). The goal of the deployment leaders is to let employees gain control over their areas of influence in line with the cascaded strategy (Dennis, 2006:32) through ascertaining the current condition of each zone or area of control and implementing appropriate countermeasures (Dennis, 2006:39).

Check progress to plan on a regular basis

Review schedules are put in place to facilitate the PDCA processes, from weekly meetings to yearly reviews (Toyota, 2007b:57, Dennis, 2006:137,146) with corresponding visual A3 measures in place (Dennis, 2006:141). Policy deployment becomes an iterative process of deploying the plan, monitoring the plan, solving problems that arise, and improving the system (Dennis, 2006:43; Liker, 2004:262).

Continue to set stretching goals

Toyota and organisations that have successfully implemented the TPS have set specific, stretching goals with regards to improvement projects coupled to a specific timetable (Womack

and Jones, 2003: 95; Liker, 2004:262). Does this infer something about the TPS itself, that the environment is more conducive for problem solving when stretching and time-driven improvement goals are in place? An example may be Taiichi Ohno's approach to go to a production line and remove 10% of operators if work had been flowing smoothly for a while, to create a crisis that requires a stretching goal to overcome (Ballé and Ballé, 2005:109).

Application at Toyota South Africa Motors (TSAM visit, 2008 and 2010)

Toyota South Africa Motors has a visible performance board in the main entrance of the plant that shows the overall performance of the Corolla in the South African, African, and European markets. It has the following headings -

- main heading: Customer First ECQC (Excellence, Customer, Quality, Challenge);
- other headings: Global organisation info; quality pledge; shop quality indicators countdown to SA, Africa and Europe; shop organogram; product information;
- specific performance section, with headings -
  - Toyota Way: Respect for People and Continuous Improvement,
  - Genchi Genbutsu,
  - Key Principles,
  - PDCA Cycle,
  - OSH (Occupational Safety and Health),
  - 3Cs: Challenge, Change, Create,
  - Best in all we do,
  - Teamwork,
  - Escalation,
  - Ownership,
  - Kaizen,
  - What's best for Toyota?;
- vision of Toyota South Africa Motors: to be a TMC global plant that can compete with European based plants on safety, quality, stable supply, and cost; and,
- mission of Toyota South Africa Motors: change TSAM to become an excellent TMC plant based on the Toyota Way – Safety, Quality, Volume, Cost, and People.

Application

Table 2-6 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-6: Application of 'Deploy policy'

Main activity	Definitions considered for the main activity
Set targets for the broader organisation	▪ Set long term or overarching goals or targets for the organisation. ▪ Focus on simple and achievable goals. ▪ Place greater emphasis on deployment rather than selection of goals.
Set management goals	▪ Develop a managerial deployment plan, including meetings where targets are discussed. ▪ Translate the organisation needs, purpose and goals into rudiments (e.g. QCDSM). ▪ Create dashboards that show measurable objectives, the indicator being measured, who is responsible to achieve the objective. ▪ Follow Deming's Plan Do Check Act cycle achieving goals stipulated on the dashboards.
Create supporting plans to achieve management goals	▪ Set a deployment leader in place for each focus area. ▪ Use A3 Dashboards as tools to plan, measure and attain goals. ▪ Cascade longer term goals into practical targets for employees. ▪ Ensure team members make problems visible as they are encountered. ▪ Hold employees accountable to gain control over their area of influence.
Check progress to plan on a regular basis	▪ Install review schedules to facilitate the PDCA process. ▪ Install visual A3 measures to support regular reviews. ▪ Ensure an iterative cycle takes place of deploying, monitoring, solving problems, and improving.
Continue to set stretching goals	▪ Ensure goals are stretching enough to facilitate high performance. ▪ Couple goals to a specific timetable.

2.6.4 Empower employees

Toyota believes that to manufacture high-quality products and achieve customer satisfaction throughout the world, it is essential that they share their methods and values that have been

handed down as implicit knowledge since its inception; and that it is the responsibility of all employees to improve work-related skills and work ethic (Toyota, 2007b:57).

Seven activities are practised to empower their workforce to master the implicit knowledge used to manufacture high quality automobiles. These are train on the task-outcome required, follow the Socratic Method, train and multi-skill in value-stream tasks, ensure active mentoring and coaching, encourage voluntary self-study, hold employees responsible to surface and solve problems and reward improvement.

Train on the task-outcome required

To create, improve, and update formal training opportunities, Toyota practices a methodology called *Critical Output Analysis,* which studies the purpose of a job and then translates that into specific competencies required (Liker and Hoseus, 2008:133). This is complemented by Toyota's use of SOPs called Toyota Job Instructions (TJIs). A TJI breaks down a complex task into tiny work elements, highlighting the outcome required. TJIs, therefore, form a critical part of training new and experienced hires (Liker and Hoseus, 2008:127).

Follow the Socratic Method

For their training Toyota follows the Socratic Method, asking questions and drawing responses out of students, but not giving answers (Liker and Hoseus, 2008:111). This potentially slower method of training is possible because Toyota's training typically takes place through four stages: trainees first acquire basic knowledge and then practise rudimentary skills in a simulation environment, move on to combining a number of steps practised, and lastly master the basics of standardised work (Toyota, 2004e; Liker and Hoseus, 2008: 119). In addition to this classroom training, training also takes place on the shop floor at the place of work, in line with the Toyota 'value' of Genchi Genbutsu (Liker and Hoseus, 2008:147).

Train and multi-skill in value-stream tasks

Regardless of which type of training is followed, the desired outcome is to multi-skill employees. A formal plan trains and develops employees to acquire more skills in their product family, as opposed to learning to do the same job on multiple product families (Ballé and Ballé, 2005:135; Liker and Hoseus, 2008:260). Toyota supports multi-skilling through job rotation (Liker and Hoseus, 2008:147) and tracking it as a key performance indicator for team leaders and employees (Liker, 2004:139; TSAM visit, 2008 and 2010). During a visit to Toyota South Africa Motors, this was demonstrated in practise at the facility's training centre and on the shop floor, an example being the KPIs in cells showing progress toward multi-skilling (TSAM visit, 2008 and 2010)

Ensure active mentoring and coaching

Just as Toyota's training department takes responsibility for formal training in training centres, on the job development is a key responsibility of managers at Toyota. They are held

accountable as the leaders of change over the resources that are under their control (Toyota, 2007b:8; Liker and Hoseus, 2008:117; Womack and Jones, 2003:267; Spear and Bowen 1999:98). There is one team leader per five to seven employees and one supervisor per three team leaders (Ballé and Ballé, 2005:135; Liker and Hoseus, 2008:260), which allows managers to act and be available as mentors (Leiker and Hoseus, 2008:137-139). Most on-the-job-development is facilitated by senior team members, team leaders, group leaders, and managers who have qualified to present Toyota's SOPs. The goal is to coach team members until a skill is mastered, similar to an apprenticeship model (Liker and Hoseus, 2008:129).

Encourage voluntary self-study

Employee development is, however, not only the responsibility of managers. Toyota employees undertake voluntary self-study under the guidance of their mentors who would again follow the Socratic Method: refuse to give the right answer but continue to ask tough questions – a process which is called Hansei or Jishuken at Toyota (Liker and Hoseus, 2008:23). Toyota also encourages their workforce to create their own personal training opportunities, e.g., attending university courses after hours (Liker and Hoseus, 2008:116).

Hold employees responsible to surface and solve problems

Holding the workforce responsible starts with managers being accountable to, and living, the Toyota values – this gives them the authority to give the workforce responsibilities for which they can be held accountable, in turn (Liker and Hoseus, 2008: 335). As team members mature, they become increasingly more responsible for resources in their area – these may include job standardisation, continuous improvement, cell configuration, job assignment, meetings, goal setting, meaningful input for new team member selection, leader/manager evaluation, peer evaluation (job skills), work hours, personnel requirements/manpower, rewards, cell budgeting/record keeping, work schedule, and training (Ballé and Ballé, 2005:135; Liker and Hoseus, 2008:147,260). After being given responsibilities, Toyota managers hold their teams responsible through process confirmation, i.e., they do not run a set of checks to catch people doing something wrong, rather they confirm a process is producing the desired result, and if not, initiate problem solving to fix the problem. In doing so they keep the entire team responsible for delivering to, and improving, the standards in place (Liker and Hoseus, 2008:105,319). This is in part because a strong emphasis is placed on employees' opportunities to use their cognitive skills (Ballé and Ballé, 2005:36) and decision-making responsibility with day-to-day operations (Ballé and Ballé, 2005:135; Liker and Hoseus, 2008:260). Toyota aims to give this decision-making responsibility the lowest levels in their organisation (Womack and Jones, 2003:267; Spear and Bowen 1999:98).

Reward improvement

At Toyota employees are financially rewarded for suggestions and improvements based on a points system, not on financial return. Toyota is willing to make a loss on most suggestions,

assuming that profit on the most effective suggestions will cover loss made on the less effective suggestions, and that the cultural benefit will outweigh any losses made (Bicheno 2004:146).

Application

Table 2-7 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-7: Application of 'Empower employees'

Main activity	Definitions considered for the main activity
Train on the task-outcome required	▪ Study the purpose of a job, translate into specific competencies required, and train accordingly. ▪ Train on and apply Standard Operating Procedures that break down a complex task into tiny work elements.
Follow the Socratic Method	▪ Follow a training model that asks questions and draws responses, but that does not give the answer. ▪ Ensure adequate on-the-job training by skilled coaches.
Train and multi-skill in value-stream tasks	▪ Ensure a formal program is in place that multi-skills employees on tasks required by the product family they fall under. ▪ Support multi-skilling through job-rotation. ▪ Measure progress towards multi-skilling as a key performance indicator.
Ensure active mentoring and coaching	▪ Ensure on-the-job development is a key responsibility for managers. ▪ Ensure smaller teams that enable employees to have access to managers. ▪ Follow an apprenticeship model, where experienced team members transfer skills they have acquired.
Encourage voluntary self-study	▪ Encourage employees to create their own development opportunities. ▪ Ensure active mentoring and coaching to support employees along their learning journey.
Hold employees responsible to surface and solve problems	▪ Ensure managers role model the required ownership of the organisation's targets. ▪ Make team members increasingly more responsible in key activities and decisions. ▪ Ensure goals are clear and hold team members responsible through process confirmation.
Reward improvement	▪ Institute an achievement of target and improvement suggestion rewards system. ▪ Ensure big and small achievements are rewarded, as the cultural benefit will outweigh the cost.

2.6.5 Eliminate waste before it occurs

Eliminate waste before it occurs may be summarised into three activities. These involve a cross-functional team during the design process, taking the overall lifecycle into account and designing products that are easy to produce.

Involve a cross-functional team during the design process

Involving a balanced team from the start of the design process, including the customer and supplier, helps to ensure that local optimisation is not achieved at the expense of global optimisation. Such teams should be co-located, even if only for intensive periods of design. Eliminating waste before it occurs must cover the entire value chain, and can help to reduce costs, improve quality and flexibility, reduce rework, etc. (Womack and Jones, 2003:54,148,193,280; Liker 2004:137,138; Ballé and Ballé, 2005:87). Womack and Jones suggest that involving factory employees in the design process is a key factor in the TPS-based turnarounds of factories (2003:193). Tool engineering also needs to participate and deliver right-sized devices to facilitate manufacturing and flow (2003:61).

Take the overall lifecycle into account

Womack and Jones (2003, 2005) suggest the TPS takes the overall lifecycle into account when designing takes place, including materials, technology, manufacturability, and maintainability. Specific responsibility is assigned to ensure this happens. The design function experiments with 'new technologies that... permit products to do new things for the user and develop new materials and methods, which make it possible to eliminate fabrications steps and reduce costs' (2003:280).

Design products that are easy to produce

Many wastes (Ohno, 1988:129) can be identified and eliminated during the design stage (overproduction, waiting, transporting, over-processing, inventories, moving, making defective parts and products), although this can be done for existing designs as well. The concept of 'Eliminate waste before it occurs' ensures easily producible products that can be quickly assembled; and some authors stress the importance of having products that do not put unnecessary pressure on the operations side of the organisation as key to understanding the TPS. (Bicheno, 2004:27, 171-172; Womack and Jones, 2003:117).

During a visit to Toyota Motor Manufacturing South Africa, it was demonstrated how the use of technology and improved design allowed removal of the chassis from the design of the 2008 model Corolla. According to a Toyota official, this principle was about removing manufacturing steps to simplify the production process, which the latest technology made possible (TSAM visit, 2008).

Application

Table 2-8 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-8: Application of 'Eliminate waste before it occurs'

Main activity	Definitions considered for the main activity
Involve a cross-functional team during the design process	▪ Involve a balanced team from the start of the design process, spanning the entire value chain. ▪ Co-locate the team, especially during intensive periods of design.
Take the overall lifecycle into account	▪ Ensure specific resources are responsible to take the overall lifecycle into account. ▪ Include materials, technology, manufacturability, and maintainability when considering the lifecycle. ▪ Experiment with new technologies to radically improve performance and reduce costs.
Design products that are easy to produce	▪ Ensure processes are simple by taking the seven wastes into account (transport, inventory, motion, waiting, over-production, over-processing, defects and waste). ▪ Improve or experiment with a design until it suits the manufacturing process and enables easy manufacturing. ▪ Where possible, use technology to simplify the manufacturing process.

2.6.6 Promote flow

Promote flow may be summarised into four activities, namely link operations' output to customer demand, remove factors impeding flow, keep the overall supply chain in mind and Manufacture 'Just-In-Time'.

Link operations' output to customer demand

The TPS promotes the frequent release of products in smaller and more regular quantities, instead of batched production, to keep inventory at its lowest possible levels (Ohno 1988:2, 39, 68, 95,107,127; Womack and Jones, 2003:110). Applying this principle, an 'Every Product Every' (EPE) mix is increased until it is (ideally) linked with that of customer consumption. This results in inventory reduction across the value-stream (Womack and Jones, 2005).

Some see the corresponding cash flow injection as the chief motivation for an inventory reduction strategy, but others suggest strategies like JIT has a primary benefit of exposing non-value added activities and variation, which present a major opportunity to improve operations

without the ability to procrastinate (Ballé and Ballé, 2005:55,155; Spear 2002:765). Regardless of the most significant benefit, Towill and Childerhouse argue that following a framework to improve smooth material flow has been statistically proven to contribute towards improved performance (2006:767).

Remove factors impeding flow

A primary challenge organisations run into when increasing EPE is with resources that become bottlenecks. Value-stream mapping or analysis is useful to discover and prioritise required interventions. Often these resources will be used to manufacture a variety of products. Typically, setup times will have to be reduced to reach the target launch frequency (Womack and Jones, 2003:58, 60, 319).

The Toyota goal is to have 'Single-Minute-Exchange-of-Dies' (i.e., set up 9:59 minutes or less) or SMED. One way of achieving this is to separate internal and external work, i.e., to do as much preparation before actual production as possible, to minimise machine downtime. The ideal is to replace large set up dependent 'do-it-all' monuments with right-sized machines dedicated to product lines. Ohno suggested that organisations have a ratio of 1:10 set up to production time (Ballé and Ballé, 2005:182,266). Hence, machine set up time will be the determining factor when deciding the EPE launch frequency. The end objective of flow thinking is to eliminate all stoppages completely in an entire production process and not to rest in the area of tool design until this has been achieved (Womack and Jones, 2003:61).

Apart from SMED, Toyota employs various techniques to achieve flow and lower inventory (Marwinski and Shook, 2006). These include Kanban driven pull systems (p39-42), Heijunka boards (p26-28), Tsurube systems (p95-96), pacemaker processes (p63), FIFO flow (p18-19), milk runs (p53), level selling (p50), and supermarkets (p74-77,88-89). These tools work best if implemented higher up in the process chain or 'upstream', e.g., installing a supermarket just prior to final assembly (Ballé and Ballé, 2005:51). Toyota also uses warning lights or Andon when the feed slows down as a way to proactively deal with flow-inhibiting problems. Liker (2004:160) suggests whatever technology is used to promote flexibility; it must be proven to avoid it becoming a burden to production.

Keep the overall supply chain in mind

The implementation of the tools should be done with global optimisation in mind before local optimisation – the best way to approach is to analyse the extended value-stream (across suppliers), and determine the most appropriate areas to improve. 'Flow thinking' has the potential to release cash throughout the supply chain when implemented correctly. The idea is pull production, i.e. throughout the supply chain orders are not released until resources become available, or in other words suppliers should only produce what has been consumed (Ballé and Ballé, 2005:226- 228; Bicheno 2004:183; Womack and Jones, 2003:61).

Another approach to improve flow throughout the supply chain is by mixing and matching models in final assembly. This will help to keep inventory low throughout the supply chain. It can be done by pulling frequently to shipping and dispatch as if the organisation had the perfect customer. Again, Heijunka boards are suggested as a helpful tool in levelling production and increasing frequency. After successful implementation, delivery frequency can be renegotiated with the customer (Ballé and Ballé, 2005:163).

Manufacture 'Just-In-Time'

When an organisation starts to mature in reducing variation and succeeds in significantly lowering inventory, it should consider Just-in-Time manufacture. Deciding to implement, the impact should be closely monitored at suppliers. If organisations further down in the supply chain are not careful, they will greatly increase the cost of supply as their suppliers might keep large volumes of inventory to supply their customer 'Just-in-Time' (Ballé and Ballé, 2005:226-228; Bicheno 2004:183; Womack and Jones, 2003:61).

When production is linked in this way, it is important that raw material, detail parts, assemblies, or supplier 'kitted' assemblies arrive with 100% quality at the right place (point of use), in exactly the required quantities (previously consumed), at exactly the required time. Purchased parts should be supplied to the line at TAKT time, ideally in small containers large enough to hold only the number necessary, with the Kanban system working seamlessly. (Womack and Jones, 2003:137; Ballé and Ballé, 2005:172). Consignment stocking can also be agreed with suppliers.

These principles were demonstrated by Toyota South Africa Motors during visits (TSAM, 2008 and 2010). One example is a stamping facility that produces panels for the Corolla vehicle from rolls of steel. They have two main lines responsible for stamping. The set-up of the tools (large, more than 1.5m x 2.5m) is semi-automated - a Toyota official explained the total time required for changeover is 4.01 minutes, in line with Toyota's global SMED standard.

The use of Kanban devices was evident throughout the manufacturing plant, from stamped parts through to assembly parts supply. A rhythm was associated with all work. If feed slowed down, the specific area of concern would start to appear in orange colour on performance LCD screens located throughout the plant, with a corresponding sound alarm to alert supervisors that might not be concentrating on their work.

Application

Table 2-9 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-9: Application of 'Promote flow'

Main activity	Definitions considered for the main activity
Link operations output to customer demand	▪ Promote the frequent release of end-products in smaller quantities, until it is ideally linked with customer consumption. ▪ Use the opportunity of inventory reduction to improve inevitable bottlenecks that will occur.
Remove factors impeding flow	▪ Conduct value-stream mapping or analysis to determine and prioritise required interventions at bottlenecks. ▪ Ensure resources can handle the required number of change-overs and production quantities given customer demand and EPE targets by applying waste-reduction tools.
Keep the overall supply chain in mind	▪ Conduct an extended supply chain analysis to prioritise areas for improvement. ▪ Ensure orders are not released before resources become available (across the supply chain). ▪ Mix and match models in the final value-stream to lighten the burden earlier in the supply chain.
Manufacture 'Just-In-Time'	▪ Manufacture 'Just-In-Time' when significant success has been achieved in reducing variation and lowering inventory. ▪ Ensure rigorous shopfloor control, e.g. right quantity, 100% defect free, right location, perfect timing, seamless Kanban, etc. ▪ Measure the impact on the extended supply chain when manufacturing 'Just-in-Time'.

2.6.7 Increase process effectiveness and efficiency

Womack (2002:20) provides a framework to explain Toyota's resource effectiveness strategy. He describes the perfect process as completely valuable (waste free), perfectly capable (quality), perfectly available (uptime, no breakdowns) exactly adequate (capacity), and highly flexible (short changeovers).

Ensure real value-add is specified – valuable

The TPS seeks to specify value by products, identify how value is created for these products, and then ensure value is achieved without stoppages (Womack and Jones, 2003:10, Liker,

2004:28). Value is ultimately specified by the end customer and organisations that wish to adopt this principle might at first have to ignore existing assets and technologies in their pursuit to add more value than what currently exists. It is suggested that only after specifying value in this way can organisations develop an understanding of whether resources utilised during operations are effective in producing value, with a first step to make the difference between value-add and no value clear to operators in the process (Womack and Jones, 2003:10, 19, Liker, 2004:27, Bicheno 2004:10).

Maximise the capability of processes by removing waste – capable

After understanding customer value, a process of the relentless pursuit of waste elimination follows. Waste is viewed as the opposite of customer value. Capable or low-waste resources maximise performance and efficiency in producing customer value (Liker, 2004:280; Dennis, 2007:20, Womack and Jones, 2003:28, Liker, 2004:30; Bicheno, 2004:15). These resources should produce at the highest quality, yield, speed, and lowest cost throughout the product's lifetime (Dennis, 2007:39; Bicheno, 2004:36; Marwinski and Shook, 2006:92; Ballé and Ballé, 2005:254).

