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Exploring determinants influencing artificial intelligence adoption, reference to diffusion of innovation theory

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ABSTRACT

An organization's ability to accept innovation heavily depends on its leadership caliber. Although leadership is known to affect all three stages of adoption (initiation, adoption, and routinization), literature has yet to examine the specific leadership components that contribute to each of these phases. Drawing from existing literature on transformational leadership and AI adoption, this article examines how transformational leadership can facilitate the successful implementation of AI technologies. This paper explores the intersection of transformational leadership and artificial intelligence (AI) adoption within organizations. This study used data from 250 companies to develop and evaluate a framework combining the Diffusion of Innovation (DOI) theory with transformational leadership (TL). The results were analyzed using structural equation modeling (SEM) techniques. The study examined the determinants influencing the adoption of AI as a new technology. This study found TL is a crucial driver of adoption, whereas elements like vision and intellectual stimulation are essential for the Intention to adopt. Also, this research indicates that adopting a significant innovation like AI is intricately linked to leaders' vision and ability to respect and recognize the feelings and needs of others (both indicators of offering individual assistance). Additionally, practical implications and recommendations for leaders are provided to navigate the complex landscape of AI adoption.

1. Introduction

Artificial Intelligence (AI) is a powerful technology capable of various functionalities across various industries. It is regarded as the most significant technological revolution, potentially disrupting multiple aspects of the technological landscape [1]. Hence, it is becoming more widely adopted across a range of industries such as bioenergy systems [2], supply chain management [3]), smart manufacturing ([4]; Ronaghi, 2023) medicine [5,6], government and healthcare ([7,8].), retail [9,10] smart homes [11], autonomous vehicles [12], enhancement of manufacturing process [7,13,14]. AI has become crucial to modern corporate frameworks and approaches, such as Big Data, algorithms, and computing power [7]. More than 22 % of companies are aggressively integrating AI into their technology products and processes, 33 % are implementing it, and the exploration phase is still ongoing for 45 % of firms (CompTIA IT Industry Outlook, 2024). Based on its vast potential, the AI market is expected to grow from $241.8 USB in 2023 to $ 740 USB by 2030 with a CAGR of 17.3 % annually (Statista Report, May 2024). This significant potential of AI to drive economic growth is causing many nations to establish supremacy in the development and adoption of artificial intelligence (AI).

As the organizational development process has been driven by data sources, cloud-based services, and increased AI-driven computational power [15,16], organizations have started considering adopting and integrating AI to foster the product and service process. However, AI adoption is still in its infancy because organizations face numerous challenges when adopting new technology. Such as regulatory issues [17,18], adoption issues i.e. lack of skilled professionals, low availability of infrastructure [19], privacy and security issues [20], accurate data and training issues [21], fear of job displacement, negative perceptions influencing bias, and limited trust in AI's operational transparency [22] to name a few. Additionally, skepticism towards AI governance, ethics, and moral implications hinders its acceptance in organizational settings. For example- The European Commission has established new legislation for "high-risk artificial intelligence," and the existing European fundamental rights framework offers clear guidelines for the use of medical AI. These regulations will likely be significant for future African AI applications [23].

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The AI adoption process involves implementing AI in an organization and its acceptance and use by the users. AI adoption in organizations is influenced by technical expertise, support from top management, digital maturity of the organization, entrepreneurial orientation (Dubey et al., 2020), innovative capacity of the organization and its strategic focus (Marshall et al., 2015), and the transformational leadership (TL) of the organization. With the proliferation of AI, new forms of leadership are necessary to address the complexities arising from the interconnections of technologies [24]. Also, how transformational leadership and innovation capability impact each other warrants further study [25]. Similarly, components of TL are rarely researched in the context of the Diffusion of innovation (DOI) theory despite their obvious significance ([26–28]; Attei& Meyer-Waarden, 2022). However, transformational leadership has been studied before the context was different. Yao et al. [29] and Bilal et al.[30] studied TL transformational leadership in the context of Chief Executive Officers (CEOs). They examined how it affects business model innovation (BMI) by exploring the top management team's (TMT) serial mediating role. Kopackova et al.[31] studied transformational leadership in the context of chief digital officers. Hence, there needs to be more studies on transformational leadership in the context of other decision-makers, including CIOs, CISOs, and senior IS managers. Moreover, competencies and leadership skills are essential for the adoption ([32]; [33]; [34]). Previous studies identify charisma and vision as two critical competencies in transformational leadership [35], whereas intellectual stimulation [36,37] and inspirational communication [36] are identified as the other crucial competencies. From the extant literature review, this study found these indicators (intellectual stimulation, inspirational communication, and vision) as the dimensions of transformational leadership that may influence the adoption process. However, there is a lack of understanding regarding the competencies needed for digital transformation [38–40]. Despite scholars identifying various relevant leadership competencies ([41]; [42]; [43]), there's a gap in examining how the driving forces behind the transformation influence these competencies. Hence, it is necessary to understand the adoption behavior of organizations comprehensively. To fill the above research gap, this study sought to add knowledge to the existing research on how transformational leadership impacts technology adoption and what competencies are required to adopt technology. Further, our study specifically tried to answer the following research questions (RQs):

RQ1. Does transformational leadership and its competencies (vision, intellectual stimulation, inspirational communication) impact on Intention to adopt AI in an organization?

RQ2. What are the possible theoretical and practical implications for stakeholders to adopt AI in the organization from the perspective of Transformational Leadership?

The study contributes multifacetedly to the literature on transformational leadership and technology adoption. First, this study presents a conceptual framework concerning transformational leadership (competencies), technology adoption intention, and organizations designed to assist transformational leaders in adopting AI. This study examines the influential role of TL in adopting AI while applying the DOI theory. Second, this study provides insight to various stakeholders (i.e., industry and academia) on the effectiveness of adopting AI through transformational leadership. To study the above relationships, we adopted SEM and further tested the proposed hypotheses to understand the possible association of the variables. Moving forward, our discussion of the paper will be structured to include the literature review, hypothesis, research methodology, investigative procedures, data analysis, discussion section, study practical implications, limitations, future research, conclusions, scope, and reference list.

