The Mediating Role Of Team Effectiveness On The Relationship Between Industry 4.0 Technologies And Operational Performance Improvement

Ijaz Ahmad¹, Dr. Qasim Ali Nisar², Dr. Ahmad Raza Bilal³, Dr. Ashfaq Ahmad⁴, Muhammad Ali Qazi⁵, Haseeb Ahmed⁶

¹Ph.D Scholar, Superior University, Lahore, Pakistan ijaz_mpa@yahoo.com ORICID ID: https://orcid.org/0000-0002-6711-5238

²Assistant Professor, Superior University Lahore, Pakistan qasimalinisar@yahoo.com

³Associate Professor, Superior University Lahore, Pakistan arb@superior.edu.pk

⁴Assistant Professor, Department of Economics, Government College Women University, Sialkot Pakistan ashfaqahmad146@gmail.com

⁵Ph.D Scholar, Superior University, Lahore, Pakistan qazihallian@gmail.com

⁶Ph.D Scholar, Superior University, Lahore, Pakistan haseebahmed09056@gmail.com

Abstract

Purpose – Current study examines how Industry 4.0 technologies affect operational performance improvement. The study also examined the mediation effect of team effectiveness that almost neglected in the previously conducted studies.

Design/methodology/approach – The target population was operations managers in the textile sector. Data were collected using a survey questionnaire from 153 respondents was subjected to PLS-SEM for analysis.
Findings – Findings revealed that team effectiveness is the significant antecedent for Industry 4.0 technologies. Moreover, found that team effectiveness positively contributes to performance improvement initiatives in the textile sector of Punjab. Furthermore, the results show, if the employees involved as a team in decision making and implementation of Industry 4.0 technologies, they feel motivated and perform better. Further, the results show that team effectiveness mediates among Industry 4.0 technologies and performance improvement initiatives.

Practical implications – Current study provides valued practical implications for the top management and policymakers to ensure the team effectiveness towards Industry 4.0 technologies to get performance improvement initiatives.

Originality/value – The proposed model considers the cyber-physical system (CPS) and the social constructionist theory (CST) in the domain of Industry 4.0 technologies to tackle team effectiveness. The current study is the novel addition in the literature by using team effectiveness as a mediator. Furthermore, it ascertains that Industry 4.0 technologies are anticipated to be a game-changing player in operational performance improvement.

Keywords Industry 4.0 technologies, Team effectiveness, Operational performance improvement

Paper type Research paper

1. Introduction

Pakistan is a developing country, and some of its industries like surgical, leather, sports and textile are making a good impact on the Gross Domestic Product (GDP) because of their export. The share of the manufacturing industry in the GDP of Pakistan is 18.4% (Nawaz, Javed, & Ullah, 2020). Now the share of the textile sector to the GDP and exports of Pakistan has decreased significantly. The textile sector is the major contributor, and its share is 60% of the total exports of Pakistan (Ministry of Textile Industry, 2021). During the COVID-19, the world GDP graph has constantly declined because the pandemic has affected production and exports. Consequently, economic growth has fallen (Vidya & Prabheesh, 2020). According to Asian Development Bank, the cost of this pandemic could reach 8.8 trillion globally or 9.7% of global GDP (Asghar, Batool, Farooq, & ur Rehman, 2020).

Industry cannot work in full swing without its optimum labour. Robo-boss will be supervising more than 3 billion workers internationally from 2020, and robotics technologies will be used by 59% of manufacturers in the U.S. (Oztemel & Gursev, 2018). In this situation, a system can get more attention with less labour involvement and can manage things virtually. Industry 4.0 is spreading worldwide because of its competitive edge for industrialists who adopt
these technologies in the social distancing scenario. Term Industry 4.0 indicates an industry having intelligent management systems, internet-connected machines and intelligent solutions. These different features are related to accomplishing intellectual production units built on cohesive computers and their mechanisms to monitor and control available resources (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014). Therefore these hi-tech improvements can lead to innovative manufacturing processes (Ashton, 2009; Taques, López, Basso, & Areal, 2021). Still, it has to investigate how to achieve continuous improvement by combining the existing production environment and Industry 4.0 technologies (Kolberg, Knobloch, & Zühlke, 2017).

