Applying the *Jidoka* concept to white-collar departments: an examination of the JKK initiative at Toyota Motors

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Abstract: This research paper explores the implementation and theoretical underpinnings of *Ji Koutei Kanketsu* (JKK), an adaptation of Toyota's renowned *jidoka* (i.e., autonomation or 'build-in quality') philosophy that was done to apply this approach to Toyota's white-collar departments in Japan. Through a comprehensive examination of the prerequisites, implementation, and effects of JKK, this study aims to elucidate its significance and impact. The research methodology combines interviews and fieldwork conducted at Toyota and its Japanese component suppliers, supplemented by internal documents and published works. The paper underscores the importance of building an organisational culture prominently featuring managerial commitment, visualisation, and open discussion as a prerequisite for successful JKK implementation, which consists of decomposing each individual process into work elements. The study reveals that JKK has numerous potential advantageous effects such as enhanced quality, efficiency, communication, and employee motivation. Furthermore, the study notes the active engagement of Toyota's business partners in JKK activities, suggesting potential avenues for future exploration.

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1 Introduction

Toyota Motor Corporation (TMC) is widely known for its international competitive advantage. In particular, the Toyota way and the Toyota Production System (TPS) have been extensively studied globally (Fujimoto, 1997; Spear, 2009; Liker, 2004; Osono et al., 2008; Chiarini et al., 2018) and some of the core elements of TPS have become well known overseas as lean production (e.g., Womack et al., 1990; Womack and Jones, 1996; Chiarini et al., 2011). TPS is based on two fundamental concepts: just in time (JIT) and *jidoka* (Ono, 1978; Sasaki, 2007, 2014).

JIT means delivering the right amount at just the right time, and *jidoka*, also known as autonomation, means quality assurance that does not rely on inspection, as per the famous Toyota saying 'quality is built into the process.' In essence, *jidoka* or the 'build-in quality' approach, embodies a process of stopping work whenever there is something abnormal in order to clarify the problem and improve quality. Ono (1978, p.16) referred to the synergy between JIT and *jidoka* stating that JIT is "teamwork – in

other words, an exercise wherein excellence in collaborative work is manifested", whereas *jidoka* is 'maximising the skill of each individual player'.

On the manufacturing shop floor, Toyota has sought to diffuse JIT and *jidoka* as codified concepts since at least the early 1960s (Ono, 1978). This paper examines efforts from the 2000s at Toyota and its suppliers to apply the concept of *jidoka* to white-collar work. Specifically, in 2007 Toyota decided to systematically apply the *jidoka* concept to all departments of the company (Sasaki, 2014). However, Toyota found that practices the company used at its production sites that are associated with the *jidoka* concept could not be applied in their original forms directly to white-collar departments. Toyota found that the principal reason for the difficulty in applying *jidoka* outside blue-collar departments is that white-collar employees deal primarily with intangible information whereas workers in plants deal primarily with tangible objects.

The existing literature offers insights for implementing TPS principles in white-collar departments, emphasising adapting the underlying philosophy to context rather than replicating practices (Chiarini et al., 2018). Research also highlights the importance of the worker-focused perspective on implementation facilitators and barriers (Marin-Garcia et al., 2018), and the necessity of integrating both softer and harder aspects of lean philosophy for improvement (Solaimani et al., 2019).

Toyota refers to the practice of *jidoka* in white-collar departments as *Ji Koutei Kanketsu* (JKK), which can be translated as 'completing your own process'. JKK may be understood as a codification of the philosophy and means of expanding *jidoka* to the work of every white-collar employee. However, in order to put JKK into practice, sufficient consideration must be given to the relationships and collaboration between departments and individuals. Hence, JKK also requires the realisation of the JIT philosophy – which is fundamentally about collaboration – in white-collar work as well.

While TPS has been extensively studied (Fujimoto, 1997; Liker, 2004; Spear, 2009), scholarship has tended to emphasise JIT (flow) and lean production (efficiency) more broadly, with less systematic attention to *jidoka*. Early analyses portrayed *jidoka* primarily as a set of technical mechanisms for detecting abnormalities (Ono, 1978), but subsequent work highlights its socio-technical nature as a system of distributed problem-solving and quality assurance (Adler, 1993; MacDuffie, 1997). More recent research emphasises that *jidoka* is not simply about halting defective work but about cultivating organisational routines that embed learning and improvement into everyday operations (Netland, 2013; Holweg, 2007).

At the same time, there has been growing interest in whether and how lean principles can be transferred to non-manufacturing contexts. Studies of 'lean office' and 'lean service' suggest both potential benefits and difficulties when applying production-derived principles to knowledge-intensive work (Piercy and Rich, 2009; Staats and Upton, 2011; Bortolotti et al., 2015). This literature establishes a broader context for examining Toyota's adaptation of *jidoka* into JKK, which is positioned as a system explicitly designed to extend quality-assurance principles into white-collar departments.

The main purpose of this paper is to describe how Toyota adapted the philosophy of *jidoka* into JKK for its white-collar departments in Japan, drawing on fieldwork at Toyota and three of its suppliers. This raises the central research question: *How can the principles of jidoka be meaningfully applied to knowledge-intensive, information-driven work outside the shop floor*? To address this question, the study pursues two further objectives: first, to theorise the relationships among JKK's underlying principles, prerequisites, and effects; and second, to analyse how these relationships shape practical

and organisational outcomes such as quality improvement, efficiency, communication, and employee motivation.

The paper argues that JKK provides a structured mechanism for embedding quality assurance into white-collar processes by decomposing decision-making tasks, clarifying judgment criteria, and fostering employee ownership, while requiring strong managerial commitment, visualisation, and open discussion as enabling conditions. In doing so, the study contributes to the literature by extending lean management theory beyond manufacturing, offering a conceptual model of JKK's prerequisites and effects, and highlighting its role as a vehicle for inter-organisational learning within Toyota and its supplier network.

2 Conceptual foundations: *Jidoka* and JKK

2.1 The concept of Jidoka

JKK is rooted in the concept of *jidoka*, which was developed on the manufacturing shop floor as a part of the TPS and is a core element of quality management at Toyota. The concept holds that each and every employee considers the subsequent process to be his or her 'customer'. When a defective product is mistakenly produced, it must not be sent on to the subsequent process. Central to *jidoka* is the notion of job ownership. For *jidoka* to happen, employees must possess a sense of ownership toward their jobs. Ownership means that each employee takes the initiative to ensure that

1 there exists a completely defect-free process by which their product will be produced

2 that he or she completely follows this defect-free process.

Job ownership that is defined in this way denotes possession of a sense of pride and responsibility in one's own work without blaming others for one's own failure to improve and complete one's own tasks. For an employee to be able to take on such job ownership, he or she must be able to determine the quality of his or her own work. JKK is a process where the employee continuously determines the product quality based on his or her proper decision making, rather than relying on a third-party evaluation, such as having the product checked by supervisors, inspection stations, or even subsequent process customers. Each employee ensures quality at his or her work process.

Jidoka means stopping work when an abnormality occurs, determining the cause, taking proper countermeasures, and then resuming work. In this way, quality assurance is performed within the process, not by inspection and assurance outside of the process. This is the same philosophy as the one found in the famous Toyota saying: '100% defect-free products'.

