

# Toyota Kata as a Scaffolding for Human-Centric Manufacturing: Applying Lean Thinking for a Digital and Sustainable Factory of the Future

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**Abstract.** Industry has a key role in leading the digital and green transitions for the economic and societal transformations that we are experiencing. The approach towards a sustainable, human-centric, and resilient European industry, so-called Industry 5.0, complements the existing “Industry 4.0” approach by focusing on a circular, human-oriented, and durable industry. Thus, industrial systems need to have a focus shift from technology to human so that technology will serve human and not vice versa. In this way, human play a central role between technology and organizations. This paper seeks the challenge of this focus shift and how lean thinking and practicing soft lean tools such as Toyota Kata may contribute to the development of a human-centric approach in the industry. A literature review was conducted to answer these questions, and a conceptual modified Toyota Kata methodology, the so-called Human-centric Kata, was suggested to assist industry in reaching its goals towards a human-centric green-digital era.

**Keywords:** Lean, Toyota Kata, Human-Centric, Industry 4.0, Industry 5.0.

## 1 Introduction

The status quo obligates industry to transform to be greener and more robust by using human-oriented approaches. Industry 4.0, known as the cyber-physical transformation, results in a comprehensive transformation of the entire world's industrial production by combining digital technology and the internet with traditional industry [1]. The term *Industry 4.0* originated from a government initiative in Germany, called Industrie 4.0. The promises of Industry 4.0 are mainly focused on the digitalization of the industry and the improvement of the processes' efficiencies. Furthermore, the decentralization design principle and technologies like blockchain encourage consumers and businesses to make environmentally friendly decisions [2, 3]. However, according to Nahavandi [4], when Industry 4.0 reaches its full effect, it may face resistance from labor unions and politicians as soon as it is realized that the benefits of Industry 4.0 are neutralized by an increased workforce. In addition, Industry 4.0's purposes do not align with the climate crisis, planetary emergency, and social tensions [5]. Thus, an updated and/or revised version of Industry 4.0, so-called Industry 5.0, may contribute to tackling these obstacles. Industry 5.0 is aimed at utilizing the creativity and craftsmanship properties

of human beings; and the speed, consistency, and productivity of robots to better appreciate the cooperation between them by combining their diverging strengths [6]. Østergaard [7] refers to Industry 5.0 as the “human-touch revolution”, and it represents a shift from mass production to mass customization. This approach focuses on human needs, interests, and what technology can do for human, not vice-versa [8]. Such evolution/revolution may combine learnings from the pandemic with the design need for the industry to be resilient and green [5].

Lean, a term coined first in 1988 [9], was originally derived from industry in Japan, and its philosophy covers the idea of creating needed value for the customers with fewer resources/less waste and pursuing this idea continuously [10]. However, only leading people to implement lean tools and methodologies is not sufficient to be competitive and continuously improving [11]. It is rather crucial to teach people to grasp the situation, react accordingly, and practice these behavioral routines on a daily basis [12]. Originating in the martial arts, Kata provides such structured routines consisting of patterns. The model is not a substitute for lean tools, but rather a support that strengthens their effectiveness [13]. According to Rother [14], there are two types of kata: improvement kata and coaching kata. Soltero and Boutier [15] combined Toyota Kata with training within industry (TWI) modules and concluded with seven kata; improvement kata, coaching kata, nested job instruction kata, problem solving kata, job relations kata, job safety kata, and job methods kata. This set of katas may boost an organization’s lean transformation [15].

This study investigates the challenge of the industrial shift from Industry 4.0 to Industry 5.0 and how applying soft lean tools such as Toyota kata mentioned above and lean thinking in general may work as a scaffolding for the human-centric approach that is needed for the digital and sustainable factory of the future. A systematic literature review method was followed, as explained in the method section. Conceptual research is exploited as a framework. The rest of the paper is structured as follows: The next section explains the research method used in this paper. Section 3 summarizes the findings from the literature review. Discussions, conclusions, and suggestions for future work are given in Section 4 and Section 5.