This study sample will validate these constructs and further examine their similar result on operational performance improvement. In addition to the theoretical contribution, this research will provide managerial implications that can help leaders and experts better explain the benefits of applying Industry 4.0 technologies in textile industries where continuous performance improves team effectiveness. Moreover, knowing the link between these approaches can help forecast different problems, having expectations from the age of the fourth industrial revolution and providing the solution to support the team involved in a higher level of operational performance. This study intends to investigate whether team effectiveness establishes the mediating relationship between Industry 4.0 technologies and operational performance in a developing country. Previous studies have discussed employee involvement for operational performance improvement with Industry 4.0 technologies, but there is a gap in team effectiveness for operational performance improvement with Industry 4.0 technologies (Tortorella, Miorando, Caiado, Nascimento, & Portioli Staudacher, 2021). This study is an effort to link that gap in the overall body of literature. The researcher tried to fill that gap by studying team effectiveness on operational performance improvement, which is a significant contribution of the current study.

2. Literature Review

2.1. Theoretical Foundation
The theoretical framework based on two theories, explicitly Cyber-Physical System (CPS) (Park, Zheng, & Liu, 2012) and the social constructionist theory (SCT) (Berger, Berger, & Luckmann, 1966). CPS is a more specific system that allows production in a sequence needed for customized goods and mass production (Kagermann, Helbig, Hellinger, & Wahlster, 2013). CPS gives a higher level of automated products by concentrating on data interchange with each other. It will help them control their production process and will help to link them with the environment (Lee, 2008; Shariatzadeh, Lundholm, Lindberg, & Sivard, 2016). Another theory is (Berger et al., 1966) social constructionism. This theory explains how reality and phenomena interact with humans how they built socially. It argues that better communication can help to produce reality (Shotter, 1993). If there is better interaction Shotter (1993) between an employer and its team, it can be helpful to make good decisions and complete the task of a team within a
stipulated time. Both of the above theories will support our study as CPS will relate to automation and technologies Industry 4.0. In contrast, social constructionism will relate to team effectiveness and the involvement of human for improvement.

Fig. 1 Research Framework

2.2. Hypothesis Development

2.2.1. Industry 4.0 Technologies and Operational Performance Improvement
Industry 4.0 was introduced by a German Professor in 2011 in a Fair known as Hannover. The central theme behind this integrated industry known as Industry 4.0 is the industry controlled virtually without labour involvement. It connects people to their objects and systems by exchanging their data (Brettel, Friederichsen, Keller, & Rosenberg, 2017). Industry 4.0 helps eliminate complex and large systems and introduce decentralized and straightforward systems (Zuehlke, 2010). However, to know the relationship between these technologies and their performance improvement, operational performance improvement has some inconsistent indications in the literature (Sanders, Elangeswaran, & Wulfsberg, 2016; Schumacher, Erol, & Sihn, 2016) guides that more study required in this area. Industry 4.0 has many new chances for organizational performance, but it also has many challenges interlinked with complete automation (Hecklau, Galeitzke, Flachs, & Kohl, 2016).

Increasing customer requirements about customization have brought unpredictable changes in business models, resultantly economic and technical challenges have arisen (Gjeldum, Mladineo, & Veza, 2016; Landscheidt & Kans, 2016). This reality became the reason for strategic alliances and different collaborations with value chains and the complexity of management models (Anderl, 2014; Schumacher et al., 2016). Moreover, the capital required to establish Industry 4.0 is comparatively high, reducing its attraction for the manufacturers of developing countries (Sanders et al., 2016). Keeping in view legal and political aspects, the government should see legal issues while using big data, particularly data privacy protection. Another issue is that the trend for flexibility in work is growing, which requires changes in work rules related to the time and safety of employees (Industry, 2016). Particularly after COVID-19, the routine is badly affected, resultantly work from home and flexibility in work has been observed which gives mental satisfaction and protection to the employees and their performance
will be improved in the flexible work environment. So, in the current situation, we may hypothesize.