The spirit of *jidoka* is said to have begun with the automatic loom invented by Sakichi Toyoda, the founder of Toyota. Afterwards, this same approach was implemented at Toyota's assembly lines, which could be stopped by an operator by pressing the stop button or pulling the 'andon' cord when an abnormality occurred (Ono, 1978). Previous scholarship has offered multiple interpretations of *jidoka*'s essence. Historical accounts stress its origins in Sakichi Toyoda's automatic loom, which institutionalised the principle that human attention should be freed from routine monitoring while ensuring defects were prevented at the source (Holweg, 2007; Fujimoto, 1999). Organisational

studies describe *jidoka* as a mechanism for empowering shop-floor workers to exercise discretion and intervene when abnormalities occur, thus linking technical systems with human responsibility (Adler, 1993; MacDuffie, 1997). In this sense, *jidoka* has long been recognised as both a technological innovation and a managerial philosophy.

Although *jidoka* is one of the two pillars of TPS, the academic literature on lean has historically placed greater emphasis on JIT, efficiency, and flow (Holweg, 2007; Netland, 2013). This imbalance risks underestimating *jidoka*'s role as the socio-technical foundation of lean production. Whereas JIT focuses on inter-process synchronisation, *jidoka* ensures that each process is intrinsically capable of delivering quality outputs, thereby integrating human judgment and technical safeguards (Adler, 1993; MacDuffie, 1997). In this sense, *jidoka* represents the human-centred complement to the efficiency-driven logic of JIT, making it essential for sustaining long-term capability development and organisational learning. This duality becomes particularly significant when lean concepts are transferred beyond manufacturing: JIT principles often seem harder to replicate in knowledge-intensive environments, but *jidoka*'s focus on quality at the source and job ownership offers a more adaptable foundation for applying lean to white-collar work.

By contrast, JKK has been addressed in only a limited number of studies, mostly in Japanese-language scholarship (Sasaki, 2014; Mori, 2010). These works emphasise JKK as a codification of *jidoka* for office-based and engineering work, but their insights have rarely been integrated into the international literature on lean management. Expanding on this prior work, the present paper positions JKK as a theoretical extension of *jidoka*, demonstrating how its principles can be applied to information-driven processes.

2.2 The concept of JKK

JKK represents Toyota's systematic effort to adapt *jidoka* to white-collar departments, where work is defined less by tangible products and more by decisions, information flows, and knowledge creation. Toyota defined JKK as determining whether the result of a task is good or bad while the task is being performed or immediately after the task is completed. As the work of white-collar departments in particular consists of a chain of decision-making, JKK involves designing those processes and arranging them in the proper order. When designing processes, the following two questions must be answered: 'What information is required to do this process correctly? (Necessary conditions) and 'What types of outputs are needed from this process?' (Judgment criteria).

While work becomes more efficient as a result of JKK, the true aim is to increase the motivation of individual white-collar employees (Mori, 2010). As work is undertaken through the skill and decision making of the person in charge, the resulting quality is recognised as being only as good or as bad as that person's own work. The desire to improve something increases when favourable evaluations are received from customers. If a poor evaluation is received, a person will understand that there is a flaw in one's own work.

Sasaki (2007) provides an interesting example. Suppose you are a greengrocer. If you closed your store even for just three days, your customers would panic. In such a case, feeling the social importance of your existence would make you perform your job with more vigour and energy, even if your job is monotonous. Plus, if you sold bad carrots or other vegetables to your customers, they would get angry and make a complaint about that directly to you. The reverse is also true. You would be glad if your customers seemed

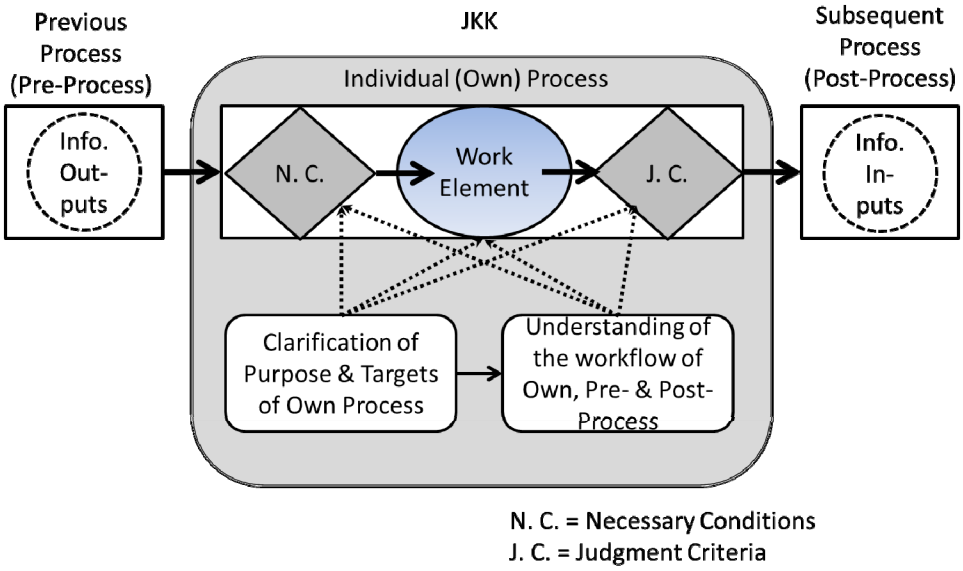
to be happy to buy the vegetables you carefully selected for sale. Thus, it is crucial that a person can obtain immediately the evaluation of one's job performance as a customer's response.

In this manner the employee becomes proactively committed to his or her work and motivation improves. The quality is determined at each work element that comprises the entire work process. A work element is defined by Toyota as breaking down the units of the process into one decision-making level. Although necessary conditions and judgment criteria function as standards, they are not carved in stone. If defects or flaws are found in the process, improvement is made and new standards are established for the next job.

2.3 Basic model of JKK

Building on Sasaki (2007, 2014) and Mori (2010), the process of implementing JKK is illustrated below as a basic model to avoid producing defects in an employee's own work process (see Figure 3). Note that this theoretical description related to JKK is only the foundation of JKK. For quality to be built into the process in JKK, information inputs from the previous process have to be compared with the necessary conditions and then the work element starts. Work results are evaluated in accordance with judgment criteria and are passed on to the subsequent process as output information only when they meet the criteria. This is the definition of JKK in the narrowest sense. However, this definition of JKK focuses only on the flow of work information. In practice, determining the necessary conditions, the work elements, and the judgment criteria is not an easy task. In other words, if the purpose and the targets of the individual processes are not established, and if work processes for the individual processes and their connection with the previous and the subsequent processes are not understood and laid out, it is impossible to establish the necessary conditions, the work elements, and the judgment criteria. It is not an overemphasis to say that the success or failure of JKK hinges on how well one has prepared matters beyond just the flow of information.

Figure 1 JKK basic model (see online version for colours)



The basic model of JKK (Figure 3) conceptualises how the philosophy outlined in this section is embedded in practice. Work begins only when necessary conditions are satisfied, and results move forward only when they meet judgment criteria. By decomposing processes into decision-making units, JKK makes quality assurance the responsibility of every employee within their own process.

