

Elements of TVET Leadership in the Industry 4.0 Era: A Short Review

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Abstract: Industry 4.0 (I4.0) is defined as a transformation of communication and automation, predominantly within the context of manufacturing. The I4.0 concept is adopted as the foundation of smart manufacturing, in which communication between humans and machines is analogous to the way humans engage via social media. Technical and Vocational Education and Training (TVET) is a very important part of I4.0, especially when it comes to getting skilled people into the manufacturing sector. Due to the increasing demand for TVET programs, numerous research has been undertaken on TVET institution leadership styles. However, research on leadership styles that fit the requirements of I4.0 is relatively rare. As such, the purpose of this paper is to prompt a brief assessment of the available research on the leadership style of TVET institutions within the context of I4.0. This short review applied a systematic literature review (SLR) method to comprehensively synthesis research, identifying 1,110 papers in the first stage and further narrowed to six research articles in the final stage. To meet the I4.0 requirement, SLR indicated a dearth of research on TVET leadership style and a prevalence of the general leadership style construct. Two leadership style clusters are identified, comprising TVET and I4.0 leadership elements. For TVET leadership in the era of I4.0, the overlapping of both styles' primary constructs is regarded as crucial. Even though this is a preliminary study, future research should focus on leadership in TVET institutions considering I4.0 requirements.

Keywords: *TVET, Industry 4.0, leadership, higher education, Industrial Revolution.*

1. Introduction

4.0 is a term that refers to changes in high-level relationships and automation in manufacturing systems or in other words, Smart Factory [1]. In a smart factory, humans and machines communicating with one another seem to communicate on social media [2]. According to Hurts et al. (2019) [3], the application of the intelligent manufacturing system depends on the current data acquisition obtained through sensors and communication activities between machine components. In this context, the digital environment considers the combination of the virtual and real worlds in the manufacturing process [4]. This digital industrial revolution promises an advantage of flexible changes to the

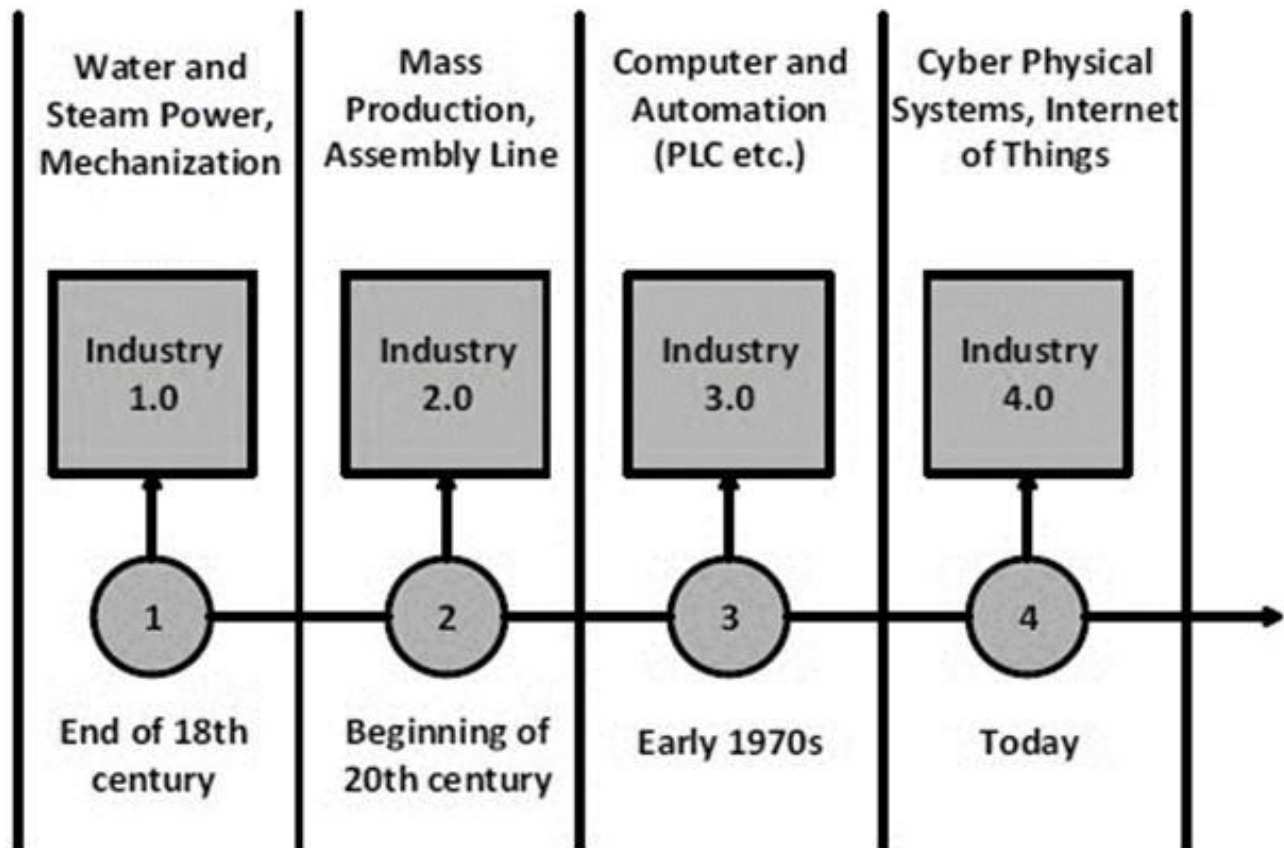
manufacturing system, improving the quality and productivity of the production process [5]. Investment to make this industry 4.0 not only costly, but it also needs to change to every level and process to ensure the implementation of the initiatives. To realize the concept of Industry 4.0, an organization needs leaders who can transform all aspects of management and operations to succeed in Industry 4.0. The leadership style brought by a leader is an essential aspect of implementing the initiatives involved. Figure 1 illustrates the Industrial Revolution and its associated technology beginning from Industry 1.0 to Industry 4.0.