Ohno developed a list called the *seven wastes* to guide his teams in identifying opportunities to improve, namely transport, inventory, motion, waiting, over-production, over-processing and defects (Ohno, 1988:129). Such wastes may be highlighted through performance indicator measurements, e.g., lead time, cycle time, yield, labour hours, inventory levels, quality/delivery, etc.; normally of A3-size close to the specific area of work (Ballé and Ballé, 2005:52; Dennis, 2007:133). Other sources may include the ability of employees to stop the production process or signal for help, the solution of one problem that highlights the need to solve another, a requirement to reduce lead time, and quality assurance/control (TSAM visit, 2008 and 2010).

A large number of performance boards were noted throughout the assembly lines and stamping shop at Toyota South Africa Motors during visits in 2008 and 2010. A seemingly significant number of operators were involved in performance management of some kind, given the multitude of A3 measures at each workstation. Measurements included working habits (eating, drinking, smoking, cell phone usage), attendance, dress code/appearance, standard work, timekeeping, defects, tools checking, target vs. actual in production runs, 4S + 1, training plans, use of material, SPC control sheets, overtime, and work instructions (TSAM visit, 2008 and 2010).

After highlighting of improvement opportunities, continuous improvement events can be arranged to realise these opportunities (Marchwinski and Shook, 2006:37-38, 98-99). Toyota uses root cause analysis, e.g. 5-why, to thoroughly understand the root cause of a problem and follows through with completing Deming's PDCA cycle (Ohno, 1988:123; Dennis, 2007:147; Liker, 2004:264; Liker and Hoseus, 2008:128). During the same visits, a Toyota official showcased a group of operators applying PDCA. This experience highlighted the importance placed upon Deming's approach, even in South Africa.

Often, A3-reporting is used as a tool to facilitate the PDCA or this systematic approach to reduce waste. The PDCA cycle forms the basis of A3 problem solving, i.e. A3 thinking is a component of the PDCA cycle (Dennis, 2006). The goal of A3 reporting or problem solving is to facilitate problem solving and communication in a logical, concise, standard and visual way; with the main focus on countermeasures (Liker, 2004:157; Dennis, 2007:136). A3-reporting has multiple uses, including strategy deployment, problem solving, proposals, status reports, etc. (Dennis, 2007:137-138, Liker & Hoseus, 2008:113-114).

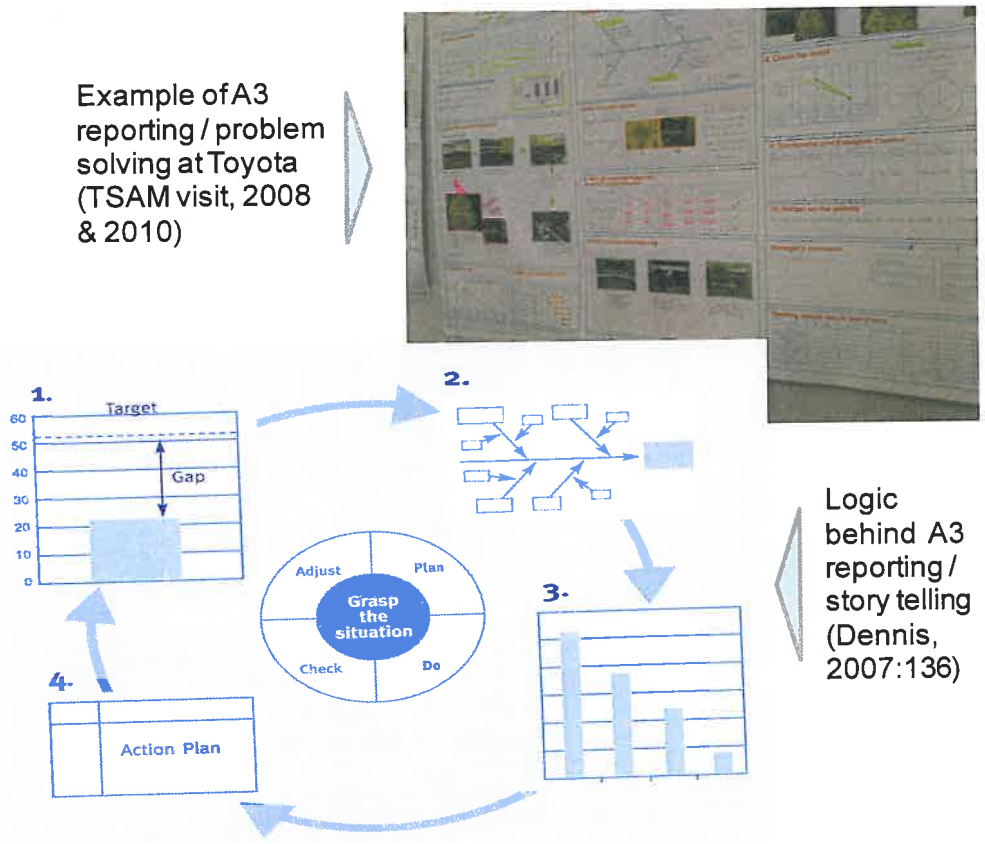

Figure 2-6: Example and logic of A-3 reporting and problem solving

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Ensure a process or resource is available when required – available

Upholding such performance through regular maintenance is an important aspect of the TPS. Toyota, like other manufacturing organisations, uses a program aimed at preventing any potential obstacles to high performance (Dennis, 2007:40; Bicheno, 2004:57; Marwinski and Shook, 2006:61). This program includes predictive and preventive maintenance, with a goal of zero defects and zero breakdowns over the total lifecycle (Dennis, 2007:39, Bicheno, 2004:56, Ballé and Ballé, 2004:254).

Available processes mean the minimum of the six major losses: downtime, changeover time, minor stops, speed losses, scrap, and rework (Bicheno, 2004:57; Dennis, 2007:41). Maximising availability, performance and quality means that overall equipment effectiveness, a key

measure, will remain high (Dennis, 2007:40; Bicheno, 2004:57; Marwinski and Shook, 2006:61). However, in prioritising machines with poor availability for improvement it is important to keep the required flow rate, or TAKT time, in mind. A machine with a poor OEE might be producing below TAKT time, and a machine with a higher OEE above TAKT time, which should cause the latter machine to be prioritised above the former (Bicheno, 2004:58). Other useful performance indicators include mean time to repair, mean time between failures, and statistical process control (Dennis, 2004:40).

This requires commitment from all employees, not only maintenance staff – examples of which include autonomous maintenance (Marchwinski and Shook, 2006:92; Liker 2004:33) and self-managed work teams (Womack and Jones, 2003:244).

Acquire processes and resources of adequate value-stream capacity – adequate

Toyota promotes right-sized, from tools to organisational activities. These tools and activities are dedicated to a specific value-stream, not a shared pool of resources (Womack and Jones, 2003:265, 316-317, Liker 2004:92-93).

This requires a rethink of the roles of machines and resources. Typical mass manufacturing used to acquire large machines able to deliver on economies of scale. Toyota realised this was local optimisation at the expense of global optimisation. Ohno started to implement dedicated product lines with right-sized equipment, adequate only to the products a specific group of customers wanted, but with the flexibility to add incremental capacity (Ohno, 1988:95; Ballé and Ballé, 2005:179).

Ohno's view was that machines, and technology, should serve the process. It is said that he judged the adequacy of machines based on whether they could deliver at the required flow rate of a specific value-stream, and not based on accounting methods of return on investment, depreciation or the age of the machine (Ohno, 1988:65; Liker, 2004:160).

Modify processes or resources to quickly change over from one product to another – flexible

Part of the start of the TPS was the quest to be so flexible that they could provide individual customer-tailored products for their unique needs, the opposite of mass production (Ohno, 1988: xiv, Liker, 2004:8; Ballé and Ballé 2005:179). This required resources that could support small lot sizes and quick set ups. Toyota practices activities that aim to reduce changeover time and improve flexibility of resources (e.g., SMED), which allow for smaller and more regular batches (Ohno, 1988:95, Womack and Jones, 2003:265, 316- 317, Ballé and Ballé, 2005:177, 283, Bicheno 2004:62).

Flexibility enables faster response to changing customer needs. The organisation therefore needs to be set up to understand changing market conditions and do quick translation into required quantities, as a flexible shopfloor provides the ability to play with batch sizes (Ballé and Ballé, 2005).

Application

Table 2-10 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-10: Application of 'Increase process effectiveness and efficiency'

Main activity	Definitions considered for the main activity
Ensure processes truly specify customer value	▪ Specify what real value add is from the perspective of the customer. ▪ Ensure employees are aware of the difference between value add and no value.
Maximise the capability of processes by removing waste	▪ Ensure processes are in place to identify and prioritise waste elimination (e.g. seven wastes analysis, performance measurements, etc.) ▪ Conduct improvement (Kaizen) activities to realise waste elimination opportunities, following the PDCA cycle ▪ Report / facilitate completion of the PDCA cycle through a formal communication approach, e.g. A3 reports
Ensure a process or resource is available when required	▪ Ensure adequate maintenance programs to uphold required performance, utilising front line staff. ▪ Measure the six major losses and overall equipment effectiveness to ensure availability. ▪ Determine which resources produce below the required flow rate to prioritise interventions.
Acquire processes and resources of adequate value-stream capacity	▪ Dedicate resources to specific value-streams or product families, avoiding shared resources. ▪ Procure resources that are right-sized for the volume requirements of their value-streams. ▪ Ensure resources can add incremental capacity.
Modify processes or resources to quickly change over from one product to another	▪ Set up the organisation to be able to quickly understand changing market conditions and customer requirements. ▪ Use tools to increase responsiveness, e.g. small lot sizes and quick set-ups through applying SMED principles.

2.6.8 Standardise

Standardisation may form the bedrock of continuous improvement and employee empowerment, and is perhaps the reason why Toyota has been able to achieve such high levels of productivity, quality, and safety (Liker, 2004:140; Ohno, 1988:21). Three activities may

be used to describe 'standardise', namely *Structure and train to a standard set of tasks*, *test whether standards are in place* and *have operators own and update standards*.

Structure and train to a standard set of tasks

Toyota structures their work to a standard set of tasks. A standard specifies the required TAKT time, the sequence of operations and motion, a description of operations, required intra-process work-in progress, cycle time, defect risks, safety requirements, and a description of the required outcome (Liker, 2004:140-142; Spear and Bowen, 1999:97, 98; Ohno, 1988:22). Typical examples at Toyota include process capacity sheets, used to calculate machine capacity in linked processes; standardised work combination tables, a process specification tool from the operator's perspective; and standardised work charts, indicating visual layout, flow, and locations (Marwinski and Shook, 2006:85,86). High utilisation is possible because operator work is specified to below one minute per work element (Ballé and Ballé: 157; Liker, 2004:147). There is systematic reduction of work content as part of continuous improvement, which assists and keeps the operator balancing dynamic (Ballé and Ballé, 2005:118,133; Bicheno, 2004:55,141).

Toyota calls their standard work charts TJIs or Toyota Job Instructions (Liker & Hoseus, 2008:127). This approach is influenced by the American military's training within industry or TWI, introduced in Japan after WWII as part of the rebuilding efforts and funded by the American government, although it can also be partly linked to Henry Ford's approach to standardisation (Liker, 2004:141).

The TJI process consists of four steps, firstly 'prepare the worker', then 'present operation', then 'try out performance' and concludes with 'follow up', analogous to the PDCA process (Liker & Hoseus, 2008:127). When training new workers, an operation is in general shown three times by the trainer and performed afterwards three times by the learner. Follow up support is also formally structured to ensure successful transfer of a skill (Liker and Hoseus, 2008:129). Toyota uses four charts to define standard work, namely, production capacity charts, standardised work combination tables, standardised work analysis charts and job element sheets (Dennis, 2007:55-57).

Test whether standards are in place

Toyota management actively test whether these standards are in place, by going to Gemba, completing the PDCA cycle and asking questions like: 'How do you do this work? How do you know you are doing this work correctly? How do you know that the outcome is free of defects? What do you do if you have a problem?' This is complemented by systematic process confirmation, where management confirms countermeasures taken by line management to improve standards adherence (Spear and Bowen, 1999:99; Liker, 2004:225; Liker and Hoseus, 2008:149- 151).

Have operators own and update standards

Standards are owned and updated by operators. The TPS builds on Taylor's idea of the one best way, but departs from his ideas in that its employees own the standards and complete their own Standard Operating Procedures or SOPs (Liker, 2004:148, Bicheno, 2004:54- 55).

Apart from Standard Operating Procedures for operators, there are also standard work lists for group leaders. A supervisor's main responsibility includes the implementation of standard work and variation reduction (Ballé and Ballé, 119). Standard work documents are controlled at the lowest possible level (by the teams who use them), and are kept at the point of use, clear, simple, and visual. In addition to all direct labour having highly specified standard work, indirect labour has standard work check sheets (Bicheno 2004:54-55; Liker, 2004:142- 143; Dennis 2007:52).

Toyota South Africa Motors' plant seemed to be well kept, floors were exceptionally clean and standards were posted everywhere – from how to organise storage areas to checklists on machines, to risks in safety, to operator standard work. Colour coding differentiated shop floor elements. Each group leader had a standard work checklist at an associated performance board (TSAM visit – 2008, 2010).

Application

Table 2-11 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-11: Application of 'Standardise'

Main activity	Definitions considered for the main activity
Structure and train to a standard set of tasks	▪ Create and apply standards which specify content, sequence, timing and outcome of operations. ▪ Break down and specify incremental work elements to below one minute each. ▪ Institute systematic reduction of work content as part of continuous improvement.
Test whether standards are in place	▪ Test understanding of standard, focusing on method and quality, at Gemba (the place where work occurs). ▪ Complement testing with process confirmation to ensure countermeasures taken will lead to increased standards adherence.
Have operators own and update standards	▪ Have employees own and update their own standards. ▪ Create standard work lists for managers and standard work check sheets for indirect labour. ▪ Keep standards at the point of use, and ensure it is visual.

2.6.9 Formalise industrial engineering

Toyota views its formal approach technical and labour efficiency, referred to in this document as *Formalise industrial engineering,* as crucial in driving the long-term profitability and economical and environmental sustainability of the organisation (Toyota, 2009a:2, 28; Toyota, 2008a:14; Toyota 2007e:14; Toyota, 2007f; Ohno, 1988:18, 62). *Formalise industrial engineering* builds upon a foundation of standardised work elements and best practise, with predictable cycle times and quality, for without, an improvement would become one of numerous accepted outcomes achieved by a process, and informal or general continuous improvement called *Kaizen* (Dennis 2007:49, 52; Liker 2004:142). Toyota's perceived high levels of productivity was, however, not always in place – at one stage the organisation faced significant financial problems because of its internal inefficiencies, according to Ohno worse than American automakers (1988:3). Toyota, therefore, developed an approach to improve its efficiency, which included a formal and systematic approach to reduce waste in processes, achieving cost cutting through profitable industrial engineering and optimising layouts for human performance.

Install a process for facilitated, radical improvement

Improvement from the Toyota perspective can roughly be divided into two categories – small, incremental improvement, and radical, stepwise improvement. The Japanese terms for these are Kaizen and Kaikaku respectively (Bicheno 2004:145; Womack and Jones 2003:23). This section focuses specifically on radical stepwise improvement that should result in reduced work content and reduced variation (Ohno, 1988:18; Ballé and Ballé, 2005:118,133; Bicheno, 2004:55,141; Womack and Jones, 2003:25). Ohno had a dedicated, formal team of industrial engineers supporting him, helping to facilitate such step-wise improvement. (Ohno, 1988:18, 71- 72,126; Womack and Jones, 2003:236).

Creating a current and future state value-stream map may be used to identify and prioritise opportunities for stepwise improvement (referred to as Material and Information Flow Analysis by Toyota), as this highlights and prioritises improvement opportunities (Dennis, 2007:87; Liker, 2004:303; Bicheno, 2004:68). Another source of opportunities for stepwise improvement comes from lowering inventory levels – the Toyota analogy of the rocks (problems) and water (inventory) in a lake (the production system) is often used to explain this method – if inventory is lowered or low, rocks or problems are exposed with the corresponding need to then resolve these to enable smooth flow (Ballé and Ballé, 2005:178). Ohno, known for his radical improvement drives, used to remove 10% of the people when a line was able to consistently achieve its production targets, causing them to run into problems which they then had to solve (Ballé and Ballé, 2005:55).

As radical changes are often met with fierce opposition, ensuring sufficient management support is in place to see changes through and provide continuity becomes a critical final step in facilitating radical improvement (Liker, 2004:180-182, Womack and Jones, 2003:260-261).

Let the industrial engineering department be profitable

Some improvements are led by a team of industrial engineers that scientifically analyse a section and implement solutions – much of Ohno's design of the original the TPS was done in this way (Bicheno, 2004:146). Ohno called this function at Toyota *Profit Making Industrial Engineering,* suggesting that all efforts aimed at increasing productivity should also lead to increased profitability, wanting this function to be comparable or superior to American organisations' version of Industrial Engineering (1988:18, 71- 72,126), an outlook that seems to have remained to this day (Toyota, 2009a:2).

Ohno had a specific interest on the systematic reduction of work content, as he believed increased shop floor productivity could be achieved by either of two ways, reducing manpower or increasing volume. Reduction of work content was not necessarily linked to retrenchment, but rather to having lines with the correct number of employees given production output. This was achieved through optimised layouts and continuous improvement of standard work (Ohno, 1988:62; Ballé and Ballé, 2005:93- 94).

Improvement is not limited to Toyota alone, but is incorporated throughout the supply chain. Suppliers are rated according to their performance history to enable Toyota to prioritise providing hands-on support and coaching (Liker, 2004:212). To expedite improvement and inform process intelligence from the TPS perspective, Spear (2002:765) suggests imbedding problem-solving triggers into the communication between suppliers and customers, with clear guidelines as to how communication should be provided and what should be expected.

Create methods and layouts that are optimised for human performance

Another way to see Toyota's focus on productivity may be in their shop floor areas. This includes the use of moving assembly lines, side-by-side manual assembly supplied from the front and Chaku-Chaku cells. A Chaku-Chaku cell is a U-shaped cell where machines involved are separated 4-feet across. This is done so that the operator can move around without having to step forward or backward. The operator moves counter clockwise and the material clockwise. Regardless of which layout is more suitable, the area is set up like a surgeon's table with logical visual flow in each manufacturing area and throughout the plant. Layout diagrams are posted in all areas. Visual management controls are used to manage any flow in the area (Ballé and Ballé, 2005:107,108; Dennis, 2007:62, 63, Marchwinski and Shook, 2006:7, 8; Liker, 2004:98).

Toyota's standards for layout include the following – the plant was organised to have direct supply where possible, with supplier controlled inventory. Supply was done using kits that are easily accessible to the operators, i.e., point of use supply happens in easily reloadable FIFO racks with visible levels. Consumables had clear min/max levels indicated. Kanban was used to control and prevent build-up of inventory. Procurement decisions seemed to promote right-sized equipment. Equipment stood on wheels where possible. Colour coding was used throughout plant. Vertical space was utilised, walking areas were clearly demarcated; the environment was

clean and orderly. Safety was promoted throughout the shop floor and colour and light were used to indicate danger (TSAM visit, 2008 and 2010).

Other observations from Toyota's shop floor included numerous electronic boards next to the assembly line promoting priority performance indicators, including safety and productivity. Frequent use of automated and semi-automated machines occurs (e.g., welding robots, torque wrenches, etc.). Overhead tool-handling systems were used in the stamping plant and in the manufacturing plant. The bulk of work was done on a moving assembly line, which ran double volume in some places. The doors and other obstructing parts were removed and refitted closer to the end of the line to ease assembly, as they would have been in the way. Rework was fixed separately from main assembly lines, the shop has an area created for end-of-line rework called the 'hospital area', and was one of a very few areas where the floor is painted (TSAM visit, 2008 and 2010).

Application

Table 2-12 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-12: Application of 'Formalise industrial engineering'

Main activity	Definitions considered for the main activity
Install a process for facilitated, radical improvement	▪ Ensure a team of dedicated, professional improvement agents are available to facilitate improvement ▪ Install a system that highlights and facilitates opportunities for significant improvement, e.g., current-future-current cycles of value-stream mapping, reduction of inventory, etc. ▪ Ensure sufficient management support is in place to support the proposed changes and provide continuity
Let the industrial engineering department be profitable	▪ Link improvement initiatives to financial impact. ▪ Direct the team to ensure a scientific labour assignment approach, i.e. ensure standard work elements and volume requirements determine the number of resources assigned to a specific value-stream, whilst continuous improvement of work elements allow reduction in labour. ▪ Task the team not only with improvement inside the organisation, but in its extended supply chain.
Emphasize methods and layouts that are optimised for human performance	▪ Create working areas where tools are point of use, flow is visual, and supply arrives in kits. ▪ Create work cells conducive to teamwork and flow, e.g. Chaku-Chaku cells. ▪ Arrange work in progress and consumables to flow FIFO, with clear min/max levels. ▪ Make 'flexible' procurement decisions, i.e. right-sized equipment preferably on wheels. ▪ Have and apply colour and layout standards.

2.6.10 Create intelligent processes

Problem solving at Toyota can be roughly divided into two groups. The first category is the proactive analysis of processes through various tools to improve them, covered in the previous section. The second category is the avoidance of errors, called 'create intelligent processes'. This may be summarised into three activities. These are stopping a process before damage can be done, Ensure specific accountability to add intelligence to processes and implement devices to prevent future occurrences of the problem.