**H1**: There is a significant effect of Industry 4.0 Technologies on Operational Performance Improvement

### 2.2.2. Industry 4.0 Technologies and Team Effectiveness

In the literature, some researchers who have studied Industry 4.0 have claimed that implementing this technology should not affect the expenditure of human factors (Romero et al., 2016). However, according to Zuehlke (2010), the current age is the age of wireless technologies, which will have data about all the motion of workers, it will help to self-organization. It will help to reduce the hierarchy of organizations. Further, Industry 4.0 will be helpful to store more data that require more financial resources and more information (Kagermann et al., 2013). As Kujala, Lehtimäki, and Pučėtaitė (2016), Thomas, Zolin, and Hartman (2009) access to more information gives a sense of trust to the employees, which gives the impression to employees that they have some important role in the team and helps to improve their performance. Similarly, it is helpful for the promotion of Industry 4.0 technologies. It also helps to enhance a culture of work-based learning (Mrugalska & Wyrwicka, 2017; Schuh, Gartzen, Rodenhauser, & Marks, 2015), contributing to team effectiveness. We hypothesize:

**H2**: There is a significant effect of Industry 4.0 Technologies on Team Effectiveness

### 2.2.3. Team Effectiveness and Operational Performance Improvement

The competitiveness level and performance of an organization are highly dependent on how the management involves its employees in the daily activities of that organization (Hecklau et al., 2016). Researchers Kyndt and Baert (2013), Mendes (2012), Welikala And and Sohal (2008) have pointed out the importance of team effectiveness for continuously changing and fast-growing organizations. By bringing employees into a team, an organization can get better results because they feel more empowered, work as a team, and give more input to improve the system and working environment. That will lead to employee satisfaction, improved quality of work, employee performance leading to team effectiveness, competitiveness, and profitability of the organization leading to operational performance (Mann, 2009).

**H3**: There is a significant effect of Team Effectiveness on Operational Performance Improvement

### 2.2.4. Mediating Role of Team Effectiveness

Alfalla-Luque, Marin-Garcia, and Medina-Lopez (2015) have studied the effect of team performance on the supply chain and its dimensions to measure performance in different ways like flexibility, quality, customer satisfaction, inventory, and delivery. Although Alfalla-Luque et al. (2015) have confirmed the relationship between operational performance and team, this
relationship is dependent on the vision of leadership. As suggested by Cohen and Bailey (1997), team effectiveness can be measured by two constructs. One can measure behavioral outcome with a scale of relationship (Anderson, Martin, & Riddle, 2001). In contrast, another is measuring team performance as member's observation about productivity, satisfaction, and achievement regarding the team's goal. As per previous studies, adopting team practices mostly has positive results on performance; consequently, other related organizational results will also improve.

Bortolotti, Boscari, and Danese (2015), Angelis, Conti, Cooper, and Gill (2011), De Treville and Antonakis (2006) have highlighted the significance of the involvement of workers in all decision-making processes so that can change the culture of the organization and sustainable improvement (Hecklau et al., 2016; Thomas et al., 2009). If a good team is involved and taken on board while implementing Industry 4.0, they will play an influential role. Then it can assume that operational performance will also improve.

Thus the team effectiveness is considered very important for achieving continuous improvement culture in any organization. The effect of introducing Industry 4.0 technologies on team effectiveness is needed to explore further. To check its relation, we have developed this hypothesis:

**H4:** The implementation of Team Effectiveness significantly mediates the effect of Industry 4.0 Technologies on operational performance improvement.