2. Theoretical framework & related literature

The term "diffusion of innovation" (DOI) describes the spread of a new concept, practice, philosophy, etc. It is how a new idea or technology spreads through a society. Because it presumes a one-way flow of innovation from technology to business, this perspective treats technological and market components of innovation as two distinct entities. Diffusion spreads creativity among members of a social system over time through specific channels [44]. DOI theory by Rogers [44] explains how innovation spreads within a company. As described by Rogers (Rogers, 2003), The DOI refers to the gradual adoption of a new concept or idea throughout society using specific communication channels. He has proposed five qualities of invention that may shed light on this enigma. According to Rogers (Rogers, 2003), diversity in adoption is attributable to qualities including observability, relative advantage, compatibility, trialability, and complexity. In addition, these features serve as a helpful checklist that technology project managers can use to assess the merits of potential innovative approaches. Also, Depietro et al. [45] emphasize the significance of getting top-level support for adoption decisions.

There are many ways in which innovation might be disseminated throughout time, according to the DOI, and this process is known as Diffusion. Innovation is the perception of something new by a person or group. De Mattos and Laurindo [46] identified individual traits like leadership and internal/external organizational factors as influential factors for innovation. Adoption is selecting and applying a modern technology or program by an organization's members [47]. An innovation's adoption rate measures how quickly people in a society take to its perceived benefits. These characteristics and others have been used in studies looking for factors influencing the acceptance of technological innovation (Oliveria & Martins, 2010; [48]). A company is in the intention stage when it has decided to adopt innovation to help its business processes. As the company gains more expertise and experience from the intention stage, it moves on to the adoption stage, where it may fully realize the benefits of the innovation by using modern technology [49].

Innovation is the perception of something new by a person or group. The adoption process involves evaluating a proposed innovation's technical, financial, and strategic merits, selecting it as the best course of action, and allocating resources to acquire it [50,51]. The DOI framework allows for tracking outcomes before, during, and after the decision-making process of a technology or solution (Mattos & Laurindo, 2017). Each stage of the process has its name, such as "intention," which refers to the "persuasion stage," "adoption," which refers to the "decision stage," and "routinization," which refers to the "implementation of the action" [49]. We consider a company in the invention stage when it has decided to help its business processes adopt the innovation. As the company gains more expertise and experience from the intention stage, it moves on to the adoption stage, where it may fully realize the benefits of the innovation by using modern technology. Over thirty years of research have been devoted to understanding how and why people adopt innovative ideas. Rogers' DOI model is widely adopted [52]. Many studies in many different areas have used the model as a starting point. Rogers' theory has been applied to many fields: politics, public health, media, history, education, economics, and technology [53]. Tech adoption researchers widely accept Rogers' theory. Rogers' theory of the DOI is highly applicable in analyzing the integration of modern technologies in academic settings [54–56].

2.1. Transformational leadership

"Leadership is the process through which an individual influences a group towards achieving a shared objective" [57]. The leadership style of top management significantly influences organizational productivity and success [58]. Also, effective leadership is essential for successful AI-driven digital transformation initiatives [59]. The key to successfully adopting AI is for organizations to have leaders who can embrace its

opportunities and transform them into innovative business models [60]. This impact extends to various organizational aspects, including strategy, structure, reward systems, and resource allocation. Effective leadership can foster a creative work environment, enabling employees to demonstrate higher levels of creativity [61]. Transformational leaders play a multifaceted role in organizational development. They initiate change, establish new visions, secure commitment, prioritize long-term goals, motivate followers to pursue higher-order objectives, and influence organizational culture. Transformational leadership goes beyond traditional methods of incentivizing performance or services. Instead, it encourages followers to become self-driven and empowered to achieve outstanding results. Yukl [62] states transformational leaders foster commitment to organizational objectives and enable followers to attain them. Thus, transformational leadership facilitates adoption by inspiring, empowering, and guiding employees through change and promoting technological innovations [63]. The study says technology adoption and transformational leadership are closely intertwined in modern organizations. TL directly or indirectly influences innovation [25]. It plays a crucial role in driving and facilitating the adoption of new technologies within a company [64]. Also, firms' digital transformation requires leadership to promote technological adoption [65].

Management theories should be improved to explain better how leaders can support adopting modern technologies. A study by Neufeld et al. [66] discovered inconsistencies in top management support, leading to variations in definitions and metrics regarding involvement and commitment. To put it another way, a leader's role is sometimes contrasted with TL (Avolio &Bass, 1995), which aims to serve the needs of leaders and their subordinates while fulfilling contractual duties related to goal-setting results, monitoring, and control. Creating an innovative and positive culture requires TL. Also, TL positively affects employee satisfaction, motivation, and performance, impacts the industry [67], and positively impacts organizational culture [68] and technology [69]. In addition to improving an organization's innovation culture, TL benefits outbound and inbound open innovation [70]. TL and absorptive capacity are crucial in establishing a culture that supports open innovation. Also, the sharing of knowledge through technology is strongly impacted by TL [71], and the evolution of performance management practices is influenced by leadership styles and organizational culture (Garengo & Betto, 2024).

TL aims to motivate and inspire a team to achieve a shared objective. When leaders are genuinely transformational, they provide their subordinates with the resources and support they need to grow as leaders while encouraging and challenging them to think freely when solving challenges. Followers of transformational leaders are more engaged and satisfied [72]. As a result of responding to TL, followers exhibit outstanding performance, frequently exceeding expectations. Hence, after examining decades of studies in TL, Bass [72] found that peer effectiveness and satisfaction were more correlated with transformative variables than contingent reward. Authentic leadership (AL) has gained significant attention in management literature due to its potential overlap with established theories like TL [73,74]. In addition to improving an organization's innovation culture, TL benefits outbound and inbound open innovation [70]. "TL" and "absorptive capacity" are essential to creating a culture that promotes open innovation. Also, the sharing of knowledge through technology is strongly impacted by TL [71]. Also, leadership styles and organizational culture influence the evolution of performance management practices (Garengo & Betto, 2024). Many researchers have reservations about the reliability of TL's contributions to the leadership theory. In this context, the study has considered three dimensions of TL: vision, inspirational communication (IC), and Intellectual Stimulation (IS), and examined how these contexts influence technology adoption.

2.1.1. Vision

According to McClelland [75], vision motivates individuals to adopt certain behaviors based on the attractiveness of organizational values rather than the charisma of a leader. Vision is a crucial component of transformative leadership [44]. According to Bass [72], charisma is the most critical characteristic of transformative leaders. Meta-analytic data corroborate this assertion by showing a substantial correlation between charisma and efficacy indicators like follower satisfaction with the leader [76]. Bass [72] argues that having an unobstructed vision is the most crucial quality of a transformational leader. According to McClelland [75], the vision emerges when people internalize the organization's values, goals, and ambitions, which leads them to adopt behaviors based on the attraction of the actions themselves rather than the attractiveness of the leader. Hence, vision is an ideologically driven, transcendent ideal that symbolizes a group's core ideals [77]. When discussing charisma, people often emphasize the importance of having a clear vision. A vision can be defined as an idealized future based on an organization's values and ideals. Rafferty and Griffin (2004) state that a vision expresses a value-driven yet fictitious image of the future. This technological adoption will be necessary to define the desired end state and set specific goals to implement this transformation effectively. An unobstructed vision with objectives and anticipated results must be established to implement this transformation properly. Vision is critical to effective TL influencing technology adoption. This is why we suggest the following hypothesis:

H1. *A leader's vision positively influences technology adoption*

2.1.2. Inspirational communication

According to Downton [78], inspiration can be distinct as the skill to stimulate one's intellect or emotions. According to Bass [72], inspirational leadership is only achieved when leaders utilize affective attributes such as emotional appeals and motivational speeches to influence their followers. To motivate and captivate an audience's emotions, good public speaking is emphasized in every definition of inspirational leadership. According to Joshi et al. [79], inspiring leaders are crucial in geographically distributed settings enabled by technology adoption. The term "inspirational communication" was coined by Rafferty and Griffin (2004), and it refers to the dissemination of upbeat and affirming messages about the company and remarks that boost morale and self-assurance. So, this study used IC as one of the constructs to get people excited and motivated. This differs from Bass and his colleagues' more general idea of inspirational motivation. Although TL has highlighted inspiring motivation as a crucial component, this concept has been characterized in many ways (Babuto, 1997). Charismatic leaders inspire followers to prioritize the group's benefit through emotive speeches and appeals [72]. IC has improved, becoming swifter, more collaborative, intentional, and united. Any firm that wishes to keep its competitive edge must use technology. Modern technologies emerge daily, and leaders might realize their company needs a technology upgrade. Implementing change is not always straightforward, and getting users to adopt modern technology can be challenging because certain staff members may resist it. Hence, IC outlines the advantages the change will bring and nudge the staff toward adoption to combat this. This is why we suggest the following hypothesis:

H2. *Technology adoption spreads more effectively when leaders inspire followers through inspirational communication.*

2.1.3. Intellectual stimulation

The definition of intellectual stimulation is to increase employees' interest in and sensitivity to issues, as well as to improve their skills to think productively. The definition of intellectual stimulation is to increase employees' interest in and sensitivity to matters, as well as to enhance their ability to think creatively. This aspect of leadership includes actions that pique followers' attention to issues, teach them to recognize difficulties, and encourage them to develop novel solutions [72]. As a result of being mentally challenged, followers show considerable improvement in their problem-solving skills and the quality of their ideas [80]. Limited studies have been done on this aspect of

leadership, but it contains a narrower and more reliable collection of actions than the other elements of transformative leadership. This study adopts Bass's [72] definition of IS to explain how this type of engagement benefits businesses and their employees. However, problems and the development of problem-solving skills can be piqued by IS. Intellectual challenge improves the quality of its adherents' solutions by increasing their capacity for abstract thought, logical reasoning, and critical evaluation. This aspect of transformative leadership has received less attention Rafferty and Griffin (2004). Still, it involves more laser-like actions and is more consistent among themselves than the rest. There is a good relationship between TL and experimental creativity [81]. March [82] characterized exploratory innovation as dependent on new knowledge and innovative alternatives that yield unpredictable, remote, and often harmful rewards. Leiponen [83] found that intellectual assets are a significant driver of innovation in knowledge-intensive firms. These businesses rely heavily on knowledge stimulation for competitive advantage. Investing in incentives and knowledge creation is vital for survival and success in any industry, with creativity and innovation as critical objectives. According to the study's findings, these businesses will either create R&D departments or provide their critical intellectual assets to their employees with training, access to technology, and an environment that fosters innovation and creativity (Mainelmelis et al., 2015). Hence, the following hypothesis can be postulated as

H3. *Intellectual Stimulation of Leaders has a positive effect on technology adoption.*

2.2. Intention to artificial intelligence adoption & actual adoption

Russell [84] described AI as developing intelligent technologies that behave similarly to humans, think like them, reason like them, and assist in making decisions. AI encompasses machine learning, robotics, computer vision, deep learning, and natural language processing. Using the Technology-Organizations-Environment framework and DOI theory, Suleiman (2018) investigated AI readiness at the organizational level in Australia. We have used DOI theory as our theoretical perspective to develop our proposed model. A PWC report estimates that the effect of AI on the worldwide economy will reach 15.7 trillion dollars by 2030 Suleiman (2018). Sulaiman (2018) argued that AI should consider the human, enterprise, and technology resources factors to determine its readiness; according to Varghese [85], regulation, high data quality, interoperability, and structured data impact AI adoption in a clinical context. Chinese telecom employees expect to use AI to manage intelligent networks, develop generic AI platforms, create AI voice assistants, and apply AI chatbots in their companies [50].

In their study, Keegan et al. [86] used the activity theory to examine the factors associated with implementing AI in B2B marketing. They considered B2B marketing a collaborative activity system that pinpointed the conflicts. Most technology acceptance models (TAM) are founded on a straightforward psychological principle: attitudes and beliefs about a particular technology heavily influence behavioral intentions to use it, which affects actual usage behavior [87,88]. In the above context, we can suggest

H4. *Adoption intention positively influences technology adoption*

2.3. Proposed framework

This study has focused on the potential benefits of TL while considering technological adoption and used Rogers' theory as a hypothetical basis. The following research has relevance to the application of AI in businesses. TL is regarded in three dimensions of it such as vision, IS, and IC. Fig. 1 presents an integrated model that combines TL with technology adoption in the DOI Theory context. From the perspective of the DOI theory, we postulate three factors (H1-H3) that influence the likelihood of interest in, commitment to, and institutionalization of AI integration. Determinants of Intended Adoption are Vision, IS, and Inspirational Communication. Based on the notion of innovation, we also proposed a connection between the intent to adopt and actual adoption (H4). The theoretical background of our study model, illustrated in Fig. 1, will be explained in this article section. With the goal of "increasing the feature-level use by users," We use a unitary design in our work, which is based on the idea that the adoption process is both systematic and linear., beginning with the TL to adopt the technology. By adding the previously published explanatory variables (Industry Sector and Firm Size), our model can capture cross-sectional shifts in AI adoption with greater precision (Sherry & Gibson, 2002). Diffusion rates are higher in industries where there is not a limited number of dominant firms, and severe competition enhances innovation's swift distribution, as DiPietro et al. (1990) reported. We have provided the theoretical justification for the study model depicted in Fig. 1.

3. Research & data methodology

This study collected data from a market research firm that listed companies and contacts targeting top and mid-level executives from Indian companies. LinkedIn was utilized to identify target respondents responsible for digitization within their companies. Invitations were sent selectively based on job roles such as C-level executives, directors, or heads of IT. To reduce bias, the sample was divided into strata based on firm size and industry, with subsequent selections being made at random within each stratum. The firm size distribution showed a healthy mix of large and small enterprises. For this study, the sample was randomly selected within each category (industry and company size) to reduce bias. Then, researchers reached out to 400 IT decision-makers in Indian firms, including CIOs, CISOs, and senior IS managers, describing the study's objective. The survey's introduction stated the study's goals and the results' academic significance. The research and the survey link were explained to the relevant individuals, including chief information officers, directors, and senior information systems managers. In the survey's introduction, researchers defined the application of AI and provided an example of its use in business settings for facilitating communication, collaboration, and CRM. Innovation and adoption literature considered business size as an extensively researched factor (Oliveria & Martins,2010; [89]). To increase participation, researchers offered a free final report. The participants represented diverse industries with an average organizational tenure of 4–8 years.

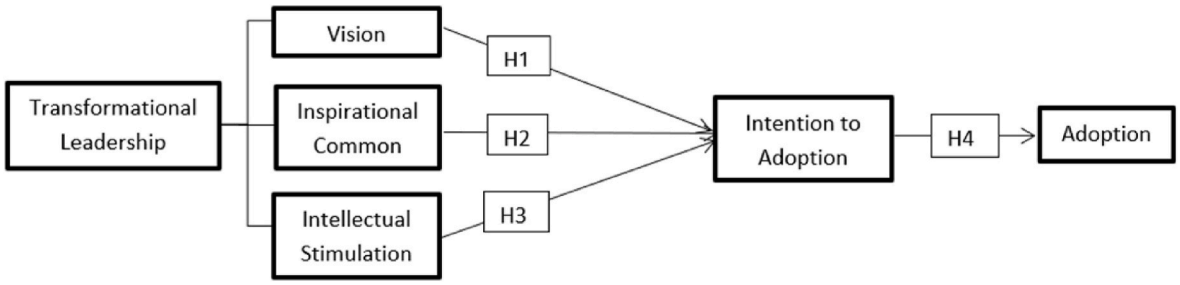

Fig. 1. Proposed framework on TL and its dimensions.

Additionally, it gave instances of how AI is applied in commercial settings, including customer relationship management, communication, and teamwork. The data was gathered in the middle of 2022. After eight weeks, 330 replies were collected, but only 250 could be used to ensure everything added up correctly.

4. Data analysis

4.1. Measurement

This study developed a questionnaire to test this theoretical framework and distributed it to Indian businesses. It considered organizations that have already applied it or are planning to implement instrument technology. To ensure validity and reliability, pre-tested constructs from other empirical investigations were used in this research. The study used a seven-point Likert scale to evaluate different elements.

Effective leadership has a dynamic role in defining the achievement of a company. Hence, this research considered the decision makers having strong leadership qualities as the respondents for the survey. Table 1 displays the personnel (decision-makers in Indian firms, including CIOs, CISOs, and senior IS managers) from different industries (micro, small, medium, and large). This study collected their opinion on the TL quality and its various dimensions. According to decision-makers, effective leadership requires a clear vision, effective communication, and the ability to inspire innovation. This study investigates how TL affects technology adoption across the ICT, Service, Manufacturing, and Retail industries. According to Table 1, the survey included 250 companies of various sizes. The results indicated that the majority of companies were medium or large-sized.

Vision: Rafferty& Griffin (2004) adapted three items to assess the construct vision. One of the items used to evaluate this construct was a clear understanding of their unit's five-year goals, with a Cronbach's alpha of 0.878.

Intellectual Stimulation: Four items taken from Rafferty & Griffin's [90] study were utilized to evaluate Intellectual Stimulation. For example, one of the items used to assess this construct was "has encouraged me to come to my conclusions about my work '' with a Cronbach's alpha (CA) of 0.894.

Inspirational Communication: Three items adapted from Rafferty & Griffin (2004) were used to evaluate the concept of Inspirational Communication. One of the items used to assess this construct was "Says positive things about the work unit '' with a Cronbach's alpha (CA) of 0.854

Adoption intention: Four items adapted from Chan and Chong [91] assess the construct of Intention to adopt. For example, one of the items used to evaluate this construct was "My company will use AI in the future'' by a Cronbach's alpha (CA) of 0.847

Adoption: Five items from Chan and Chong's [91] study were revised to evaluate the adoption construct. For example, one of the items used to assess this construct was "My company invests resources in AI' with a Cronbach's alpha (CA) of 0.881

This study calculated CA, AVE, and CR. The AVE measures the average of squared errors, and the CR measures the correlation between the predictions. The AVE is an essential measure of the reliability of a prediction model. The CR measure helps indicate how well the predictions are correlated with the actual outcomes. Both measures are necessary for understanding the predictability of a model. By computing CA and CR values, we ensure that the scale is consistent and stable. All variables have CA values between 0.847 and 0.894 and CR values between 0.88 and 0.89, confirming that the research has good reliability (Fornell and Larcker, 1981). The AVE value and the composite reliability (CR) are shown in Table 2. All the constructs have CR values of more than 0.7, supporting the scales' validity. The construct's average variance extracted (AVE), indicating convergence of the model, exceeds 0.5. The factor loading (in Table 3) and the CA value are more than 0.7, demonstrating the instrument's high indication of reliability. Reliability analysis was applied to check the questionnaire's reliability. Afterward, SEM and CFA analysis were used to test direct hypotheses.