Stop a process before damage can be done[viii]

'Stopping a process before damage can be done' goes by the name *Autonomation* or *Jidoka* at Toyota. The underlying concept is that zero defects will be accepted – which Ohno explains as automation with a human touch (1998:6). It is based on the idea of Sakichi Toyoda's called the automatic loom, where a potential problem is highlighted before damage can be done to part, machine or operator (Toyota, 2004d; Liker 2004:16,129; Dennis, 2007:95). This requires a machine to stop after a normal production run as well as to stop when a defective product will be produced; allowing only products of sufficient quality to continue to downstream processes. In some instances this means employees can monitor more than one machine as the machine will stop when production completes, or if an error occurs; and the worker will be notified via an Andon board (Toyota, 2008c:9; Liker, 2004:129-132). In other instances the Andon cord is applied, where operators can stop the production line when a problem occurs and highlight the issue to management, which will then pay immediate attention to the problem. At first, the line continues to move ahead, and a yellow light will flash to raise the attention of the team leader. If the vehicle arrives at the next workstation, and the problem has not been fixed, the light will turn into red and that section of the line stop (Liker, 2004:131). Autonomation is regarded one of the two pillars of the TPS (Ohno, 1989:6; Liker, 2004:129-130; Womack and Jones, 2003:231)[ix].

Ensure specific accountability to add intelligence to processes

Spear (2002:765) suggests that the effectiveness of such triggers in processes depends on the ability to call on specific people to solve specific problems and may be the reason why problem-solving systems like the TPS have sustained an outstanding performance. A system of escalation is used should first line response not be able to solve the problem within a specified time period. Such individual accountability forms part of the Toyota culture (Liker, 2004:257-258).

[viii] The Toyota slogan for this is 'stop production so that production does not have to stop'

[ix] The other pillar being Just-in-Time , which has been covered under the chapter called TAKT-Flow-Pull

Implement devices to prevent future occurrences of the problem

Ohno also implemented problem prevention devices and called these Poka Yoke or 'mistake-proofing'. He explains 'at Toyota, a machine automated with a human touch is one that is attached to an automatic stopping device'. Throughout all Toyota plants, most machines, new or old, are equipped with such devices as well as various safety devices, fixed position stopping, the full work system, and fool-proofing systems to prevent defective products. In this way, 'human intelligence or human touch is given to machines' (Ohno, 1988:6- 8,121-122).

Poka Yoke devices perform an automatic 100% inspection and either stop or give warning when an abnormality occurs. There are three categories of Poka Yoke: those that act as 'go, no-go' gauges, called contact Poka Yoke; those that look for a fixed number of items, called fixed value Poka Yoke; and those that check whether a specific set of motions or steps has been done in sequence, called motion step Poka Yoke. Another method is to visually display the correct or required outcome, but is not as effective as the automatic stopping of a process (Bicheno, 2004:137 - 138; Dennis 2007:98 -104; Liker 2004:128 - 130).

Application

Table 2-13 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-13: Application of 'Create intelligent processes'

Main activity	Definitions considered for the main activity
Stop a machine before damage can be done to part, machine or operator	▪ Install triggers that will stop a process if a defective product will be created, and after a production run is completed. ▪ Allow employees to stop a process if they believe defects or other problems occur, and give immediate management attention once this happens.
Ensure specific accountability to add intelligence to processes	▪ Ensure specific employees are assigned to respond to triggers. ▪ Create an escalation system should problems not be solved within a specified time period.
Implement devices to prevent future occurrences of the problem	▪ Install devices that automatically stop errors or hard wire the correct application, e.g. - 'go, no-go' gauges, i.e. contact Poka-Yoke; - devices ensuring a correct number, i.e. fixed value Poka-Yoke; and, - devices checking steps, i.e. motion step Poka-Yoke. ▪ Install visual measures that display the correct outcome (if Poka Yoke devices are not possible).

2.6.11 Balance resources

Toyota defines three types of waste: Muda, Muri, and Mura. Muda entails non-value, Muri involves overburden of machines or people, and Mura implies unevenness (Liker, 2004:115). Balancing resources addresses Muri and Mura as opposed to flow thinking that is about the ideal of linking production exactly to customer consumption, i.e., removing all Muda. Toyota seems to balance the two concepts and finds equilibrium between the goal of once piece flow and the advantages of steady production. Balance resources may be described by the following activities, namely fit customer demand into a level schedule, Use standard work to balance resources, separate rework from normal production and find equilibrium between make to order and make to stock.

Fit customer demand into a level schedule

The strategy of resource balancing entails levelling demand and actively balancing operator work. Toyota makes use of a concept called Heijunka, which means to level out the workload and balance resources (Liker, 2004:115). A primary tool here is Heijunka boards (load levelling boxes) and Kanban. This allows visual use of TAKT time, which aids balancing of resources (Marchwinski and Shook, 2006:28)

A similar approach is mixing and matching models in final assembly. This helps to keep inventory low throughout the supply chain. It is done by pulling frequently to shipping and dispatch as if the perfect customer existed. Again, Heijunka boards are suggested as a helpful tool in levelling production and increasing frequency. After successful implementation, delivery frequency can be renegotiated with the customer (Ballé and Ballé, 2005:163).

Use standard work to balance resources

Toyota calculates the number of operators by taking standard work content and dividing it by TAKT time (Ballé and Ballé, 2005:79).

Standard work rollout is part of the team leader's job description, which allows for high utilisation of operators because standards are highly specified (Ballé and Ballé, 119). At Toyota, work is specified to below 1 min per work element (Ballé and Ballé: 157; Liker, 2004:147). Operators are also responsible for managing their own standard work (Liker, 2004:148, Bicheno, and 2004:55). This result in systematic reduction of work content as part of continuous improvement assists and keeps the operator balancing dynamic (Ballé and Ballé, 2005:118,133; Bicheno, 2004:55,141).

In addition, Toyota not only tries to balance the feasibility of a work element within a given work cycle, but also the amount of effort exerted by operators in performing their tasks throughout the workday (Womack and Jones, 2003:40).

Separate rework from normal production

Core to the concept of resource balancing is the principle that zero defects are accepted / passed on (Ballé and Ballé, 2005:217; Ohno, 1988:41). To avoid unnecessary disruption to steady production, rework is separated from normal production if a problem cannot be solved within one Takt cycle, with the supervisor responsible to deal with the rework, which is normally moved to a separate area (Ballé and Ballé, 2005:83).

The description of this activity may potentially be in conflict with some authors' understanding of the principle of 'Jidoka', e.g. sees Liker (2004:129). According to the principle of Jidoka, a process needs to be stopped to fix an error rather than letting the process run and ignoring the problem until a more convenient time to solve. However, it was observed at Toyota South Africa Motors that a hospital area was created for more serious repairs (TSAM visit 2008, 2010).

It seems the fundamental nature of the TPS may be open to some pragmatism and not fully set in stone, balancing the principle of stopping a process to ensure a root cause fix with the requirement to keep the line balanced.

Find equilibrium between make to order and make to stock

Liker suggests that organisations that have successfully implemented the TPS have found a balance between building to order and maintaining some level of finished goods inventory (Liker, 2004:121). An example is where Toyota schedules their production based on forecasts,

and then allows 'a *change to order*' approach as exact customer demand becomes known (Liker, 2004:122).

Another method is the use of supermarkets. Supermarkets can be used throughout the value-stream, but works best if already implemented upstream, e.g. installing a supermarket just prior to final assembly. Supermarkets can carry consumables, semi-completed work-in-progress or completed sub-assemblies to help balance the line (Ballé and Ballé, 2005:51).

On the televised screens used at TSAM, overtime is indicated should the operators fail to meet the day's production targets. TSAM runs a two-shift system, and leaves three hours between each for the shift to catch up if major problems occur – each shift is kept accountable to achieve their targets. If a shift does not make target, overtime is used to catch up. Each shift is responsible for their targets (TSAM visit, 2008 and 2010).

Application

Table 2-14 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-14: Application of 'Balance resources'

Main activity	Definitions considered for the main activity
Fit customer demand into a level schedule	▪ Install Heijunka boards or other devices to level the production schedule. ▪ Couple various processing steps through the use of Kanban cards and pull systems. ▪ Mix and match models in final assembly. ▪ Pull frequently to shipping and dispatch.
Use standard work to balance resources	▪ Ensure standard work is in place, specifying work elements to below 1 minute. ▪ Calculate the number of operators by taking standard work and dividing it by TAKT time. ▪ Ensure standard work roll-out and improvement is part of a team leader's job description. ▪ Balance not only work elements, but also effort exerted by operators throughout the day.
Separate rework from normal production	▪ Ensure zero defects is accepted or passed on. ▪ Separate rework from normal production. ▪ Make the supervisor responsible to perform rework.
Find equilibrium between make to order and make to stock	▪ Find a way to balance customer demand and make to stock, e.g. Toyota's example of 'change to order'. ▪ Use supermarkets as a secondary method to balance manufacturing lines. ▪ Ensure flexibility is available to finish each day's production targets, e.g. through overtime agreements.

2.6.12 Enable visual management

Toyota uses visual communication as part of their strategy to have efficient closed-loop communication and make problems visible (Liker, 2004:158). The method or discipline Toyota uses to drive this is called the Four S' and consists of Separate – sort/eliminate, Set in order – order, Set countermeasures – check, Sustain – sustain. Practicing these disciplines enables a visually self-explaining, self-ordering, and self-improving workplace (Ballé and Ballé, 2005:121; Liker 2004:36, 150 - 152, Dennis, 2007:31; Bicheno 2004:53).

Separate

'Separate' means to separate needed from unneeded items. It is often referred to as 'sort' in English translations of 4S, and is a regular activity performed as part of the 4S discipline (Marchwinski and Shook, 2006:19, Dennis, 2007:32). Application requires that items are

classified and placed / ordered by frequency of use (Bicheno, 2004:52). Red tagging items that are not used and placing them in a quarantine area allows a buffer period to search for alternative use before these items are thrown away. Action lists are created to direct activities (Bicheno, 2004:52, Dennis, 2007:33).

Set in order

The definition of 'Set in order' includes organising and simplifying; with a goal to be able to tell if something is out of order with one glance of the eye. This includes placing items in the work area (from tools to performance measures) in a logically determined place (e.g. organised by frequency of use) and then creating standards to ensure it is visible if something is out of place (Marchwinski and Shook, 2007:19, Bicheno, 2004:52; Dennis, 2007:34).

Some authors use the quote 'a place for everything and everything in its place' as part of their explanation of 'Set in order' (Dennis, 2007:34; Liker, 2004:150)[x].

Visual measures – to establish whether something is 'Set in order', Toyota uses visual measures. Visual measures are classified into different visual indicators -

- signals, e.g., performance measures – often displayed on electronic boards, shadow boards, etc.;
- controls, i.e., limiting behaviour, e.g., lines; and,
- guarantees, i.e., forcing behaviour, e.g., a device stopping when a certain quantity is reached (Dennis, 2007:36).

The goal of visual measures is to enable visual management. This entails that all tools, parts, tasks, and performance measures are visible so that the system can be understood easily and immediately, and that deviations from standard is immediately visible (Marchwinski and Shook, 2006:100). Examples include Kanban, A3 reporting, semi-transparent machines, performance measures, Heijunka boards, Andon systems, employee suggestions, standard layouts, footprints, maintenance sheets, etc. (Liker, 2004:152,153,157; Bicheno, 2004:61).

To classify performance measures, Toyota uses safety, quality, cost, delivery, and morale (Liker and Hoseus, 2008:56). However, an emphasis is placed on safety and cost during the early years of a plant (Liker and Hoseus, 2008:57). Toyota also uses colour and sound as additional methods to enable easy classifying and checking whether items are 'Set in order' (Dennis, 2007:35).

Ergonomics – 'Set in order' also includes a focus on applying ergonomics, e.g., having tools and dies at the same level as the work table (Bicheno, 2004:52). One tool used is to test the

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[x]This quote emanates from the early 19th century: 'There is as much meaning in the old adage, and the observance of which let me urge you as a remedy for every degree of evil I advert to – 'have a place for everything, and keep everything in its proper place" (Ohio Repository, Canton, Ohio, December 1827)

layout is to construct a spaghetti diagram, tracking flow of parts and tools, before and after a 'Set in order' exercise (Dennis, 2007:34, Bicheno, 2004:52). The goal is to minimise wasted motion and eliminate unsafe motion (Dennis, 2007:34).

Set countermeasures

'Set countermeasures' means to clean and check, also referred to as shine and inspect or scrubbing (Dennis, 2007:36; Bicheno, 2004:52). The principle includes the habit of regular cleaning, and accompanying cleaning activities with checking and initiating counter measures when items are out of order or malfunctioning. Team members are proactive about raising countermeasures if anything is found out of place, and if a discrepancy cannot be solved immediately will raise it to the attention of management and fellow team members (Marchwinski and Shook, 2006:19, Dennis, 2007:36). Toyota creates cleaning routines by which operators go through a set route of checks and cleaning activities at the end of each shift (Bicheno, 2004:52). What to clean, how to do it, who will do it and the required level of cleanliness is specified to create responsibility and prevent ambiguity (Dennis, 2007:36).

Sustain

'Sustain' means creating rules or standards to regularly practise the first 3 S', to become part of the way things gets done (Liker, 2004:151, Bicheno, 2004:5, Dennis, 2007:37). This links with the strategy of *Standardisation* covered earlier. Toyota aims to have these standards clear, simple, and visual (Dennis, 2007:37).

Some authors add a fifth S called 'self-discipline' (Bicheno, 2004:52; Dennis, 2007:38), which includes overall involvement of the workforce (Dennis, 2007:38). Toyota traditionally only uses the first four S's, with 'Sustain' referring more to an outcome of cleanliness because of the practise of the first three S's (Marchwinski and Shook, 2006:19, 20). Managers can support and instil self-discipline by regular audits, promotion, communication, and training (Liker, 2004:151, Bicheno, 2004:52, Dennis, 2007:38).

During a visit to TSAM, in November 2008 and April 2010, A3-driven performance measures were noted on most open walls and next to most workstations (next to the line, on both sides, a sequence of two performance boards and then a team table seemed to be the standard). TSAM uses A3-reporting for KPIs, standards, and other types of communication – e.g., standard layouts and operating procedures, tracking of KPIs, etc. Major KPIs as well as visualisation of cause and just effect could be seen. Problems were made visible through signals (e.g., Andon). Electronic LCD screens acted as live performance measurement boards showing output, flow, status, TAKT time, down time, running time, target, actual, overtime, etc. Sound was used to signal information or warnings. Posted data provided area-specific information. The screens also had pictures of the layout and these were used to highlight the bottlenecks (would turn red on the layout). The flow of shop floor areas was visible. As soon as a status change took place sound was used to alert supervisors of the delay in production. There was use of visual aids

next to lines/on walls, e.g., correct vs. incorrect parts. A colour-coding standard was applied throughout. Some of the tour guides referred to the implementation of the 4 S' as an important tool to support the TPS.

Application

Table 2-15 shows a summary of the main points of this section. This dissertation regards the presence of these activities as evidence that a similar strategy as that of the TPS is followed.

Table 2-15: Application of 'Visual management'

Main activity	Definitions considered for the main activity
Separate	▪ Classify items and place / order by frequency of use. ▪ Red-tag items that are not used and place in a quarantine area. ▪ Create 4S action lists to direct activities (should become an ongoing habit).
Set in order	▪ Organise all items in the work place according to frequency of use and importance, taking ergonomics into account. ▪ Create standards or measures that make it visible when something is out of place (from tools to performance measures). ▪ Apply colour, sound and light to help enforce standards.
Set countermeasures	▪ Establish a habit of regular cleaning, inspection and restoration of the established workplace order (specify what to inspect or clean, how to do it, and who should do it). ▪ Be proactive about raising countermeasures for anything that is found out of place. ▪ Make problems that cannot be resolved immediately visible to management and fellow team members.
Sustain	▪ Create rules and standards for the practise of the first three S's. ▪ Ensure the standards are clear, simple and visual. ▪ Ensure managers conduct regular audits, promotion, communication and training on the requirement for visual management.

The previous sections summarised the twelve strategies of the TPS Level One and made it operational. This covers the fundamental nature of the TPS, which is later compared with selected South African organisations. A summary follows below:

2.6.13 Summary of the TPS Level Zero and Level One

Figures 2-4 and 2-5 summarise the twelve strategies that comprise the fundamental nature of the TPS.

Figure 2-7: Summary of the fundamental nature of the TPS

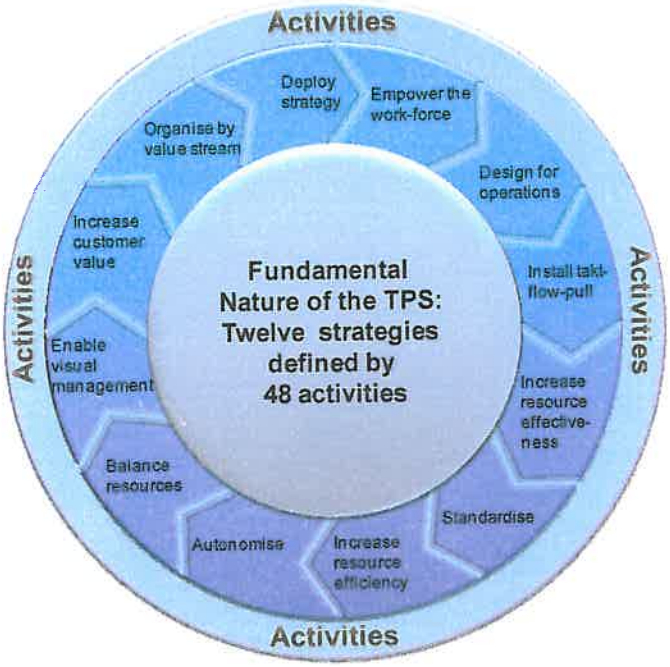

Figure 2-8: Summary of the theoretical framework – the fundamental nature of the TPS

Section 2.7 will discuss the rest of the TPS according to the Bateson's *Learning Two* and *Learning Three* respectively. An illustration of all four levels is also included.

Given the theoretical framework, a matrix may be designed to help facilitate answering the main research question, i.e.:

> **How prevalent is the fundamental nature of the TPS in selected South African organisations?**

An example is given in table 2-16 of how the TPS Level One strategy 'increase customer value' may be made operational, with similar matrices that may be constructed for other strategies:

Table 2-16: Comparing selected organisations with 'Increase customer value' - hypothetical

Main activity	Case one	.	.	.	.	.	Case n	**Total**
Understand the customer's perspective of value.	S	N	S	S	S	S	S	w/n
Re-engineer core products to improve customer value.	N	N	N	N	N	S	N	x/n
Redefine organisation processes to increase customer value.	N	S	N	N	N	N	S	y/n
Add value to the customer throughout the lifecycle of the product.	N	N	N	N	N	N	N	z/n
Total per case	1/4	1/4	1/4	1/4	1/4	2/4	2/4	--

Legend:		
	S	Some evidence found to suggest activity is present
	N	No evidence found to suggest activity is present
	n	Total number of cases selected to participate in the study
	w,x,y,z	Variables indicating the number of cases where some evidence was found to suggest the activity is present

The outcome of this matrix would then show (hypothetically) that the 'increase customer value' strategy of the TPS Level One is not found to the same extent at all cases. Such matrices can be created for all the strategies of the TPS Level One.

Before this comparison can be done, however, other considerations important for this study are taken into account.

2.7 Higher Levels of TPS – the context of Level One and Zero

Arguably the most important reason for using Bateson's (1972) theory is that it allows for the modelling of the context in which the TPS operates. The next sections continue to model the higher levels of the TPS according to Bateson.

2.7.1 Modelling the TPS: Level Two

Level Two may be described as positive change or correction to the context of Level One (Bateson, 1972:293), i.e., a correction in the strategies that Toyota employs. This dissertation uses the word *'values'* to describe such instances. Toyota published five values that they promote in a document entitled 'Toyota Way 2001'. These values are *challenge, Kaizen, Genchi Genbutsu, respect,* and *teamwork*. They group these values under two categories called *Continuous Improvement* and *Respect for People* (Toyota, 2009a:54; Toyota, 2008a:32; Toyota, 2007b:57). This grouping is used to summarise literature that could help 'correct' the TPS Level One.

Continuous Improvement

Liker and Hoseus (2008:15) explain that, for Toyota, *Continuous Improvement* means never to be satisfied with where they are and to always improve their organisation by putting forth their best ideas and efforts. The following section elaborates on the three values of *challenge*, *Kaizen*, and *Genchi Genbutsu* that Toyota summarises under *Continuous Improvement.*

Challenge

Challenge may be seen in Endurance, Competitiveness and Idiosyncrasy:

Endurance

Toyota has faced challenges for survival through the many crises it has faced: An example is the crisis of 1950 that led to Kiichiro Toyoda's resignation and retrenching of a third of Toyota's workforce (Womack and Jones 2003:233). Liker and Hoseus (2008:25) suggest the value of self-reliance, both individual and collective, originated even earlier, with the start-up of Sakichi Toyoda in the Aichi farming prefecture, overcoming the challenges presented to his community.

