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IDENTIFYING LEADERSHIP STYLES THAT SUPPORT THE ORGANIZATION'S MATURITY UNDER INDUSTRY 4.0 CONDITIONS

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Purpose: The aim of the article was to examine the effectiveness of different leadership styles in the context of Industry 4.0 and to determine which ones best support organizational maturity in the conditions of digital transformation. This article sought to compare the perceptions of leadership style effectiveness among academics and industry practitioners.
Design/methodology/approach: The study was conducted using the Delphi method, involving 33 experts, of whom 26 respondents were ultimately selected based on a competence coefficient (Kk). The participants were divided into two groups – representatives of science and industry. The experts assessed the effectiveness of selected leadership styles in the context of Industry 4.0 using a five-point Likert scale, which enabled a detailed analysis of their opinions.
Findings: The results of the study showed that both academics and practitioners considered participatory and transformational styles to be the most effective in Industry 4.0 conditions. On the other hand, autocratic and transactional styles, although useful in certain situations, were considered less appropriate in an environment requiring flexibility and rapid adaptation to technological changes.
Research limitations/implications: The study is limited by the relatively small number of experts and its focus on selected leadership styles. However, the results indicate a need for further analysis of the role of leadership in the digital transformation of organizations and the development of their maturity in the context of Industry 4.0.
Originality/value: The article provides cognitive value by identifying leadership styles that best support organizations in the Industry 4.0 era. It also makes a valuable contribution to understanding the differences between how leadership is perceived by theorists and practitioners, emphasizing the importance of leadership based on cooperation, flexibility, and innovation.
Keywords: Leadership, Leadership 4.0, Industry 4.0, Management, Organization maturity.
Category of the paper: Research paper.

Introduction

Industry 4.0, the result of dynamic technological change, involves the transformation of traditional manufacturing and management processes with the help of modern technologies such as artificial intelligence, the Internet of Things, Big Data, and autonomous robots. This transformation is not only revolutionizing the way organizations produce and deliver their products, but is also affecting the structure and management of organizations. Industry 4.0 requires new skills and approaches from leaders that are able to meet the challenges of digitization, automation, and the growing complexity of processes (Erboz, 2017; Tay et al., 2018; Dubey et al., 2022).

In this context, leadership plays a key role in shaping and adapting organizations to changing conditions. Traditional leadership styles, such as autocratic or transactional, are gradually giving way to more flexible and collaborative approaches that promote innovation and adaptation in the face of increasing automation (Oberer, Erkollar, 2018). The literature is paying increasing attention to participative and transformational leadership styles that promote collaboration, employee engagement and decentralization of decisions - traits that are key to the successful operation of organizations in Industry 4.0 (Gupta, Gupta, 2020; Canbay, Akman, 2023).

The gap of this research lies in the fact that there has been limited understanding of what kind of leadership style best fosters organizational maturity in the context of Industry 4.0. While literature provides various approaches on styles, on the other hand, large-scale empirical data is missing with respect to how these styles can enable organizational adaptation to the rapid technological changes brought about by Industry 4.0, in particular, automation, AI, and Big Data. The study further points to the under-researched gap concerning differences in preferred leadership styles by practitioners and academics in light of digital transformation. This gap constitutes a dire need for further research on the various ways of leading an organization to best performance in times characterised by constant technological disruption. The paper also points out that the previous literature has not sufficiently debated how leadership styles have to be adapted in order to meet the specific challenges caused by decentralized decision-making and innovation in highly automated environments.

The purpose of this article is to explore which leadership styles are most effective in supporting organizational maturity in an Industry 4.0 environment. To this end, a survey was conducted with industry experts and academics, allowing them to compare their preferences for different leadership styles. The analysis aims to provide practical guidance for leaders who need to adapt their approach to the requirements of digital transformation.

The article poses the following research questions:

- Q1 - What leadership styles support organizational maturity in an Industry 4.0 environment?
- Q2 - Are there differences in perceptions of the effectiveness of different leadership styles between academics and industry representatives?
- Q3 - Which characteristics of leadership styles are most desirable in a rapidly changing technological environment?
- Q4 - Which leadership styles group into key managements that support organizational maturity in Industry 4.0, and what lessons emerge from these groupings for industry leaders?

By answering the above questions, this article aims to fill a research gap concerning the relationship between leadership styles and organizational maturity in the context of the Fourth Industrial Revolution. The results of the study can make a significant contribution to both the development of leadership theory and management practice, providing an understanding of which leadership styles best support the flexibility, innovation, and adaptability of organizations, which is becoming a key success factor in an environment characterized by continuous technological progress. Consequently, this study is an attempt to combine scientific and practical perspectives in order to identify leadership styles that enable organizations to function effectively in the dynamically changing world of Industry 4.0.

Identification of leadership styles

Dynamic technological changes have led to the concept of Industry 4.0, which is seen as a comprehensive transformation of traditional production and management processes with the help of modern technologies, such as: Autonomous Robots, Augmented Reality, Simulations, Incremental Manufacturing, Integration of Information Systems, Cybersecurity, Internet of Things, Cloud Computing, Big Data, Artificial Intelligence (Erboz, 2017; Tay et al., 2018; Trzop, 2020; Dubey et al., 2022). This revolution not only includes the optimization of production processes, but also the changes taking place in the ways organizations are managed and their structures, which requires modern skills and approaches from leaders (Gupta, Gupta, 2020; Canbay, Akman, 2023).

Leaders in Industry 4.0 play a key role in leading organizations in the face of increasing automation and digitization (Oberer, Erkollar, 2018). In traditional industrial models, where processes were clearly defined, the role of the leader was mainly to make decisions, control teams, adapt his own policies, and influence the group to achieve common goals by motivating, inspiring, and mobilizing (Moore, 1927; Morris, 1959; Weber, 1972; Gleick, 1987; Abercrombie, 1988; Yukl, 1989; Bogdanor, 1993; Adair, 2009). In the context of Industry 4.0,

the situation becomes even more complex, as organizations must operate in a dynamically changing environment in which not only technology, people and data are highly integrated, but also market requirements and needs are constantly changing (Vaida, et al., 2018).

Modern technology is changing not only how organizations produce and deliver their products, but also how they are managed. This poses many challenges for leaders in terms of how they approach people management, using advanced analytical tools to make decisions and forecast future trends.

One of the main challenges for leaders in Industry 4.0 is to integrate advanced technologies with the work of human teams (Venkatesh, 2020; Puhovichova, Jankelova, 2021). This requires the ability to manage diverse teams, flexibility and the ability to collaborate in an environment that is constantly evolving (Behie et al., 2023, Haleem et al., 2024). Leaders must not only understand how technologies affect operational processes, but also support their teams in adapting to new tools and work methods. In this context, leadership based on cooperation, trust, motivating and supporting employee innovation becomes particularly important (Juhro et al., 2019; Mubarak, Petraite, 2020).

Traditional approaches to leadership are the foundation on which modern management concepts in Industry 4.0 are based. The literature distinguishes several basic leadership styles that are still applicable, although their role is constantly evolving.

Autocratic Leadership

Autocratic leadership is characterized by the leader making decisions on his own, without consulting his team (Hoel et al., 2010; Erdem, 2021). It expects strict adherence to issued instructions and procedures. Employees have little freedom to express their opinions, and their role is mainly reduced to following orders (Jony et al., 2019). This style can be effective in crisis situations when quick decisions are needed (Makhdoom et al., 2021; Saadi et al., 2023). In the long run, it can lead to a decrease in motivation and commitment in the team (Abdullahi et al., 2020).

Participatory Leadership

Participative leadership involves actively involving the team in the decision-making process (Kezar, 2001, Damanik et al., 2021). The leader promotes cooperation and joint problem-solving, allowing employees to participate in decision-making (Ahn, Bessiere, 2022). This style fosters a sense of community and responsibility within the team, which can increase employee motivation and creativity (Prasetyo et al., 2021; Huang et al., 2022). Participative leadership is particularly effective in organizations where innovation and collaboration are key (Lythreatis et al., 2022; Mata et al., 2023).

Democratic Leadership

Democratic leadership is based on including team members in the decision-making process (Fakhri et al., 2021). Decisions are made based on employees' opinions and input, which fosters participation and cooperation (Adobor, 2020; Setiawan et al., 2021). A democratic leader not only listens to his employees, but actively encourages them to offer ideas and suggestions (Haryanto et al., 2022). This leadership style builds commitment and supports team development (Hilton et al., 2021). The time-consuming nature of this style may make it unsuitable for organizations that require quick action (Fakhri et al., 2021).

Transformational Leadership

Transformational leadership is a style in which a leader inspires and motivates a team to achieve higher goals, often beyond current needs and expectations (Bojovic, Jovanovic, 2020, Tongkachok et al., 2022). Transformational leaders strive to make changes that have a long-term impact on the organization, as well as develop the potential of individual team members (Usman, 2020). With their vision and commitment, transformational leaders often build strong relationships with their team, leading to higher motivation and innovation (Afsar, Umrani, 2020; Shafi et al., 2020).

Transactional Leadership

Transactional leadership focuses on the exchange of rewards and consequences for performance (Mahdinezhad et al., 2013). The leader clearly defines the goals to be achieved by the team and then rewards employees for achieving them or applies consequences for failure (Brahim et al., 2015). This style is particularly effective in situations where work is clearly defined and results must be measurable (Laohavichien et al., 2009; Aga, 2016). Transactional leadership can limit employee creativity and autonomy (Wei, Yuan, 2010; Ma, Jiang, 2018).

Laissez-faire Leadership

Laissez-faire leadership, also known as the “free hand” style, is characterized by minimal intervention by the leader in the team's activities (Salas, 2020). Employees have a great deal of freedom in making decisions and carrying out tasks (Lawrence, 2000, Ali, Ullah, 2023). The leader intervenes only when absolutely necessary. This style can be effective in teams composed of highly skilled professionals who do not need supervision (Chaudhry, Javed, 2022). However, the lack of an active leadership role can lead to chaos or a decrease in efficiency in situations that require more coordination (Skogstad et al., 2007; Eğriboyun, 2023).

Charismatic Leadership

Charismatic leadership is based on the strong personality of a leader who can inspire and mobilize a team through his charisma (Wisniewska, 2021). Such a leader often builds a strong emotional bond with employees, which can lead to high levels of loyalty and commitment (Babcock-Roberson, Strickland, 2010, Xenikou, 2014). The team is willing to follow the leader due to his vision and ability to inspire enthusiasm (Conger, 2011). Nevertheless, there is a risk that the effectiveness of charismatic leadership may depend mainly on the person of the leader, rather than on stable organizational structures.

Servant Leadership

Servant leadership focuses on meeting the needs of the team and supporting its members in reaching their full potential (Jackson, 2008; Hanse et al., 2016). A servant leader puts the well-being of the team above his or her own interests, nurturing the development of employees and helping them overcome difficulties (Jit et al., 2017). This leadership style is conducive to building strong, committed teams based on trust (Wdowiak, 2022). Servant leadership is particularly effective in organizations where interpersonal relationships play a key role (Rai, Prakash, 2012; Gotsis, Grimani, 2016).

Situational Leadership

Situational leadership implies that the leader adapts his management style to the specific circumstances and individual needs of team members (Kaitonen, 2016). Depending on the level of competence and commitment of employees, a leader may use a more authoritarian or more democratic management style (Bhargavi, Yaseen, 2016; Smith et al., 2018). Situational leadership requires a high degree of flexibility and the ability to assess current conditions in order to match the management style to the situation (Rajbhandari et al., 2014). In this way, the leader can maximize the effectiveness of the team by responding to changing circumstances.

Methods

In the Delphi survey, 33 people participated in the first round. On the basis of a self-assessment questionnaire from this round, based on the competence coefficient (Kk), which is the arithmetic average of the familiarity coefficient (Kz) and the argumentation coefficient (Ka), 26 experts were selected - 13 from industry (working in organizations) and 13 representatives of science - who scored $Kz \geq 0.5$ (Męczyńska, 2006). The participants in the survey were selected using the recommendation method, and the final selection was based on certain coefficients.

The purpose of the study is to assess the correlation between preferences for different leadership styles under Industry 4.0 conditions in groups of respondents from industry and science. The analysis aims to compare the extent to which preferences for one leadership style in one group are correlated with evaluations of other styles in the same group, and then contrast these patterns with the results of the other group, in order to identify similarities and differences between groups in leadership style preferences.

In the survey, respondents were asked to rate the extent to which each leadership style fit the requirements and context of Industry 4.0. Ratings were made on a five-point Likert scale, with 1 representing the least fit and 5 the greatest. The scale provided detailed insight into both the industrial and scientific group's preferences for different leadership styles, allowing them to compare their opinions in the context of the modern requirements of organizations operating in an Industry 4.0 environment.

Results

Table 1 shows the results in detail on how different leadership styles are perceived to provide support for organizational maturity in Industry 4.0. For each leadership style, the average score, standard deviation, and median are considered in order to find out the degree to which various forms of leadership are perceived to mean greater growth and adaptation in an ever-evolving industrial context.

Table 1.
The assessment of leadership styles level of supporting organizational maturity in the context of Industry 4.0

Management styles	Average	Standard Deviation	Median
Autocratic	2.42	1.21	2
Participative	4.31	0.55	4
Democratic	3.88	1.14	4
Transformational	4.15	0.83	4
Transactional	3.23	1.27	3
Laissez-faire	2.77	1.18	3
Charismatic	3.50	0.99	4
Servant	2.85	1.01	3
Situational	3.73	1.04	4

Source: Own elaboration.

The autocratic leadership style received a low average score of 2.42 with a high standard deviation of 1.21. In general, the median of 2 indicates that most of the respondents perceive autocratic leadership as less effective for supporting organizational maturity, as often required by the context of Industry 4.0: flexibility, innovation, and collaboration. The high SD in response represents high variability, which basically suggests that perceptions of autocratic

leadership are highly variable across respondents, with some finding the style less appropriate and others seeing value in certain situations.

Participative leadership is one of the best evaluated styles; the mean score provided by the sample is 4.31. The very low standard deviation of 0.55 reflects a very strong agreement among the participants. Additionally, the median, which is 4, expresses great and deep consensus on the effectiveness of participative leadership in supporting organizational maturity. This style of leadership is therefore oriented toward involvement and collaboration that will fit well into the principles of Industry 4.0 with the requirements of decentralizing decisions and employee empowerment that will help in innovativeness and agility.

Concerning the average score for democratic leadership at 3.88 and the standard deviation at 1.14, a medium of 4 recorded that this style, where equal participation and full input from team members is encouraged, was supportive of organizational maturity, although there is a bit more dispersion in the responses than for participative leadership. This could imply divergent visions on the balance between decision-making efficiency and the need for inclusiveness in Industry 4.0.

Similarly, transformational leadership is regarded as very supportive of organizational maturity, with an average of 4.15 and a standard deviation of 0.83. The median score, with a value of 4, strengthens the assertion that the leadership style of transformational leaders-who inspire, influence, and motivate through vision and change-can handle organizations through the complexities of Industry 4.0. It can, therefore, be said that this leadership type especially provides value during this industrial context by assuring innovation and adaptation to changes.

From this, the transactional leadership style with an average of 3.23 and a standard deviation of 1.27 is one of the more moderate standings. The median score of 3 suggests that this style, focused on clear structures and rewards, is somewhat supportive but perhaps not as highly valued in the context of Industry 4.0 as more flexible and collaborative styles. The higher standard deviation here reflects difference of opinion, perhaps because the transactional approaches may be more or less applicable depending on the specific organizational needs.

Meanwhile, laissez-faire leadership is treated as not very supportive of organizational maturity, too, with an average of 2.77 and a standard deviation of 1.18. The median score of 3 indicates that some may find the hands-off approach of laissez-faire leadership somewhat helpful; however, as a general trend, it does not support the dynamism and the innovation-oriented context of Industry 4.0, where often quite active and engaging leadership is needed.

The charismatic leadership, therefore, only reaches an average of 3.50 with a standard deviation of 0.99, showing a moderate support for organizational maturity whose median score is 4. It can, therefore, be perceived that charismatic leaders are moderately effective in inspiring and influencing through personal charm and vision; however, this can have an impact which might be less consistently recognized as opposed to structural styles such as transformational or democratic.

The last one refers to servant leadership, putting great attention on the issues of serving and developing employees. Its average score is 2.85, with a standard deviation of 1.01. The median at a score of 3 indicates that some respondents believe that some value of servant leadership does exist; servants in general, however, are seen as less effective leaders as compared to the rest of the styles within the Industry 4.0 framework. This perhaps is because of increased demands on high-velocity innovation and critical strategic decisions which may or often conflict with the Servant leadership philosophy.

Situational leadership, which also would finally adapt to whatever the situation or the team requires, has an average of 3.73 and a standard deviation of 1.04. A median score of 4 shows that this adaptive style of leadership is found helpful to support organizational maturity on the transforming dimensions of Industry 4.0. Probably, the ability to adapt various leadership approaches according to the prevailing conditions is seen as one of the most valued assets in treading through the labyrinth of modern industrial environments.

Table 2 presents the result of an assessment that captures the opinion of two different groups, scientists and representatives of industry, with regard to the level of various leadership styles in efficiently supporting organizational maturity in the context of Industry 4.0. Such comparative analysis enables one to draw conclusions about the perception of two groups in regard to different managerial approaches and their contribution to organizational growth and adaptation.

Table 2.
The assessment of leadership styles level of supporting organizational maturity in the context of Industry 4.0 – division between scientists and industry representatives

Management styles	Scientists	Industry representatives
Autocratic	2.38	2.46
Participative	4.31	4.31
Democratic	3.54	4.23
Transformational	4.31	4.00
Transactional	2.85	3.62
Laissez-faire	2.85	2.69
Charismatic	3.77	3.23
Servant	3.00	2.69
Situational	3.77	3.69

Source: Own elaboration.

Both groups have a similar mean score regarding participative leadership, which is 4.31; this suggests that there is strong agreement in the belief of this type of leadership being particularly serving the interest of organizational maturity. Convergence of views from scientists and industrial representatives would suggest that by all concerned, collaboration and employee involvement in decision-making is seen as critical drivers in treading the challenges thrown up by Industry 4.0. This high agreement rate attests to participative leadership as a facilitator of innovation and adaptability within organizations.

Democratic leadership is viewed differently by the two groups. The average for scientists in scoring democratic leadership was 3.54, while for industry representatives, this average was higher at 4.23. From this divergence, it can be said that representatives from industry consider democratic leadership much more valuable for organizational maturity than scientists do. The orientation to teams for input and consensus building may be more relevant to the industrial representatives, who are bound to feel in actual operation the effects of these leadership styles.

Transformational leadership is similarly rated by the two groups: 4.31 average for scientists and 4.00 for the industry representatives. Even though both groups agree on the superiority of transformational leadership for motivating and encouraging employees, this small difference in ratings would indicate that scientists see the impact as being somewhat stronger. Based on this result, it is easier to interpret that scientists might appreciate the long-term perspective and drive for innovation typically associated with transformational leadership more than their industry counterparts.

Transactional leadership receives contrasting ratings from the two groups. Where scientists on average rated this style 2.85, indicating only a very low level of support, industry representatives rated this style at an average of 3.62, which is significantly higher. One may infer from this that the representatives value the structured and performance-oriented elements of transactional leadership, in keeping with practical realities of managing workforce productivity to achieve results. The scientists may view transactional leadership as less valid for developing organizational maturity and may, instead support an approach that emphasizes innovation and teamwork.

The rating of analysis of laissez-faire leadership is relatively low for both groups, where the average for scientists is 2.85 and that of industry representatives stands at 2.69. This would mean a general feeling by the respondents that the laissez-faire kind of leadership does not considerably help in achieving organizational maturity. It should be expected by both groups to realize that the hands-off approach probably would not provide sufficient guidance and support for teams to deliver their full potential in an industrially dynamic environment.

Another difference is charismatic leadership, which obtained an average rating of 3.77 among scientists, as opposed to the rating of industry representatives at 3.23. This may imply that while scientists could attach a higher value inspirationally and motivational-wise to charismatic leaders, the industry representatives place more importance on other styles of leadership as proving more effective in a real-life context.

Servant leadership received 3.00 by scientists and 2.69 by industry representatives, the lowest scores from both groups. This already tells us that, though serving and developing the team members is important, neither group perceives servant leadership as effective in building organizational maturity for Industry 4.0. These lower ratings probably signal a preference for more directive or transformational approaches better-suited to the fast pace and innovation demands placed on today's organizations.

Situational leadership is also viewed similarly between the two groups, as scientists graded it 3.77, while industry representatives graded it at 3.69. This serves to suggest that a shared understanding is in place: namely, that the ability to adapt the style of leadership depending on the particular context carries value. The small difference in scores will testify that both groups appreciate the flexibility carried within situational leadership and acknowledge its relevance in addressing the diverse challenges at hand brought about by Industry 4.0.

The Mann-Whitney U test was conducted for scientists and industry representatives in order to define whether there is any statistically significant difference between their judgments with regard to the various types of leadership styles in terms of effectiveness for organizational maturity in view of Industry 4.0. The Mann-Whitney U test is a non-parametric test that is used to compare differences between two independent groups where a dependent variable is either ordinal or continuous but not normally distributed.

The significant differences detected from this analysis are only for the democratic leadership style. The implication of the p-value, 0.0415, at the significance level of $\alpha = 0.05$ is that there is a difference in the perceptions of scientists and those of industry representatives on democratic leadership. In this case, democratic leadership was rated by scientists at an average of 3.54, while for industry representatives, it received an average score of 4.23. This discrepancy might suggest that representatives of industry consider democratic leadership to be more helpful for organizational maturity than representatives of science do.

Table 3: Correlation coefficients between the leadership styles as assessed by scientists and industry representatives. The table searches for relations between the assessment of different management styles by the two groups in supporting organizational maturity in the context of Industry 4.0. These correlation coefficients lie between -1 and 1. A value close to -1 indicates a perfect negative correlation; that is, there is a perfect negative linear relation between the variables. A value close to 1 indicates that there is a perfect positive correlation between the variables. A value near 0 suggests no or negligible relationship between the two variables.

Table 3.
The corelations of results between scientists and industry representatives

Management styles (scientifics)	**Management styles (industry representatives)**								
	Autocratic	**Participative**	**Democratic**	**Transformational**	**Transactional**	**Laissez-faire**	**Charismatic**	**Servant**	**Situational**
Autocratic	-0.458	-0.503	-0.202	0.453	-0.414	-0.029	0.557	-0.201	0.142
Participative	-0.116	-0.064	0.171	0.321	-0.358	0.192	0.011	-0.562	0.309
Democratic	-0.247	-0.722	-0.516	0.205	-0.205	-0.456	0.083	0.186	-0.109
Transformational	0.432	-0.064	-0.147	-0.321	-0.213	-0.120	0.151	0.453	0.032
Transactional	-0.107	-0.556	-0.568	0.361	-0.533	0.198	0.551	-0.199	-0.240
Laissez-faire	-0.312	-0.452	0.027	-0.241	0.176	0.140	0.288	0.029	0.020

Cont. table 3.

Charismatic	0.152	0.204	0.343	-0.258	0.215	0.511	0.078	-0.150	-0.103
Servant	0.057	-0.229	-0.264	-0.134	-0.060	0.000	0.292	0.169	-0.289
Situational	-0.365	-0.489	-0.303	0.093	-0.181	-0.354	-0.025	-0.108	-0.234

Source: Own elaboration.

Starting with autocratic leadership, the highest negative correlation was to participative leadership with a value of -0.503, while democratic leadership had -0.458 among scientists. It appears that as the assessment of autocratic leadership by scientists goes up, then their assessments for the participative and democratic leading styles go down. Therefore, it would seem from these findings that scientists perceive the more authoritarian methods to be in conflict with collaborative and democratic ways, which most often are considered indispensable on the path to innovation and adaptability toward Industry 4.0. In contrast, it is positively correlated with transformational leadership, 0.453, suggesting that those scientists who rate transformational leadership highly also view autocratic leadership in positive terms. It would follow that some scientists may view a combination of directive and visionary approaches as being effective under certain circumstances.

As for the participative style, the most salient relationship, democratic leadership presents a negative value of -0.722, that is a very strong negative correlation with this leadership style. This would mean that the scientists who hold a positive view of participative leadership are less likely to like democratic approaches, possibly as a result of a preference for direct involvement rather than consensus-building. The association with situational leadership is 0.309, indicating a moderate positive correlation and that the scientists partly view participative leadership in relation to the flexibility and adaptability of situational leadership.

Democratic leadership stands in relation to other correlations, most notably the negative association of -0.516 with transformational leadership and the positive of 0.343 with charismatic leadership. This relation to negative transformational leadership could hint that those oriented toward democratic processes might view the transformational style less favorably, perhaps too top-down or visionary compared to their preference for inclusive decision making. This positive correlation with charismatic leadership may suggest that scientists view something positive about inspirational and engaging leadership within the team but still maintaining democratic processes.

Transformational leadership correlates positively with autocratic leadership at 0.432 and negatively with transactional leadership at -0.568. Those rating transformational leadership highly would view autocratic leadership favorably, perhaps perceiving that a blend of inspiration and direction offers something useful. The strong negative correlation with transactional leadership may indicate that scientists valuing transformational approaches perceive transactional methods, focusing on structured reward and punishment systems as less effective to support organizational maturity.

In the case of transactional leadership, relations are much more complex. Strong negative relations exist with democratic leadership (-0.568) and participative leadership (-0.556); this means that people who believe in transactional leadership do not support collaborative or inclusive approaches. This may mean that the transactional approach is perceived as not fitting into the demands of flexibility and participation that organizations raise for Industry 4.0.

The laissez-faire leadership style only shows low correlations overall, which might propose that this style of leadership does not greatly influence other styles of leadership. It has a very slight positive correlation of 0.288 with charismatic leadership, which might be indicative that within the population sampled, there is a belief that a hands-off approach can balance out inspiring leadership in a particular context.

Charismatic leadership normally correlates positively with the other styles of leadership, in particular transformational leadership 0.511. This might suggest that the scientists who prefer charismatic leadership also like transformational styles because they are inspirational and vision-oriented. The negative correlation with situational leadership -0.150 would suggest that the scientists view this as somewhat of a disconnect between these two styles, possibly in the respect that charismatic leadership might not be as adaptable to specific contexts when compared to situational leadership.

In the servant leadership style, we generally notice a weak linkage with other styles, with a slight positive correlation of 0.292, which may indicate that scientists view servant leadership compatible with the inspirational qualities of charismatic leaders. On the other hand, the negative correlation with participative leadership is at -0.229, which means that those who support servant leadership do not pay attention to direct involvement and collaboration in their decisions, reflecting potential divergence in leadership priorities.

In particular, situational leadership is negatively related to autocratic, -0.365; participative, -0.489; and laissez-faire leadership, -0.354. That would suggest that scientists feel that situational leadership somewhat inhibits these respective styles because true leadership must be adapted to the situation and context.

From Table 3, it is clear that there is something really interesting in the evaluation of various leadership styles by scientists and representatives of industry; this proves how each group perceived which management approach is effective in reaching organizational maturity in the context of Industry 4.0.

The first important observation to be made is the clear orientation of the scientists toward participative and transformational styles of leadership, which shows a strong positive correlation between the different measures. This disposition reflects the assumption that collaboration and transformational leadership are required to generate innovation and adaptability. Industry representatives, by contrast, are more tolerant of transactional leadership on dimensions of structure and performance management, which can better meet practical needs than those of academic environments. This strong negative correlation might suggest that the scientists are somewhat skeptical of the democratic approach, believing that a choice has to be

made between direct involvement and consensus-building, whereas the industry representatives do not display such polarity in their ratings.

Another interesting divergence is the correlation between autocratic and transformational leadership. There is a positive correlation among these styles from the scientists' standpoint, which may indicate that they consider an integration of the authoritative direction and visionary inspiration as something worthwhile. Industry representatives do not demonstrate the same tendency, perhaps indicating a more pragmatic perspective that would keep the two styles apart based on their situational applicability. This deviation suggests that scientists might want to combine these styles more, while business associates keep them separate-but maybe a function of the particular contextual environment.

Transactional leadership scores different ratings between the two groups; again much lower ratings from scientists than business associates. The high negative correlations with both participative and democratic styles indicate that scientists are incredulous about transactional methods because these seem deleterious for creating an innovative atmosphere. Industry representatives, however seem to have taken pleasure in transactional leadership since their scores were more encouraging of practical orientation appreciating the need for performance-based management required in their work environments. That says a lot about greater acceptance of structured ways among industry representatives- their focus on measurable outcomes.

The second important difference is related to the correlation of laissez-faire leadership. Scientists are more skeptical of this style, as can be read from the generally low correlations across the different styles, suggesting it holds little if any value in promoting organizational maturity. By contrast, representatives of industry treat the laissez-faire leadership style with a bit more leniency, yet their ratings still remain low. This could be an indication that representatives of industry see value in a hands-off approach under specific circumstances, especially in environments that require creativity and innovation.

About charismatic leadership, correlations also show a difference in perception. Scientists have more favorable views over charismatic leadership with higher positive correlations into transformational leadership. This would mean that scientists are seeing the inspirational qualities of charismatic leaders and view them as compatible with the visionary dimension of transformational leadership. These are in contrast to the charismatic leadership of industry representatives, which has a weaker correlation and therefore might not be as cherished by them as it is by their scientific counterparts. This difference in pattern suggests that while scientists are drawn to leaders who can inspire and motivate, industry representatives may place more emphasis on leadership styles that yield tangible results.

The situational leadership analysis yields that scientists view this type of leadership as equally adaptable and relevant within various contexts; hence, it strongly negatively correlates with autocratic and participative leadership. As to the industry representatives, all the signs for correlations are weaker; therefore, they tend to be more balanced in representing the

applicability of situational leadership in diverse scenarios. This would mean that scientists could stress flexibility and context awareness more, while the representatives of industry could hold on to the more traditional view in which the variety of styles signals the variety of organization-specific needs.

Factor analysis for leadership styles examined was conducted. In factor analysis, variables are grouped into factors by the method. Normalized Varimax rotation was applied. The Kaiser-Meyer-Olkin test of the correlation matrix for adequacy gives a value of 0.77, hence justifying the factor analysis to be applied in the case under consideration. A KMO value higher than 0.7 is commonly regarded as acceptable, and so this result supports the validity of the analysis. The Kaiser criterion suggests retaining 4 factors whose eigenvalues are greater than 1. By the scree plot criterion of Cattell, it also retains 4 factors. Table 4 Factor analysis output After running factor analysis, the exact picture of how different dimensions of management styles group into four factors, or ways, which account for the total variation in data by 72%. Each factor represents another dimension of management styles, as can be seen from the factor loadings in Table 2. Normalized Varimax Rotation was used for identifying the factors because this rotation method maximizes the variance explained by each factor and keeps orthogonality or uncorrelated factors. In general, 72% of the variance is explained by the identified factors. This will mean that these factors are representative; they give a wide variety of the underlying structure of the management styles under study.

Table 4.
The loadings of factors

Management styles	Factor 1	Factor 2	Factor 3	Factor 4
Autocratic	0.183	0.141	-0.285	0.765
Participative	0.609	0.034	-0.360	0.294
Democratic	0.117	0.871	-0.253	0.114
Transformational	0.001	0.022	0.821	-0.075
Transactional	-0.029	0.468	0.642	0.128
Laissez-faire	0.722	0.236	-0.341	0.157
Charismatic	0.572	0.474	0.152	0.210
Servant	-0.107	0.006	0.067	0.838
Situational	0.046	0.752	0.452	0.103
Explained value	1.281	2.053	1.709	1.487

Source: Own elaboration.

Factor 1 - Collaborative and Empowerment Oriented Leadership. Factor 1 is characterized by high loadings on the Laissez-faire (0.722), Charismatic (0.572), and Participative (0.609) styles of leadership. It would, therefore, suggest that the kind of leadership represented by this factor is flexible, loosely structured, and empowering to team members. High-scores on this factor enact behaviors that facilitate independence among followers, the prevailing climate is one where there is more freedom for the individual and more democratization of decision-making. This style of leadership has been characterized as a collaborative form wherein leaders are commanding through charisma and ideas, not fiat. Thus, positive loadings of Participative and Charismatic leadership styles develop this idea that this factor reflects those kinds of leaders

who inspire their teams and motivate them by allowing a certain degree of personal initiative and shared responsibility.

The second factor is Structured and Democratic Leadership. The factor structure indicates that Factor 2 is particularly related to the Democratic style of leadership with a loading of 0.871, and secondarily, the Situational, 0.752, and Transactional, 0.468 styles of leadership. This structure of the factor suggests that leaders classified under this factor make decisions in a structured manner and at the same time ensure participation and adaptability. The high loading on Democratic leadership, which is 0.871, indicates that the leader derives input from the members of the group and arrives at consensus. A high association with Situational leadership, 0.752, signifies that leaders change their style to suit the demands of the situation and capabilities of the team. Besides, Transactional leadership, with a loading of 0.468, indicates the leader's preference for clarity in structure, reward, and performance management. Overall, Factor 2 stands for a leadership style that is democratic in its processes and flexible enough to change with evolving contexts.

Factor 3-Performance-oriented and Transformational Leadership. This factor is primarily defined by high loadings from Transformational (0.821) and Transactional (0.642) leadership styles. This factor has been characterized by leaders who accomplish high performance through motivation, vision, and a clear system of rewards. The Transformational leaders, with a loading of 0.821, inspire their teams by giving them a sense of direction and infusing innovation and change into the workplace. Meanwhile, the positive loading into Transactional leadership, 0.642, would suggest that while these leaders may inspire, there is also an emphasis on concrete goals and outcomes, rewarding success, holding individuals accountable for results. In this case, the combination of transformational and transactional styles here shows a strong focus on driving performance and organizational change by means of both visionary leadership and structured incentives.

Factor 4 - Authoritarian and Supportive Leadership. The leadership styles of Autocratic and Servant are significantly loaded into Factor 4, with 0.765 and 0.838, respectively. Curiously, though those two styles contrast in concept, the emergence here in this single factor does indicate a sort of leadership which is both authoritarian in making decisions and supportive in its practice. But these findings also indicate that high scorers on this factor may strongly control and make decisions unilaterally-as evidenced by the loading of 0.765 from the Autocratic style-yet still demonstrate servant leadership, focusing on their followers' needs and development, as indicated by a loading of 0.838 with Servant. Such leadership can be realized in contexts where the leaders hold authority but are deeply concerned with the well-being and personal growth of their subordinates.

Discussion

The results of the study indicate that participative and transformational leadership styles are key to fostering organizational maturity in Industry 4.0. The participative style received the highest score (mean 4.31), suggesting that employee involvement in decision-making is not only desirable, but necessary. Similar findings can be found in a study by Oberer and Erkollar (2018), who noted that leaders in the era of Industry 4.0 must promote collaboration and decentralization of decisions in order to effectively manage high-tech organizations. The research results described in this article are consistent with their findings, pointing to the important role of participatory approaches in adapting to changing technological conditions.

Transformational style, which received an average score of 4.31 in our survey, also plays an important role in managing in an Industry 4.0 environment. As Dubey, Gunasekaran and Childe (2022) note, transformational leadership is essential in organizations that must constantly evolve and adapt to new technologies such as Big Data and artificial intelligence. Transformational leaders motivate their teams to embrace innovation and adaptation, which is consistent with our findings.

In this study, the democratic style scored lower (mean of 3.54) than the participative style, which may suggest that while promoting equal participation in decision-making is important, there is a diversity of opinion about its effectiveness in a rapidly changing technological environment. A study by Behie, Alizadeh and Gillani (2023) showed a similar trend, indicating that democratic leadership, while promoting cooperation, may be less effective in situations that require quick decision-making. The results reflect these findings, showing that while democratic leadership is valued, its effectiveness may be limited in the context of rapid technological change.

Interestingly, the transactional style received an average score of 2.85, which is consistent with the findings of Dubey, et al. (2022), who emphasize that transactional leadership, which focuses on explicitly setting expectations and rewarding performance, is less effective in an Industry 4.0 environment where innovation and flexibility are key. Our results suggest that while this style can be effective in structures that require close supervision, it is seen as less appropriate in an environment that promotes innovation and agility.

The low autocratic style scores (mean of 2.38) in our study confirm previous research by Oberer and Erkollar (2018), who found that an authoritarian approach is not responsive to the needs of modern technology organizations. The high standard deviation (1.21) in our sample suggests that while some leaders may prefer an autocratic approach in specific situations, it is generally considered inappropriate in settings that require innovation and flexibility.

Conclusion

Research on leadership styles in the context of Industry 4.0 indicates that participative and transformational styles are key to fostering organizational maturity. The participative style, with its ability to promote employee involvement and decentralize decisions, is particularly effective in an environment that demands innovation and flexibility. Transformational leadership, which inspires teams to achieve long-term goals and adapt to rapidly changing technologies, also plays a key role in managing organizations operating in Industry 4.0.

On the other hand, styles such as autocratic and transactional are less effective in the context of Industry 4.0, where flexibility, innovation and collaboration are fundamental. While autocratic leadership can be useful in specific situations requiring quick decisions, its long-term effectiveness in technology organizations is limited. The transactional style, focused on clear expectations and rewards for performance, also shows limited usefulness in an environment requiring rapid adaptation to changing market conditions.

Participative leadership, according to the research, is the best, with the average of 4.31 showing the situation where employees are engaged in decision-making processes Q1. Through this form of leadership, it promotes decentralization and collaborativeness. These are essential ingredients for organizations in fast-changing technological environments. Innovation and flexibility thrive through participative leadership whereby employees are integrated into making major decisions. This decision is very crucial in treading the complexities occasioned by automation and digital transformation that characterize Industry 4.0.

Meanwhile, transformational leadership also has a very important contribution, with 4.15 in this research, and is noted for engaging in inspiring teams for long-term-oriented vision. In the Industry 4.0 era, when business models are being disrupted by emerging technologies like artificial intelligence, Big Data, and autonomous systems, transformational leadership would permit employees to be more open towards change and innovation. This leadership enables the continuous learning and adaptation necessary to ensure the organization remains competitive and responsive to emerging digital demands.

Finally, with regard to Q2, there are noted differences between the academia and industry representatives in the perceived effectiveness of various leadership styles in supporting organizational maturity in Industry 4.0. In particular, democratic leadership is highly divergent between the groups. The respective rating for democratic leadership is 4.23 for industry representatives on an average, while the scientists have provided an average score of 3.54. What this may further indicate is that in an industrial environment where things are fast-moving and practical, there is a greater belief in collaboration and incorporation of employee input through consensus. The latter may view it as less productive in their context of rapid technological changes, which will call for speedier and more centralized decisions. Another important difference deals with the perception of transactional leadership as viewed by the two

groups: industry representatives with 3.62 versus 2.85 for the scientists. This innately indicates that industry professionals will appreciate the transactional leadership structure for its clarity and performance-based rewards, possibly quite critical toward the meeting of immediate operational goals. Contrarily, scientists will view this style as less conducive to fostering innovation and flexibility required in Industry 4.0; hence, they would favor other leadership approaches that emphasize long-term development and adaptability. The observed differences bring to light the different needs and priorities of academia versus industry in terms of leadership in the context of digital transformation.

Among such styles, those that can give full significance to adaptability, collaboration, and innovation are the most wanted from the point of view of a fast-changing technological environment. In this respect, participative leadership works especially well, for which an average score of 4.31 was registered within the study. This kind of style allows employees to participate in decision-making, promoting a culture of shared responsibility and collaboration. These are attributes particularly in demand within an environment where technological progress happens point-blank, with a requirement for the ability of rapid adaptation to new toolsets and processes. Participative leadership instances, with their bottom-up approach to decision-making, allow organizations to be even more responsive to trends and emerging challenges in Industry 4.0.

Another highly valued leadership style in this environment is transformational leadership, which received an average score of 4.15. The leaders practicing transformational leadership let their teams be inspired and motivated to pursue innovation and change, something quite relevant to the industries where the introduction of AI, Big Data, and automation will continue to reshape business. Transformational leadership encourages a forward-thinking mindset that promotes creativity and continuous learning. It is ideal for leaders to take into action in leading the organizations through complexities and uncertainties at a digitized and automated world.

From the factor analysis in the study, the leadership styles-including participative, charismatic, and laissez-faire-which clustered into "Collaborative and Empowerment-Oriented Leadership" are P4. The participative leadership style focuses on employee involvement and making decisions, while charismatic leadership and laissez-faire leadership focus on employee empowerment and independence with factor loadings of 0.572 and 0.722, respectively. Put together, the styles mentioned imply that Industry 4.0 leadership should be about empowering workers, encouraging innovation, and giving them latitude of autonomy for self-alignment with a rapidly changing environment.

Another significant grouping from the factor analysis involves transformational and transactional leadership, which are combined into "Performance-Oriented Leadership". Transformational leadership has a strong loading of 0.821, since it inspires and motivates teams toward innovation and change, while transactional leadership comes in at 0.642, with a focus on clear goals and performance-based rewards. Having both approaches to the methodology combined into one style suggests that Industry 4.0 leaders need to somehow balance visionary,

imaginative leadership with a practical, results-oriented approach to management. This makes it possible for organizations to be innovative, while drawing on clear structures and accountability are an important ingredient in today's dynamic and fast-evolving technological landscape.

In general, modern industrial organizations, in order to succeed in Industry 4.0, should strive for leadership based on collaboration, engagement and inspiring teams.

The article adds significant value by providing new empirical data on preferred leadership styles in the context of Industry 4.0, which allows for a better understanding of the role of leaders in technology organizations. Of particular value is the demonstration of how participative and transformational styles foster innovation and adaptation in changing environments, which has direct application to management practice. These findings can be used by leaders of industrial organizations to adjust their leadership strategies, enabling more effective management of technology teams and projects.

Limitations of this study include a relatively small sample of respondents, which may affect the ability to generalize the results to a broader population. In addition, the research focused primarily on the context of Industry 4.0, which may limit its applicability to other sectors. In addition, using only quantitative research methods may not fully capture the complexity of leadership styles, so future research could also incorporate qualitative approaches to get a more complete view.

Despite these limitations, the article provides a solid foundation for further research on the role of leadership in the era of digital transformation, offering concrete conclusions that can be useful in both management theory and practice

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