Table 2
Measurements (items adopted from different scales).

Constructs	Measurement items	Source
Vision	TLVision1: Has a pure thought about where we are heading? TLVision2: Has a pure logic about where we see the organization in the next 5 years. TLVision3: Not having a clue where the organization is heading.	Rafferty& Griffin (2004)
Intellectual Stimulation	IS1: Contests me to reflect on old difficulties in innovative ways IS2 Upon reflection, I have had to reconsider things I have never questioned. IS3: I have been tested to reconsider some basic assumptions about my work. IS4: Has Encouraged me to come to my conclusions about my work	Rafferty& Griffin (2004)
Inspirational Communication	IC1: By making staff satisfied to be a part of this organization IC2: Use constructive things about the work unit IC3: Use inspiration for people for changing environments as circumstances full of chances	Rafferty& Griffin (2004)
Intention to adopt	IA1. My company intends to use AI. IA2. My company gathers data on AI, and we may use this Information for future purposes. IA3. My company recently carried out a pilot test to assess the effectiveness of AI. IA4: My company plans to incorporate AI technology in the future.	Chan and Chong [91]
Adoption	Ado1. My company allocates resources towards AI development. Ado2. Our company utilizes artificial intelligence (AI) for various business activities. Ado3. The functional areas within my company rely on using Artificial Intelligence (AI). Ado4: I suggest marking major AI adoption budgets this year. Ado5: I have planned for the upgrade of AI adoption.	Chan and Chong [91]

(Source: Author's Compilation).

Table 1
Displays the sample's characteristics.

Industry	Numbers	Percentage	Firm size	Numbers	Percentage
Information & Communication	78	31.2	Micro	38	15.2
Service	51	20.4	Small	53	21.2
Manufacturing	32	12.8	Medium	64	25.6
Retail	44	17.6	Large	95	38.0
Other	45	18.0			
Total	**250**	**100**		**250**	**100**

(Source – Author's calculation & Compilation).

Table 3
Measurement model analysis (CA, CR, AVE values).

Variables and Items	Factor Loadings	C.Alpha	AVE	CR
Vision		0.878	0.71	0.88
VIS1	0.801			
VIS2	0.834			
VIS3	0.892			
Intellectual Stimulation		0.894	0.68	0.89
IS1	0.761			
IS2	0.807			
IS3	0.841			
IS4	0.896			
Inspirational Communication		0.854	0.66	0.85
IC1	0.815			
IC2	0.797			
IC3	0.828			
Intention to adoption		0.847	0.58	0.84
IA1	0.703			
IA2	0.74			
IA3	0.703			
IA4	0.899			
Adoption		0.881	0.59	0.88
ADO1	0.799			
ADO2	0.799			
ADO3	0.723			
ADO4	0.842			
ADO5	0.687			

(Source – Author's calculation & Compilation).

4.2. Structural model fitment representation

The model in Fig. 2 represents the structural paths between the TL components. The first is vision, intellectual stimulation, and inspirational communication, which influence the Intention to adapt and adapt.

4.3. Measurement model

This study evaluated the theoretical model empirically using Structural Equation Modeling (SEM). For the model evaluation, we used AMOS. Further, CFA was examined (see Table 3) to evaluate the factor structure of the study's measurements. Two hundred fifty respondents were used for the analysis. Five variables with 19 items were used in this analysis. This study examined leadership factors and outcome factors and presented their structural relationships. Table 4 represents the

Table 4
(Model fit).

Model Fit Indices	CMIN/DF	GFI	NFI	TLI	CFI	RMSEA
Computed value	2.362	0.95	0.96	0.98	0.97	0.04
Recommended value	<3	>0.85	>0.85	>0.85	>0.9	<0.08
$p < 0.001$						

(Source – Author's calculation & Compilation).

Model fit statistics. For model fit cut-off criteria, a small CMIN/DF ratio, CFI of 0.95, and RMSEA of less than 0.08 are required. Table 4 presents a detailed analysis. Moreover, the proposed model was found to be valid after being tested. The results showed that the proposed model was successful in predicting adoption intention.

As seen in Table 4, the measurement model provides an excellent fit to the data, as [CMIN/DF = 2.362, p < .001; GFI = 0.95, CFI = 0.97, NFI = 0.96, RMSEA = 0.04]. Table 4 presents a strong correlation between leadership factors and results in the estimated structural models, and it fits both the data and the measurement model well.

This study examined the possible association among the variables with the help of path estimates. Path estimates are used to evaluate the association between variables. The estimated paths were used to identify which variables are the primary drivers of the association. The analysis findings have been presented in Table 5.

4.4. Structural model & hypothesis testing

Henseler et al. [92] recommend using a bootstrapping approach with 5000 rounds of resampling to evaluate the significance of path coefficients. The variables in the model that are statistically important to each adoption stage are shown in Fig. 2. The findings imply that vision can explain the Intention to adopt technology (b = 0.115; p statistically significant). The study model accounts for 11.5 % of the variation in technology adoption intention. Having an unobstructed vision would benefit the Intention to adopt the technology. This hypothesis was maintained by the distinctive positive connection between vision and Intention to adopt technology (b = 0.115, p.001). Hence, hypothesis H1 holds good.

IS for adoption (b = 0.141; p statistically significant) accounts for 14.1 % of the variation in technology adoption. Having IS would benefit the aim of adopting the technology. This hypothesis used the distinctive

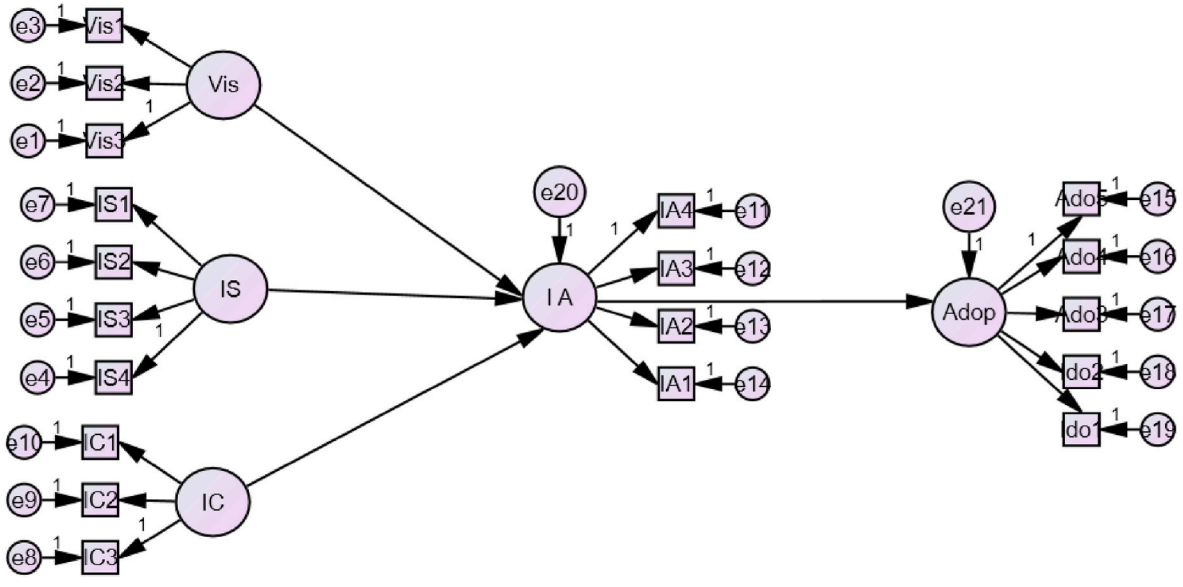

Fig. 2. Structural model.

Table 5
Test of hypotheses.

Hypotheses	Path coefficients between factors	Estimate	SE.	CR.	P-Value	Significant	Results
H1	Vision →IA	0.115	0.081	1.420	0.001	S	Supported
H2	IS→IA	0.141	0.105	1.335	0.001	S	Supported
H3	IC→IA	0.200	0.085	2.337	0.019	NS	Not
H4	IA→ Ado	0.675	0.060	11.289	0.001	S	Supported

IA- Intention to adoption.
IS- Intellectual stimulation.
IC- Inspirational Communication.
Ado- Adoption.
(Source – Author's calculation & compilation).

positive connection between IS and the Intention to embrace technology (b = 0.141, p.001). Hence, hypothesis H2 holds good.

Similarly, IC for adoption (b = 0.200; p statistically insignificant) accounts for 20 % of the variation in technology adoption. It was assumed that IC would benefit remarkably from adopting the technology. This hypothesis was not supported by the distinctive positive connection between IC and Intention to embrace technology (b = 0.141, p.019). Hence, hypothesis H3 does not hold well.

Again, Intention to adoption technology adoption (b = 0.675; p statistically significant) accounts for 67.5 % of the variation in technology adoption. Having the aim to adopt would significantly improve the adoption of technology. This hypothesis was supported by the distinctive positive construction between the objective to use technology and technology adoption (b = 0.675, p.000). Hence, hypothesis H4 holds good.

5. Discussion and findings

This study aims to comprehend how TL components affect the two stages of AI diffusion—Intention and adoption in organizations. The results help us understand how these constructs are related to one another, Table 6 below presents the current findings of the study:

Table 6
Study findings.

Research Question	Findings
RQ1: Does transformational leadership and its competencies (vision, intellectual stimulation, inspirational communication) impact on Intention to adopt AI in an organization?	This study found that components of transformational leadership positively influence AI adoption intention. However, inspirational communication was found to have an adverse effect on AI adoption intention.
RQ2: What are the possible theoretical and practical implications for stakeholders to adopt AI in the organization from the perspective of Transformational Leadership?	This study has provided both theoretical and practical implications for various stakeholders, including industry and academia. Effective leadership is crucial for successful AI-driven digital transformation initiatives in the industry [59]. Therefore, leaders must support AI adoption, establish clear goals, and foster a culture that values learning. Similarly, in academia, the study has introduced new dimensions for further exploration of transformational leadership. Transformational leaders communicate a compelling vision for their academic institution or department, inspiring faculty, researchers, and students to work towards common goals that contribute to academic excellence and institutional growth.

In the following sections, we will discuss the leadership factors (vision, Intellectual stimulation, Inspirational communication, Diffusion stages (Intention to Adoption)) and their relation with AI Adoption.

5.1. Vision

Our research indicates that the leader's vision is the most significant factor in determining the aim to adapt technology. This result supported the research findings by Sarros et al. [93] that visionary leaders are more expected to work for companies that support innovation with time and resources, as well as with people and financing. The most intriguing findings from this study are the linkages between the aim to adopt modern technology and the articulation of a vision. Vision showed a notable favorable correlation to the use of technology. According to research, transformational leaders can inspire followers to look for changes [94], as well as encourage, support, and reinforce creative engagement by informing staff members that their company appreciates and expects imagination and innovation [95]. These professionals possess a unique blend of digital competencies, business acumen, and soft skills. They excel in grasping new technologies and cultivating an environment encouraging experimentation, risk-taking, and ongoing learning. Their roles are crucial for advancing digital transformation initiatives in both large corporations and small to medium enterprises (SMEs). Leaders with strong vision can encourage innovative thinking by emphasizing practices and values while maintaining high-performance expectations. Hence, in AI implementation, it was discovered that vision has a greater capacity to influence a more open environment for technology adoption.

5.2. Intellectual stimulation

Intellectual stimulation was also highly associated with adopting technology, enhancing long-term commitment to the company. Employees feel more invested in the organization due to the extra effort they put in. This can be attributed to leaders who motivate their followers to adopt new ways of thinking and actively participate in the workplace. As a result of this increased emotional involvement, loyalty is strengthened over time. IS can also explain the Intention to adopt. The dynamics set up by the leader to encourage employees to reconsider their working practices and participate in problem-solving activities are known as IS (Rafferty& Griffin, 2004; Podaskoff et al., 1990). A leader's mental stimulation produces fresh concepts and an experience essential to innovation [93]. The findings of this study highlight that leaders who promote intellectual stimulation foster innovative thinking and creativity by encouraging new practices and high-performance expectations, which is aligned with the findings of Bass [72]. These leaders emphasize re-examining assumptions and rational problem-solving, positively impacting technology integration in organizations. Research indicates that leaders who excel in intellectual stimulation score higher in assessing technology needs. This multifaceted approach aids in articulating organizational goals. It aligns with findings from Chu [96] and Schepers et al. [97] that show intellectual stimulation enhances the perceived usefulness of technology in the workplace.

5.3. Inspirational communication

Leaders who use positive, encouraging language are more likely to inspire their followers to go beyond the minimum necessary technical standards and perform a wide range of proactive, integrative duties, as stated by Rafferty and Griffin (2004). However, our study found a substantial, insignificant correlation between IC and the Intention to adopt the technology. Though intentions to use AI are negatively impacted by IC, Intention to adopt technology positively impacts actual adoption. This issue aligns with research suggesting that more transformational leadership (TL) may sometimes provide undesirable results [98]. While inspirational communication can motivate and energize teams, it may also negatively affect technology adoption under certain circumstances. Inspirational leaders might focus heavily on technology's vision and potential benefits without addressing practical concerns. This can lead to unrealistic expectations and frustration among employees when the technology fails to meet the promised outcomes [99]. Inspirational communication may prioritize emotional engagement over the technical aspects of implementation. If leaders provide adequate Information about the technology's functionality, employees might feel prepared and confident about using it [100]. Similarly, Inspirational messages can sometimes create a sense of urgency that leads to resistance if employees feel overwhelmed by rapid changes. When the emotional appeal is not matched by a clear, step-by-step plan for adoption, it can increase anxiety and resistance to the new technology [101]. Inspirational communication may discourage open dialogue, making it difficult for employees to express concerns or provide feedback. This can lead to a gap between the intentions of leadership and the readiness of employees, which hinders effective technology adoption [102]. Employees might engage superficially with the inspirational message without internalizing the practical steps needed for successful adoption. This can lead to a gap between motivation and action, where enthusiasm does not translate into effective use of the technology [44].

5.4. Diffusion stages (intention to adoption)

According to the research findings, TL has a more significant impact on adoption intentions and adoption. To successfully implement change processes, including adopting modern technologies, top management must develop an integrated vision and overarching strategy, create a solid foundation of support, and direct and oversee the implementation process. It is better to encourage middle-level managers to reform their departments to align with the company's vision and strategy than to detail the specific prerequisites for change at every level of the organization. Management should encourage change and offer the resources, encouragement, and support needed to make it happen, but they should not try to dictate how it should be done ([47]; [103]). Thus, for innovation to be successfully implemented, senior management must remain committed, organizations must work together to create user support, and progress must be tracked until the new method and innovation become standard operating procedures.

5.5. Managerial implications

Considering the importance of the three dimensions of transformational leadership, this study has outlined the following managerial implications. A clear and compelling vision for AI adoption helps align the organization's efforts and motivates employees to embrace change. Hence, leaders who articulate a strong vision can inspire teams to understand the potential benefits of AI, fostering a forward-thinking culture [99]. Transformational leaders encourage employee involvement in the AI adoption process. Leaders enhance engagement and ownership by empowering team members to contribute ideas and solutions, leading to higher acceptance of new technologies [104]. They must align technology initiatives with organizational goals to ensure effective integration. Organizations must invest in ongoing training and skill development as AI technologies evolve. Transformational leaders are responsible for championing professional development initiatives that effectively equip employees with the necessary skills to leverage AI [105]. Investing in training programs is also essential to equip employees with the skills needed for new technologies, ensuring they can leverage new tools.

Moreover, leaders who promote intellectual stimulation can cultivate a mindset that embraces continuous learning. Also, open and transparent communication about AI initiatives helps build trust and reduce employee resistance. Hence, by combining a solid vision, fostering intellectual stimulation, and maintaining clear communication, leaders can effectively navigate the complexities of AI adoption, driving successful implementation and maximizing the benefits for the organization.

5.6. Practical implications

The study offers valuable insights for organizations adopting AI. It serves as a practical guide by providing a blueprint for assessing their readiness and potential for AI implementation. Organizations can use the findings to make informed decisions about adopting AI and planning its implementation based on identified conditions. Furthermore, the study aids organizations already using AI by helping them assess additional opportunities for AI applications. By incorporating transformational leadership, organizations can strengthen their AI initiatives. Overall, the study underscores the importance of understanding how various conditions interact in shaping the organizational adoption of AI.

Transformational leaders are crucial in articulating a clear and compelling vision for AI adoption. This helps align organizational goals and motivates employees to embrace new technologies [99]. Leaders can foster a shared understanding of AI's potential benefits by providing a strategic direction. Transformational leaders empower employees by involving them in the AI adoption process. This inclusive approach enhances engagement and encourages individuals to contribute ideas and feedback, fostering a sense of ownership [104]. Engaged employees are more likely to embrace change and adopt new technologies. Leaders who promote a culture of innovation encourage experimentation and learning. By supporting creative problem-solving and allowing for mistakes, transformational leaders can create an environment where AI initiatives thrive [106]. This culture encourages employees to explore new applications of AI, driving innovation. AI adoption requires ongoing training and skill development. Transformational leaders can facilitate this by prioritizing professional development programs that equip employees with the necessary skills to work with AI technologies [105]. This investment in training helps to reduce resistance and enhances overall competence. Effective communication is a cornerstone of transformational leadership. Leaders must maintain open lines of communication to address employee concerns, provide updates, and solicit feedback during the AI adoption process [102]. Transparent communication fosters trust and helps mitigate resistance to change. Transformational leaders should establish metrics to evaluate the success of AI initiatives. By regularly assessing progress and providing constructive feedback, leaders can help ensure that AI technologies are effectively integrated into workflows [44]. This approach allows for timely adjustments and reinforces accountability.

The analysis of this research shows that implementing a significant technological innovation is closely correlated with leaders' vision, paired with their ability to study others' emotions and understand others' unique requirements (both signs of offering different support). Vision must be shared frequently and through a variety of media. Face-to-face contact is more effective than less engaging and individualized types of communication for explaining and clarifying potential concerns. The findings of this study further corroborate the suggestion made by Van Knippenberg and Sitkin [107] that leader vision communication be further studied as a component of transformative leadership.

5.7. Theoretical implications

DOI Theory describes the distribution of a particular service in a specific community. This theory aims to clarify how novel concepts and technological advancements are disseminated within a community. As identified by the theory, key factors that impact the adoption of innovative technologies include vision, intellectual stimulation, and the ability of inspirational communication. To use cutting-edge innovation successfully, all of these factors must be considered. New technologies are adopted at different rates depending on several factors. We can understand why some organizations and people are likelier to adopt technology using the DOI theory. Groups and individuals with a higher degree of adaptability may be one explanation. Some organizations and individuals have advanced technology, which is considered technologically advanced. Technology adoption may be more likely among companies who see it as the future of their industry and as an opportunity to gain a significant competitive advantage over their current competitors. Businesses adopt technology if they see it as a complement to their existing practices and values, not a threat [108]. Effective communication is a crucial tenet for technology to spread effectively and transparently. Communicating technology's advantages clearly and effectively to potential users is critical to widespread adoption. Influential individuals, known as opinion leaders, have a pivotal role in shaping others' views and facilitating technology adoption, as stated by Ayoko [109].

Rogers' theory (1962, 2003) assesses innovation adoption and spread factors. The study's primary focus is understanding user motivations and behaviors related to adoption. Rogers' theory suggests that an innovation is more likely to be adopted if its perceived benefits outweigh the perceived costs. In addition, the innovation must be perceived as compatible with the user's current lifestyle and values. The user must have access to the necessary resources to adopt the innovation.

To understand innovation, diffusion theory must be studied in the context of multiple stakeholder levels, including individuals, communities, organizations, and countries. A new product, idea, service, method, or invention has been associated with innovation across several disciplines, including sociology, marketing, and economics. An organization should, therefore, consider diffusion theory when adopting a new technology. Diffusion theory can be used to understand how innovation is adopted and diffused across various stakeholder levels. It also helps organizations identify potential barriers and opportunities to adopt new technology. Finally, diffusion theory can help organizations identify strategies for successfully adopting a technology.

6. Limitations and future research

When interpreting and putting the results into practice, the study's limitations should be considered and might open new research directions. First, it will be crucial to ascertain whether the findings are consistent with those of other nations and areas since the investigation was only conducted in India. Second, despite the focus on TL in this study, transactional leadership has a place in organizational learning processes and is crucial to spreading modern technologies, according to writers like Vera and Crossan [110]. Hence, learning processes must be simplified throughout the business to fight the tendency to connect organizational learning with TL [72]. Thirdly, this research only refers to static measurements and does not offer a longitudinal view of Diffusion. Prior research on Diffusion has noted that accepting any innovation is dynamic [51]. Therefore, we advise doing a longitudinal study to evaluate AI's dispersion over time. This study emphasizes how components of transformative leadership affect the uptake of AI integration. Although it is based on reliable research on how innovation is adopted in organizations, many other aspects may impact it. Also, different industries and business sizes and big, small, and medium-sized organizations may have distinct reasons for adopting AI. Hence, future studies can address these various drivers.

Whether it is an individual or an organization, technology adoption requires emotion. Technology needs to be emotionally appealing to the user to drive adoption. The user experience must be intuitive and enjoyable, and the technology should be personalized to the user's desires and preferences. Additionally, the user must be encouraged to use and adopt technology. It can be challenging to understand employees' emotions against technology acceptance [111]. Adopting complex technology is even more challenging [112,113]. Hence, the Theory of Planned Behaviour, the foundation of UTAUT and TAM, is criticized for ignoring affective reactions such as emotion in technology adoption [114]. As managers are in charge of implementing innovative technology, understanding employees' feelings may help address resistance to change during implementation (Van Dun & Kumar, 2023). Hence, future studies should consider users' emotions in technology adoption.

7. Conclusion

This study is unique in its approach. While transformational leadership has been extensively researched, limited research has been conducted in the Indian context. Previous studies have primarily focused on CEOs as transformational leaders, but this study considers all organizational decision-makers transformational leaders. Additionally, this study introduces two new variables—inspirational communication and intellectual stimulation—as components of transformational leadership and examines their impact on AI adoption.

Transformational leadership (TL) is critical in successfully adopting AI within organizations. Leaders who embody transformational qualities—such as vision, intellectual stimulation, and effective communication—create an environment that fosters innovation and adaptability. They inspire teams to embrace change and engage with new technologies by articulating a clear vision for AI integration. The findings of this study suggest that through vision articulation and individual employee support, TL contributes to the adoption stages. According to the findings, TL is linked to the adoption phases when a vision is articulated and people are given individualized support.

Furthermore, transformational leaders encourage intellectual stimulation, allowing employees to explore creative solutions and overcome challenges associated with AI implementation. Effective communication is also essential for addressing concerns and building trust among employees, facilitating smoother transitions during the adoption process. Transformational leaders enhance collaboration and commitment by ensuring that all stakeholders understand the benefits and goals of AI initiatives. Hence, transformational leadership is pivotal in guiding organizations through the complexities of AI adoption, ultimately driving success and fostering a culture of innovation that aligns with future technological advancements.

This study emphasized the significance of institutional transformation through TL and helped to study innovation's technical aspects from the Diffusion or adoption processes. It can also serve as a framework for developing modern technologies. Since this study focused on the DOI theory, Administrators, IT professionals, informatics specialists, and agents of change can all benefit from it, and the study's emphasis on all concerned stakeholders will help the targets of change as well.

CRediT authorship contribution statement

Priyadarsini Patnaik: Writing – original draft. **Mahmoud Bakkar:** Writing – review & editing.

Data availability

Data will be made available on request.

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