In this way, JKK can be understood as a theoretical extension of *jidoka*:

1 It shifts the unit of analysis from physical tasks to decision-making processes.

2 It links process ownership to motivation, learning, and organisational capability.

3 It provides a framework for applying TPS principles to intangible, knowledge-intensive work.

3 Jidoka and lean research beyond Toyota

Although *jidoka* originated within Toyota, related ideas have long been debated in wider management scholarship. Quality management approaches such as Deming's principle of 'quality at the source' and Juran's focus on 'fitness for use' resonate strongly with *jidoka*'s emphasis on defect prevention and continuous improvement (Deming, 1986; Juran, 1992). Likewise, socio-technical systems theory emphasises the joint optimisation of human and technical systems, anticipating *jidoka*'s insistence on integrating human judgment with technological safeguards. In organisational behaviour, high-involvement and empowerment approaches (Lawler, 1986; Pfeffer, 1998) similarly reflect *jidoka*'s concern with granting employees responsibility and autonomy in ensuring quality.

Within the lean literature itself, scholars have noted that research often privileges JIT and flow, while giving comparatively less attention to *jidoka* (Holweg, 2007; Netland, 2013). Yet in applications beyond Toyota, *jidoka*-like principles play a central role in service settings such as healthcare and IT, where error prevention and reliable decision-making are critical (Staats and Upton, 2011; Bortolotti et al., 2015). Studies of lean service (Piercy and Rich, 2009) and lean healthcare (Toussaint and Berry, 2013) emphasise that building quality into white-collar processes requires both structured routines and employee engagement, paralleling *jidoka*'s dual technical and human dimensions in a blue collar setting.

By piecing together these aspects, it becomes clear that *jidoka* is not simply a Toyota-specific technical device but part of a broader management discourse on quality, empowerment, and organisational learning. What distinguishes Toyota's JKK, however, is the systematic codification of these principles into a coherent, standards-based framework for white-collar work. This highlights both Toyota's uniqueness and the potential for JKK to work as a template facilitating management practice in other organisational and industry contexts.

4 Research methodology

The purpose of this research is to describe how Toyota put the philosophy of *jidoka* into practice as JKK in its white-collar departments, while also theorising and analysing the relationships among its conceptual foundations, implementation mechanisms,

prerequisites, and effects. By combining descriptive and theoretical aims, the study seeks to clarify both how JKK operates in practice and how it contributes to the broader development of lean management in knowledge-intensive work.

Table 1 Summary of interview surveys

Date	*Place, time*	*Person, etc.*
10 November 2011	Toyota, Japan (9:00–16:00)	Hiroyoshi Suzuki (general manager, JKK Promotion Dep.)
11 November 2011	Toyota, Japan (9:00–16:00)	Hiroyoshi Suzuki (general manager, JKK Promotion Dep.)
22 February 2012	Supplier A, Japan (9:30–11:30)	(Anonymous)
22 February 2012	Supplier B, Japan (13:30–16:00)	(Anonymous)
24 February 2012	Supplier C, Japan (13:00–16:00)	(Anonymous)
28 February 2012	Toyota, Japan (9:00–14:00)	Managers in charge of JKK promotion at Divisions A and B
28 February 2012	Toyota, Japan (14:00–15:00)	Shinichi Sasaki, Executive vice president
29 February 2012	Toyota, Japan (10:00–17:00)	Managers in charge of JKK promotion at Division C, D, E, and F
7 March 2012	Toyota, Japan (13:00–16:00)	JKK Exhibition of Kyohokai (Toyota's supplier association)
12 March 2012	Toyota, Japan (13:00–16:00)	Hideki Ono (General Manager, TQM Promotion Div.) + 3
23 April 2012	Toyota, Japan (13:00–17:00)	JKK Exhibition of Toyota, TQM Division
26 April 2012	Toyota, Japan (9:00–17:00)	JKK Exhibition of Toyota

To accomplish these purposes, the authors surveyed the relevant literature, and the first author conducted 45-hours of interviews at Toyota in Japan between 2011 and 2012 with four individuals whose roles focus on the promotion and adoption of JKK at Toyota, including the General Manager of the total quality management (TQM) Promotion Division and the General Manager of the JKK Promotion Department. During the interviews, the first author was given access to an abundance of internal materials (documents), including records and detailed explanations regarding the current state of the matter and the philosophy behind the concept of JKK. Furthermore, during this period the first author visited six divisions in Toyota and collected data to research examples of JKK initiatives within the company. An interview was also conducted with Shinichi Sasaki (former Executive Vice President at Toyota), who was the first to systematically broaden the concept of *jidoka* so that the concept of JKK could be created and promulgated companywide. Sasaki later published the results of this effort (Sasaki, 2014). This fieldwork was used to write Section 5.

To shed light on the application of JKK outside of Toyota Motors, the first author conducted similar interviews in February 2012 with three Japanese component suppliers that have close relationships with Toyota and have studied the development of JKK at Toyota through Kyohokai, Toyota's supplier association in Japan (see Section 4.4 for

more on JKK's development outside of Toyota). This fieldwork was used to write Section 6. Also, the information shown in Section 6 concerning the effects of JKK were collected from JKK Conferences held by Kyohokai and JKK Exhibitions held within Toyota.

A summary of the fieldwork that was conducted for this paper is displayed in Table 1. The facts and findings from fieldwork have been augmented with information collected from several different sources such as documents, records, and published works, as explained in Yin (2009).

Although the interviews were conducted in 2011–2012, they remain highly relevant because Toyota's management philosophy and practices are characterised by long-term continuity rather than short-term shifts (Fujimoto, 1999; Liker, 2004, Heller and Fujimoto, 2018). Core principles such as *jidoka* and JKK evolve incrementally but rarely undergo radical change, meaning that insights from this fieldwork continue to reflect the dynamics of implementation today. Evidence that Toyota's suppliers independently sustained and expanded JKK further supports the enduring relevance of these findings. Thus, the 2011–2012 data should be understood not as outdated snapshots but as critical windows into the institutionalisation of a long-lasting management practice.

5 The evolution of JKK

In order to understand the current state of the JKK concept, it is important to study the process by which the concept *jidoka* was refined into the concept of JKK. This section begins with a case study at a large-scale vehicle production plant in Japan.

5.1 The Genesis of JKK: countermeasures for rain leaks at the Tsutsumi Plant

In 1997, Shinichi Sasaki, who was then a senior manager in the production division at Toyota's Tsutsumi Plant, was trying to solve the problem of rain leaks in Toyota automobiles. Rain leaks in automobiles, a major problem that requires many hours of repair work at dealers, had been the cause of significant negative impact on customer satisfaction. To address this problem, shower tests were performed as a method of quality assurance at the factory. However, even if defects were discovered using this testing method, finding the cause was very difficult as there were many processes that could be the cause, coupled with the fact that it took over one day to conduct the test after the assembly had taken place. There were cases where cars still had leaks even after having passed the test. For example, after vehicles were sold, incessant rain gradually infiltrated the interior of the automobile from tiny pores called 'pinholes' generated when welding the car body. These defects were discovered during customer use, causing customer complaints. The existing method of quality assurance made a negative impact on the work efforts of employees in the production department. The worker would be at a loss if he was told that the task he conducted did not give the expected results even though he had followed the designated procedure when the problem occurred. On the other hand, the inspector's finding had no bearing on upstream countermeasures and defects never reached zero. Hence, traditional methods of quality assurance resulted in decreased worker motivation.