### 3. Methods

#### 3.1. Sample design and data collection

The population of this study is the textile industry of Punjab, Pakistan. Collected data from the operations manager of selected textile industries using a survey questionnaire. A Google form developed and shared the link with the accessible operations managers, and a questionnaire was also distributed by visiting the industry personally. Non-probability convenience sampling used for data collection from the targeted population. A total of 300 questionnaires distributed among different textile industries, out of which 170 questionnaires returned. The screening is done carefully to assess the usable data for analysis, and 153 questionnaires were found complete in all aspects.

#### 3.2. Questionnaire and pre-test

The questionnaire consisted of 18 items. The first part is regarding demographic information, i.e. size of the respondent's organization, gender, and age. The second part of the questionnaire regarded team effectiveness, four adopted items (Anderson et al., 2001). The third part of the questionnaire was adopted from (Industry 2016) based on ten items to check the implementation of Industry 4.0 technologies on the studied sample. Likert scale from 1 to 5, 1 for “not used” to 5 for “fully adopted” was used to check the implementation of technologies. The last part based on four items regarding operational performance improvement adopted from (Tortorella et al.,
2021). Likert scale from 1 to 5, 1 for “worsened significantly” to 5 for “improved significantly”. The expert academicians established the content validity regarding the scales. Based on their guidelines, few minor changes made. The scales were already used and tested by previous researchers. In this study, we have adopted different scales of different studies. Therefore pre-test was not required.

4. Results

This study developed PLS-SEM to test the proposed hypothesis by using Smart PLS 3. The reason for using Smart PLS 3 is that it is considered the modern assessment technique in most business studies (Rasoolimanesh, Ali, & Jaafar, 2018). This study aims to predict and explain the contemporary theory grounded, and variables studied in this study. Further, selecting PLS-SEM has fewer requirements regarding sample size and normality as Amos has (Hair Jr, Hult, Ringle, & Sarstedt, 2016). This technique is considered more flexible for model assessment (Hair Jr et al., 2016; Naz, Jamshed, Nisar, & Nasir, 2021). Apart from all these, PLS bootstrapping techniques and algorithms performed to check the factor loadings to check the validity of constructs, internal consistency reliability, corresponding significant level and path coefficients to test the hypotheses (Rasoolimanesh et al., 2018). Firstly, the measurement model performed, and estimations checked through SEM.

4.1 Measurement Model Assessment

The measurement model assessed and convergent validity checked with loadings, competitive reliability and convergent validity. Table 1 and Fig. 2 factor loadings were more than the recommended value of 0.60 except for a few values. Composite reliability (C.R.) of all values exceeded the value of 0.70 recommended. Similarly, the average variance extract (AVE) values of all constructs of this study are more than the recommended value of 0.50 (Hair Jr et al., 2016). Therefore, items with factor loading less than (<0.50) deleted.

Similarly, the Heterotrait-Monotrait Ratio (HTMT) results have confirmed the measurement as mentioned in Table 2. We can notice that all the values less than the cutoff value of 0.85, which confirms its discriminant validity (Kline, 2015). Both of these results confirm that there is no threat to the previous research because of discriminant validity.

Table 1 Convergent Validity

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Items</th>
<th>Loadings</th>
<th>Alpha</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry 4.0 Technologies</td>
<td>INDT2</td>
<td>0.787</td>
<td>0.905</td>
<td>0.922</td>
<td>0.597</td>
</tr>
<tr>
<td></td>
<td>INDT3</td>
<td>0.789</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>INDT4</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>INDT5</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To measure the reliability and validity of the constructs performed the structural modeling. Standard errors, t-values and path coefficients are calculated to check the significance of the model and collected data. It is evident from the values of the path coefficient whether the hypothesis supported or not. Smart PLS-3 was used to calculate the bootstrapping procedure to check the primary and mediation effect (Hair Jr et al., 2016) to check the primary and mediation effects.