Ohno believes that without a crisis that challenges its survival, an organisation will not be able to adopt the TPS (Womack and Jones 2003:231). This might explain why, in an effort to promote improvement, he sometimes deliberately caused a crisis for divisions by removing ten percent of their labour, if they had been operating without facing challenges for a significant period (Ballé and Ballé, 2005:55). Toyota, in line with the value of challenge, recently placed a goal for all of its overseas bases to become self-reliant (Toyota, 2007b:84, 2008a:32).

Competitiveness

Toyota encourages their employees to confront obstacles with the belief that success is possible, and that overcoming such challenges is part of Toyota's nature and will strengthen the organisation (Toyota, 2008a:9, 2008c:4, 2007a:13; Athanasopoulos, 2006). They challenge their employees to search for breakthroughs, not to be constrained by previous thinking, and to pursue creatively and bravely opportunities to realise the long term vision of Toyota (Liker and Hoseus, 2008:15, 323; Liker, 2004:25, 203). An example is Ohno, who was a staunch believer in radical change. From some of the earliest Toyota turnarounds he considered it possible to double labour productivity and significantly reduce plant space in a short amount of time, and he would not be satisfied until it happened (Womack and Jones, 2003:222; Liker and Hoseus, 2008:323).

Idiosyncrasy

Sakichi Toyoda accepted the challenge that they could compete with the West and made a shift from the textile industry into the automobile industry (Toyota, 2002a). This behaviour continued during the capital liberalisation of 1960 in Japan, when Toyota made the decision not to partner with Western companies, despite their Japanese counterparts doing so in order to survive (Toyota, 2005b). Another example of the spirit of challenge is when the Toyota leaders refused to compromise on the essentials of the Toyota Way when they started the first USA-based plants (Liker and Hoseus, 2008:26).

Toyota idiosyncratically faces challenges through endurance and competitiveness. The next section will focus on the value of Kaizen, the never ending pursuit of improvement.

Kaizen

Kaizen means continuous incremental improvement of organisation processes (Toyota, 2008b:61). This value of Toyota may be summarised as ingenuity, structure, leadership and significance.

Ingenuity

Kaizen is about a mindset of constant and creative analysis and improvement of performance (Athanasopoulos, 2006, Toyota 2004c, 2007:22, 2008:61; Liker and Hoseus, 2008:15). Toyota has a 'just-solve-the-problem' attitude, and although it is a simple practical statement, it entails not casting the blame, but fixing the problem. It is a core attitude of the TPS and is viewed as a learning opportunity with a mentor. No one is ashamed to be associated with a problem (Ballé and Ballé, 2005:278,279).

Structure

The foundation of continuous improvement lies in a highly standardised and stable environment that enables continuous improvement (Dennis, 2007:19). In such an environment Kaizen becomes the conscientious analysis and improvement of standard work elements by employees who own their own standard work (Dennis, 2007:49). The aim is to

turn motion – all aspects that do not add value – into work, using a measure of labour density as work divided by motion (Ballé and Ballé, 2005:26; Dennis, 2007:51).

Toyota employees are taught to thoroughly consider all problem solving and then implement solutions rapidly (Liker, 2004:137, 238). Such improvement is done using the scientific method, whilst being coached by a mentor (Spear and Bowen, 1999:98). This belief in the scientific method is paramount to Toyota culture (Liker, 2004:246,256; Spear and Bowen, 1999:98,102,105). In this context, Ohno had a strong emphasis on productivity and believed that productivity could and should be achieved through the scientific method rather than through large capital expenditure (Womack and Jones, 2003:222). Marchwinski and Shook (2006:94) explain that the TPS is continually improved through the application of the scientific method by standardising improvements. They credit this approach as underpinning the success behind Taiichi Ohno's deployment of the TPS after World War II through to the 1960s, and implementation at suppliers through to the 1970s. Toyota does not view problems as a function of an independent set of variables (e.g. six sigma) that can be manipulated, but rather as integrated waste that needs to be attacked. This is done through team members gaining the same insight as a Sensei and testing all ideas as hypotheses (Liker and Hoseus, 2008:24).

Leadership

Liker and Hoseus suggest leaders at Toyota are selected because of their ability to model, coach, and teach the culture of Toyota (2008:318), which includes embracing the value of Kaizen (2008:324) and fostering the Kaizen mentality through creating a Kaizen-conducive environment (2008:325). Senior leaders seem to value being involved with solving, learning from, and confronting problems (Liker and Hoseus, 2008:31). Kiichiro Toyoda described his father, Sakichi Toyoda, founder of Toyota, as one who gave genuine thought to ideas rather than relying on intuition. An example was the invention of a winding machine and the world's first power loom, only successful after numerous iterations (Liker and Hoseus, 2008:11, Toyota, 2002a). Toyota managers are leaders with an improvement mindset that can inspire others to do the same. They work hands on and are promoted as their ability to work with, and influence, people develops. They are good at problem solving and aim for 100% of targeted results (Liker and Hoseus, 2008:199, 200). Toyota believes the onus to improve resides with the entire organisation and, therefore, all should actively participate. (Dennis, 2007:119).

Significance

Womack and Jones suggest the Toyota improvement strategies eventually have one outcome in mind: continuous flow of value to the customer (2003:59). This value can sometimes require radical decisions, such as closing off entire sections of plants not producing value (2003:167).

Toyota seeks to continuously increase their significance to their customers through a continuous, ingenious but structured improvement approach, role-modelled by leaders of the organisation. The next section elaborates on the value of Genchi Genbutsu, the value of 'going to the source'.

Genchi Genbutsu

The Toyota Way 2001 states 'we practice Genchi Genbutsu, believing in going to the source to find the facts to make the correct decisions, build consensus, and achieve goals at our best speed' (Toyota, 2006d: 46). Ohno regularly emphasised the value of Genchi Genbutsu, or going to the source to observe and familiarise oneself with the facts. This is as opposed to relying on data received through some or other system (Toyota, 2006c). Genchi Genbutsu may be explained by the terms support and accountability, mastery, pragmatism, realism, expediency and insightfulness.

Support and accountability

Genchi Genbutsu assumes it is easier to build consensus around the root cause of a problem when everyone observes it. Employees at Toyota would rather take more time in reaching consensus about the root cause than implement actions quickly without unity in direction (Liker, 2004:237-241). Genchi Genbutsu prescribes to employees and managers that learning is maximised through improvement coaching and guidance of employees, especially in 'defining, analysing, communicating, and solving problems' (Liker and Hoseus, 2008:9, 10, 11; Toyota, 2006d: 18, 2008c:49). The availability of coaches or Sensei's at Toyota is claimed by some as the reason why improvement has been so effective (Spear and Bowen, 1999:102). Formal coaching requires a trust relationship between employees and management, with managers held accountable as the leaders of change over the resources that are under their control (Womack and Jones, 2003:267; Spear and Bowen 1999:98). Such problem solving often happens in teams – an example is quality circles or Kaizen circles, a team-based approach to improvement introduced by Deming and refined by Ishikawa (Dennis 2007:111). The key is to plan extensively and then implement the solution rapidly (Liker, 2004:237-241).

Mastery

Sakichi Toyoda himself built and fixed the first looms, regardless of challenges faced – a tradition which has informed Toyota's expectations of their employees (Liker and Hoseus, 2008:10). Even for HR practitioners it is foreign to sit behind a computer rather than to actively engage where value is being added on the shopfloor (Liker and Hoseus, 2008:19).

Pragmatism and Realism

Genchi Genbutsu prescribes to employees and managers that learning is best done by being on-site at the location where the problem occurs (Liker and Hoseus, 2008:11, Toyota, 2006d: 18, 2008c:49). It means to go and see for yourself or go to the source – the principle is to avoid hearsay and gain agreement by arguments that are supported with facts observed first

hand, at Gemba, the real place (Athanasopoulos, 2006; Liker and Hoseus, 2008:30, Toyota 2007b:57).

Toyota's strong value for problem solving leads problem solvers to do so in the most efficient way, which is normally at 'Gemba', the Toyota/Japanese word used to indicate the real place, i.e., through direct observation, (Ballé and Ballé, 2005: 231,262-263).

Expediency

The promotion of fast problem solving at the point of occurrence with those responsible is key to the problem-solving nature of the TPS (Spear, 2002:765, Bicheno 2004:146). The appropriate statement associated at Toyota with problem solving is 'right now' (Womack and Jones. 2003:251, 252).

Toyota's manufacturing system design communicates the requirement for immediate problem solving (as opposed to procrastination) as operators can easily stop their segment of the assembly line through pulling an Andon chord (Ballé and Ballé, 2005:88, 89, Toyota, 2006e:12, Ohno, 1988:128). In addition, the Andon visual system and all Jidoka/Autonomation devices also promote immediate attention to a problem (Womack and Jones, 2003:231, 240).

Insightfulness

Liker (2004:223) explains the prominence of Genchi Genbutsu by providing two examples. Firstly, Toyota managers claim the insight they gain by applying Genchi Genbutsu is a distinguishing factor between the TPS and other management systems. Secondly, former President Fujio Cho, upon his visits to American plants, would take time every morning to go to the shop floor and observe, until he understood something that needed improvement.

Toyota practices the value of Genchi Genbutsu by giving support at the source where a problem occurs, keeping themselves accountable to solving a problem there and then if possible. They gain mastery of the problem through taking a pragmatic and realistic approach, and provide insight through observing and reflecting on the real cause.

The first group of values of Toyota, summarised as 'Continuous Improvement', has been discussed as Challenge, Kaizen and Genchi Genbutsu. The next group of values, summarised as 'Respect for People', follows in the section below.

Respect for People

Respect for people includes all that Toyota employees come into contact with – fellow colleagues, customers, suppliers, investors, the community where they operate and suppliers at large (Liker and Hoseus, 2008:14). This grouping contains two values, respect and teamwork.

Respect

Toyota explains this value in their Toyota Way 2001 document as 'we respect others, make every effort to understand each other, take responsibility, and do our best to build mutual trust'

(Toyota, 2007b:57). The following terms - reverence, integrity, congruence, service, humility, altruism and community - may be used to describe this value.

Reverence

For Toyota, respect starts with mutual understanding and mutual trust. They promote respect for all stakeholders in the organisation and request that everyone contributes towards building trust through respect and communication (Liker and Hoseus, 2008:14). Respect for people includes honouring colleagues in the organisation for the knowledge they have acquired due to their position, and therefore different opinions are presented in a respectful way (Athanasopoulos, 2006). According to Liker and Hoseus (2008:23) Toyota fits well into the mould of Eastern culture that emphasises harmony, membership in a collective, and, at the same time, an emphasis on self-control. Toyota endeavours to be a respected organisation throughout the world, and regards this as a key growth strategy (Toyota, 2002b:5).

Integrity and Congruence

Toyota leaders model and promote integrity – it applies both to the individual conduct within the organisation and the corporate conduct outside the organisation. External examples include placing a significant emphasis on honouring the laws, culture, and customs of a country (Toyota 2006f:2, 3, 7, 8, 15; 2007b:5). Internal examples include honouring the values and aspiring to humility and honesty, etc. During a visit to Toyota, in November 2008 and April 2010, it seemed managers respected rules of the organisation, e.g., wearing of safety glasses for managers, visitors, and employees, only walking in demarcated walking lanes, etc. (Toyota visit, 2008).

Service

Toyota promotes servant leadership – people who put the interests of the employees, organisation, immediate community, and society before themselves. Managers respect employees through active development – setting and managing goals and holding those in their teams accountable. They focus on confirming the process, not catching people out (Liker and Hoseus, 2008:319). They respect the organisation by holding the view that they are caretakers of an institution that will extend beyond their lifetime (Liker and Hoseus, 2008:73).

Toyota strives to put the interests of the customer first, ahead of their dealers and ahead of themselves (Toyota, 2003a:66; 2007c). This thinking starts with the question of how the customer would define value as opposed to pushing products onto the customer (Womack and Jones, 2003:16).

Liker and Hoseus (2008:45) also claim that Toyota as an organisation stands on its head, i.e., senior management is there for the upliftment and support of shop floor employees. Another example about integrity and respect is when Kiichiro Toyoda resigned as President

of the organisation when employees had to be laid off in the late 1940s (Womack and Jones, 2003:233).

Humility

Liker and Hoseus (2008:28) recall a story when one of them were trained as a team leader at Toyota, and was sent to work on one of the assembly lines at Toyota City, Tsutsumi. He had to pull the Andon chord because he had scratched the inside of a wheel. Expecting to be ridiculed at the end of the day during the team meeting, he had the opposite experience – they clapped hands for him to show their appreciation for being honest about making a mistake.

Altruism

Liker and Hoseus (2008:12) suggest Japanese culture differs from Western culture in that the individual is subservient to the group, and long-term thinking overrides short-term gains. The start of Toyota was birthed from an altruistic desire to improve the suffering of a group of people: Sakichi Toyoda perfected the first wooden handloom in 1890 to help women of his community who were working under difficult circumstances (2008:10). Sakichi Toyota accordingly instructed his son, Kiichiro, to start a project in his lifetime that would benefit society (2008:11).

Respect requires showing reverence towards all stakeholders of the organisation, conducting oneself with integrity - congruent with Toyota's values, having attitudes of service and humility and seeking the wellbeing of the community inside and outside Toyota. The next section describes the subsequent Respect for People Value, namely Teamwork.

Teamwork

In the Toyota Way 2001, Toyota describes teamwork as 'We stimulate personal and professional growth, share the opportunities of development, and maximise individual and team performance' (Toyota, 2005c:53). Teamwork may be described by the terms competition, socialism, selflessness, consensus, synergy and commitment.

Competition

Toyota tries to blend healthy competition with teamwork, aimed at creating optimally functioning teams (Toyota, 2006d: 49). Liker and Hoseus suggest that in America, Toyota went through significant efforts to transfer the value of teamwork without hindering the American culture of individual competition (2008:257).

Liker and Hoseus (2008:25) also believe Toyota is unique in emphasising both individual and collective performance. This can be seen in the role Sakichi Toyoda played in individually inventing looms but believing strongly in the purpose lying only in the greater good, contrasting with the strong-willed individual forceful leadership style of Taiichi Ohno. Toyota promotes a thinking workforce, both individually and collectively.

Socialism

Toyota aims to foster a corporate culture that enhances individual creativity and teamwork value, while honouring mutual trust and respect between labour and management (Toyota, 2006f:2). Toyota takes various measures aimed at illustrating the value of teamwork - no executive parking spaces, restrooms, dining rooms, offices, dress codes, etc. (Liker and Hoseus, 2008:258). The role of the team leader in such an environment, according to Ballé and Ballé, is that of a skipper of a boat more than a captain – part of the crew but a tactical decision maker (2005:134). Every five to seven employees report to a team leader; and every three team leaders to one supervisor (Ballé and Ballé, 2005:135; Liker and Hoseus, 2008:260)

Selflessness

Teamwork is about serving the organisation's interest and that of the team before one's own (Athanasopoulos, 2006). In return, apart from mutual trust and respect, Toyota strives to create an environment of long-term employment stability (Toyota, 2007b:51). Team leaders at Toyota do not have a fixed production job but forms the first line of support for the members of their team. Their responsibilities include standard work, relieving of employees that are unable to work, providing assistance, responding to problems, conducting kaizen activities, and bringing problems to the surface (Marchwinski and Shook, 2006: 91, Liker and Hoseus, 2008:260).

Consensus

Toyota values employee participation and consensus, therefore, problem solving often takes place in a team environment (Liker and Hoseus, 2008:13).

Synergy

Liker and Hoseus also suggest Toyota intentionally promotes and develops teamwork through daily team-based work and problem solving. Teamwork takes place vertically and horizontally, and teams share their best practice gains with other teams (Liker and Hoseus, 2008:260).

Commitment

According to Toyota, an example where international teamwork played an integral role was the successful simultaneous launch of the Camry line in four countries on three continents, something possible because of a shared commitment to the value of teamwork across many Toyota bases (Toyota, 2006a:19-21).

Teamwork has been described with the words competition, socialism, selflessness, consensus, synergy and commitment. Teamwork is one of five values Toyota promotes, with the other values being Respect, Genchi Genbutsu, Kaizen, and Challenge.

In summary, below is an extract from the Toyota Way 2001, showing their interpretation of these values:

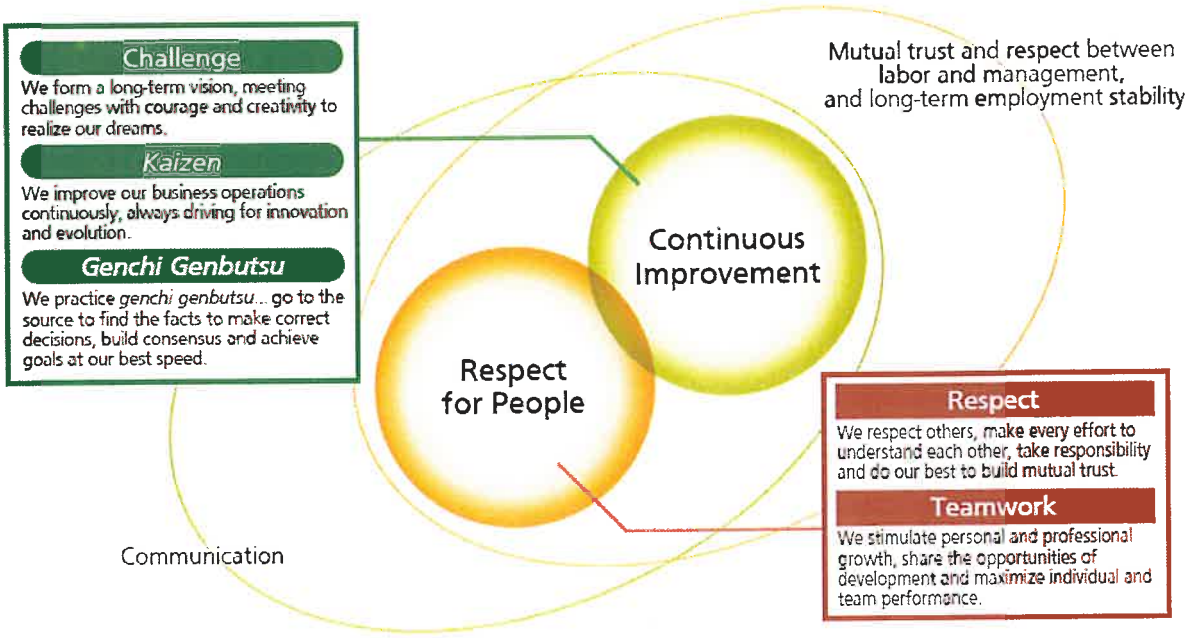

Figure 2-9: Toyota's values as published in the 'Toyota Way 2001'

2.7.2 Modelling the TPS: Level Three

Level Three may be described as positive evolution or correction to the context of Level Two (Bateson, 1972:301), i.e., to the values of the TPS. This dissertation uses the word 'purpose' to describe such instances. The following section summarises the views of some authors as it relates to the context of the values that Toyota practices. Four expressions may be used to describe TPS Level Three, namely success, perfection, contribution and honour. The first one described is success:

Success

Toyota's aim for success is a primary focus (Toyota 2004a:9; 2005a:3; 2006a:5; 2007a:9 2008a:7, 2008c:5). Three terms are defined to describe success from Toyota's perspective, namely consummation, realisation and beneficence.

Consummation

Toyota understands that being faithful to their underlying principles will result in success, and that faithful, studious, and creative behaviour leads to success (Toyota, 2006b, 2006a:53). Womack and Jones (2003:234) suggest part of the reason why Toyota has been successful is because of the knowledge and change contribution of Ohno and the continuity of Eiji Toyoda, President of the organisation during Ohno's tenure. Toyota also focuses on success in technological innovation through slogans like 'taking on unheard of challenges' and 'taking on challenges that defy common sense', (Toyota, 2004a:25).

For this dissertation consummation is defined as being faithful to underlying principles, with the end goal of success in mind. The next term defined to describe success is realisation:

Realisation

Womack and Jones (2003:339) suggest perseverance is a key characteristic of the TPS – elsewhere explaining success is derived through 'doing one thing at a time and working on it continuously until completion'. Toyota safeguards their success and does not view it as guaranteed (Toyota, 2008a:60). Senior management consistently warns against complacency and arrogance, and repeatedly states that success is not a given, rather it needs to be deserved by Toyota (Toyota, 2008a:60-61). Konishi (2007), who heads the Toyota Institute in Japan, says there is a 'sense of danger', and that Toyota has to 'prevent the Toyota Way from getting more and more diluted as Toyota grows overseas' (2003:95). Toyota believes they 'must adapt to the environment but can also exert control over the environment' (Liker and Hoseus, 2008:73).

For this dissertation realisation is defined as persevering to complete one thing at a time until completion of the end goal is reached. The term defined to describe success is beneficence:

Beneficence

Toyota believes their future success relies upon their ability to satisfy customers with value through speed, innovation, and competitively priced products (Toyota, 2008:60). Success for Toyota is also mutual, i.e., if prosperity is not shared between all members and partners then it cannot be counted as success (Toyota, 2003a:78).

For this dissertation, beneficence is defined as creating and sharing prosperity with all members and partners in reaching the end goal.

Success is therefore defined as being faithful to underlying principles, with the end goal of success in mind; persevering to complete one thing at a time until completion of this goal; and, creating and sharing prosperity with all members and partners in reaching this goal.

The next expression used to describe TPS Level Three is perfection:

Perfection

Ohno infers the achievement of perfection should be the primary objective of an organisation and counted as a crime against society where it does not exist (1988:129). Ohno was said to never be satisfied with less than 100% achievement of results (Liker and Hoseus, 2008:323). Three terms are defined to describe perfection from Toyota's perspective, namely evolution, virtue and fulfilment.

Evolution

Ohno states the total and comprehensive elimination of waste is the basis of the TPS (1988:9, 95). Womack and Jones describe the absolute elimination of waste as being part

of Toyota culture (2003:90). As an example, they claim Toyota 'certainly had a picture of perfection' when they conducted radical improvements to the provision of service parts, and although perfection is unattainable, the drive to reach it provides essential inspiration and progress (2003:94). Womack and Jones (2003:244) suggest Toyota understands waste from an extended supply chain or global perspective, which helps them to avoid local optimisation without any real effect on the performance of the overall supply chain.

For this dissertation, evolution is defined as the journey towards the complete elimination of waste. The next term defined to describe perfection is virtue:

Virtue

Toyota mentions perfection when talking about the aim of their brands (Toyota 2005a:25) and new roll outs (2006a:23), a potential indication of the value-add they intend to provide customers with. Value as defined by the customer is the opposite of waste, e.g., all activities that the customer is willing to pay for and the goal of the TPS is to achieve expedient provision of such value at a reduced cost (Womack and Jones, 2003:97; Ohno 1989:9, 57, Liker 2004:280).

For this dissertation, virtue is defined as providing customers with perfect value. The next term defined to describe perfection is fulfilment:

Fulfilment

One of the wastes that the TPS tries to eliminate is the waste of not utilising human potential (Liker and Hoseus, 2008:38). Ohno describes the role of human productivity in the following manner: 'There is no magic method. Rather, a total management system is needed that develops human capacity to enhance creativity and fruitfulness' (Ohno: 1988:9). Toyota actively promotes innovation and creativity amongst employees in their drive towards perfection (Toyota 2006:52, 2004:26, 2005:21, 2007:48).

For this dissertation, fulfilment is defined as developing and applying human capacity to its full potential.

Perfection may therefore be defined as the journey towards the complete elimination of waste to provide customers with perfect value through developing and applying human capacity to its full potential.

The next expression used to describe TPS Level Three is contribution:

Contribution

Toyota aims for the sustainable contribution of people, partners, and society through the manufacture and provision of their products and services and their corporate activities (Toyota, 2007:48; 2006:5; Liker and Hoseus 2008:10; Liker, 2004:81). Three terms are defined to describe contribution from Toyota's perspective, namely charity, bestowment and augmentation.

Charity

Sakichi and Kiichiro Toyoda started the organisation with the ideal of the greater good of society (Liker and Hoseus, 2008:11). Still today, Toyota vigorously encourages its affiliates to participate in philanthropic activities that enrich and benefit society (Toyota, 2007a:49, 57).

For this dissertation, charity is defined as participation for the greater good of society. The next term defined to describe contribution is bestowment:

Bestowment

Eiji Toyoda, former chairperson, viewed people as the most important asset of Toyota and the determinant of the rise and fall of Toyota (Liker and Hoseus, 2008:12, Toyota, 2006g). The contribution to people, partners, and society is viewed from the standpoint of a global citizen, motivated by a drive to win the 'trust and respect of the world', according to former President of Toyota, Hiroshi Okuda (Liker and Hoseus, 2008:12).

For this dissertation, bestowment is defined as winning the trust and respect of the world. The next term defined to describe contribution is augmentation.

Augmentation

In promoting itself as a responsible global corporate citizen, Toyota communicates the concept of mutual trust and contribution (Toyota, 2006g). It is the obligation and responsibility of all Toyota employees, both senior and junior, to work towards the benefit of each other, the organisation, customers and society at large, and this is stated as one of the guiding principles (Toyota, 2008a:52; 2006a:53). An example of this is the resigning of Kiichiro Toyoda and his entire management team after taking responsibility for financial hardships that led to lay-offs in 1950 (Toyota, 2007b:56, Womack and Jones, 2003:233).

For this dissertation, augmentation is defined as significantly benefiting all stakeholders involved.

Contribution is therefore defined as participating for the greater good of society to win the trust and respect of the world through significantly benefitting all stakeholders involved.

The next expression used to describe TPS Level Three is honour:

Honour

To satisfy a customer is a matter of honour for Toyota employees (Liker and Hoseus, 2008:73). Three terms are defined to describe honour from Toyota's perspective, namely magnanimity, empathy and friendship

Magnanimity

Toyota views 'the customer first' as a primary philosophy (Toyota 2007c, 2007d; 2008a:52; 2003a:66). This translates into quality products and Toyota's art ('monozukuri') to produce

and meet the reality and rhythm of customer needs through value-added products (Toyota 2007c, 2003a:5, 2008b:61).

Toyota Motor Sales was established by Shotaro Kamiya. He was well known for his outlook on who should be beneficiaries of automotive sales – first the customer, then the dealer, then the manufacturer, as it would ultimately benefit the manufacturer (Liker, 2004:177; Toyota, 2007c).

For this dissertation, magnanimity is defined as first and foremost meeting the reality and rhythm of customer needs. The next term defined to describe honour is empathy.

Empathy

Toyota understands that only the customer can define value, and strives to present such value to their customers. Toyota is set up to understand their customer. The original Toyota selling approach was to engage their customers directly with door-to-door sales (Toyota, 2007c, Liker 2004:177). One of the significant ideas behind the TPS was the realisation that customers' needs are unique and that mass production of a specific product in general might not satisfy the average customer. For this reason, Ohno engineered the manufacturing capabilities of Toyota to have continuous flow in small lot production (Womack and Jones, 2003:23).

For this dissertation, empathy is defined as having a real and comprehensive understanding of individual customers. The next term defined to describe honour is friendship:

Friendship

Toyota aims to keep and satisfy customers for life (Liker and Hoseus 2008:496; Liker, 2004:177; Toyota 2003a:43, Womack and Jones 2003:235). Toyota employees and dealers are encouraged to build relationships with customers and experience firsthand what customers want. (Liker, 2004:177,178). They actively collect and study customer information through various sources, from surveys to complaints, and try to integrate 'the voice of the individual customer' and link this with research and development divisions (Toyota, 2003a:66).

For this dissertation, friendship is defined as building lifelong satisfying relationships with customers.

Honour is therefore defined as first and foremost meeting the reality and rhythm of customer needs through having a real and comprehensive understanding of individual customers, in order to build lasting satisfying relationships.

2.7.3 Summary of the TPS according to Bateson

Below follows a summary of TPS Level One, Two and Three for the purposes of this dissertation:

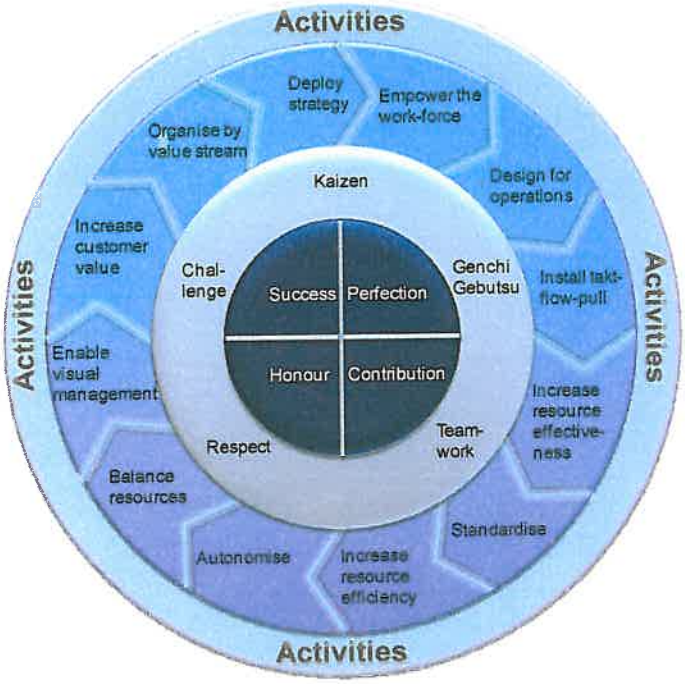

Figure 2-10: Summary of TPS Level One, Two and Three

Comparison with existing models of the TPS

When comparing this model with e.g. Womack and Jones (1996,2003) or Liker (2004), or the Shingo Prize (2010, version four), some differences and similarities may be noted. An example comparison with Womack and Jones' five principles of Lean Thinking is provided below:

- Womack and Jones' (1996, 2003) five principles of Lean Thinking is potentially comparable with TPS Level One as modelled in this dissertation. Some of the strategies depicted are similar and informed by Womack and Jones' ,e.g. their 'Specify value' vs. the TPS strategy of 'Increase customer value', or their 'Identify the value stream' with the TPS strategy of 'Organise by value stream' , their 'Flow' and 'Pull' with the TPS strategies of 'Promote Flow' and 'Balance resources'.
- Womack and Jones' remaining principle, 'perfection', may be coupled with a number of TPS strategies, most notably 'Formalise industrial engineering' , 'Increase process effectiveness and efficiency' and to some extent 'Standardise' , 'Create intelligent processes', and 'Eliminate waste before it occurs'.
- Some of the TPS strategies mentioned may also be viewed as enablers of Womack and Jones' five principles of Lean Thinking, e.g. the TPS strategy 'Enable visual

management' may be a requirement for effective flow, whereas 'Deploy policy', 'Empower employees' may be seen as enablers for all five of their principles.

- Womack and Jones' principles do not seem to touch on higher levels of the TPS as proposed by this dissertation – e.g. they do not provide the context of their principles as this dissertation does in the form of 'values', or 'purpose'.

Similar comparisons are possible with Liker's (2004) fourteen principles of the Toyota Way, and the Shingo Prize.

- Whereas Womack and Jones provide a succinct summary, both Liker and the Shingo Prize elaborate, in a way similar to that of the twelve strategies and 48 activities of the TPS proposed by this dissertation.
- Again, Liker (2004) and the Shingo Prize (2010, version four) are comparable to the TPS Level Zero and One as proposed by this dissertation. Although both models provide some context for their principles (limited referral to what this dissertation calls 'values'), the bulk of their models depict a level similar to TPS Level Zero and One
    - The only reference Liker (2004) makes to a higher level is with one principle – 'Base your management decisions on long term philosophy, even at the expense of short-term financial goals (2004:69). The Shingo Prize refers to two values, i.e. 'lead with humility' and 'respect every individual'.
    - No reference is made to the 'context of the context', i.e. what this dissertation proposes as TPS Level Three or 'purpose'.

Application

- Given the limited reference to the context in which the TPS operates by existing models, it is decided not to use existing models when comparing selected organisations to Toyota but rather to apply Bateson (1972) from first principles to available literature. This allows references to the 'context' and 'context of the context' to be made, and to satisfy the criticism of Ballé et al (2006) and Johnson's (2006) theories.
- When compared to the existing models, the twelve strategies this dissertation proposes may potentially be at different levels of resolution as compared to these models. However, the intention is to provide an exhaustive and holistic view of the TPS using Bateson (1972).

2.8 Other considerations when comparing organisations with Toyota

This section discusses two considerations which may influence the interpretation of the main research question, i.e.

> **How prevalent is the fundamental nature of the TPS in selected South African organisations?**

As explained earlier, the fundamental nature of the TPS is regarded as TPS Level Zero and one.

Specifically, the type of product and manufacturing process combination and cultural differences between Japan and South Africa are analysed to consider when comparing South African organisations to Toyota.

2.8.1 Type of product and manufacturing process

An organisation's position on the product and process lifecycle matrix (Hayes and Wheelwright, 1979), subsequent implications for its management approach (Schmenner, 1987) and distinction between competitive dimensions (Chase et al, 2001) may all impact an organisation's selection of strategies:

Stage in the product and process lifecycle

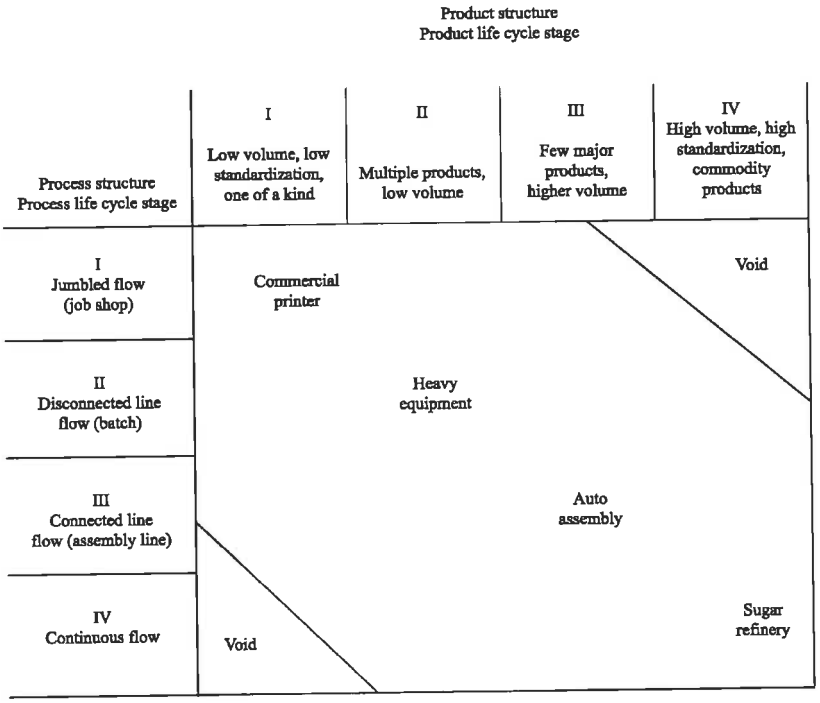

Figure 2-11: Product Process Matrix (Hayes and Wheelwright, 1979a:135)

Hayes and Wheelwright (1979a:133) constructed a product structure/lifecycle – process structure/lifecycle matrix and suggest that understanding an organisation's position on their matrix may describe its strengths and weaknesses in the corporate strategy. A further distinction is drawn – the closer an organisation stays to the centre diagonal the more similar it remains to its competitors, but when it pursues more or less flexibility in production or a broader or narrower product line it further distinguishes itself from its competitors, it pursues a different competitive advantage that should impact the manufacturing organisation in setting objectives, investment decisions, changes to production processes, and market positioning (1979a:140, 1979b:127, 136).

Inference for Toyota - Toyota, as an organisation focusing on automobile assembly, would fit the 'few, major products; connected line flow' position. However, given Ohno's assertion that differences between Japanese and USA markets required Toyota to move away from Ford's focus of a mass production system to develop a larger variety of models at smaller quantities (Ohno, 1988:37; Cachon and Terwiesch, 2009:203), it suggests Toyota is positioned to the left of the diagonal with regards to Ford.

Implications for management of manufacturing organisations

Schmenner (1987:247-249) goes further to suggest the position on the product process matrix not only has operation, marketing and strategy implications but also organisational culture and management implications, as different positions hold different challenges for management and the organisation.

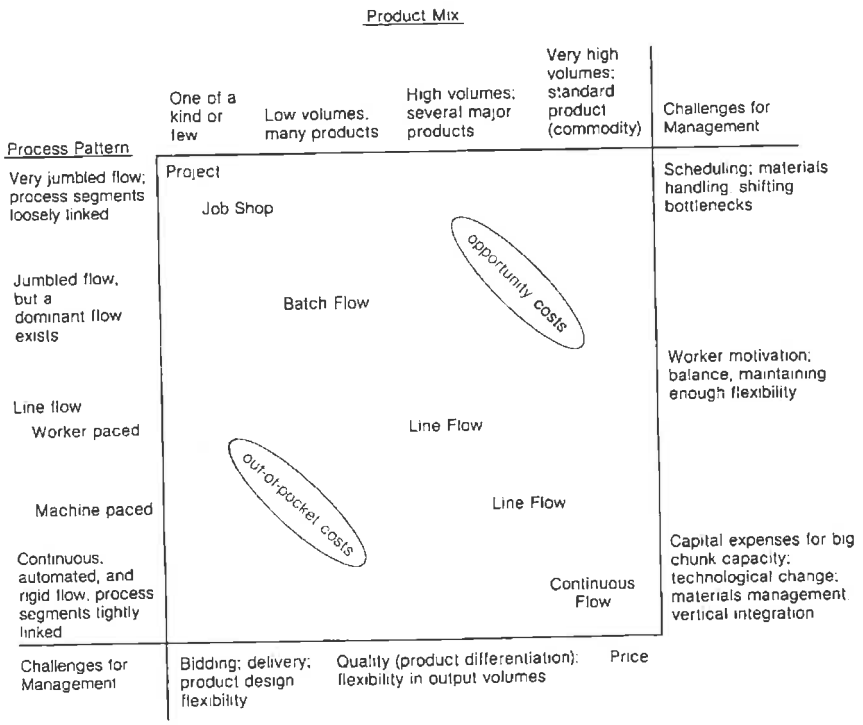

Figure 2-12: Product Process Matrix and Related Challenges for Management (Schmenner, 1987:249)

Inference for Toyota - Toyota falls in the 'high volumes, several major products' category, but given their line flow driven by Takt time, would fall in the machine paced category, which again positions them left of the diagonal. Applying Schmenner's matrix (1987), this implies Toyota faces or have had to overcome management challenges related to quality, product differentiation, flexibility in output volumes, worker motivation, balance and maintaining enough flexibility; which would have impacted their culture and strategies.

Implications for management of service organisations

In addition, Schmenner suggests the management challenges a service organisation faces may be different from challenges a manufacturing organisation need to overcome due to the different product type offered (1987:250). The degree to which it has contact with customers and its labour intensity may be a further determinant in challenges its management will need to overcome, and may be summarised in matrix related to the product process matrix (Schmenner, 1987:256). It is difficult to locate Toyota on Schmenner's service process matrix – one reason is that Toyota is primarily involved in manufacturing. For a discussion on how Toyota may be positioned on the service process matrix see appendix K.

		Degree of Contact with, and Customization for, the Consumer		Challenges for Management
		Low	High	
Degree of Labor Intensity	Low	The Service Factory Airlines, trucking, hotels, resorts, and recreation	The Service Shop Hospitals, auto, and other repair services	Capital decisions, technological advances, managing demand to avoid peaks and to promote off-peaks, scheduling delivery of service
	High	Mass Service Retailing, wholesaling, schools	Professional Service Physicians, lawyers, accountants, architects	Hiring, training, methods development and control, employee welfare, scheduling workforces, control of often geographically spread locations, start-up of new units, managing growth
Challenges for Management		Marketing, making service "warm," attention to physical surroundings, managing fairly rigid hierarchy with need for standard operating procedures	Fighting cost increases, maintaining quality, reacting to customer intervention in process, managing advancement of people delivering service, managing flat hierarchy with loose subordinate-superior relationships, binding workers to the firm	

Figure 2-13: Service Processes Matrix and Related Challenges for Management (Schmenner, 1987:256)

2.8.2 Japanese culture

Liker (2004:234) suggests Japanese culture does play a role in the success of the TPS, and that significant effort is applied by Toyota to transfer their culture when manufacturing in non-Japanese locations. Toyota manufactures in 26 countries on six continents, including South

Africa (Toyota, 2009b:10-11). To consider culture, this dissertation considers the work of Hofstede (2001), and comments by Liker and Hoseus (2008).

Hofstede (2001) conducted an in-depth comparison of 50 cultures and suggested it plays a significant role in the determining organisational values. He suggests culture may be described and compared by comparing relative outcomes of five cultural dimensions, i.e. power-distance index, individuality, masculinity, uncertainty avoidance and long term orientation. A comparison between South African and Japanese culture can accordingly be drawn.

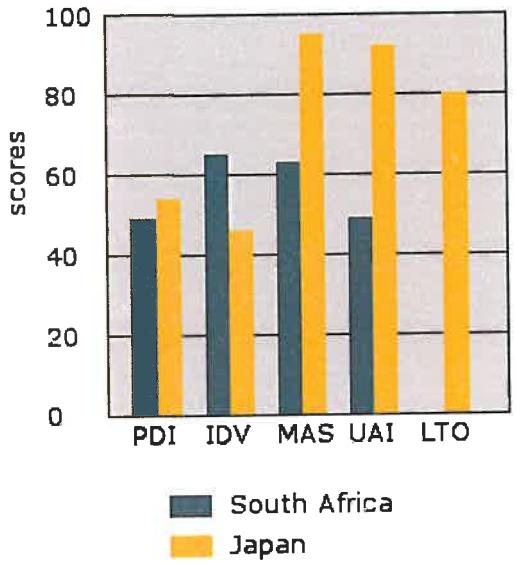

Figure 2-14: Relative Comparison across Five Cultural Dimensions between South Africa and Japan (Hofstede, 2003)

Hofstede (2001: xix-xx; 2003) explains the graphs as follows

Power Distance Index (PDI) is a measure of how likely people are to accept unequal distribution of power. Individuality (IDV) is a measure of how un-group oriented the society is. Masculinity (MAS) is a measure of the distribution of roles between the genders, with a high outcome indicating assertiveness and competitiveness of men; with women taking the modest and caring values. Uncertainty Avoidance Index (UAI) is how tolerant the nation is of vagueness. Long-Term Orientation (LTO) is an indication of the time horizon to which a society prescribes.

The Hofstede comparison between South Africa and Japan show two major differences in the outcomes of 'Masculinity' and 'Uncertainty Avoidance'[xi].

- Difference in the 'Masculinity' outcome - Cultures with a high outcome in masculinity will seek challenge and recognition in their jobs as opposed to harmonious relationships, higher job stress as opposed to lower, prefer larger as opposed to smaller

[xi] Long term orientation was not measured in South Africa by Hofstede

organisations, allow work to take a central role in life space opposed to wanting more separation, pursue high mastery vs. low mastery, pursue survival above well-being, and seek leadership and self-realisation above service (Hofstede, 2001:298).

- Difference in the 'Uncertainty Avoidance' Outcome - Cultures with a high outcome in Uncertainty Avoidance show, amongst others, the following behaviours: tendency to stay with the same employer as opposed to less hesitation to change, view organisation loyalty as a virtue as opposed to not, has a preference for larger rather than smaller employers, prefer specialist to management positions, and have an ideological preference for consultative management rather than authoritative management. They also believe organisation rules may not be broken, even when necessary, may believe what is different is dangerous, prefer to take only known risks, have a fear and respect for older people, and feel a need for clarity and structure (Hofstede, 2001:160-161).

A third aspect of culture, where Hofstede did not include South African culture in his comparison, is long-term orientation. Long-Term Orientation is an indication of the time horizon to which a society prescribes. South African culture is expected to have a lower score than Japanese culture, which may explain some differences as well.

Other views

Denison et al (2004) question whether it can be proven that significant differences exist in organizational culture across different nationalities. They conducted a study among 218 independent supermarket groups affiliated to an international body in seven countries, including South Africa and Japan. Using a well-known organizational culture measuring instrument, they could not find significant differences between the different regions among their sample along different dimensions of the instrument. Although they believe significant differences exist between national identities and expression of culture, they question the widely held assumption that significant differences in organisational culture exist and what employees value. They suggest that their study is not necessarily in conflict with national culture instruments such as Hofstede, as they focused specifically on organisational culture.

Spoelstra and Raubenheimer (1981) disagree. They do not believe a comparison between South Africa and Japan is straightforward, as South Africa has a heterogeneous composition and Japan homogenous. Their work compares two South African groups (western and non-western) and Japanese culture, and suggests differences in organisational values play a significant role in individual effectiveness. From this perspective they suggest further research to understand the differences in South African sub-cultures, and would not agree with research such as Hofstede that assumes a single cultural setup for South Africa. Regardless, they draw some comparison between western groups in South Africa and Japanese culture, noting individual effectiveness in Japan centres around cultural variables of good judgement, cooperation, and drive; and in South Africa (western cultures) around intelligence, ambition and

self confidence. They suggest 'initiative' is a shared cultural variable around which individual effectiveness revolve. In addition, Spoelstra (1980) suggest that where western South African organisational culture is mostly driven by 'individualism' (1980:59), 'groupism' is the major organisational culture driven in Japan.

Inference for Toyota - The TPS was developed in Japan by Ohno, a Japanese industrial engineer, supported by other Japanese engineers (Ohno, 1989). This dissertation therefore assumes the fundamental nature of the TPS is distinctly informed by Japanese culture.

2.8.3 Implications for this study

Four implications for this study are considered. Firstly, the impact of an organisation's position on the product process matrix of Hayes and Wheelwright, including Scwhemmer's adaptation. Secondly, the impact of culture when comparing South African organisations with Toyota. Thirdly, as a counterargument, Toyota South Africa's apparent success with the TPS despite a predominantly South African workforce, and lastly, the implications for case selection.

- Different positions on the product-process matrix or competitive dimensions chosen than that of Toyota's may result in different strategies being promoted.
    - Organisations in different stages or positions on the product-process matrix faces specific operational and managerial challenges related to their position on this matrix. Organisations will focus on strategies that help them to overcome these challenges.
    - Similarly, organisations select to excel in specific competitive dimensions given the way they wish to position themselves in the market as opposed to their competitors, which further influences the strategies and approach to improvement they select.
- This study notes different views on the role that cultural differences between Japan and South Africa may play, but decides to use Hofstede (2001) to understand cultural implications: The cultural differences between South Africa and Japan may result in different strategies being promoted by the South African organisations as opposed to Toyota, related to differences in 'Masculinity' and 'Uncertainty Avoidance' outcomes of the Hofstede (2001) comparison.
    - Japanese culture's higher outcome for 'Masculinity' could, for example, mean strategies associated with waste reduction or improvement are more readily promoted by Japanese as opposed to South African organisations, as one of the outcomes associated with a high outcome in this dimension is a higher drive for mastery

- Japanese culture's higher outcome for 'Uncertainty Avoidance' may mean that, compared to South African organisations, the TPS strategies related to standardisation is much more sought after and easier to implement, as one of the outcomes of a culture with a high outcome in this dimension is a tendency to want, and follow, rules

An attempt is made below to map the impact of these cultural differences to the TPS strategies:

Table 2-17: Map of potential impact of Cultural differences between South Africa and Japan to TPS strategies

Strategy	Japan cultural influence supporting the TPS strategy (Hofstede, 2001)
Increase customer value	**Long-term orientation** (Toyota will view the relationship as longer term)
Organise by value-stream	**Masculinity** (Toyota management will pursue mastery)
Deploy policy	**Masculinity** (Toyota employees will demand challenges and recognition)
Empower employees	**Masculinity** (Toyota employees will pursue mastery; Toyota employees will demand challenges and recognition)
Eliminate waste before it occurs	**Long-term orientation** (Toyota may view lifecycle from a longer term perspective)
Promote flow	**Masculinity** (pursues high mastery vs. low mastery)
Increase process effectiveness and efficiency	**Masculinity** (pursues high mastery vs. low mastery)
Standardise	**Uncertainty avoidance** (believe what is different is dangerous)
Formalise industrial engineering	**Masculinity** (Toyota employees will pursue mastery)
Create intelligent processes	**Masculinity** (pursues high mastery vs. low mastery)
Balance resources	**Masculinity** (pursues high mastery vs. low mastery)
Enable visual management	**Uncertainty avoidance** (Toyota employees will believe organisational rules may not be broken)

- Toyota's apparent success with the TPS in South Africa could mean that different cultural values drive similar strategies.
  - In the 'Deploy Policy' section of the literature study it was shown that Toyota promotes similar strategies and values of the TPS in South Africa as in Japan. Although the success in applying these values and strategies in their South

African operations compared to their Japanese operations are not known, one explanation could be that they linked the TPS values and strategies as used in Japan to other aspects of South African culture, e.g. South Africa's lower outcome in 'Uncertainty Avoidance' as compared to Japan may mean that strategies linked to continuous improvement fit the culture due to a higher natural desire for change.

- A selection of cases in different positions on the product-process matrix, or pursuing different competitive dimensions, allows some understanding of the impact these dimensions have on strategy development and prioritisation at the selected cases.
    - Ideally, case selection would allow the exclusion of variables such an organisation's position on the product process matrix, or its competitive dimensions prioritised or country culture. Would this be possible, organisations participating in this study would manufacture automobiles, be infused in Japanese culture and have a multi-competitive dimension approach similar to Toyota.; and conclusions regarding the absence or presence of the TPS Level One strategies might be drawn with more certainty. Would this not be possible, then the best selection would include organisations on very different positions on the product process matrix, pursuing different competitive dimensions, as this would allow a discussion on the potential impact of these parameters on the presence or absence of the TPS Level One strategies at these organisations. This dissertation assumes the latter, and will aim to select cases based on different positions on the product-process matrix, or pursuing different competitive dimensions.

2.9 Summary

Some authors view the TPS as a set of tools that drives efficiency in organisations. Others note that the TPS is best described by viewing it as a system that facilitates learning, of which Bateson's theory of learning may explain the phenomenon and why some organisations are unable to successfully implement the TPS (Ballé et al, 2006; Ballé and Régnier, 2007; Tosey et al, 2005; Tosey, 2005; Johnson, 2006).

Bateson (1972) describes learning as the ability to understand, apply, and improve skill sets on four different levels, i.e. Learning Zero, One, Two and Three; and is according to him the only correct way to understand learning in social contexts. Bredo (1989) suggests that higher Bateson levels inform lower levels. Tosey (2006, 2008) suggests the description of the class of a lower level is a description of the higher level and that learning takes place simultaneously on all Bateson's levels. Dilts (1998) explains how the levels of learning relate to vision, values, strategies and activities of organisations. The application of Bateson, Bredo, Tosey and Dilts allows the creation of the theoretical framework of the TPS, by defining its activities, strategies,

values and purpose. The fundamental nature of the TPS, called TPS Level One, is defined as its strategies, equivalent to Bateson Learning One. .

A study of literature on the TPS revealed 48 activities (defined by 135 sub-activities) on the TPS Level Zero; the context of which inform twelve strategies on the TPS Level One; as can be seen in the table 2-18:

Table 2-18: Summary of the fundamental nature of the TPS

strategies (TPS Level One)	activities (TPS Level Zero)
Increase Customer Value	Understand the customer's perspective of value. Re-engineer core products to improve customer value. Redefine organisation processes to increase customer value. Add value to the customer throughout the lifecycle of the product.
Organise by value stream	Reconfigure teams to let value flow. Install horizontal accountability and leadership. Re-align vertical roles.
Deploy Strategy	Set targets for the broader organization. Set management goals. Create second-level plans to achieve management goals. Check progress to plan on a regular basis. Continue to set stretching goals.
Empower employees	Train on the task-outcome required. Follow the Socratic Method. Train and multi-skill in value-stream tasks. Ensure active mentoring and coaching. Encourage voluntary self-study. Hold employees responsible to surface and solve problems. Reward improvement.
Eliminate waste before it occurs	Involve a cross-functional team during the design process. Take the overall lifecycle into account. Design products that are easy to produce.
Promote Flow	Link operations output to customer demand. Remove factors impeding flow. Keep the overall supply chain in mind. Manufacture 'Just-In-Time'.
Increase process effectiveness and efficiency	Ensure processes truly specify customer value. Maximise the capability of processes by removing waste. Ensure a process or resource is available when required. Acquire processes and resources of adequate value-stream capacity. Modify processes or resources to do quickly change over from one product to another.
Standardise	Structure and train to a standard set of tasks. Test whether standards are in place. Have operators own and update standards.
Formalise industrial engineering	Install a process for facilitated, radical improvement Let the industrial engineering department be profitable Emphasize methods and layouts that are optimised for human performance
Create intelligent processes	Stop a machine before damage can be done to part, machine or operator. Ensure specific accountability to add intelligence to processes. Implement devices to prevent future occurrences of the problem.
Balance Resources	Fit customer demand into a level schedule. Use standard work to balance resources. Separate rework from normal production. Find equilibrium between make to order and make to stock.
Enable Visual Management	Separate. Set in order. Set countermeasures. Sustain.

2.10 Conclusion

The main research question of this dissertation asks **'How prevalent is the fundamental nature of the TPS in South African organisations?'**

Chapter two provides insight into how this question should be answered. It defines the fundamental nature of the TPS as twelve strategies, using a framework based on an adaptation of the theory of learning of Bateson. It also highlights aspects that need to be taken into account when comparing South African organisations with the TPS, such as the type of product or process, competitive dimensions chosen and cultural context. It also specifies the higher levels of the TPS model according to Bateson, as this information may provide insights explaining potential differences.

The main hypothesis of this study states that the fundamental nature of the TPS will be found at selected South African manufacturing organisations.

Given the description of chapter two, this dissertation interprets this statement to imply that all the activities that inform the strategies or fundamental nature of the TPS will be found at the selected manufacturing organisations when compared. Chapter three explains how this study sets about to answer the main research question through testing this hypothesis.

3 Methodology

This section presents a qualitative multiple case research approach and proceeds to explain the research design, focusing on the research question, hypotheses, units of measure, case selection, and the potential audience interested in the outcome of this study. This is followed by a discussion on validation of the research methodology, construct validity, internal validity, external validity, and lastly reliability. The chapter concludes by reviewing the case study protocol, database design, and pilot case study.

How to read this section

The application of theory has been given a light grey background. This allows the reader to navigate easily between theory and application.

3.1 Research approach

There are many approaches to understand research in the field. Kumar (2008:6-10) suggests research may be thought of as descriptive vs. analytical or interpretive, applied vs. fundamental or pure, quantitative vs. qualitative, conceptual vs. empirical, experimental vs. non-experimental, confirmatory vs. exploratory, cross-section vs. longitudinal, etc.

Leedy (1997:109) advises that when the object of research consists of multiple constructed realities or if the study is exploratory or interpretive, it is best to use a qualitative approach. If the purpose of the study is to examine a specific phenomenon in detail with a relatively small number of participants, a qualitative approach becomes paramount, for which a case study approach is ideal.

Dul and Hak (2008:5) suggest when a case study approach is considered to an experiment, the question is whether instances will be manipulated or not, and when considered to a survey, the number of instances from which data is collected and the method of data analysis. They suggest a case study approach when instances will not be manipulated and where either a single case study or a small number of cases will be compared from a using a qualitative approach. They suggest quantitative statistical analysis is better used with surveys.

Yin (2003:14) suggests the legitimacy of a case study approach depends on the type of research question, purpose of the case study, and approach to replication. His view differs from Dul and Hak (2005) as he argues that the question whether research is qualitative or quantitative is irrelevant when considering a case study approach, as a case study may be entirely based on quantitative data.

This study will follow a qualitative approach as it intends to explore multiple approaches by South African organisations related to the fundamental nature of the TPS, and takes note of the suggestion of Leedy (1997) and Dul and Hak (2005) to consider a case study approach given the exploratory nature including a small number of instances analysed from a qualitative

perspective. However, to confirm whether a case study approach is more appropriate than experiments, field studies, surveys, a history or computer-based analysis of archival records; Yin's suggestion to explore the type of research question, purpose of the case study and approach to replication is followed.

3.1.1 The type of research question

Some authors suggest a case study approach could be helpful to concentrate on specific instances or elements called by different names or applied in different settings in the object of analysis (Bell, 1999:11; Leedy, 1997:157).

This research explores the prevalence of the TPS activities and strategies in participating South African organisations. It does not require these organisations to have a prior knowledge of the TPS, and similar strategies may be called by different names or applied in different settings, which makes a case study approach applicable.

3.1.2 The purpose of the study

According to Yin (2003:14), the following definition should hold when a case study approach is selected: 'A case study is an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries of the phenomenon and context are not clearly evident' (Yin, 2003:13) and 'the case study enquiry copes with the technically distinctive situation in which there will be many more variables than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical hypotheses to guide data collection and analysis'.

The following paragraphs focus on elements Yin raises above to determine whether the criteria for selecting a case study approach are met.

Contemporary phenomenon

Marchwinski and Shook (2006) and Liker (2004) suggest the TPS is a contemporary phenomenon. They explain how the TPS was popularised in 1990 through publication of 'The Machine That Changed the World' by Womack, Jones, and Roos; which highlighted the vast efficiency differences between Toyota and other motor manufacturing groups, resulting since in the application of the TPS principles in a wide array of service and production environments (Marchwinski and Shook, 2006:95; Liker, 2004:16, 25).This dissertation therefore regards the TPS as a contemporary phenomenon, and suggest a case study approach is applicable.

Real-life context

The object of analysis is the real-life operation of selected organisations, to understand whether they apply similar strategies as the TPS level as informed by comparing their activities to that of the TPS Level Zero. In addition, the literature study showed how Bateson's theory, used by this dissertation to create a theoretical framework of the TPS, is based on understanding context,

emphasising the requirement to take the real-life context into account (Bateson, 1972:288, 293, 301).

Boundaries of the context and phenomenon

The literature describes the phenomenon, the fundamental nature of the TPS, as twelve strategies. This research focuses on selected South African organisations (culturally fully South African) operating in different industries, none of which are in the automotive industry (i.e. occupying a different position on Hayes and Wheelwright's product-process matrix). It would, therefore, be difficult to define the boundaries of the context to be studied, as many of these organisations could follow similar or equivalent strategies as Toyota, without calling it the same.

Amount of variables compared to data points

Due to the large and sophisticated nature of Toyota Motor Corporation, it would be difficult to use only one data source at participating organisations to inform a set of variables. The literature study also showed how the context or class of a group of activities (multiple data points) inform one strategy (single variable). Therefore, it seems a case study approach is appropriate.

Amount of sources of evidence

Apart from improving the reliability of the research, studying a large system like the TPS or its fundamental nature would require more than one source of data to comprehend its application. This dissertation would, therefore, have to consider multiple sources of evidence, which makes a case study approach appropriate.

Prior development of theoretical hypotheses

The study of the prevalence of the TPS strategies at South African organisations requires the development of hypotheses prior to the start to guide the research. Practically, this means the research instrument will search for similar activities in participating South African organisations as those practised by Toyota, or its equivalents, to inform whether similar strategies are in place. This requirement and approach suggest a case study methodology is applicable.

3.1.3 Strategy for replication

If it is not possible to select a representative sample of the object of analysis, research can achieve external validity by wisely selecting specific cases, and replicating case results to support a specific theory, e.g., through the use of a case study approach (Yin, 2003:34, 47).

It would not be possible to select a representative sample of South African organisations to study its main research question. As per Yin's suggestion, this study will select specific organisations to participate to replicate results.

3.1.4 Conclusion on research strategy

Judging the type of research question, purpose of the case study, and approach to replication, it seems a case study approach is the best methodology to follow.

3.2 Research design

After determining the research strategy, Yin suggests focusing on the research design. He describes it as follows: 'Colloquially, a research design is a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there some set of conclusions (answers) about these questions' (2003:20). He warns that the research design needs to be the logical argument that will answer the research questions, and it includes the questions to focus on, the relevant data, what information to search for and then how to conduct the analysis of this information (2003:21). He suggests a mature research design will cover the purpose, questions and hypotheses, embedded vs. holistic design, unit of analysis, multiple vs. single case design, selection of cases, modification of theory and ethics.

The following section discusses the topics suggested by Yin (see above) to develop the research design.

3.2.1 Research purpose

A case study can be used for descriptive, exploratory or explanatory purposes in research work (Yin, 2003:3, Tellis, 1997).

Descriptive case studies illustrate phenomena (Yin, 2003:15) and require the investigator to start with a descriptive theory. It may use pattern matching as a technique of analysis with cause/effect relationships (Tellis, 1997). Yin disagrees and says causal relationships are not part of descriptive case studies and, therefore, internal validity is irrelevant (Yin, 2003:35). Both, however, agree that if pattern matching is used in research, the theoretical pattern(s) need to be established prior to data collection (Yin, 2003:116; Tellis, 1997).

Exploratory case studies rely on criteria by which the success of the study will be judged, and the analysis to define the case. Fieldwork and data collection may be undertaken prior to development of the study's questions or hypotheses, as long as the theoretical framework is determined ahead of time. Pilot case studies will support the development of the final hypotheses (Tellis, 1997).

Explanatory cases study the causal links between phenomena. Internal validity is important for explanatory case studies (Yin, 2003:34), and the case must consider rival theories and alternative explanations (Yin, 2003:163,164). Pattern matching is a useful analytical technique in explanatory studies (Yin, 2003:35, Tellis, 1997).

Application in this dissertation

As stated before, the purpose of this dissertation is to study the prevalence of the fundamental nature of the TPS at selected organisations (defined as the strategies of the TPS, evident because of the activities being practised). It is not interested per se in what caused the presence or absence of certain strategies or activities, i.e., not explanatory; nor in describing the individual working of these organisations, i.e., descriptive. Rather, the idea is to explore the presence of strategies at the participating organisations, and it relies on the use of sub-hypotheses to focus the data gathering. This dissertation follows an exploratory approach.

3.2.2 Research question and hypotheses

The aim of research is to answer a specific question. A study's theoretical hypotheses should reflect the research questions and reviews of literature. The hypotheses shape the data collection plan and give priorities to the relevant analytic strategies. It helps focus attention on certain data and ignore other data (Yin, 2003:112).

The aim of this dissertation is to answer the question: how prevalent is the fundamental nature of the TPS in selected South African organisations? The main hypothesis is that the fundamental nature of the TPS will be found participating manufacturing organisations.

After completion of the literature study, the fundamental nature of the TPS was summarised as twelve strategies of the TPS. Thus, the main research question can be subdivided into twelve smaller research questions, i.e. how prevalent is each strategy of TPS Level One in South African organisations. The secondary hypotheses, therefore, becomes that the following strategies of the TPS are covered by participating South African manufacturing organisations -

- increase customer value;
- organise by value-stream;
- deploy policy;
- empower employees;
- eliminate waste before it occurs;
- promote flow;
- Increase process effectiveness and efficiency;
- standardise;
- formalise industrial engineering;
- create intelligent processes;
- balance resources, and;
- enable visual management.

3.2.3 Embedded vs. holistic design

Yin explains an embedded case study is one where the design requires multiple units of analysis, as opposed to a holistic design if the research focuses on the global nature of something (2003:43). A holistic study can also be followed if no logical subunits can be found or the underlying theory is of a holistic nature, but he warns that this should not 'result in the researcher not examining specific phenomenon in operational detail or lacking clear measures or data' (Yin, 2003:45). The multiple case approach could include multiple, embedded cases (2003:53), even surveys, however, the study of each case should still be viewed as separate with cross-case conclusions drawn at the end (2003:54).

This study follows an embedded design. The global statement, the fundamental nature of the TPS, was broken down into twelve strategies that comprise its fundamental nature. The study does, however, conclude generically as the main research question asks how prevalent the fundamental nature of the TPS is in selected South African organisations.