Sasaki felt that the shower test had limitations and planned to transition from assurance through testing to assurance through production at the process level. The

causes of vehicle rain leaks encompassed many areas including the precision of vehicle body panels, welding precision, position and amount of sealant coating in the sheet metal joints, precision and condition of assembly parts, etc. Therefore, cooperation between not only each factory department, but also cooperation with white-collar departments in product engineering, production engineering, and in component manufacturers was necessary to solve the problem. While the purpose of the new assurance method was the implementation of the *jidoka* concept within the TPS, the size and scope differed greatly from traditional improvement activities that were largely limited to the plant. The activities associated with this new assurance method that extended beyond the plant to white-collar work were given the name, JKK.

Within JKK, the worker must assess the results of his or her task while it is being performed or immediately after finishing the work. For that purpose, standards are established for the following four elements that comprise the tasks of each process. The progress of JKK is determined by evaluating these elements.

1 Worker: has received sufficient education and training in the knowledge and skills to perform his/her individual work and is able to correctly distinguish between defective and normal status of the work, equipment, tools, and the products in question.

2 Product to be processed: has structure wherein one can tell the product is obviously defective if it is not correctly processed and assembled; precision is within certain criteria and standards.

3 Equipment, jigs, and tools: the precision and reliability of equipment, jigs, and tools employed in processing and assembly are consistent with their intended aim.

4 Process design: level of complexity and absence of elements that generate worker errors and product defects.

When the work elements do not meet the above criteria, cooperation is sought with the responsible division to deploy countermeasures. It is important to take action regardless of whether or not the work element has actually caused a defect.

To prevent the occurrence of the aforementioned pinholes during spot welding, visualisation of the welding marks on the car body is dome immediately after the welding process finishes and a decision table that enables the five-step evaluation is created. The best evaluation is an 'OK' decision that is granted if the welding status is 'completely white' and pinholes 'do not occur'. A mid-level evaluation of 'needs attention' is given when the welding status at both the centre and the peripheral are black and pinholes may possibly occur. The lowest evaluation of 'NG' is given if the welding status shows that 'pinholes have occurred', which requires an immediate remedy.

In this manner, each division and component manufacturer cooperated in the JKK effort and approximately 800 processes and 2,000 items were revised in connection with the rain leaks. As a result, aftermarket rain leak defects fell sharply to 1/20 of what they were prior to the JKK effort. Furthermore, it became clear that workers wanted to be proud of their own work, and rather than merely passing an assurance inspection, they felt satisfaction for taking greater responsibility for their tasks in the JKK process (Sasaki, 2001).

5.2 The launch and promotion of JKK in white-collar departments

The rain-leak prevention success at the Tsutsumi Plant demonstrated the potential validity of JKK in contexts extending beyond individual shop-floor departments. Following this, JKK was gradually expanded into other blue-collar departments and their related white-collar functions, with many lines achieving zero defects within their processes. However, these improvements did not translate into a noticeable reduction in Toyota's overall recall numbers. Two major factors help explain this outcome. First, increasing product complexity and technological sophistication led to fragmented jobs and intricate interdependencies where interface issues could easily be overlooked, generating specification non-conformance. Second, human resource diversity meant that differing assumptions and communication styles sometimes caused essential tasks to be skipped or know-how to be incompletely transferred.

In response, Toyota resolved to apply JKK comprehensively to all white-collar departments. To drive this initiative, in January 2007 the company established the 'BR (business reform) JKK Promotion Department,' reporting directly to the president of Toyota. Its mission was to aggressively promote JKK adoption throughout both blue-collar and white-collar areas. The department not only set policies and provided tools but also engaged in external dissemination of JKK principles. After operating independently for two years, the JKK Promotion Department was integrated into the TQM Promotion Division in January 2009, where it has remained as of 2023. Among its key contributions was the creation of the employee guide to JKK Activities, a manual detailing the procedures for JKK. In addition, it developed the 'basic three points set', consisting of the awareness check sheet, job requirements organisation sheet, and work process flowchart, which served as core tools for evaluating work units, defining work purposes and processes, establishing judgment criteria, and clarifying workflows.

5.3 Deployment of JKK outside of the company: the role of Kyohokai

Automakers procure 70% of their parts from outside of the company and also undertake joint development of many of these parts with suppliers (Fujimoto, 1997). Therefore, JKK's mission cannot be fulfilled without the cooperation of component manufacturers. Toyota organises suppliers through Kyohokai, founded in 1943 (Kyohokai, 1994). The fundamental idea of Kyohokai is 'to ensure that TMC and its member companies contribute to the development of the world economy and society through a wide variety of activities based on a global and open partnership' (Kyohokai Website, https://www.kyohokai.gr.jp/english/outline). The number of member enterprises was 227, as of February 2024.

Knowledge sharing across firms has been encouraged through various Kyohokai activities (Dyer and Nobeoka, 2000; Manabe and Nobeoka, 2002). Member companies engage in study groups on specific themes through workshops, with themes selected yearly in light of Toyota's procurement policy. In 2008, Kyohokai selected 'JKK for employees' as the workshop theme, and JKK remained an important theme in subsequent years. On 8th March 2012, the results debriefing session for 2011 activities were held under the theme 'creating structures rooted in JKK'. It was emphasised that the results of activities could be freely utilised by all member companies in the network, even those that did not participate in the theme workshops.

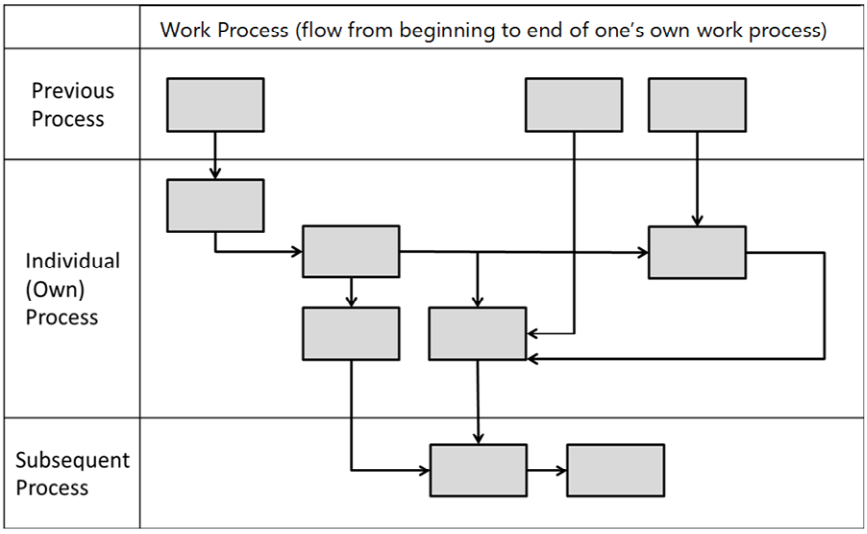
6 Implementing JKK: processes and mechanisms

Building on the conceptual foundations of *jidoka* and JKK outlined earlier, this section turns to the practical mechanisms through which JKK is implemented in Toyota's white-collar departments. Whereas Section 2 established JKK as a theoretical extension of *jidoka* and presented its basic model, the present section explains how these principles are operationalised in daily work. Specifically, it examines the processes required for implementation: clarifying work purposes and targets, decomposing processes into work elements, establishing necessary conditions and judgment criteria, and applying the PDCA cycle in routine management. Together, these mechanisms demonstrate how JKK moves from abstract principle to actionable practice.

6.1 Clarification of purposes/targets and the design of business processes

As a prerequisite for determining whether quality is good or bad, it is necessary to clarify for what one works (purpose) and to what degree the work must be performed well (targets). Purposes and targets that reflect all customer needs, including subsequent processes, must be determined logically and, as much as possible, quantitatively. At the same time, the outputs of individual processes must be clarified.

Figure 2 Workflow



Next there is a need to recognise one's work process as existing within the entire workflow that consists of the previous process, one's own individual process, and the subsequent process. The entire domain of the individual process needs to be laid out from information input to output (see Figure 1). The characteristics of the work necessary to achieve the purpose and targets need to be evaluated for each work process. The content and timing of the information exchanged between processes needs to be clarified based on the relationship between processes, while the purpose and targets of one's own individual process are delineated.

6.2 Fragmentation of individual processes and work elements

Under the JKK approach, each individual process is decomposed into work elements – the smallest decision-making units to which necessary conditions and judgement criteria can be applied. Through decision-making for each work element, the quality of the entire process is secured. Therefore, the definition of work elements is important in JKK.

A work element means the unit of work for which a person in charge can make a decision, based on the idea 'one process, one decision'. Decision making can be performed as individual processes are decomposed down to the state where the person in charge can determine the quality of the task on site. Judgement is needed for verifying the presence/absence and accuracy of required information and for transforming and processing information. The work element is considered to be the smallest unit for this kind of judgment.

6.3 Determining necessary conditions and judgment criteria

To perform quality assurance for each work element, it is required to ensure conditions for producing high quality results prior to starting the work element and to establish standards to determine the quality of the results themselves before finishing the task. In JKK, the former is referred to as necessary conditions and the latter as judgment criteria.

6.4 Necessary conditions and judgement criteria

Work in the individual process cannot start unless the conditions for producing the outputs required for the subsequent process are reliably met. In JKK, satisfying conditions in the following five items is deemed sufficient for generating acceptable results (i.e., non-defective products). These are called the 'necessary conditions' for completing an individual work process. These items are checked prior to starting a work element and work can be started only after it is verified that everything is in place.

1 Information inputs: information obtained from the previous work process that is needed to do a subsequent work process.

2 Tools: predetermined software, devices, etc. required for performing a work element.

3 Methods: manuals, software handbooks, measurement methods, etc. including the procedures required for performing a work element.

4 Ability: the ability to use the tools and methods that are necessary to perform a work element.

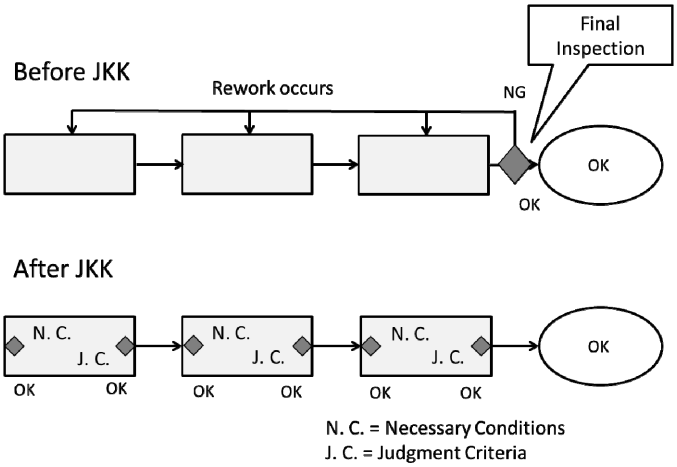
5 Reference items: points that require attention when performing a work element such as past experience of failures/trouble, know-how.

In JKK, the employee checks by himself or herself before the work element passed on the next work element to see if the work results satisfy the demands and expectations of the subsequent process and customers.

More specifically, the standard for determining the quality of the outcome of one's own task is the judgment criteria. The aforementioned work purpose and targets are built into judgment criteria which need to be clarified in a specific manner. Unless the standard is satisfied, deliverables do not move to the subsequent process. As long as the judgment

criteria are satisfied, the subsequent process expectations will not be breached. Therefore, in principle, rework will not occur (see Figure 2).

Figure 3 Before and after JKK



6.5 Accomplishing work and PDCA

When implementing JKK, it is important to go through the so-called PDCA cycle in daily job management. In JKK specifically, one goes through the PDCA cycle as follows.

1 Plan: clarification of the aforementioned work purpose and targets; clarification of the process for accomplishing the purpose and targets; decomposition of individual processes into work elements; clarification of the necessary conditions and the judgment criteria; preparing the usage environment and ensuring accumulation of results for future reference.

2 Do: execute the formulated plan.

3 Check: review the 'do' activities within the work responsibilities.

4 Act: improve the work processes, the necessary conditions, and the judgment criteria; return to plan.

In this manner, the PDCA cycle is repeated constantly (Imai, 2010) when pursuing JKK.

7 Prerequisites and effects of JKK

7.1 Prerequisites for JKK

Here we consider the necessary prerequisites for executing JKK. In JKK, not producing defects in one's own process is essential. For that to happen, one must know not only one's own process, but also what inputs are required from the previous process and what outputs need to be handed over to the subsequent process. To execute JKK, what needs to be done in one's own process must be done in consideration of one's interface with the

previous process and the subsequent process. Only after this consideration is made can one establish the necessary conditions for the previous process and judgment criteria for the subsequent process.

Put another way, JKK will not work if one thinks only about one's own process. The relationship with the previous and the subsequent processes is crucial for the execution of JKK. Toyota's well documented organisational culture that values multi-skilled workers (Fujimoto, 1999) undergirds thinking beyond one's own process on the shop floor. A similar foundation for white-collar employees is needed. Our investigation revealed that a workplace prominently featuring *manager commitment*, *visualisation* and *open discussion* contributed to developing such a foundation. Introducing JKK outside of Toyota into its suppliers made it clear that understanding the basic model of JKK does not necessarily mean it will be easy to implement JKK. The authors believe that this is because these foundational elements are a prerequisite for JKK, and the elements are present to varying degrees in Toyota's suppliers. Each element is discussed in turn.

7.1.1 Manager commitment

Central to JKK, and to *jidoka* more generally, is the role of managerial leadership. Unlike traditional supervisory models that emphasise control, *jidoka* requires leaders to empower employees to stop processes and take corrective action when abnormalities occur. This redistribution of authority depends on leaders cultivating trust, ensuring that employees feel supported when making quality-related interventions. Along the same lines, in JKK managers must provide enabling structures, such as clear judgment criteria, visual management systems, and opportunities for open discussion, that allow JKK to function as a system rather than an individual initiative. Leadership must legitimise employee autonomy while aligning it with organisational objectives. Without such leadership, both JKK and *jidoka* risk being perceived as an additional burden rather than a source of empowerment.

The managers' role is to create an environment for employees to accomplish their work in the best possible manner (Mori, 2010). To promote JKK, managers themselves must understand JKK to lead its introduction. JKK is a philosophy that respects the right of each employee to make decisions regarding one's own process. However, this does not mean that managers delegate all their responsibility to their subordinates. Managers need to commit thoroughly to preparing their subordinates to initiate JKK, and managers must continue to be closely involved in their work. According to Toyota's internal documents, the following five points represent the managers' responsibilities in putting JKK into practice.

1 Raising the awareness of subordinates: a manager should identify existing or potential issues related to the introduction of JKK, address organisational issues, inform all members, and motivate all employees to work together to resolve them. Managers need to perform problem visualisation to check the situation facing each employee to help them understand the current quality of work and need for JKK.

2 Arranging the work environment to conduct JKK: managers should encourage subordinates to organise knowledge and information in proper order. Managers should align the content of information with the timing of information exchange between their division and other divisions (i.e., connect with previous processes and subsequent processes). They should enforce the establishment of the necessary

conditions for each work element. In this manner, the environment necessary for JKK is established. As the implementation of JKK progresses, employees make suggestions for changing the work environment. Managers must consider these suggestions.

3 Promotion of PDCA in daily management: the completion of the PDCA cycle is a vital part of JKK. The JKK process is confirmed with employees in the plan activity. In the do activity, the work is delegated. In the check activity, the work is reviewed with employees and issues are identified and communicated to all members. In the act activity employees are encouraged to make improvements regarding future tasks. Improvements are constantly encouraged through daily management to continue to meet the established standards.

4 Understand work that cannot be performed according to JKK and promote its improvement: when employees are unable to produce good work results, the necessary conditions are considered inadequate. Work that cannot be performed according to JKK needs to be rearranged and improved.

5 Expanding the organisational domain of JKK: implementation of JKK needs to be planned and should not be transient. JKK begins with an understanding of one's own process and work quality is improved through practice. Over time the activities covered by JKK need to be expanded to the standardisation of all routine work activities, critical tasks and cross-functional activities, which requires rotating through improvement cycles, transfer of know-how, and the development of human resources. The JKK program needs to be expanded in a gradual manner and to be led by all employees who participate in it by taking ownership of their own work.

7.1.2 Visualisation

Likened to *andon* boards in production lines that show where a line has stopped, visualisation is defined here as ensuring that information can be easily seen, so that it can be shared widely in order to solve the problems inherent in group activities. Visualisation has variations depending upon how it is used and can be divided into four categories (Endo, 2005):

1 Visualisation for mentally grasping: visualisation to show information, facts, and numbers required for group activities regardless of the intentions of the viewing party.

2 Visualisation for checking: visualisation of information, facts, and numbers that goes beyond simply grasping and extends to analysing and carefully examining their nature and main sources.

3 Visualisation for diagnosing: visualisation for viewing details to identify concrete problems.

4 Visualisation for overlooking: visualisation not for individual processes, but for obtaining a bird's eye view of the big picture.

In designing white-collar work processes, visualisation is applied to hierarchical structures (from division to individual levels) to show how information circulates (Shimizu, 2010). However, it is in the flow of information within a work group, that a

key difference between blue-collar productive work and white-collar productive work is revealed. When working on the production line, creative thinking (problem solving) is needed only when abnormalities occur. In contrast, it is common for white-collar productive work to require creative thinking in both normal situations and abnormal situations. Creative work implies doing something new or different often in an unstructured way. In such cases, it can be difficult to define clearly work processes and connections with previous and subsequent work processes. This, in turn, can complicate defining clearly the judgement criteria. So, care must be taken in visualising these connections and judgement criteria in white-collar work, so as not to overly constrict white-collar employees who need to engage in creative work.

7.1.3 Creating an environment conductive to open discussion

What should be addressed first when implementing JKK is work for which problems are known to be difficult to solve. Recurring problems or difficulties should not be kept to themselves, but such issues should be brought into the open for work groups and managers to discuss freely. Toyota has a corporate culture that emphasises open and personal communication conducted irrespective of rank or job title (Osono et al., 2008).

Even members within the same group may have different perceptions of problems due to each person being in a different position and experience. Only after these different approaches to problems are acknowledged can one understand what type of work is appropriate and what the purpose and targets of the work are. Hence, without a corporate culture or common ground where open discussion reaches beyond position and experience, understanding the status of the work and establishing a common direction for solving problems will be difficult.

Open discussion requires some level of trust between employees, and in particular trust between managers and subordinates. Within an atmosphere of trust, a feeling of psychological safety makes it easier for employees to share different perceptions of problems, even if they conflict with the views of other members or the view of a group leader. Trust at Toyota is rooted in the expectation of Toyota managers that all employees will raise their individual perspectives to drive continuous improvement. Furthermore, a long history of and stable pay and employment at Toyota's facilities in Japan helps establish a basic level of trust and an atmosphere where open discussion can flourish.

7.2 Effects of JKK

As previously mentioned, the main purpose of JKK is to improve employee motivation. However, according to Toyota, JKK has various effects that combine together to create this enhanced motivation. The following is an overview of these effects including enhanced motivation. The eight effects are: Improved quality of work, increased customer satisfaction, improved efficiency, active communication between departments, organisational memory of standards and know-how, improved employee abilities, smooth job rotation, and enhanced employee motivation. Each effect is described as follows.

1 Improved quality of work: there are no defects in one's own process and if defects do occur, they are not delivered to the subsequent process. Thus, the overall quality of work is improved.

2 Increased customer satisfaction: information based on the needs of the subsequent process including the final customer can be reliably delivered. As a result, the level of satisfaction of the subsequent process and the final customer is increased.

3 Improved efficiency: as a result of the high quality of the work, there is less or no rework, thus eliminating wasted time and reducing cost.

4 Active communication between departments: visualisation, especially for overlooking, is performed to understand the relationships with related departments, and information is transmitted as needed and when needed. Activation of informal communication may also take place through clearer communication routes between departments.

5 Organisational memory of standards and know-how: through JKK, work methods and individual knowledge/know-how are standardised and organisationally recorded as formal knowledge. Past work becomes more easily referenced, and know-how and knowledge are put to use.

6 Improved employee abilities: know-how and evaluation standards necessary for work become more accessible than before. As the philosophy of JKK is assimilated into employees' style of working, sensitivity toward quality can be expected to increase.

7 Smooth job rotation: job responsibility can be understood quickly and accurately even for new jobs, making the learning process easier. As a result, training employees for new work can be done more efficiently, thus facilitating smooth job rotation, including job succession.

8 Enhanced employee motivation: the aforementioned effects contribute significantly to enhanced employee motivation.

Figure 4 summarises the logical flow by which JKK contributes to motivation. Going forward, further research is needed to verify these causes and effects.

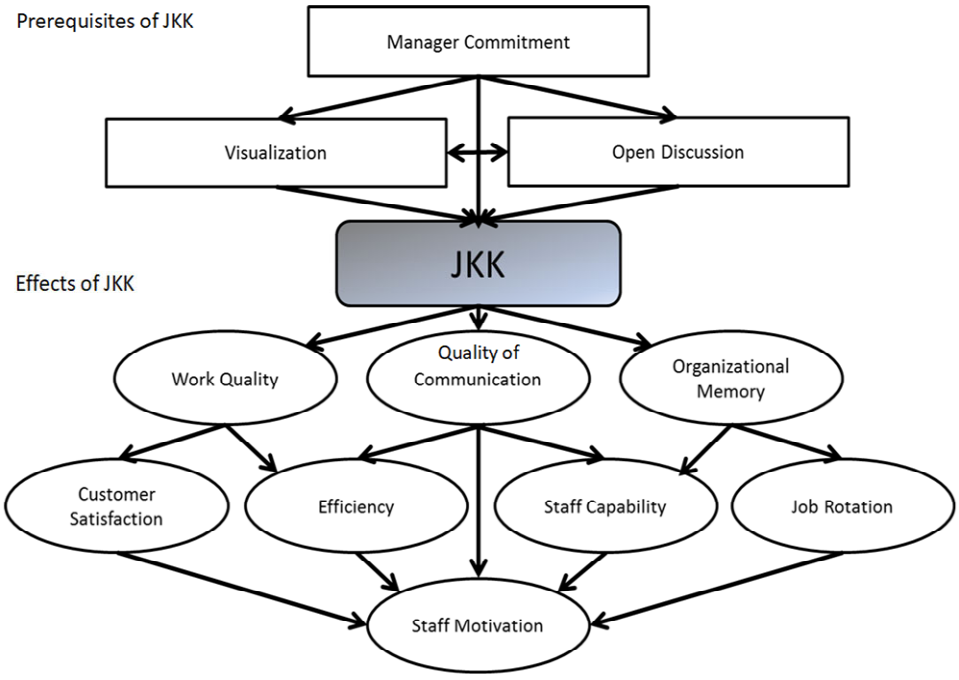
At this point we can provide a few hypothetical examples of JKK that illustrate its practical application in white-collar settings. These concrete applications illustrate how JKK can transform white-collar workflows into more reliable and value-adding processes by embedding quality checks directly within routine tasks.

For example, in engineering design departments, JKK may require that drawings or specifications be released to downstream processes only when predefined judgment criteria, such as completeness of documentation, verification of compliance with design standards, and confirmation of cost assumptions, are satisfied. Doing so reduces costly rework and accelerates decision-making cycles. However, for it to work in this way clear standards showing what constitutes compliance and completeness are needed. A tradition of standardisation at Toyota greatly helps in this regard (Hino, 2006, Whitney et al., 2007).

In administrative functions such as human resource management, JKK may entail checking that all required documents and approvals are in place before a contract is finalised, thereby preventing errors that could delay employee entry or payroll processing. Similarly, in inter-departmental communication, JKK may encourage staff to confirm that meeting inputs (e.g., data reports, proposals) meet clarity and completeness standards before circulation, which optimise discussion time and minimise

misunderstandings. The documentation standardisation process, in particular the use of the A3 method at Toyota, offers a concrete way of ensuring clarity and completeness (Rother and Shook, 1998; Shook, 2008).

Figure 4 Logical flow of the establishment and effects of JKK for enhanced motivation (see online version for colours)



8 Conclusions and implications

By building on the widespread use of *jidoka* in blue-collar departments, Toyota applied this idea in the form of JKK to engineering and other white-collar departments and promoted intra-process quality assurance. There are various advantages that can be achieved with JKK, such as improved quality of work, increased customer satisfaction, improved efficiency, active communication between departments, organisational memory of standards and know-how, improved employee capabilities, smooth job rotation, and improved employee motivation. However, launching and establishing JKK in white-collar departments is not an easy task for three reasons. First, successful implementation depends on prerequisites such as manager commitment, visualisation, and open discussion. Second, the degree of difficulty varies across types of work, being easier to apply to routine tasks than to creative and unstructured work. Third, JKK requires time and effort to establish; and if it is perceived as a burden, it risks being abandoned before its cumulative benefits are realised.

By situating JKK within the broader debates on lean production, this study makes three contributions to existing research. First, it extends analyses of *jidoka* beyond its traditional framing as a shop-floor quality-control mechanism, showing how its

underlying principles of process ownership and built-in quality can be meaningfully adapted to knowledge-intensive, white-collar work. Second, it advances the emerging literature on lean in non-manufacturing contexts by offering a concrete, empirically grounded model – JKK – that demonstrates both the opportunities and challenges of such transfers. Third, it contributes to research on inter-organisational learning in lean supply networks by showing how Toyota's suppliers not only adopted but also shaped JKK practices, creating a two-way flow of knowledge. Taken together, these contributions suggest that JKK provides a bridge between classical TPS principles and the demands of contemporary organisations where collaboration, information flows, and decision-making quality are as critical as physical production processes.

Our findings not only illustrate how JKK operates within Toyota and its suppliers but also speak to overarching themes in management and operations research. By demonstrating how *jidoka* principles can be adapted to decision-making and information flows, JKK extends the applicability of lean concepts into domains often seen as resistant to standardisation. In doing so, it offers an empirical counterpart to theoretical discussions of quality-at-the-source, socio-technical integration, and high-involvement management. Moreover, the evidence that JKK enhances motivation, communication, and learning shows how *jidoka*'s human-centred logic complements the efficiency orientation of JIT – thus contributing to the ongoing debate about the dual nature of lean production.

While JKK clearly reflects Toyota's unique organisational philosophy – characterised by long-term orientation, continuous improvement, and respect for people – the context within which it may be applied is not necessarily limited to Toyota. The independent promotion of JKK by suppliers demonstrates that, under appropriate conditions, its principles can be transferred beyond Toyota. However, successful transfer depends on organisational factors such as leadership commitment, cultural openness to employee-driven quality assurance, and the ability to codify judgment criteria in knowledge-intensive work. Firms lacking these characteristics may find JKK difficult to sustain or that the idea has been reduced to a procedural tool stripped of its motivational and learning dimensions. Thus, JKK illustrates both the uniqueness of Toyota's lean system and the possibility of selective transferability, provided that firms adapt the philosophy to their own cultural and organisational contexts.

Looking forward, further research should investigate how JKK evolves in global contexts and across industries, particularly in organisations where knowledge-intensive and creative tasks dominate. Comparative studies between Toyota and its suppliers, or between different international subsidiaries, could shed light on how cultural, organisational, and technological factors shape the adaptation of JKK. More broadly, examining JKK as a living system of inter-organisational learning may help explain how lean management continues to evolve in response to the complexity of modern business environments.

Declarations

All authors declare that they have no conflicts of interest.

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References

Adler, P.S. (1993) 'Time and motion regained', *Harvard Business Review*, Vol. 71, No. 1, pp.97–108.

Bortolotti, T., Romano, P. and Danese, P. (2015) 'Successful lean implementation: organizational culture and soft lean practices matter', *International Journal of Production Economics*, Vol. 160, pp.182–201.

Chiarini, A., Baccarani, C. and Mascherpa, V. (2018) 'Lean production, Toyota Production System and Kaizen philosophy: a conceptual analysis from the perspective of Zen Buddhism', *The TQM Journal*, Vol. 30, No. 4, pp.425–438.

Deming, W.E. (1986) *Out of the Crisis*, Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge, MA.

Dyer, J. and Nobeoka, K. (2000) 'Creating and managing a high-performance knowledge-sharing network: the Toyota case', *Strategic Management Journal*, Vol. 21, No. 3, pp.345–367.

Endo, I. (2005) *Visualization: 'Visualized' System for Creation of Strong Corporation* [Mieruka: Tsuyoi Kigyou o tsukuru mieru Shikumi], Toyo Keizai Inc., Tokyo.

Fujimoto, T. (1997) *The Evolution of Production Systems – Organizational Power and Creative Invention Processes at Toyota Motors* [Seisan Shisutemu no Shinkaron: Toyota Jidousha ni mieru Soshiki Nouryoku to Souhatsu Purosesu], Yuhikaku, Tokyo.

Fujimoto, T. (1999) *The Evolution of a Manufacturing System at Toyota*, Oxford University Press, New York.

Heller, D.A. and Fujimoto, T. (2018) 'Monozukuri management: driver of sustained competitiveness in the Japanese auto industry', in Nakano, T. (Ed.): *Japanese Management in Evolution: New Directions, Breaks, and Emerging Practices*, Vol. 6, pp.107–126, Routledge, NY.

Hino, S. (2006) *Inside the Mind of Toyota: Management Principles for Enduring Growth*, Productivity Press, New York.

Holweg, M. (2007) 'The genealogy of lean production', *Journal of Operations Management*, Vol. 25, No. 2, pp.420–437.

Imai, M. (2010) *Kaizen: Management know-how for Japan's Success in International Competition*, (Revised Reprint) [Kaizen: Nihon Kigyou ga Kokusai Kyousou de Seikou shita Keiei Nouhau], Nikkei Publishing Company, Tokyo.

Juran, J.M. (1992) *Juran on Quality By Design: the New Steps for Planning Quality Into Goods and Services*, Free Press, New York.

Kyohokai 50 Year History Publication Committee (1994) *50 Year History of Kyohokai* [Kyouhoukai Gojuunen no Ayumi, Kyohokai], Kyohokai, Nagoya.

Kyohokai Website [online] https://www.kyohokai.gr.jp/english/outline (accessed 8 February 2024).

Lawler, E.E. (1986) *High-Involvement Management: Participative Strategies for Improving Organizational Performance*, Jossey-Bass, San Francisco.

Liker, J.K. (2004) *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, McGraw-Hill, New York, NY.

MacDuffie, J.P. (1997) 'The road to root cause: Shop-floor problem-solving at three auto assembly plants', *Management Science*, Vol. 43, No. 4, pp.479–502.

Manabe, S. and Nobeoka, K. (2002) 'Building a network of trust: Toyota Motor's inter-organizational learning system', [Nettowaaku Shinrai ni okeru Soshikikan Gakushuu Shisutemu no Yakuwari: Toyota no Jirei Kenkyuu]', *Hitotsubashi Business Review*, Vol. 50, No. 3, pp.184–193.

Marin-Garcia, J.A., Juarez-Tarraga, A. and Santandreu-Mascarell, C. (2018) 'Kaizen philosophy: the keys of the permanent suggestion systems analyzed from the workers' perspective', *The TQM Journal*, Vol. 30, No. 4, pp.296–320.

Mori, K. (2010) 'JKK Efforts at Toyota', [Toyota ni okeru Jikoutei Kanketsu no Torikumi], *Quality Management*, Vol. 61, No. 4, pp.18–29.

Netland, T.H. (2013) 'Exploring the phenomenon of company-specific production systems: one-best-way or own-best-way?', *International Journal of Production Research*, Vol. 51, No. 4, pp.1084–1097.

Ono, T. (1978) *The Toyota Production System – Toward Management for Smaller Scale* [Toyota Seisan Houshiki – Datsu Kibo no Keiei o mezashite], Diamond Inc., Tokyo.

Osono, E., Shimizu, N. and Takeuchi H. (2008) *Extreme Toyota: Radical Contradictions That Drive Success at the World's Best Manufacturer*, John Wiley & Sons, New Jersey.

Pfeffer, J. (1998) *The Human Equation: Building Profits By Putting People First*, Harvard Business School Press, Boston, MA.

Piercy, N. and Rich, N. (2009) 'Lean transformation in the pure service environment: the case of the call service centre', *International Journal of Operations and Production Management*, Vol. 29, No. 1, pp.54–76.

Rother, M. and Shook, J. (1998) *Learning To See*, The Lean Enterprise Institute, Brookline, MA.

Sako, M. (1996) 'Suppliers' associations in the Japanese automobile industry: collective action for technology diffusion', *Cambridge Journal of Economics*, Vol. 20, No. 6, pp.651–671.

Sasaki, S. (2001) 'The challenge of creating 100% quality products – zero leak activity through JKK' [100% Ryouhin Tsukurikomi e no Chousen – Jikoutei Kanketsu ni yoru Amamore Zero Katsudou]', *Engineers*, No. 632, pp.21–31.

Sasaki, S. (2007) 'Toyota's quality assurance activities – aiming for 'quality is built in the process (= JKK)', [Toyota no mezasu Hinshitsu Hoshou Katsudou – 'Hinshitsu wa Koutei de tsukurikomu (= JKK)'], *Quality Management*, Vol. 58, No. 4, pp.36–43.

Sasaki, S. (2014) *Completing Your Own Process* (JKK) [Ji Koutei Kanketsu (JKK)], Nihon Kikaku Kyoukai, Tokyo, Tokyo.

Shimizu, H. (2010) *Q Assurance' in Monozukuri' Japanese Society for Quality Control, Chubu Branch – Edition for the Industrial Collaboration Workshop 'Q Assurance in Development and Design': Toward Higher Quality Monozukuri*, Japan Standards Association.

Shook, J. (2008) *Managing to Learn: Using the A3 Management Process to Solve Problems, Gain Agreement, Mentor, and Lead*, Lean Enterprise Institute, Brookline, MA.

Solaimani, S., van de Veen, J., Sobek, D.K., Gulyaz, E. and Venugopal, V. (2019) 'On the application of Lean principles and practices to innovation management: a systematic review', *The TQM Journal*, Vol. 31, No. 6, pp.1064–1092.

Spear, S.J. (2009) *Chasing the Rabbit: How Market Leaders Outdistance the Competition and How Great Companies Can Catch Up and Win*, McGraw-Hill, New York, NY.

Staats, B.R. and Upton, D.M. (2011) 'Lean knowledge work', *Harvard Business Review*, Vol. 89, No. 10, pp.100–110.

Toussaint, J.S. and Berry, L.L. (2013) 'The promise of lean in health care', *Mayo Clinic Proceedings*, Vol. 88, No. 1, pp.74–82.

Whitney, D.E., Heller, D.A., Higashi, H. and Fukuzawa, M. (2007) *Production Engineering as System Integrator? A Research Note Based on A Study of Door Engineering and Assembly At Toyota Motor Corporation*, The University of Tokyo Manufacturing Management Research Center, Discussion Paper Series, Vol. 169, pp.1–16.

Womack, J.P. and Jones, D.T. (1996) *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Simon and Schuster, New York, NY.

Womack, J.P., Jones, D.T. and Roos, D. (1990) *The Machine that Changed the World: The Story of Lean Production*, Rawson Associates, New York, NY.

Yin, R.K. (2009) *Case Study Research: Design and Methods Fourth Edition*, SAGE Publications Inc., Thousand Oaks, California.