The importance of leadership in implementing Industry 4.0 concept is due to strategic requirements in an organization. In the context of leadership, leaders in Industry 4.0 era need to quickly respond to the change through the

organizational achievement [9].

A transformational leadership style is needed in Industry 4.0, where the leading focuses on change and innovation [10]. In reference to Haddud & McAllen [11], leadership within

Figure 1: The roadmap of industrial revolution as described by Baygin et al. [7]



information and data obtained through various means [6]. According to Kelly [6], among the characteristics of future leaders in the context of Industry 4.0 is a desire to collaborate with various parties so that the information obtained can be used in implementing changes and seizing opportunities in developing organizational capacity. Leaders also need to ensure that individuals can comprehend the concept of organizational networks so that the value is seen as an agent in the implementation of Industry 4.0 initiative in the organization. Furthermore, the study conducted by Kelly [6] shows a phase in shaping the characteristics of Industry Revolution 4.0 leaders. The first characteristic is charismatic leadership which is closely related to how leaders move the organization through personal actions and traits [8]. The second characteristic is leadership-oriented, where leaders will implement instructions through the top-down approach [6]. The third, Industry 4.0 leaders is closely related to transformational leadership to foster followers by throwing new ideas and innovations in solving problems. Lastly is transactional leadership, where leaders will recognize the achievement of followers or subordinates based on

the digital environment must be explored and understood to ensure leaders have the relevant knowledge and skill to lead and manage digital necessities. In addition, managers will refer to organization leadership within the context of Industry 4.0 to initiate change and understand suitable methods to manage issues in the digital environment. In the virtual environment, leaders must quickly adapt to changes and enhance skills to ensure relevancy to the current needs. Leaders need to provide themselves and enhance their knowledge, skills and understanding of any factors that can contribute to performing tasks in the digital and environmental environment that changed in the Industry 4.0 era.

In the context of Industry 4.0, TVET institution’s facilities must be improved to ensure that graduates from the TVET program remain relevant to meet the industry’s needs. According to Grennrinch [12], TVET programs need to be reviewed and collaborated with the industry. Technical and vocational manpower’s skills levels need to be improved in line with the implementation of Industry 4.0. TVET

Internet academic databases such as Google Scholar and Microsoft Academics are utilised to conduct the study. This short systematic review does not aim to generate new information, and it relatively seeks to integrate and analyse current knowledge, implying pertinent research on the existing subject. The review utilised keywords such as (1) “TVET Leadership”, (2) “TVET Leadership” AND

Table 1: Summary of keywords

No	Keyword(s)	Filter	Outcome
1	TVET Leadership		
2	TVET Leadership AND Attribute		
3	TVET Leadership AND Attribute AND Industry		
4	TVET Leadership AND Attribute AND Industry, AND 4.0		
5	Industry 4.0	Abstract, Objective, Methodology and Result	Leadership styles, Leadership characteristics
6	Industry 4.0 AND Leadership		
7	Industry 4.0 AND Leadership AND TVET		

institutions are strongly encouraged to ensure that the curriculum and level of program skills are based on the Industrial Revolution 4.0. Failure to recognize and adapt to Industry 4.0 has negatively impacted the country's economic development sector. Furthermore, in Malaysia perspective the TVET student enrolment is on a declining trend as opposed to the funding allocated to the TVET sector in the past few years [13]. To ensure that graduates can meet the industry's technology needs, Information and Communication Technology (ICT) based teaching and learning approach similarly is seen as a compulsory method

“Attribute”, (3) “TVET Leadership” AND “Attribute” AND “Industry”, (4) “TVET Leadership” AND “Attribute” AND “Industry”, AND “4.0”. Key words from (1) to (4) is specifically to define the searching of article related to the leadership style in the TVET institution and its relationship with the Industry 4.0. In addition to that, key words such as (5) “Industry 4.0”, (6) “Industry 4.0” AND “Leadership” dan (7) “Industry 4.0” AND “Leadership” AND “TVET” is used to identify the leadership style in relation to the concept of Industry 4.0. Using keywords such as those listed in Table 1, the first phase examined prominent databases such as Google

Table 2: Summary of screening criteria

Criteria	Document Types	Language	Research Area
Inclusion	Articles	English	Articles focusing on leadership characteristic/style in TVET institution within the context of Industry 4.0
Exclusion	Books, proceedings, review articles, abstracts	Non-English	Articles not focusing on leadership characteristic/style in TVET institution within the context of Industry 4.0

for all TVET students. The leadership of TVET institutions in the Industrial 4.0 era needs to be supported so that the direction of leaders brought to TVET institutions can produce skilled and knowledgeable lecturers and graduates in the future [14]. Various literature and studies were conducted on leadership characteristics in Industrial 4.0. However, the study focuses on organizational leadership in general, so the main objective of this article is to obtain critical characteristics of TVET institution leaders in the Industrial 4.0 era by exploring the published journal articles.

Scholar and Microsoft Academics for articles relating to Industry 4.0 characteristic organisational setting.

The term AND was used to encompass a wider variety of results and narrow the search to a study of Industry 4.0 elements, whereas the operator OR was introduced to allow alternative phrasings and synonyms where appropriate [15] [16]. The published and unpublished articles are systematically searched for research on a particular intervention or activity. This search must attempt to include all accessible articles to ensure an objective judgment. The subsequent phase examined and categorized the contents of these articles based on author(s), year of publication and the key element of leadership within the respective domain. The closing phase involved compiling the publications' keywords to ascertain how author(s) placed their works. The chosen

2. Methodology

A transformational leadership style is needed in Industry 4.0, where the leading focuses on change and innovation [10].

keywords that express leadership abilities in the TVET institution. This analysis utilised a specific period of timeline because it corresponds to research maturity [17]. Additionally, throughout the publishing of this timeline, influential papers such as Whitmore and Knafl [18] and Dixon Wood et al. [19] have established a critical review

performing management tasks, but leaders have the ability to face changes. These changes include implementing constructive transformation by ensuring that strategies and followers are based on the vision and mission [21]. Therefore, leaders must be essential in supporting the transition to implementing Industry 4.0. Implementing leadership in the

Table 3: The reviewed journal articles

Author	Key elements
Kotter (2001)	Lifelong Learning, Divergent Thinking, Innovative
Watt (2002)	Transformational, Innovative, Entrepreneurial, Strategic, Participative, Authentic And Democratic
Alsolami (2016)	Innovative, Commitment, Planning
Mokhber et. al. (2018)	Technical Comptencies, creative thinking
Sivathanu (2018)	Responsive
Oberer (2018)	Responsive, Lifelong Learning, Openness, Innovative, Trust, Relationship, Teamwork, Digital Skill, Sociable

methodological principles (e.g., integrative review; mixed-method analysis) that should be addressed. Table 2 summarises the screening criteria used in this review.

This study selected to evaluate only English language article since Linares-Espinos et al. [20] emphasized the significance of preferencing publications in their English language, as articles in foreign languages might add to the confusion, increase of review costs and use of time. This purpose is to ascertain the required leadership abilities for the Industry 4.0 leadership characteristic in the TVET institution. The following research question leads this investigation:

1. What are the elements of TVET institution and Industry 4.0 leadership?
2. What are the overlapping elements of TVET institution and Industry 4.0 leadership?

The initial search resulted in the identification of 1,110 articles. After reviewing the titles and abstracts, 38 papers were retained for in-depth consideration. Following up on references and conducting online searches resulted in the inclusion of one article in the worldwide education research database. From the 38 papers subjected to full-text investigation, 32 fulfilled at least two exclusion criteria, leaving six for inclusion in the evaluation. After full-text selection, the remaining papers were evaluated using a critical analysis procedure for methodological quality. Finally, all retrieved articles' reference lists were manually examined to identify any research overlooked throughout the database searches. Additionally, the search should include unpublished research to mitigate publication bias. The key elements of TVET leadership within the context of Industry 4.0 are summarized in Table 3.

3. Discussion

Leaders in the Industry 4.0 era are now not only

Industrial 4.0 requires investment and openness to cultural change. Leaders in the Industrial 4.0 are in an important position, where digitalization is not only by applying new technologies but also by determining the effectiveness of the technology application. Therefore, the leadership style for Industry 4.0 needs to be open to guiding the culture of enhancing knowledge and innovation, which focuses on improving knowledge and divergent thinking [21]. In addition, the Industrial Revolution 4.0 is also led by responsive leadership, a leader who can respond to an ever-changing situation [22]. Leaders in the Industrial 4.0 era are different from technology leaders, where these technology leaders are driven by new technologies and set out the focus on human relations.

On the other hand, social leaders could create a friendly atmosphere but ignore technology and innovation. Based on Oberer & Erkollar [23], the dominant elements of Industry 4.0 leadership are based on the 4.0 Leadership Matrix, where these constructs include the importance of human relations, technology, and innovation. Based on the theoretical approach of Industrial Leadership 4.0 related articles, some of these elements can be determined to define leadership in the Industry 4.0 era. These characteristics include responsibility, approachable, lifelong learning, innovative, openness, agile, participatory, network, trust, digital and cooperation.

Innovative leadership is a suitable leadership style in TVET educational institutions within the context of Industry 4.0 which requires leaders who drive innovation and can adapt to change. According to Stenvenson & Kaafarani [24], innovation leadership is focused on inspiring followers to be more open-minded to drive discoveries in performing organizational tasks. Similarly, Daniel [25] stated that innovation leadership is a combination of various leadership styles within an organization to influence followers to create creative ideas, products, services and solutions to problems. For Alsolami [26], an innovative leader needs to know the

process of shaping the direction, relationships and commitments needed to plan and implement new things to add value to the organization. According to Mokber et al. [27], innovative leaders can implement innovations according to their skills, knowledge, and creativity to ensure that the organization remains competitive and sustainable.

Watt [28] explains that the organization needs leaders who constantly look at processes, strategies, and techniques for reforms to define innovative organizations. Based on the research conducted, several elements in which described the core of innovation leadership. Among the characteristics highlighted are transformational, innovative, entrepreneurship, strategic, authentic, participatory, and democratic. These elements are mapped with leadership in the context of Industry 4.0 to get an accurate picture of the leadership style to bring TVET educational institutions into the Industry 4.0 era.

Leadership style in line with educational institution leadership is a leader with future vision and mission, confidence, able to communicate to share ideas, influencing, appreciate and able to change differences into strength. In the era of Industry 4.0, educational institution leaders also need the element of entrepreneurship so that entrepreneurial skills could produce a wide range of innovations and creativity especially from the teachers and students. The challenge of Industry 4.0 is to sustain the path of diurnal routines without losing out upon the current technological trend. Leaders need to have specialized skills in order to successfully wean off globalization challenges from the organization. Looking at the various challenges in the world of education in the Industry 4.0, TVET institution leaders need to instrument innovations consistently and have thoughtful ideas to take advantage of difficulties in solving problems. In addition, leaders must carry out their duties and responsibilities to drive 21st-century learning methods to meet the demand of Industry 4.0. According to Ali et al. [29], it is found that TVET institutions need to revisit the course content, information, and learning outcomes and focus on producing industry ready human capital. In determining the elements of TVET institution leadership in the Industry 4.0 era, two domains are explored which are the TVET institutional leadership and the Industry 4.0 leadership. Both domains are studied to demonstrate the relationship between TVET institution and Industry 4.0 leadership element. As a result of the relationship, a preliminary model of the TVET institution's leadership element in the Industry 4.0 can be formed. This relationship generally denotes to the transformational leadership style, where the leadership style is closely linked to the leadership style needed for Industry 4.0 leaders. Figure 2 shows the key element of leadership that TVET's leaders need to have in the Industry 4.0 era.

Although the characteristics of leadership elements of TVET institutions and Industry 4.0 have been explained based on previous studies. When these elements are mapped, it illustrates there are three essential characteristics of TVET institution leaders in the Industry 4.0 context. These three

important features are innovation, participation and knowledge. Uncertainty and complex situations, especially in current social and economic challenges, innovative leadership elements are the key to face the said conditions. Therefore, leaders need to equip themselves with innovative skills in the technical and management field in light of the challenges. Participatory elements are a branch of democratic leadership. Participatory is an important element where a leadership of an organization involves followers in making decisions for the organizations. Generally, participatory element makes decisions based on the following processes: group discussions, providing information, sharing ideas, formulating ideas and information and making decisions. In today's Industry 4.0 era, the element of innovative and participatory are essential to ensure that TVET education remains relevant and further enhanced to meet the needs of the country's industry. TVET leaders of the Industry 4.0 era need to encourage subordinates to implement innovative methods in teaching and learning. In addition, leaders in the institution which include the middle leaders within the organisation must be together in giving ideas and engaging in the innovations undertaken by subordinates [30].

4. Conclusion

Several research on TVET's institution and Industry 4.0 leadership have been conducted. Both leadership components are intertwined, and the leadership element indicated that its influence on the organization may be viewed from a variety of perspectives. The leadership of TVET institutions plays a vital role in ensuring that the organization continues to move forward. Based on the above analysis, leadership elements such as transformational, participatory, innovative and others are essential in developing TVET institutions. In addition to the aforementioned leadership characteristics, the Industry 4.0 leadership characteristics should be adopted to ascertain that the institution's leaders are encouraged to promote an innovative and creative culture. The connected components depicted in Figure 2 represent the core of leadership which is capable of charting and implementing the institution's vision and mission in conformance with Industry 4.0 requirements. This is evidenced by three elements that overlap between the TVET institutions and Industry 4.0 leadership domain.

Leaders with innovative, participating and knowledgeable characteristics can appreciate the concept of Industry 4.0 in the leadership and management and of TVET educational institutions. These three elements can also drive leaders, subordinates and students to a higher level and meet the organization's vision and mission. TVET institutions may designate future leaders who specialize in managing organisations and executing reforms that have a favourable influence on national TVET education due to the aforementioned characteristics. This research produced a preliminary model for detecting the leadership qualities of TVET institutions in the era of Industry 4.0. Consequently,

the model must be verified to establish its validity, which may result in the discovery of leadership elements through further investigation. In addition, future direction of the literature review could broaden the academic database by exploring other prominent research repository.

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