3.2.4 Unit of analysis

Yin explains the unit of analysis is related to the research question that needs to be answered (2003:24), and therefore the accurate description of the research question is essential, as well as context and scope. The unit of analysis also determines the strategy that will be followed in research design and data analysis (2003:25).

The unit of analysis for this study is an organisation selected for this study.

3.2.5 Multiple vs. single case design

Yin suggests following a single case design approach if the research is a critical test of a significant theory, or if a 'representative' or 'typical' case can be found (2003:41). If not, a multiple case approach should be followed, with each case study chosen for a specific purpose (Yin, 2003:47). The objective is not to work towards a representative sample, rather to build towards the support of a theory through literal and theoretical replication in support of the hypotheses of the study (Yin, 2003:48).

It was decided to follow a multiple case approach because the research question falls in neither the category of critical test of a significant theory, nor could a 'representative' or 'typical' case be found.

3.2.6 Case selection

This section will discuss the logic behind the number of cases selected and the criteria for selection of participating organisations, including considering requirements for replication.

Potential base case and control for culture

The ideal control for this dissertation would be to conduct a case study at Toyota Japan, followed by a case study at Toyota South Africa, after which comparative case studies at other organisations could follow. Two major benefits of this approach could be:

- testing and maturing of the theoretical model against actual practice; and
- isolating the impact of cultural differences (between South Africa and Japan) when applying the model of the fundamental nature of the TPS.

Before pursuing this approach, an alternative was considered. The alternative approach would base the model of the fundamental nature of the TPS solely on literature, and use available research on anthropology to understand and explain cultural differences between South Africa and Japan. For this option, the following would need to be in place:

- Significant literature on the Toyota Production System to allow a realistic model to be constructed from a literature study alone; and
- Well documented research on cultural differences between South Africa and Japan.

It was found that both of these conditions are met – numerous researchers note volumes of work already done on Toyota (Liker, 2004; Bicheno, 2004; Dennis, 2007, Liker & Hoseus, 2008), and Hofstede (2001) provides well documented comparisons between South Africa and Japan.

Given that these conditions were met, it was decided to follow a pragmatic approach and base the model of the TPS on literature, augment the literature study with site visits to Toyota South Africa (rather than a full case study), and understand the impact of cultural differences between South Africa and Japan on the work of Hofstede (2001).

Theory - criteria for selection

It is suggested to develop criteria for the selection of cases beforehand as part of the case preparation process. If a significant number of potential cases exist, a two-stage selection process may be used (Yin, 2003:78).

Yin suggests each case chosen should serve a specific purpose in support of a theory, i.e., the original hypotheses (2003:47), and should be viewed as a study on its own (2003:50). It is also important to draw 'cross-case' conclusions at the end of the study. The investigation should conclude 'how' and 'why' the hypothesis was demonstrated (Yin, 2003:50).

Case selection should always be seen in the context of the research question being answered, as this may provide additional data points to select and deselect cases (Leedy, 1997:155).

Implication – criteria for selection

The aim of this dissertation is to answer the question: how prevalent is the fundamental nature of the TPS in selected South African organisations? The main hypothesis is that the fundamental nature of the TPS will be found in participating manufacturing organisations.

Following from the research question and hypothesis, it becomes evident that 'groups' of cases will be required, at the very least 'manufacturing' and 'non-manufacturing'[xii] groups. For manufacturing organisations, using Hayes and Wheelwright's (1979) product-process matrix, a further rough breakdown is possible into high-volume and few products, and lower volume and many products. This results in three 'groups' of cases to be sought – a) Higher volume, fewer products manufacturing organisations – referred to as 'high-volume manufacturers' from this point onward for easy reference, b) lower volume, numerous products – referred to as 'low-volume manufacturers' from this point forward, and c) service organisations.

Following this approach (selecting a wider variety of cases) holds the following potential:

- It allows for a natural extension and more detailed conclusion on the main hypothesis (that the fundamental nature of the TPS will be found in manufacturing organisations), i.e. the study can differentiate between the three groups in its conclusion.
- It provides an improved test of the proposed model of the TPS as an increase in the types of organisations leads to a greater variety of contexts.
- It complements the exploratory nature of the study, whereas if the study was explanatory in nature, a smaller focus or single type would be preferred.

Theory – number of cases

The selection of the number of case studies depends on the level of certainty needed and the type of study (Yin, 2003:51). If the rival theories are significantly different and lead to easily distinguishable cases, two or three cases per replication set – literal and theoretical - should suffice (Yin, 2003:51, 52). If two or three cases provide outstanding predicted, similar results in support of the theory, the research design could only focus on literal replication (Yin, 2003:52). Glaser and Strauss (1967, cited from Eisenhardt, 1989) agrees that no cases should be added after the theoretical saturation point is reached, i.e., when results repeat and incremental learning is minimal.

Eisenhardt (1989:545) suggests selecting four to ten cases when building theory from case study research as fewer cases make it difficult to draw conclusions on hypotheses, and more than ten could add too much complexity.

Implication – number of cases

Given the three groups of cases suggested (high-volume manufacturers, low-volume manufacturers and service organisations), two to three cases will be sought that fit each group. This satisfies Yin's requirement of two to three cases per replication set, avoids unnecessary duplication past the theoretical saturation point as per Glaser and Strauss, and keeps

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[xii] Non-manufacturing organisations refers to service organisations, e.g. banks or hospitals

Eisenhardt's suggestion of avoiding unnecessary complexity, limiting the amount of cases below ten.

Other implications

Given that the goal of the study is to understand the prevalence of the TPS at selected South African organisations, case selection will be limited to organisations that reside in South Africa or, if multinational organisations, will consist only of a comparison of their South African operations.

Outcome

Thirty-five organisations were invited to participate in the study. These organisations were selected, with criteria to cover a wide spectrum on the product-process matrix (to allow for selection of high-volume and low-volume manufacturers) and service organisations. Ten organisations responded positively from the invitation list. To facilitate selection, these organisations were grouped by 'type' as suggested earlier:

- Service organisations – four
- High-volume manufacturers – three
- Low-volume manufacturers – three

For each of these, a goal was set to select two to three cases as per the type:

Service organisations – Two cases were deselected in total from the group of four. One organisation (a multinational franchise furniture retailer) was deselected as they could not confirm the presence or participation of their South African operations. Another organisation (a multinational property consortium) was deselected after they deferred participation by three months, which would have made it impossible for the author to conduct the research.

High-volume manufacturers – One organisation (a large pharmaceutical manufacturer) was deselected as it had become public knowledge that they had decided to close a significant portion of their manufacturing operations in South Africa, and there was concern that this decision may influence the behaviour of participants.

Low-volume manufacturers – All three organisations who responded positively were selected.

The organisations and types are listed as case one to case seven (sorted alphabetically by their withheld name):

Table 3-1: Cases selected for participation in the study

No	Organisation	Type	Description
1	Case one	High-volume manufacturer	Aerospace manufacturer
2	Case two	Service organisation	Consultancy
3	Case three	High-volume manufacturer	Multinational pharmaceutical manufacturer (South African operations)
4	Case four	Low-volume manufacturer	Jewellery manufacturer coupled with franchise system
5	Case five	Service organisation	Human resources consultancy specialising in recruitment
6	Case six	Low-volume manufacturer	Building industry manufacturer
7	Case seven	Low-volume manufacturer	Food and beverage company coupled with franchise system

All of the cases are South African organisations without a Japanese culture.

An alternative view is provided by plotting these cases on the product-process matrix of Hayes and Wheelwright (1979a):

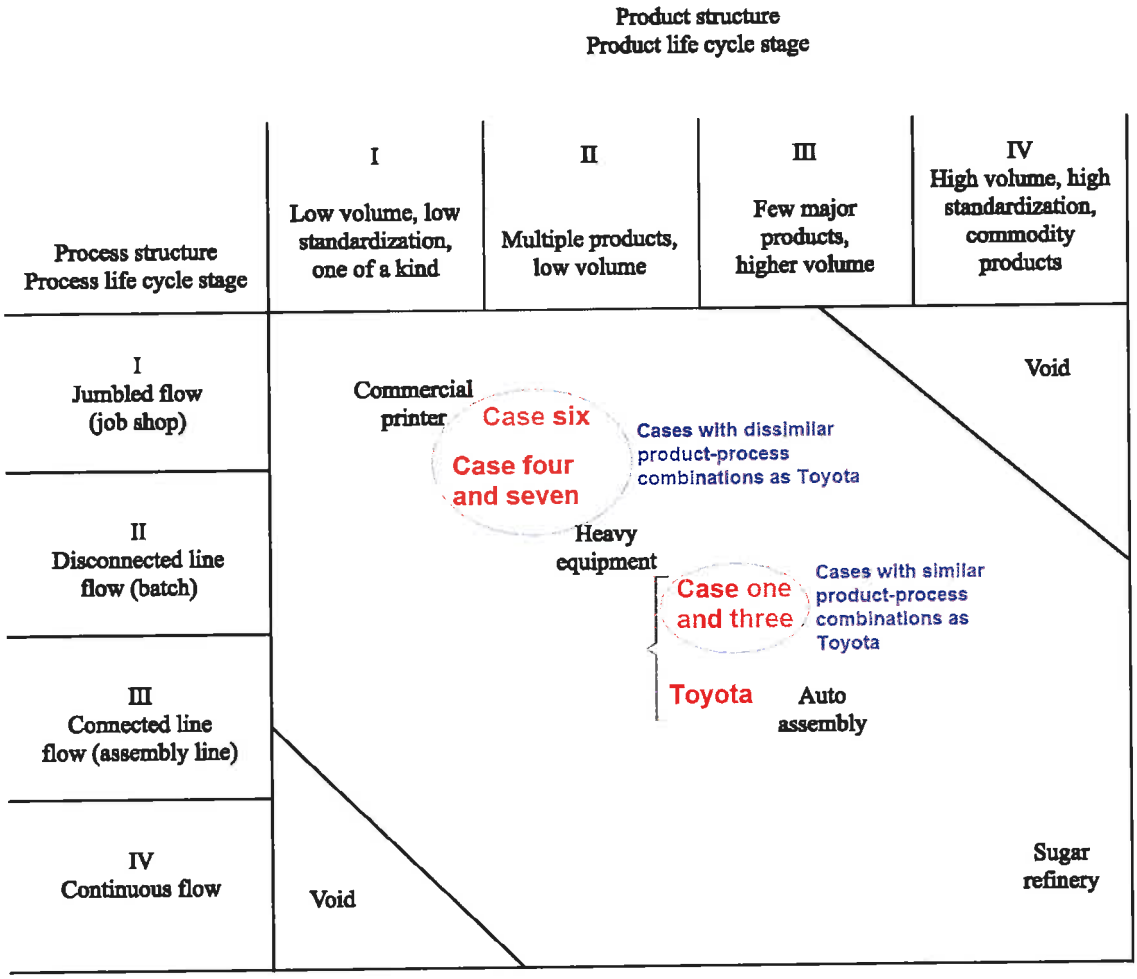

Figure 3-1: Selected cases plotted on the product-process matrix of Hayes and Wheelwright (1979a)

Replication

Part of case selection is concerned with whether the selected cases will allow for replication of results. Replication is either literal or theoretical - with both important to ensure validity – and an important consideration in case selection (Yin, 2003:50).

Literal replication - Cases selected for literal replication should provide similar results in line with the hypotheses stated in the beginning of this study. The theoretical framework built through the literature study, should state the conditions under which the phenomenon is to be found or repeated (Yin, 2003:50).

This study asks the question 'How prevalent is the fundamental nature of the TPS in selected South African organisations?' The main hypothesis is that the fundamental nature of the TPS will be found at selected South African manufacturing organisations, i.e. case one, three, four, six and seven.

As such, five out of seven or all the manufacturing cases are therefore selected for literal replication, with a potential distinction high-volume and low-volume manufacturers.

Theoretical replication - Yin (2003:50) suggests cases selected for theoretical replication should provide different but expected results. The theoretical framework should again state the conditions under which the phenomenon is not to be found. However, not all studies require theoretical replication (Yin, 2003:50).

Service organisations participating in this study are selected for theoretical replication, therefore the main hypothesis is extended to include that *the fundamental nature of the TPS will not be found in selected service organisations, i.e. case two and case five.*

As such, two out of seven cases or both service organisations are therefore selected for theoretical replication. Case selection therefore complies with the requirements for replication.

3.2.7 Modification of theory

Yin (2003:51) suggests if the cases operate outside of the theoretical framework modification to the theory (redesign) should take place. If this is to happen, the researcher must be sure to understand the 'nature of the alteration', and not just select new cases that could support a possibly biased opinion (2003:55).

The framework given in chapter two modifies theory and the results will be discussed to see if the design (especially strategy and activity definitions) should be modified.

3.2.8 Ethics

Leedy (1997:116) suggests researchers should fulfil requirements of 'fairness, honesty, openness of intent, disclosure of methods, the ends for which the research is executed, a respect for the integrity of the individual and the obligation on the part of the subject to participate voluntarily in the research activity'. He also warns that researchers should guard their own integrity, and take care to ensure what is cited as own work is in fact their own work (1997:118,119).

This study aims to fulfil all ethics requirements. Below, three examples as evidence of an ethical approach are discussed, i.e. anonymity to participating organisations, no attempts to influence participating organisations and giving credit to contributions:

- Anonymity was offered to the participating organisations and the contributors inside these organisations, which they accepted. The case study protocol also directed behaviour at the various cases, as agreed with the respective CEOs or managing directors of the participating organisations before the actual case studies took place. These agreements continue to be respected, and as such the study refer only to 'cases' and 'respondents' throughout the research.

- Attempts to influence the selected organisation were not undertaken and, in some cases, organisations who felt they may be compromised were substituted.
- In addition, contributions made by other authors in this research are fully acknowledged.

3.2.9 Conclusion on research design

The purpose of this study is to explore the prevalence of the fundamental nature of the TPS at selected South African organisations. The main hypothesis states the fundamental nature of the TPS will be found at all participating manufacturing organisations, and not found at service organisations. The fundamental nature of the TPS is defined as its strategies, and twelve strategies are compared. Hence, the study follows an imbedded design. The unit of analysis is one of the selected South African organisations, resulting in multiple case study approach. Seven cases were selected, and criteria for selection included covering all competitive dimensions and positions on the product process matrix (partially met). Five of the seven selected cases provide for literal replication (manufacturing organisations), with two of the seven selected for theoretical replication (service organisations). If necessary, modification of theory will be considered in the results section. Lastly, to ensure an ethical approach, anonymity is provided to participating organisations, no attempts to influence participating organisations are made and credit is given to contributions.

3.3 Analysis techniques

The purpose of this section is to discuss the analytical approach and techniques followed. It starts off with a general discussion on approaches to link data to the hypotheses. This is followed by a focus on the approach used to interpret the findings. It concludes with the logic behind the choice of reporting format.

3.3.1 Strategy for analysis

General strategy

The data analysis should correspond with the general analytical strategy that the case will follow (Yin, 2003:26), and could be either relying on theoretical hypotheses, setting up a framework of rival explanations or building case descriptions. If the study is of an exploratory nature, the most suitable approach is to rely on theoretical hypotheses (Yin, 2003:111-114).

Of the various analytical strategies available, this dissertation relies on the theoretical hypotheses to guide the analysis of the data, as were developed through the literature study. The latter two frameworks are less suitable as this study does not focus on causation or description per se.

The logic of linking data to the hypotheses

The hypotheses shed light on what data to ignore and what data to include (Yin, 2003:112). One way of linking the data to the hypotheses is through pattern matching. The idea is to describe a theoretical pattern and test the data against this (Yin, 2003:26,116). However, case study data is often qualitative and the data analysis might not be straightforward. To overcome this, displays can be built to organise the data, including using matrices, figures, or graphics (Miles and Huberman, 1984:79; Yin, 2003:111). This can be a simple table with quotes and summaries, and allows eyeball testing to search for commonalities and contrasts. It can also be used for as input into other matrices, comparison with similarly formatted displays and used in a case report (Miles and Huberman, 1984:80).

This dissertation relies on organising the data into different matrices to analyse the main research question. To construct these matrices, data corresponding with the twelve TPS strategies developed through the literature study are firstly organised according to strategies and secondly according to main activities. Tables 3-2, 3-3 and 3-4; discussed in the section 'Criteria to interpret the findings', show how these matrices are constructed. As the strategies have differing numbers of associated activities (between three and seven activities per strategy), comparison is done using fractions (i.e. if two out of three activities are found, this corresponds to 0.67, etc).

Clustering of data

Clustering is the general name given when using or forming categories and conducting iterations on data sets. It can be applied to many variables, including actions, respondents, cases, processes, locations, etc. The idea is to understand a phenomenon by grouping and then conceptualising objects with similar patterns or characteristics; and is especially useful when multiple research questions are answered. An example of this is a conceptually clustered matrix, which lists sources of data on one end and research questions on the other. This helps the researcher not only to answer multiple research questions simultaneously but also to study themes. It also allows the researcher to compare evidence from various sources or respondents, compare respondents, allow for further analysis, and lend itself to easy cross-case analysis (Miles and Huberman, 1984:110; 1984:218-221). However, it is suggested that such a table limits the number of questions so that the researcher can still comprehend all that is before him, on a single page (Miles and Huberman, 1984:114).

The interaction of theory and data enlightens what clusters should be formed. One can start by sorting data into a case-by-strategy matrix to understand whether sorting according to a specific strategy will be useful. Clustering also pertains to moving to higher levels of abstraction, e.g., using a dendogram method or reversed tree diagram or other structured methodologies. Care needs to be taken in verifying the matrices, especially noting outliers and to which clusters they belong. It also needs to be ensured that matrices are representative of the universe being studied (Miles and Huberman, 1984:218-221).

After the first iteration of compiling a matrix, it might be helpful to cluster data through, e.g., across-category clustering (Miles and Huberman, 1984:155). This enables the data to be presented integrated and across multiple cases (Miles and Huberman, 1984:156). It is sometimes helpful to focus on the content of the matrices more, without much attention to the specific cases where it originates. This can be done by creating a matrix display that portrays the dimensions the researcher is interested in, focusing on concepts rather than individual cases, and is called an ordered summary tabulation (Miles and Huberman, 1984:158).

This study uses a database to allow multiple views or clusters, e.g. organising the data in a case by the TPS strategy matrix (see appendix F, G and H). One view allows a matrix to be constructed, comparing evidence against the definitions of each activity that indicate a strategy for each case. Subsequent iterations apply a structured methodology to move to higher levels of abstraction. To answer the main research question, a meta-matrix clusters information through an ordered summary tabulation, according to the twelve strategies of the TPS Level One, against each case.

Cross-case analysis

To facilitate cross-case analysis, meta-matrices can be used, which can range from simple descriptive matrices to complex explanatory matrices that highlight causation. The unordered meta-matrix is a straightforward way to bring together data from various cases, and is useful for descriptive purposes (Miles and Huberman, 1984:151). Its basic function is combination of all site data onto a master chart, which requires a reporting format for each site and the compilation of a site level summary display (Miles and Huberman, 1984:152). The data can then compile to a single, large format. It might, however, be necessary to distil individual case information to make the volume of data more manageable (Miles and Huberman, 1984:153). Regardless, this should be avoided during the first iteration, as care needs to be taken to determine whether data sets are actually comparable (Miles and Huberman, 1984:154).

After comparing data for each case against the twelve TPS Level One strategies, data are clustered according to strategies. This clustering allows cross case analysis. A meta-matrix allows analysis at a higher level of abstraction.

Structuring of matrices

Although there are no set rules for constructing such matrices, it must enrich understanding of the data and ultimately help to answer the research question (when the focus is mainly descriptive, the matrices will rely less on ordering). If it is a multiple case study with comparable data from the cases, a row or column may be devoted to the cases (Miles and Huberman, 1984:211). Various ways of ordering the data exist, e.g., strength, intensity, time, roles, participants, or any other variable. Matrices can consist of more than one dimension, by subdividing rows and columns, and entries in cells can take on various formats, e.g., direct quotes, extracts from notes, summaries, researcher notes, researcher explanations, ratings,

judgements, and combinations, etc. Complex matrices can be subdivided into streams or families. The definition of the rows and columns should be fine enough to accommodate meaningful differences in the data, but avoid creating too much detail. A research question might require the use of a series of matrices to be answered (Miles and Huberman, 1984:212). Note what decision criteria are employed when selecting data from the evidence collected for input into matrices. Codes can be used to link raw data to entries in the database (Miles and Huberman, 1984:213).

The proposed database allows multiple views of data to facilitate the use of matrices. The database is clearly coded to ensure easy reference to data inside matrices. The detail definitions of activities allow for thorough analysis. The main research question is answered through compiling a meta-matrix based on analysis of each TPS Level One strategy. Table 3-2 (in the next section) shows the outcome of one strategy for a single case. Table 3-3 shows how one strategy may be summarised across all the cases. Table 3-4 shows the meta-matrix that will be used to analyse results for each individual case and across cases.

3.3.2 Criteria for interpreting the findings

Analytic strategies that could be followed include pattern matching, explanation building, time-series analysis, logic models, and cross-case analysis (Yin, 2003:116-137).

Analytic strategies not used

Logic models are used when cause and effect patterns are studied over time and compared with theoretical models (Yin, 2003:127). Time-series analysis studies a chain of events over time, and tracks changes (Yin, 2003:124). Explanation building is primarily concerned with 'how' and 'why' certain events occurred and find the causal links (Yin, 2003:120) and relies on the study of rival explanations to improve external validity (Yin, 2003:122).

Logic models are not applicable as this study is neither time-delineated nor primarily interested in causation. The primary focus of this study is also not to understand a chain of events over time or build explanations.

Analytic strategies used

This study uses a combination of pattern matching and cross case analysis to answer research questions.

Pattern matching - Yin (2003:27) suggests that when statistical analysis of data is not possible, the ideal would be to have data patterns significantly contrasting to at least test two rival hypotheses. Pattern matching compares an 'empirically-based pattern with a predicted one' (Yin, 2003:116).

The two opposing patterns for this study are the absence or presence of the TPS Level One strategies that describe the fundamental nature of the TPS as per the framework developed through the literature study. The main hypothesis assumes presence of activities for

manufacturing organisations, whilst the null hypothesis would assume absence. Some of the literature work shed light on why some strategies may be absent, other than the selected cases just not applying similar strategies.

Cross case analysis - Cross-case analysis first treats each case as an individual case and then uses techniques like displaying the data in tables that correspond to a theoretical framework (Yin, 2003:134) from which cross-case conclusions are drawn (Yin, 2003:135). It relies on 'argumentative interpretation' and therefore the researcher needs to build 'strong, plausible, and fair arguments' that are supported by the data (Yin, 2003:137).

Such arguments can be supported by the compilation of matrices. After matrices have been compiled the researcher may scan across columns and down rows to get a first impression of the data. If such a matrix is ordered by case, and it is helpful to first scan individual cases to get a general awareness before searching for cross-case patterns (Miles and Huberman, 1984:213).

The purpose of this study is to understand whether the fundamental nature of the TPS is equally prevalent at selected cases. Cross-case analysis is helpful for answering this question, as it allows a view of how prevalent the TPS Level One is overall and per each strategy. Interpretation is argumentative and thematic, requiring the use of matrices as described before.

Analysis of matrices

One way to clarify descriptive matrices is to draw summary tabulations that collapse and summarise data through, e.g., counting or strength indication, etc. (Miles and Huberman, 1984:166,167).

When conclusions become apparent, explanatory notes need to be written as this will help with comprehension and reformulation. Such conclusions should also be tested against the raw data to ensure fit. Illustrations from the raw data may be used in the main report to enrich and support conclusions. It is important to also tie such conclusions to a theory that is being developed or studied (Miles and Huberman, 1984:213,214).

Other ways of analysing descriptive data sets is to look for patterns, and looking for plausibility or a lack of it, though this should be subjected to one's own and others' scrutiny (Miles and Huberman, 1984:216, 217). Metaphors may be used to describe and compact data and illuminate patterns, and form analogies to connect data with theory (Miles and Huberman, 1984:221). Variables may be split or generalised, and large sets of data may be factored to identify general themes (Miles and Huberman, 1984:222-224).

The analysis procedure needs to be documented to ensure reliability, and include matrices in final text that allows the reader to draw his or her own conclusions (Miles and Huberman, 1984:214).

Some rules are applied to ensure consistent analyses of matrices: to answer whether a specific TPS Level One strategy is prevalent or practised in any of the cases, it is necessary to first

make a judgement on the TPS Level Zero activities, after which this is used to inform whether a strategy is present or not. To ensure validity, detailed 'Possible definitions by activity' matrices were constructed that specify what the presence of an activity constitutes – allowing the researcher to be consistent in analysing evidence gathered. These matrices also summarise whether some or no evidence was found on activity level (see Table 3-2). This dissertation specifies that if any of the possible definitions are met, then it is judged as 'some evidence present' for an activity. If none of the possible definitions are present, it is judged as 'no evidence found to suggest activity is present'. This allows a matrix of activities against cases to be constructed, indicating 'some' or 'no' evidence to support the presence of an activity (see Table 3-3). Lastly, an outcome may be allocated to each strategy in a 'Meta-Matrix' of strategies against cases, i.e. some evidence support x out of y activities that inform a strategy is being practised per case (see Table 3-4). As each of the strategies has varying amounts of activities associated with them, fractions are used to enable comparison (e.g. 2/3, 4/7). This study regards a TPS Level One strategy to be present if all activities associated with informing a strategy show some evidence. For the fundamental nature of the TPS to be present, evidence must be found for all strategies in this manner. To facilitate cross-case analysis, an outcome for each activity (whether some or no evidence was found) is also given out of seven (due to seven cases selected).

Table 3-2: Hypothetical matrix used for analysis at an individual case level (example for 'Increase customer value' strategy)

Main activity	Definitions considered for the main activity	Outcome
Understand the customer's perspective of value (S)	▪ Set up a value-stream in every major market.	✓
	▪ Define value jointly with the customer around cost, quality, delivery and overall specification.	×
	▪ Ensure a general sensitivity and awareness regarding customer needs and satisfaction throughout the organisation.	×
	▪ Use personal relationships as an approach to understand what the customer really values.	✓
Re-engineer core products to improve customer value (S)	▪ Rethink core products after obtaining an improved understanding of customer requirements.	✓
	▪ Involve customers in design from the outset.	✓
	▪ Test whether end-designs meet customer requirements.	
Redefine organisation processes to 'Increase customer value' (S)	▪ Ensure the right processes are in place, producing the right results (e.g., maximise value add, accessible, competent, sufficient, facilitates flow, triggered by the customer, balanced).	✓
	▪ Find ways to deliver such value faster.	×
	▪ Include the extend supply chain in redefining processes.	×
Add value to the customer throughout the lifecycle of the product (N)	▪ Focus on the customer experience throughout the lifecycle of the product.	×
	▪ Focus on internal (e.g. dealers) and external (e.g. motorists) customers when optimising for lifecycle value add.	×

Legend:		
	✓	Activity definition met
	×	No evidence found linked to definition
	(S)	Some evidence found to suggest activity is present
	(N)	No evidence found to suggest activity is present

Table 3-3: Hypothetical 'activities by Strategy' matrix used for analysis (example for 'Increase customer value' strategy)

Main activity	Case one	Case two	Case three	Case four	Case five	Case six	Case seven	**Total**
Understand the customer's perspective of value.	S	N	S	S	S	S	S	w/7
Re-engineer core products to improve customer value.	N	N	N	N	N	S	N	x/7
Redefine organisation processes to increase customer value.	N	S	N	N	N	N	S	y/7
Add value to the customer throughout the lifecycle of the product.	N	N	N	N	N	N	N	z/7
Total per case	1/4	1/4	1/4	1/4	1/4	2/4	2/4	--

Legend:

S	Some evidence found to suggest activity is present
N	No evidence found to suggest activity is present
w,x,y,z	Variables indicating the number of cases where some evidence was found to suggest the activity is present

Table 3-4: Hypothetical Meta-Matrix used for analysis

Strategy	Case one	two[xiii]	three	four	five	six	seven
Increase customer value	4/4	0/4	1/4	.	.	.	.
Organise by value-stream	3/3	0/3	1/3	.	.	.	.
Deploy policy	5/5	0/5	1/5	.	.	.	.
Empower employees	7/7	0/7	4/7	.	.	.	.
Eliminate waste before it occurs	3/3	0/3	1/3	.	.	.	.
Promote flow	4/4	0/4	1/4	.	.	.	.
Increase process effectiveness and efficiency	5/5	0/5	4/5	.	.	.	.
Standardise	3/3	0/3	1/3	.	.	.	.
Formalise industrial engineering	3/3	0/3	2/3	.	.	.	.
Create intelligent processes	3/3	0/3	2/3	.	.	.	.
Balance resources	4/4	0/4	2/4	.	.	.	.
Enable visual management	4/4	0/4	3/4	.	.	.	.
Grand total	**48/48**	**0/48**	**23/48**	.	.	.	.
Main hypothesis supported	✓	✓	×	.	.	.	.

Legend:		
	x/y	Number of main activities with some evidence out of total number of main activities
	×	Indication that evidence do not support the main hypothesis
	✓	Indication that evidence supports the main hypothesis

[xiii] The main hypothesis states that the fundamental nature of the TPS will not be found in case two and case five, as they are service organisations. Hence a full outcome for case one, three, four, six and seven is required and zero outcomes for case two and five to support the main hypothesis.

3.3.3 Written format and compositional structure

The data should be analysed with the reporting format that the final audience will need in mind (Yin, 2003:143), e.g., academic colleagues, special groups. The emphasis, length and detail are determined by the receiving audience, and hence are important to take into account during data analysis (Yin, 2003:145).

Written Format

Four written formats are suggested for case study research: single case, multiple case, non-traditional description, and cross-case analysis (Yin, 2003:147-149). A discussion follows on the written formats applicable to this study (single case format not applicable).

A multiple case study can present multiple narratives in separate chapters or sections of the individual cases, with cross-case analysis included as a chapter. Often, the main report would discuss the cross-case analysis in detail and have the individual case reports residing in the appendices (Yin, 2003:147)

A non-traditional description structures the cases according to a series of questions and answers, based on the questions and answers in the case study database (a shortened and edited version). This format is recommended for multiple case studies (Yin, 2003:147, 148).

The non-traditional description can state a series of questions and answers with each answer having a length of 3-4 paragraphs. The answers should contain all relevant information and be supported by tables and notes, with a possible summary of each case if uncomfortable with a lack of a narrative (Yin, 2003:148).

Cross-case analysis is another way to structure the format and applies to multiple-case studies. In this type of report, each chapter or section would focus on separate cross-case issues (Yin, 2003:148).

This dissertation follows a combination of the non-traditional narrative and cross-case analysis. The twelve strategies of the TPS provide the structure for most of the report.

Compositional Structure

Six structures are suggested for a case study report: linear-analytic, comparative, chronological, theory building, suspense, and un-sequenced (Yin, 2003:152). The linear-analytic structure normally starts with the issue or problem being studied, a review of literature, methodology, findings from data, ending with conclusions and implications (Yin, 2003:152, 153).

This dissertation follows a linear-analytic structure as the focus is neither to compare the same case using various descriptive models nor to study a time sequence or causal links.

3.4 Validation of the research methodology

Research achieves validity if the research design enables researchers to accurately measure what they intend to measure (Leedy, 1997:34). The quality of a case study's research design can be judged by testing construct validity, internal validity, external validity, and reliability (Yin, 2003:33, 34).

3.4.1 Construct validity

Construct validity measures whether the case design accurately captures the essence of what is being studied with the disregard of non-essentials (Leedy 1997:34). A researcher can help ensure his or her case design is valid in this regard through the use of multiple sources of evidence, establishing a chain of evidence (i.e., using more than one analysis tool) and an informed review of the draft case study report (Leedy, 1997:34; Yin, 2003:35, 36). It is important to guard against completely subjective judgement of the case study data, and to ensure that the measurement tools have the ability to measure what the research focuses on, specifically within the boundaries set by the hypotheses and research questions (Yin 2003:35).

This dissertation's approach towards construct validity includes the following:

- Use of multiple sources of evidence (interactive presentation feedback, interviews, structured observations, etc.).
- Use of the TPS Level One strategies to guide the search for information.
- Detailed matrices to ensure accurate analysis of data.
- Discussing the research with leading academics involved with the TPS/Lean Manufacturing in South Africa.

3.4.2 Internal validity

Internal validity is the ability of a case design to show how certain conditions lead to other conditions and is not applicable to exploratory or descriptive case studies (Leedy, 1997:35; Yin, 2003:34).

As this study is an exploratory study, i.e., there are no conditions that will lead to other conditions that are critical to consider in answering the research question, internal validity is not applicable.

3.4.3 External validity

A study would be externally valid if it establishes a domain to which the conclusions are applicable (Leedy, 2007:34). However, case studies do not attain external validity through selecting a representative sample, but rather collect evidence in support of a theory (Yin, 2003:37). The idea is to start with theory, build cases around a hypothesis and study questions, replicate in a few cases, and then build toward a revised theory.

As this study is exploratory in nature, and not building towards a theory that explains causality, one of the limitations of this study is that validity is limited to the comparison of the prevalence of the TPS Level One strategies between the selected cases.

3.4.4 Reliability

A test of reliability measures how well this case study would be able to repeat its results (Leedy 1997:35). Yin (2003:34) suggests that the use of a proper case study protocol and the development of a database of case studies can help with ensuring reliability.

This dissertation addresses reliability through a high level of specificity, the use of a case-study protocol and use of a database – described in the next section (also see appendix F, G and H).

High level of specificity – each strategy consists of between three and seven activities. The research design assumes the presence of 'some evidence' of an activity to constitute that activity to be present. To ensure reliability, the literature section specifies what 'some evidence' constitutes by providing detailed descriptions for each activity. The protocol (discussed next) uses these descriptions to guide the researcher when searching for evidence, and demarcates what is considered as evidence and what is not. This approach ensures the outcome of this study will be able to be repeated i.e. reliable. Although care is taken to avoid subjective interpretation of data, analysis is still open to some extent to the judgment of the researcher. However, Leedy (1997:158) suggests that such interpretational analysis is accepted in case study research design.

Use of protocol – section 3.5 discusses the protocol in detail. The purpose of the protocol is to ensure consistent search and analysis of data, which in turn helps achieve reliability

Use of a database – section 3.5 discussed the use of a database in detail. The purpose of the database is to ensure accurate and consistent handling of data, which in turn helps achieve reliability

3.5 Case preparation, protocol and data gathering

Preparing for a case study is an important part of the case study process. Preparation requires the researcher to focus on the skills they and research assistants need to have, training in this group, developing a case study protocol, screening potential cases for final selection and completing a pilot case study (Yin, 2003:57). The development of protocol should specify the approach to gather data and include the design of the case study database (Yin, 2003:77).

This research is completed without the use of research assistants, which simplified the preparation stage as no detail training had to be given to other researchers. However, to ensure a fair presentation of data, a significant amount of effort was put into the case study protocol. A database is used to document and sort information for easy retrieval and analyses, with a pilot case study held to test and mature the data collection, storage, and research design.

3.5.1 Skills of the investigator

Good investigative skills enable researchers to discount their own ideologies and preconceived ideas and search for the facts (Yin, 2003:59). To do so, they must be able to ask the right questions, realising that research is more about questions than about answers (Yin, 2003:60).

Listening skills enable researchers to work with, and incorporate, large amounts of data and not get trapped by their foregone conclusions. This includes taking the interviewee's or case's context into account and looking for inferences between the lines (Yin, 2003:60).

If the study of a case does not go as planned, the research questions forms a guiding light for the researcher. However, if the research focus shifts, the researcher will need to start again (Yin, 2003:60, 61).

Thorough subject knowledge helps the researcher with analysis, judging when deviation is acceptable or desirable, data interpretation, making inferences, and replication (Yin, 2003:61).

The researcher should also aim to be a neutral and objective judge of the evidence as far as possible. This includes avoiding selective data gathering to support predetermined conclusions and being open to outcomes than that which was not initially supposed (Yin, 2003:61, 62).

This study aims to augment the skills of the researcher through following a strict protocol and other practical steps:

- Test and prepare for the investigation through a pilot case study.
- Spend two to three days at each case to increase understanding of the context of the organisation relative to the fundamental nature of the TPS.
- Focus on protocol and database design that facilitate answering of the research questions.
- Use multiple sources of information and capturing in a database to decrease the chance of selective data gathering and interpretation.

3.5.2 Case study protocol

The case study protocol is a plan that directs the researcher during the data collection process and contains the instrument, procedures, and general rules to be followed (Yin, 2003:67). The protocol helps with contingency planning and keeping the focus on answering of the research questions (Yin, 2003:69).

The following sections cover the information gathering strategy for the main sources of evidence this study pursued, i.e. the interactive presentation feedback, followed by interviews and structured observations.

Interactive presentation feedback

The purpose of the presentation is to understand case participants' reaction to being confronted with the fundamental nature of the TPS. Participating cases are asked to invite a cross-section

of their management teams to a session where the fundamental nature of the TPS is presented. The audience is asked to record notes on current application and actions for future implementation as they are confronted with this knowledge. Their reaction is used to analyse the prevalence of the fundamental nature of the TPS, and is used in conjunction with other means of gathering evidence. The following aspects are important in preparation for this session:

- Prepare and review the three to four-hour presentation on the fundamental nature of the TPS based on the literature chapter. Arrange a date and time with participants. See appendix C for a copy of a blank feedback form.
- Arrange suitable facilities.
- Prepare/print the blank feedback sheet to capture the participants' response during the presentation.
- Request wide representation of different roles and responsibilities to attend. Arrange 4 hours for the presentation. Explain to them that this presentation is focused at middle and senior management levels.
- Explain the purpose of the interviews and how the prepared feedback sheet will be used.
- Ask participants to note aspects already in place and record any actions or ideas they think they can implement at their organisations that come to mind as they listen to the presentation and participate in the discussion. Stop for 1-2 minutes after every major point to give them time to do so.
- Run through the presentation of the fundamental nature of the TPS (3-4 hours), every time explaining the theory and offering an example outside their environment. At the end of the session, ask permission to interview some of those attending.
- Try to spend an equal amount of time on each of the aspects of the fundamental nature of the TPS. Also cover the higher levels of the TPS model, should this information be useful for later application.
- Take regular breaks to avoid participant fatigue.
- Pace the presentation so that the last session will not be rushed due to time constraints
- Provide examples to make the theory practical, and provide the same examples at each case presentation (use presenter view in Microsoft PowerPoint to have the same examples within sight, whilst presenting).
- Ask whether the audience has examples of how this had been implemented.
- Be sure to stop after every point to allow participants to write notes.
- At the close, thank the participants for their time.
- Summarise the data collected, insert in the database and associate each piece of evidence with any TPS Level One strategy it may help inform, as well as with the higher levels of the TPS model.

Interviews

The purpose of the interviews is, as with the structured observations and interactive presentation feedback, to search for evidence that supports the presence of the TPS Level One strategies. The interviews focus on problems the organisation has recently resolved, as this may indicate learning and reveal some of the strategies used to overcome these problems. The interviews are relatively informal in order not to lead the interviewees in the way they answer the questions. Interviews take place on an individual basis. There are no correct or incorrect answers to the questions to ensure the interviews provide an objective indication of whether the strategy aspects of the fundamental nature of the TPS are present. The interviews are conducted with three people at each organisation, operating at different levels in the organisation. This typically involves the CEO, a person on a level reporting directly to him or her, e.g., a senior manager, and a person on a level reporting directly to a senior manager, e.g., a manager.

The interview focuses on examples of problems where the interviewee was involved. The interviewer continuously asks questions about the context of the problem, for a minimum of three times. This gives an opportunity for evidence to be enriched, but also allows the interview to remain free of jargon as no reference is made by the interviewer to the twelve strategies of the TPS Level One. The process is repeated twice, focusing on different problems, with each interviewee. The following steps are important during the process:

- Arrange a date and time with the respondents, explaining the purpose of, and the requirements for, the interview.
- Ensure the digital recorder's batteries are charged to record the interview.
- Pre-prepare and open Mindjet Mind Manager to capture the information during the interview.
- Thank the respondent for their time and agree on the time available for the interview
- Ask whether the interview may be recorded on a digital recorder. If the interviewee is comfortable, start recording.
- Explain the purpose and the structure of the interview, i.e., that they will be queried around problem solving, answering 3 questions and that the process would be repeated.
- Type notes during the interview (fast typing is a prerequisite skill).
- Ask the respondent the first question: 'Can you give an example of a problem that you have recently successfully solved (i.e., results are improved as expected and the problem is not recurring)?'.
- Ask the respondent the second question: 'Why was it important to solve this problem?' Or, 'what was the context of solving this problem that made it important to solve?'.
- Ask the respondent the third question: 'Why are these aspects important?'
- If the respondent is not forthcoming with information, probe further by asking questions like 'why is this important?'.

- Repeat the process for a second example.
- Thank the respondent for his/her time.
- Stop the recorder.
- Transcribe the recorded interview for use in the database.
- Insert in the database and associate each piece of evidence with any TPS Level One strategy it may help inform, as well as with the higher levels of the TPS model.

Structured observations

The purpose of the structured observations is to search for evidence present in the organisation related to the fundamental nature of the TPS, through observing processes as they take place. The twelve strategies of the TPS Level One are used as a framework during a guided walkabout. The gathered data will either augment or diminish the evidence gathered during the interactive presentation and interviews. The following steps are important during the process:

- Arrange a date and time for the analysis of the operations, explaining the purpose of, and the requirements for, the analysis.
- Prepare the notebook and twelve questions beforehand, each on a separate page of the A4 notebook.
- Arrange for a manager from the organisation to accompany the researcher.
- Thank them for their time and the opportunity to analyse and observe the operations.
- Look for evidence and take notes related to the twelve strategies of Toyota Learning One, i.e.,
    - increase customer value;
    - organise by value stream;
    - deploy policy;
    - empower employees;
    - eliminate waste before it occurs;
    - promote flow;
    - Increase process effectiveness and efficiency;
    - standardise;
    - Formalise industrial engineering;
    - create intelligent processes;
    - balance resources; and,
    - enable visual management.
- Ask questions around the context of the various items, and the context of the context to capture Toyota Learning Two and Toyota Learning Three where applicable.
- Thank any persons who accompanied the walkabout.
- Summarise the data collected, insert in the database and associate each piece of evidence with any TPS Level One strategy it may inform, as well as with the higher levels of the TPS model.