![Structural Model Assessment](http://www.webology.or)

**Fig. 2 Measurement Model Assessment**
Table 2 Discriminant Validity (HTMT Ratio)

<table>
<thead>
<tr>
<th></th>
<th>Industry 4.0 Technologies</th>
<th>Operational Performance Improvement</th>
<th>Team Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry 4.0 Technologies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Performance Improvement</td>
<td>0.474</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Effectiveness</td>
<td>0.349</td>
<td>0.439</td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 3 and Fig. 3, Industry 4.0 technologies significantly and positively related with operational performance improvement ($\beta = 0.336$, $t = 4.05$; $LL = -0.282$, $UL = 0.535$), so H1 is supported. In addition to this, the statistical findings also confirmed that there was a significant relationship between Industry 4.0 technologies and team effectiveness ($\beta = 0.346$, $t = 4.785$; $LL = 0.169$, $UL = 0.468$), hence H2 is supported. The findings also reveal that team effectiveness has significant relationship with operational performance improvement ($\beta = 0.266$, $t = 2.581$; $LL = 0.022$, $UL = 0.461$), therefore H3 is supported. Moreover, it was also found that team effectiveness mediated the association of Industry 4.0 technologies with operational performance improvement has a significant and positive association with environmental performance ($\beta = 0.092$, $t = 2.61$; $LL = 0.024$, $UL = 0.173$) thus, H4 is supported.

Fig. 3 Structural Model Assessment

Table 3 Path Analysis

<table>
<thead>
<tr>
<th>Relationships</th>
<th>Beta</th>
<th>S.D</th>
<th>T-</th>
<th>Pvalues</th>
<th>L.L.</th>
<th>U.L.</th>
<th>Decision</th>
</tr>
</thead>
</table>

http://www.webology.or
5. Discussion

Exploring team effectiveness on Industry 4.0 in the textile sector of Pakistan is the main contribution of this study. The adoption of Industry 4.0 in the manufacturing sector is not a unique idea. Still, in the present situation that arises because of COVID-19, it could be more effective to use the latest technologies like Industry 4.0 and get more productivity, interconnectivity, sound control, and monitoring of production systems. Therefore, industry 4.0 may play a tremendous role in the country's productivity. Specifically, the country's textile sector is the primary contributing sector toward GDP because of its highest share in the country's total exports.

Based on the CPS statement, the current study protracted the initial study of Tortorella et al. (2021) to articulate a paradigm of employee involvement suitable for the implementation of Industry 4.0. The paper tries to check that how employee involvement is beneficial for the effective implementation of Industry 4.0. Being resourceful only is not sufficient. Instead, how successfully one manages resources matters to get actual value (Teece, 2007). In today's digitalized age of constant change, the organizations required to regenerate the current competencies and this advancement extremely dependent on performance improvement, which is the central theme of CPS. Therefore, the current work explored the involvement of employees in implementing the Industry 4.0 technologies (Tortorella et al., 2021).

This study takes comprehension from contemporary studies like; the quantitative study conducted by Tortorella et al. (2021) in Industry 4.0 (Akan, Jack, & Mehta, 2020; Anderson et al., 2001) highlighted the importance of team effectiveness. They argued that team effectiveness is important to get performance improvement initiatives. The findings of the current study support the concept that the Industry 4.0 technologies successfully implemented with the help of effective team management. Consequently, it will improve the performance of the industry and

\[
\begin{array}{cccccc}
H1 & \text{Industry 4.0 Technologies} & \rightarrow & \text{Operational Performance} & \text{Improvement} & \text{values} \\
& & & & 0.336 & 0.083 & 4.05 & 0 & 0.282 & 0.535 & \text{Supported} \\
H2 & \text{Industry 4.0 Technologies} & \rightarrow & \text{Team Effectiveness} & \text{values} & 0.346 & 0.072 & 4.785 & 0 & 0.169 & 0.468 & \text{Supported} \\
H3 & \text{Team Effectiveness} & \rightarrow & \text{Operational Performance Improvement} & \text{values} & 0.266 & 0.103 & 2.581 & 0.01 & 0.022 & 0.461 & \text{Supported} \\
H4 & \text{Industry 4.0 Technologies} & \rightarrow & \text{Team Effectiveness} & \rightarrow & \text{Operational Performance Improvement} & \text{values} & 0.092 & 0.035 & 2.61 & 0.009 & 0.024 & 0.173 & \text{Supported} \\
\end{array}
\]
productivity will increase. Moreover, the results applied in different industries after slight modification in antecedents of Industry 4.0.