## 2 Method

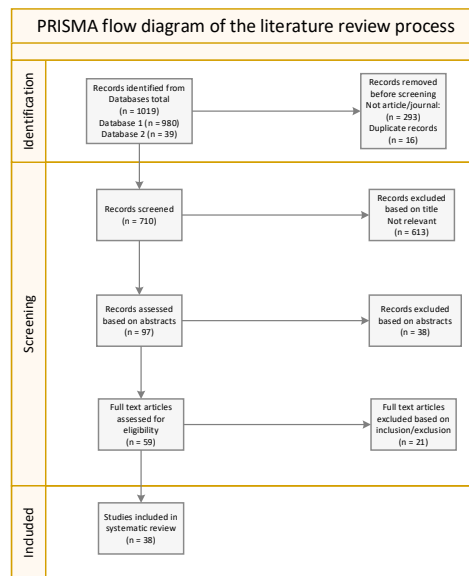
In this paper, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method is used [16]. A systematic approach was key. The primary objectives of this review were to determine the major transition challenge of the industry towards Industry 5.0, the interrelationship of lean thinking/soft lean tools, and a human-centric approach, and how Toyota Kata methodology can contribute to this transition towards a digital and sustainable factory of the future. Thus, this review aimed to answer the following Research Questions (RQ):

- (RQ1): What is the challenge of transition from Industry 4.0 to Industry 5.0 from the aspect of human-centric focus?
- (RQ2): Can/How Toyota Kata methodology be used as a basis to create a new methodology for the human-centric digital and sustainable factory of the future?

For this systematic review, electronic searches were conducted for eligible studies, including conference papers, within Google Scholar and Scopus between 2011 and 2023, until December 5<sup>th</sup>, 2022. Scopus is modern and has a greater emphasis on the humanities. The goal, in conjunction with Google Scholar results, is to find the most related results within the subject. In addition, all eligible studies' reference lists were searched, and forward citation tracking was used. The search was limited to English records. The following string was searched on each database:

- lean AND human AND kata (digital\* OR sustain\*) -karate -finance

From the 1019 records identified, 38 were eligible (see Fig. 1) Inclusion criteria are human-centric, kata as a coaching method, soft lean, and industry 4.0/5.0, while exclusion criteria are finance, economy, karate, and martial arts.



**Fig. 1** PRISMA literature review process

### 3 Findings

In this section, findings from the literature review and our forward-looking analysis are given in three groups. These findings are used as the basis for the discussion.

#### 3.1 Soft lean, digitalization, and sustainability

Lean communities had a focus on tools until around the mid-1990s. In the twenty-first century, there has been a shift in emphasis toward culture and human-aspects of lean [17]. Powell and Coughlan [18] stated that lean is more of an education system than a production system, while Liker [19] defined it as a socio-technical system. Furthermore, lean is described as a psychological theory with Kaizen, which supports the

human focus on lean [20]. The learning roadmap for Digital Lean Manufacturing (DLM) suggests a five stage maturity model, and the last stage, namely “advanced innovation,” is based on human and system integration [21]. Human-centric decisions about process improvements are possible by adopting lean [22].

It is crucial that workers are involved in every step of the digital transition to ensure a human-centric approach in the industrial context [8]. Lean thinking principles were suggested as a driving motor for digitalization initiatives in the industry to avoid focusing on the technologies, rather than using them as enablers [23]. Digital continuous improvement (CI) must have “go to gemba” principles so that it will not replace employees or their creativity, but rather support them [24].

The expected results of lean; scheduled production activities, decreased non-value adding activities, and waste, are positive impacts for environmental sustainability [25]. However, the literature also reveals several aspects regarding the synergy between lean and green, which argue against the negative impacts of lean on sustainability [26].

### **3.2 Industrial revolutions and a human-centric approach**

It is still debatable whether Industry 5.0 is an evolution or revolution, and obviously the very same question was asked before for Industry 4.0 as well [23]. In recent years, new concept discussions have moved from Cyber-Physical Systems and the Internet of Things (IoT) to human-centered production with competent workers [22]. According to Nahavandi [4], utilizing human brain power and creativity will increase process efficiencies, which will be possible by bringing back human workers to the factory floor, namely with the fifth industrial revolution. Finally, for manufacturers that would like to be successful in adopting I4.0 technologies, complementarity with lean, defined as cognitive and behavioral transformation, can be enabled by action learning [27].

### **3.3 Toyota Kata**

The Kata concept, which originated from ancient Japan’s martial arts, consists of basic, repetitive forms. The concept is also derived as a standard, a predefined or choreographic sequence, a training method, and a structured practice routine [14, 28]. Organizationally, Improvement Kata and Coaching Kata create muscle memory for continuous improvement [29]. Toyota Kata is expected to decentralize decision-making, allowing employees to propose improvements on their own [22]. The three main benefits of using Toyota Kata are collaboration, learning, and continuous improvement [30]. Finally, developing an appropriate kata competency necessitates interaction and experience [12].

## 4 Discussion

### 4.1 The challenge of transitioning from Industry 4.0 to Industry 5.0

The literature review revealed that concept discussions are moving from Cyber-Physical Systems to human-centered production [4, 22]. Industry 4.0, which aims to connect human and organization to technology by placing technology as an interaction center between human and organization, does not fulfill the requirements of this industrial trend. On the other hand, Industry 5.0 puts the human aspect at the center to make it the main interaction hub between technology and organization. This implies that a shift in interaction center will be required for human, technological, and organizational aspects. Activities and strategies should be designed in such a way that human is the interaction center between organization and technologies. As a conclusion, this focus change may be one of the major challenges. Industry 4.0 already focuses on the interaction between technology and human. Thus, especially the soft part of lean may contribute well to this transition since it focuses mainly on the other bridging element, namely interaction between human and organization [31].

To illustrate the transition challenges from Industry 4.0 to Industry 5.0, the Human-Technology-Organization (HTO) concept, suggested to analyze interactions between these three aspects in regards to Industry 4.0 and lean [31, 32], may be used as a basis (see Fig. 2).

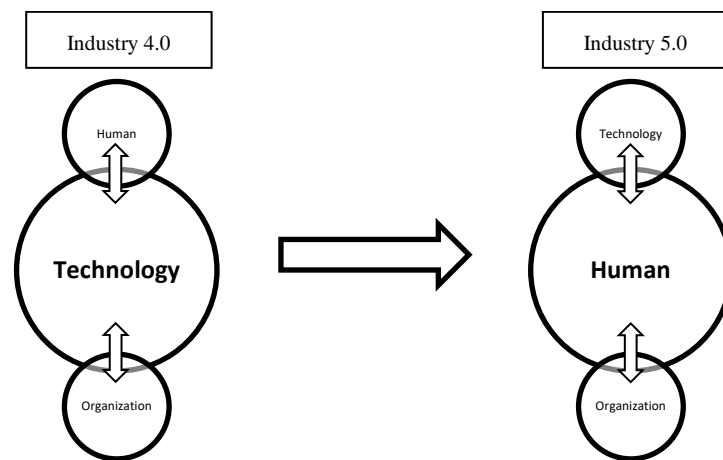


Fig. 2 Interaction center shift from I4.0 to I5.0

### 4.2 Applying lean thinking and Toyota Kata for a human-centric approach

Both lean thinking and industry have a tendency to have a common focal point in recent years, namely the human aspect [17]. Likewise, several studies indicate that Toyota Kata may serve as a structured standard routine that synchronizes the industry towards

a human focused approach by creating a humane muscle memory [14, 28, 29]. Its strength in centralizing decisions on employees, its advantages of collaboration, learning, and continuous improvement, may provide a good foundation for the industrial transition [22, 30]. Thus, applying lean thinking by practicing a standard routine such as Toyota Kata may assist this transition. In the next section, a modified version of Toyota Kata, the so-called “Human-centric Kata,” is introduced for this purpose.

### 4.3 Human-centric Kata

Human-centric Kata is a conceptual modified Toyota Kata that aims to assist industry in having a habitual human-centric approach towards Industry 5.0. Toyota Kata is made up of four-steps and routines: vision, current condition, next target condition, and experiments/obstacles towards the next target [14]. 4-steps for Human-centric Kata are given below.

**Human-centric vision.** This is the first step in understanding our sense of direction. For Human-Centric Kata, the vision is to have a focus on human and to involve human in every action we take.

**Current condition.** At this step, we examine our current situation clearly. From the perspective of human-centric kata, this is a verification of whether the process we work on has human factors in it or not. If so, whether the human involvement is sufficient should also be evaluated at this step. It will help us identify our next target condition.

**Next target condition.** At this step, we determine a good next step goal for the challenge. When determining the next step for human-centric kata, it is important to define the step towards a goal that will serve human so that the next step makes the process more humane.

**Experiments/obstacles.** At this final step, we conduct an experiment scientifically, to achieve the next target condition.

## 5 Conclusion

Findings of the literature review reveal that the major challenge in transitioning from Industry 4.0 to Industry 5.0 from a human-centric perspective is the required interaction center shift from technology to human and that applying lean thinking by practicing Toyota Kata has a positive impact on human focus. In line with this information, this paper suggests a conceptual modified version of the Toyota Kata, the so-called “Human-centric Kata,” that may be used to accomplish industry’s transition towards the human-centric digital and sustainable factories of the future.

This study was limited to the human-centric approach of Industry 5.0. Thus, all other challenges related to the industrial transition were not investigated. As future work and

research, it is suggested to empirically validate the “Human-centric Kata” concept in real-world use cases.

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