5.1 Managerial Implications

The results foresee various implications for decision-makers interested in getting performance improvement initiatives, mainly in the textile sector of Pakistan. Managing the challenges associated with the effective implementation of Industry 4.0 technologies is the real problem. This paper highlights the importance of team effectiveness for the effective implementation of Industry 4.0. This study theoretically contributes in different ways. First of all, to link the existing research gap, the study contributes theoretically by the testing relationship between the theories of CPS and SCT in the setting of a Pakistani manufacturing firm. Secondly, during the review of emergent trends in the Pakistani context, this study attempted to fill the gap in existing research and get detailed knowledge regarding the phenomenon of team effectiveness and how it relates to operational performance improvement. The study gives solid systematic evidence that if the team's adoption of Industry 4.0 technologies is done through the team, it will bring performance improvement initiatives in the industry. Finally, the current study contributes to the overall body of knowledge by incorporating team effectiveness to fill the literature gap highlighted in previous studies (Tortorella et al., 2021). Hence this study spreads the combined model of CPS and SCT by giving empirical evidence regarding the mediation effect of team effectiveness on the Industry 4.0 technologies and performance improvement initiatives.

5.2 Academic Implications

The current study provides valued practical implications for the top management and policymakers to ensure the team's commitment towards performance improvement initiatives. Further more, this study gives practical implications to the textile sector owners and managers interested in implementing Industry 4.0 technologies. As Tortorella et al. (2021) recommended, employee involvement is mandatory, and in future research, team effectiveness should focus. Owners and managers should involve their team in the effective implementation of technologies. So the team is motivated and gives the best solution for effective implementation.

Further to check and enhance the operational performance, team effectiveness strategies should implement within the firms to achieve optimum performance. Such policies motivate team members to perform their roles in the best interest of the organization. Lastly, the study's findings provide directions for practitioners to reward teams through financial and non-financial ways to motivate members to participate in team effectiveness. To encourage them and get maximum productivity to form management should get their suggestions to overcome the problems associated with the effective implementation of Industry 4.0 technologies. Practising such activities resultantly increases employee's interest to perform better.

5.3 Limitations and future research directions
Although this study has achieved its objectives, however, there are few limitations of the current study. Future studies should be conducted on other manufacturing sectors, and data should be collected from different geographical locations of the country or other countries. Further, the questions can also be changed related to technologies used in that particular sector. Future research can also study different variables like leadership, communications styles, etc.

5.4 Conclusion

According to the current study, it is evident that hi-tech methods like Industry 4.0 are not contradictory to human involvement. In fact, in this study, we have tried to prove that while implementing different technologies, those companies will perform better who will involve their teams while implementing these technologies. All our respondents belong to the emerging economy. Such economies face different problems, particularly regarding the successful implantation of Industry 4.0 technologies without the involvement of a team. This study concludes that the implementation of Industry 4.0 technologies is the need of the hour for the manufacturing industry of Pakistan. The study closely examined how team effectiveness can be helpful in the best implementation of Industry 4.0 technologies while analytical findings endorsed it. It is helpful to get an operational performance improvement. Furthermore, the results highlighted that team effectiveness is mandatory and positively affects operational performance improvement while implanting Industry 4.0 technologies. This study, in its context, has proved, to get maximum performance in the textile sector, implementation of different latest technologies is mandatory.

References:


