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Examining the Impact of Transformational Leadership and Team Collaboration on Team Innovation within Software Companies in Shenzhen City

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Abstract: In the fast-paced and competitive landscape of Shenzhen's software industry, innovation is vital for sustaining growth and maintaining a competitive edge. This study aims to examine the influence of transformational leadership and team collaboration on enhancing team innovation within software companies in Shenzhen. A quantitative research approach was employed, using survey data collected from 400 employees across various software firms, and analyzed through Structural Equation Modeling (SEM). The findings reveal that transformational leadership has a significant positive impact on team innovation, both directly and indirectly through team collaboration. Additionally, team collaboration was found to be a key driver of innovation, highlighting its central role in facilitating the sharing of diverse ideas and joint problem-solving. The study contributes to the literature by providing empirical insights from China's tech industry, demonstrating the critical importance of leadership and collaborative team dynamics in fostering innovation. These findings offer valuable guidance for industry practitioners seeking to boost innovative performance through effective leadership practices and team collaboration strategies.

Keywords: Transformational leadership, team collaboration, team innovation, software companies, Shenzhen city

1. Introduction

The rapidly evolving business environment of the 21st century, marked by heightened global competition and continuous technological advancements, has redefined the importance of innovation, especially within the software industry (Porath, 2023). Innovation is not merely a strategic choice for organizations but a fundamental component of survival and growth (AlTaweel & Al-Hawary, 2021), particularly in technology hubs like Shenzhen, China. Shenzhen is home to some of the world's most dynamic software companies (Du, 2020). These organizations operate in a highly competitive landscape that demands constant innovation to meet the growing and shifting needs of global markets (Wen et al., 2022). With the increasing complexity of software products and the accelerated pace of technological change, fostering team innovation is more crucial than ever.

Transformational leadership, characterized by leaders who inspire, motivate, and elevate their followers to higher levels of performance, has gained considerable attention in research as a critical factor influencing organizational innovation (Khan et al., 2022). This leadership style is pertinent in the software industry, where leaders must navigate both the creative and technical aspects of development projects. Transformational leaders are often able to foster a culture of creativity and open communication, essential ingredients for innovation (Gui et al., 2024). Moreover, team collaboration, which involves coordinated efforts among members, knowledge sharing, and synergy in solving complex problems, has also been recognized as a key driver of innovative outcomes (Wang & Hu, 2020). When effectively harnessed, the combined forces of transformational leadership and team collaboration can significantly enhance a team's innovative capabilities.

In Shenzhen's software sector, the high-pressure, fast-paced environment creates unique challenges and opportunities for innovation. Companies are pushed to not only create novel software solutions but also to iterate quickly based on user feedback and market trends (Huang & Liu, 2020). Consequently, understanding the role of transformational leadership and team collaboration in enhancing innovation has become increasingly critical.

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Despite the well-documented importance of innovation in driving organizational success, many software companies in Shenzhen continue to struggle with fostering a consistent culture of innovation. A significant factor contributing to this issue lies in the organizational dynamics related to leadership and team processes. While transformational leadership is known to positively influence employee motivation and creativity, its direct impact on team-level innovation, especially when moderated by collaborative efforts within teams, is not entirely understood in the context of the software industry in Shenzhen. Moreover, team collaboration is often hindered by factors such as hierarchical communication barriers, diverse team compositions, and the pressure to meet tight deadlines, all of which can stifle innovative potential (Sidhu, 2024).

In Shenzhen, where software companies are faced with intense pressure to innovate rapidly, traditional leadership approaches that rely on top-down directives may no longer be effective. Instead, there is a growing recognition that leaders who embrace transformational practices and foster a collaborative environment could be better positioned to drive innovation. However, there is a lack of empirical research examining this interplay in the specific context of Shenzhen's software firms. Existing studies have largely focused on Western settings or other industries, thus providing limited insights applicable to the unique socio-cultural and economic landscape of China's tech sector. Additionally, the unique pressures faced by software companies in Shenzhen, including the need for rapid innovation cycles and the management of cross-functional teams, necessitate a more nuanced understanding of leadership and collaborative practices. Therefore, this study aims to investigate the role of transformational leadership and team collaboration in enhancing team innovation, addressing a critical gap in both academic literature and industry practice.

2. Literature review

2.1 Studies on transformational leadership and team innovation

In recent years, a growing body of literature has investigated the positive relationship between transformational leadership and team innovation. Transformational leadership, characterized by attributes such as inspiration, intellectual stimulation, individualized consideration, and idealized influence, is widely regarded as a key factor that can foster a climate conducive to innovation within teams. The existing research suggests that transformational leaders, by creating a vision and motivating team members towards achieving it, can significantly enhance the innovative capabilities of their teams.

Klaic et al. (2020) explored the direct relationship between transformational leadership and team innovation, highlighting how the behaviors associated with transformational leaders can foster a culture of creativity and novel thinking within teams. Through a comprehensive analysis involving multiple teams across different contexts, the study found that transformational leaders tend to inspire their team members by articulating a compelling vision of the future. This vision acts as a catalyst for team innovation, encouraging members to go beyond routine tasks and seek novel solutions to problems. The study argued that transformational leaders' emphasis on a shared vision and collective goals creates a strong motivational foundation that aligns individual efforts with team objectives, thus driving a higher level of innovative performance. The study concluded that transformational leadership has a strong, positive effect on team innovation, primarily because of the increased intrinsic motivation and commitment of team members.

Sheehan et al. (2020) provided empirical support for the positive relationship between transformational leadership and team innovation, focusing on the role of intellectual stimulation as a key mechanism. The study found that transformational leaders, by encouraging intellectual exploration and challenging existing assumptions, create an environment where team members feel empowered to think creatively and experiment with new ideas. The study emphasized that transformational leaders promote an open exchange of ideas, allowing team members to feel safe in proposing novel approaches without fear of negative evaluation or criticism. This environment of psychological safety, fostered by the leaders' supportive and non-judgmental attitude, was shown to significantly enhance team innovation. The findings suggest that the encouragement of critical thinking and exploration by transformational leaders leads to a dynamic process of idea generation and refinement within teams, resulting in higher levels of innovation.

Hui et al. (2024) examined how transformational leadership influences team innovation by focusing on the aspect of individualized consideration. The study argued that transformational leaders, by offering personalized support and attention to the unique needs of each team member, can effectively nurture the talents and creativity of individuals, which in turn contributes to the overall innovation of the team. The study found that when leaders take the time to understand the strengths and developmental needs of each team member, they are better able to assign tasks and roles that align with individual skills and interests, thereby maximizing creative output. The study concluded that the individualized support provided by transformational leaders helps build strong interpersonal trust and a sense of empowerment among team members, both of which are critical elements for fostering a culture of innovation. The findings indicate that transformational leadership's positive influence on team innovation is largely attributed to the leader's ability to recognize and cultivate the potential of individual members, leading to enhanced collective creativity.

These studies underscore the positive impact of transformational leadership on team innovation, demonstrating that leaders who inspire, intellectually stimulate, and provide individualized support are more likely to cultivate an environment where creativity and innovative thinking thrive. By fostering a shared vision, encouraging intellectual exploration, and offering personalized guidance, transformational leaders can effectively enhance the innovative capabilities of their teams. The evidence from these studies highlights the crucial role that transformational leadership

plays in driving team innovation, providing strong empirical support for the notion that the behaviors associated with this leadership style are key determinants of a team's innovative performance.

2.2 Studies on transformational leadership and team collaboration

Transformational leadership has been extensively studied for its potential to enhance team dynamics and collaboration. It is characterized by the ability of leaders to inspire, motivate, and facilitate change among team members. Several studies highlight the positive influence of transformational leadership on team collaboration, illustrating how this leadership style contributes to the development of effective, cohesive, and cooperative teams.

Sutisna et al. (2024) investigated the relationship between transformational leadership and team collaboration through a comprehensive analysis of leadership behaviors and their influence on team dynamics. Their findings suggest a strong positive correlation between transformational leadership and enhanced collaboration among team members. The study emphasized that transformational leaders, by setting a compelling vision and encouraging open communication, create an environment where team members are more willing to share knowledge and work together towards common goals. The research found that when leaders demonstrate inspirational motivation, team members become more engaged, aligning their individual efforts with the collective objectives of the team. The study concluded that the leaders' emphasis on shared vision and mutual respect is instrumental in fostering a collaborative team culture. The leaders' ability to articulate a clear and motivating vision plays a key role in unifying the team, which subsequently improves overall team collaboration.

Gaspersz (2024) explored the mechanisms through which transformational leadership enhances team collaboration, focusing on the role of individualized consideration and intellectual stimulation. The study argued that transformational leaders enhance team collaboration by paying attention to the unique needs and strengths of individual team members while simultaneously challenging them to think creatively and innovate. The study found that when transformational leaders provide personalized support and recognition, it increases trust and openness among team members, making them more inclined to share their ideas and collaborate effectively. Furthermore, the leaders' focus on intellectual stimulation encourages a culture of questioning, exploration, and shared problem-solving. The study concluded that these behaviors not only improve interpersonal dynamics within the team but also promote a collaborative mindset where members actively seek to integrate diverse perspectives and contribute to collective decision-making processes.

Su et al. (2020) conducted an analysis of studies examining the influence of transformational leadership on team collaboration and revealed a consistent positive relationship between transformational leadership and team collaboration, highlighting that teams led by transformational leaders tend to exhibit higher levels of cooperation, cohesiveness, and synergy. The study noted that transformational leaders foster a sense of collective identity and shared purpose among team members, which is crucial for effective collaboration. By emphasizing idealized influence and encouraging team members to transcend their self-interests for the sake of the group, these leaders create a strong sense of unity and collective effort. The study also indicated that transformational leaders' emphasis on open and transparent communication is a key factor in enhancing collaboration, as it reduces misunderstandings and promotes a more inclusive, participative approach to teamwork.

In summary, these studies consistently support the positive impact of transformational leadership on team collaboration. Across different studies, transformational leaders are shown to enhance collaboration by creating a supportive and trust-based environment, encouraging innovation and shared problem-solving, and fostering a collective sense of purpose. These findings underscore the importance of transformational leadership in facilitating cohesive team dynamics and promoting effective teamwork.

2.3 Studies on team collaboration and team innovation

Research exploring the connection between team collaboration and team innovation has generally demonstrated a positive relationship between these two elements.

Cromwell & Gardner (2020) examined how collaborative practices within teams can foster innovation by creating an environment where information, ideas, and diverse perspectives are openly shared. The findings indicate that when team members actively engage in collaborative activities, such as brainstorming, open dialogue, and mutual feedback, they are more likely to generate novel and creative solutions. The study highlighted that collaborative teams tend to have a shared understanding and alignment of goals, which streamlines the process of idea generation and problem-solving. Through the constant exchange of ideas and collective efforts to refine these ideas, teams become more capable of devising innovative solutions. The study emphasized that team collaboration does not merely involve cooperation but also requires a deeper integration of individual contributions, which can spark new insights and lead to higher levels of creativity within the group.

Van der Voet & Steijn (2021) found a strong positive correlation between team collaboration and innovation outcomes, which focused on examining how the dynamics of interaction among team members can drive creative performance. The study argued that team collaboration fosters a psychological environment of safety and trust, which is essential for innovation. When team members feel safe to express their ideas and are confident that their contributions will be valued rather than judged, they are more likely to share unique perspectives and experimental ideas. The research further highlighted that collaboration helps teams leverage diverse knowledge bases and skills, allowing for the

integration of various viewpoints that can lead to more innovative outcomes. The study found that teams that regularly engage in collaborative practices, such as problem-solving sessions and collaborative planning, tend to exhibit higher levels of innovation compared to teams where members work more independently. The study concluded that fostering a collaborative environment can be a key strategy for enhancing a team's capacity for innovation, as it encourages continuous exchange and the synthesis of diverse ideas.

Zou et al. (2023) provided empirical evidence supporting the positive impact of team collaboration on team innovation. The study focused on the mechanisms through which collaborative efforts within teams translate into innovative outputs, emphasizing the role of shared knowledge and collective creativity. The findings suggest that when team members collaborate effectively, they are better able to pool their knowledge and expertise, creating a rich resource for innovative thinking. The study noted that collaboration allows teams to identify and exploit synergies between different skills and ideas, which often leads to novel solutions that would not have emerged from individual efforts alone. The study also found that teams with strong collaborative dynamics are more adept at adapting their approaches based on new information, thus maintaining a flexible and responsive stance that is conducive to innovation. The study argued that the iterative process of collaboration, involving feedback, adaptation, and continuous idea exchange, is central to the innovation process, enabling teams to refine their ideas and produce creative solutions more effectively.

In summary, these studies consistently indicate that team collaboration plays a crucial role in enhancing team innovation. These studies underline the importance of creating a collaborative environment where open communication, mutual trust, and shared objectives prevail, as these factors are instrumental in driving innovative outcomes. By facilitating the free flow of ideas and encouraging the integration of diverse perspectives, collaboration serves as a catalyst for creativity and helps teams navigate the complexities of the innovation process effectively.

3. Research Methodology

This study employs a quantitative research method to investigate the relationships between transformational leadership, team collaboration, and team innovation. The quantitative approach is suitable for this research because it enables the collection of numerical data that can be analyzed using statistical techniques to identify patterns and test hypotheses. Given the complex nature of the relationships between the constructs, quantitative research allows for a rigorous examination of these connections and helps provide robust evidence regarding the direct and indirect effects of transformational leadership and team collaboration on team innovation.

Moreover, a quantitative methodology is preferred in this context because it offers greater objectivity and generalizability, especially when studying a large and diverse population such as employees in Shenzhen's software industry. By utilizing structured instruments like surveys, the study can systematically gather data across multiple teams and organizations, ensuring consistency and reducing the risk of biases that may arise from subjective interpretations.

The decision to utilize a quantitative research method in this study is guided by several key considerations. Firstly, the primary aim of this research is to test predefined hypotheses regarding the influence of transformational leadership and team collaboration on team innovation. The quantitative approach is well-suited for hypothesis testing, as it allows for the empirical validation of theoretical constructs through the application of statistical techniques. Secondly, the use of a quantitative method facilitates the analysis of relationships between multiple variables simultaneously, an essential requirement given the study's focus on exploring both direct and mediated effects. Specifically, Structural Equation Modeling (SEM) can be employed to examine the complex interdependencies among transformational leadership, team collaboration, and team innovation, providing insights that might be difficult to obtain through qualitative methods alone. The software industry in Shenzhen is characterized by its large workforce and diverse team compositions, making a quantitative approach ideal for capturing data that is representative of this broad population. Given the scope of this research and the need for data that can be generalized across different software companies, a quantitative method offers a pragmatic and efficient means of gathering relevant information from a wide sample of respondents.

The software industry in Shenzhen is a major economic sector, employing a significant portion of the local workforce. According to statistical data from the Shenzhen Business Daily and the Shenzhen Bureau of Statistics (2024), the total number of employees in the software industry has reached 225,400. Given the large population size, determining an appropriate sample size is crucial for ensuring the validity and reliability of the research findings.

To establish a representative sample, this study used the Raosoft sample size calculator, which is widely recognized for its accuracy in determining sample sizes for survey-based research. Based on a confidence level of 95%, a margin of error of 5%, and an estimated response distribution of 50%, the recommended sample size was calculated to be approximately 384 respondents. However, to account for potential non-responses and incomplete surveys, the study aims to select 400 employees through random sampling. This sampling technique is chosen to minimize selection bias and ensure that the sample reflects the diversity of roles, experiences, and perspectives within Shenzhen's software industry.

The primary data collection instrument for this study is a structured survey questionnaire, which includes items adapted from established scales used in prior research on transformational leadership, team collaboration, and team innovation. The questionnaire is adapted and designed based on previous studies using a 5-point Likert scale, ranging from "1 = Strongly Disagree" to "5 = Strongly Agree", to capture the respondents' perceptions and attitudes towards the key constructs. The Likert scale format is chosen for its simplicity and ease of use, which facilitates accurate responses and increases the reliability of the data collected. During the data collection phrase from October 8 to November 8, the

study distributed 400 questionnaires through Wenjuanxing platform to employees in Shenzhen software companies through random sampling method. After collecting data, the study obtained 391 questionnaires, then organized and sorted out questionnaires and finally acquired 387 valid questionnaires through deleting 4 invalid questionnaires.

To analyze the collected data, this study employs a combination of descriptive statistics and Structural Equation Modeling (SEM). Descriptive statistics, including measures of central tendency (mean, median) and variability (standard deviation), are used to provide an overview of the sample characteristics and the general trends in the responses. The core of the data analysis involves SEM path analysis, which is chosen for its ability to test complex theoretical models and examine the direct and indirect effects of multiple variables simultaneously. SEM is effective in this study as it allows for the investigation of the mediating role of team collaboration in the relationship between transformational leadership and team innovation. By using SEM, the study can assess the strength and significance of these relationships, providing a comprehensive understanding of how transformational leadership and collaborative dynamics interact to influence innovation outcomes in software teams.

The study conducts the following flow of the research process to examine the impact of transformational leadership and team collaboration on team innovation within software companies in Shenzhen city, presented in Fig.1.

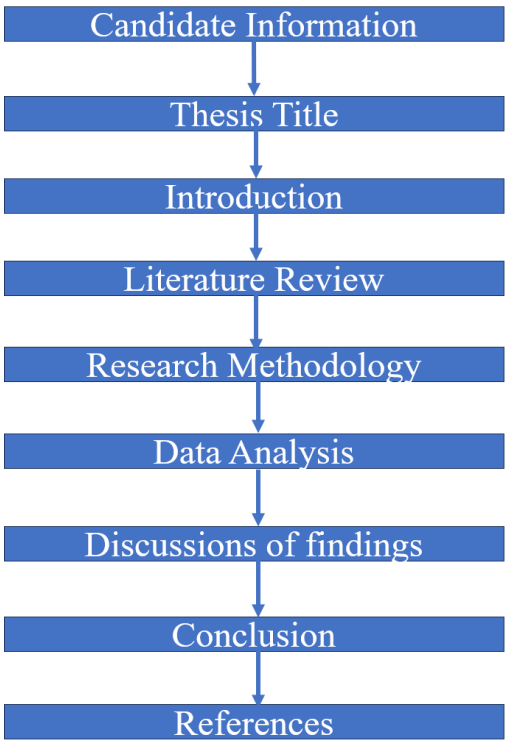


Figure 1. Research process

4. Data Analysis

In this study, SEM-AMOS path analysis was adopted to check the relationship between transformational leadership, team collaboration and team innovation in Shenzhen software companies. After data analysis, the results are displayed in Table 1.

Table 1. SEM path analysis results

Path	Estimate	S.E.	C.R.	P-value	Std Path coefficient
Transformational leadership--->Team innovation	0.616	0.058	10.621	***	0.514
Transformational leadership --->Team collaboration	0.589	0.057	10.333	***	0.487
Team collaboration ---> Team innovation	0.688	0.061	11.279	***	0.586

Based on data presented in Table 1, the direct path from transformational leadership to team innovation has an estimated coefficient of 0.616 (standardized coefficient: 0.514), with a critical ratio (C.R.) of 10.621 and a p-value of less than 0.001 (***). This indicates a highly significant positive relationship. The standardized path coefficient of 0.514 suggests that transformational leadership has a substantial direct impact on team innovation, accounting for more than half of the variance in team innovation attributed to leadership behaviors. The findings align with previous research that

highlights the ability of transformational leaders to inspire creativity, foster a shared vision, and encourage intellectual stimulation, all of which contribute to enhanced innovative outcomes within teams.

The path from transformational leadership to team collaboration shows an estimated coefficient of 0.589 (standardized coefficient: 0.487), with a C.R. of 10.333 and a p-value of less than 0.001 (***). This significant positive relationship suggests that transformational leadership plays a critical role in enhancing team collaboration. The standardized coefficient of 0.487 indicates a strong influence, as nearly 49% of the changes in team collaboration can be attributed to the behaviors of transformational leaders. This finding supports the notion that transformational leaders, through their inspirational motivation, individualized consideration, and emphasis on collective goals, foster an environment conducive to open communication, mutual trust, and collaborative efforts among team members.

The direct effect of team collaboration on team innovation is represented by an estimated coefficient of 0.688 (standardized coefficient: 0.586), with a C.R. of 11.279 and a p-value of less than 0.001 (***). This path demonstrates the strongest direct relationship in the model, indicating a highly significant positive impact of team collaboration on innovation outcomes. The standardized coefficient of 0.586 suggests that team collaboration is a key driver of team innovation, contributing to more than half of the variance in innovative performance. The strong direct effect highlights the importance of collaborative dynamics, as effective teamwork facilitates the sharing of diverse knowledge, integration of ideas, and collective problem-solving, which are essential for generating novel and creative solutions in a fast-paced software industry environment.

In summary, the direct effects analysis highlights the critical role of transformational leadership in shaping team collaboration and innovation. The strong and statistically significant relationships between these constructs suggest that transformational leaders not only directly enhance team innovation but also indirectly influence it through their positive impact on team collaboration. The findings underscore the importance of leadership behaviors that promote a supportive, inclusive, and collaborative team culture, particularly in the context of the dynamic and competitive software industry in Shenzhen.

Besides, the study checks the mediating effect of team collaboration in the relationship between transformational leadership and team innovation through bootstrapping method with detailed mediating effect analysis results presented in Table 2.

Table 2. Mediating effect analysis results of team collaboration

Standard effect	Path	Effect coefficient	95% confidence interval		S.E.	P-value
			Lower	Upper		
Total effect	Transformational leadership--->Team innovation	0.799	0.746	0.8522	0.027	***
Direct effect	Transformational leadership--->Team innovation	0.514	0.465	0.563	0.025	***
Indirect effect	Transformational leadership--->Team collaboration--->Team innovation	0.285	0.242	0.328	0.022	***

The analysis of the mediating effect of team collaboration in the relationship between transformational leadership and team innovation, as presented in Table 2, reveals significant insights.

The total effect of transformational leadership on team innovation is measured at 0.799, with a 95% confidence interval ranging from 0.746 to 0.852, and a p-value of less than 0.001. This strong total effect indicates that transformational leadership has a substantial positive impact on team innovation in Shenzhen's software companies, highlighting the importance of leadership behaviors in fostering innovative outcomes.

When examining the direct effect, the path coefficient between transformational leadership and team innovation is 0.514, with a confidence interval of 0.465 to 0.563 and a p-value of less than 0.001. This direct relationship suggests that transformational leaders directly contribute to enhanced innovation within teams by inspiring creativity, providing intellectual stimulation, and cultivating a shared vision.

The difference between the total and direct effects is explained by the indirect effect, which quantifies the mediating role of team collaboration. The indirect effect, with a path coefficient of 0.285 and a 95% confidence interval from 0.242 to 0.328, is statistically significant (p-value < 0.001). This finding suggests that a significant portion of the influence of transformational leadership on team innovation is mediated through team collaboration. In other words, transformational leadership enhances team innovation not only directly but also indirectly by fostering a collaborative

environment. This mediated pathway indicates that transformational leaders play a crucial role in shaping collaborative team dynamics, which in turn facilitate the sharing of ideas, integration of diverse perspectives, and collective problem-solving, all key drivers of innovative performance.

The substantial indirect effect highlights the importance of team collaboration as a mediator, accounting for 35.7% of the total effect of transformational leadership on team innovation. This indicates that while transformational leadership has a direct positive impact on team innovation, the enhancement of team collaboration significantly amplifies this effect. The results underscore that transformational leaders who prioritize collaboration create an environment where team members feel empowered, communicate openly, and engage in joint problem-solving activities, leading to greater innovative outcomes.

5. Discussion of findings

5.1 Transformational leadership and team innovation

The results indicated a strong, positive relationship between transformational leadership and team innovation, with a standardized path coefficient of 0.514 ($p < 0.001$). This finding is consistent with the work of Eisenbeiss et al. (2008), which suggests that transformational leaders play a crucial role in fostering a creative and innovative environment within teams. Transformational leadership is characterized by behaviors that inspire, intellectually stimulate, and provide individualized support to team members, all of which are conducive to enhancing team innovation. The significant coefficient underscores the importance of leadership behaviors in promoting a shared vision and cultivating a team culture that values creative thinking and novel problem-solving approaches.

Transformational leaders motivate team members to transcend their self-interests for the greater good of the team, thereby fostering a sense of collective purpose. By articulating a compelling vision and encouraging intellectual exploration, transformational leaders enable team members to engage in risk-taking and experimentation, key drivers of innovation. In the context of Shenzhen's software companies, where the demand for rapid innovation is high, this leadership style appears particularly effective. Transformational leaders likely create an environment that not only supports but actively encourages team members to generate and implement new ideas, essential for staying competitive in the software industry.

5.2 Transformational leadership and team collaboration

The study also found a significant positive relationship between transformational leadership and team collaboration, with a standardized path coefficient of 0.487 ($p < 0.001$). This suggests that transformational leadership significantly enhances collaborative dynamics within teams, a finding that is consistent with previous research (Cha et al., 2015). Transformational leaders, through inspirational motivation and individualized consideration, help to foster an atmosphere of trust and open communication, which are essential components of effective team collaboration. By paying close attention to the unique needs and strengths of individual team members, transformational leaders can facilitate better interpersonal relationships, leading to more cohesive and cooperative teamwork.

The importance of transformational leadership in enhancing team collaboration is particularly evident in the context of the software industry in Shenzhen, where projects are typically complex and require the integration of diverse expertise. Transformational leaders create a shared sense of identity and purpose among team members, which is critical for fostering collaboration. In environments characterized by tight deadlines and high pressure, as is common in Shenzhen's software sector, the emphasis on a shared vision and collective effort can help reduce friction and align team members towards common goals. This alignment likely enhances the team's ability to collaborate effectively, share knowledge, and work together to solve complex problems, all of which are vital for achieving innovative outcomes.

5.3 Team collaboration and team innovation

The direct relationship between team collaboration and team innovation was found to be the strongest in the model, with a standardized path coefficient of 0.586 ($p < 0.001$). This result highlights the critical role of collaborative dynamics in driving innovation within software teams. The positive correlation between team collaboration and innovation is well-supported by the study by Gressgård (2011), which demonstrated that effective collaboration leads to better idea generation, knowledge sharing, and problem-solving. The findings suggest that when team members actively engage in collaborative activities, such as brainstorming and mutual feedback sessions, they are more likely to develop creative solutions and innovative products.

The significance of the relationship between collaboration and innovation is particularly relevant in the context of Shenzhen's software industry, where cross-functional teamwork and the integration of diverse skills are key to developing cutting-edge software solutions. Effective collaboration enables teams to leverage a wide array of knowledge bases and skills, fostering an environment where diverse perspectives can be synthesized into novel ideas. In a highly competitive and dynamic industry like software development, the ability to pool collective expertise and engage in joint problem-solving is crucial for maintaining a competitive edge.

5.4 Mediating role of team collaboration

The analysis also examined the mediating effect of team collaboration in the relationship between transformational leadership and team innovation. The results revealed a significant indirect effect, with a path coefficient of 0.285 ($p < 0.001$), suggesting that team collaboration plays a mediating role in this relationship. This mediating effect indicates that transformational leadership enhances team innovation not only directly but also indirectly by fostering a collaborative team environment. The total effect of transformational leadership on team innovation was measured at 0.799, with the indirect effect accounting for approximately 35.7% of this total impact. These findings highlight the importance of team collaboration as an essential mechanism through which transformational leadership exerts its influence on innovation.

The indirect effect observed in this study suggests that transformational leaders create a supportive and inclusive environment where team members feel empowered to share ideas and work together towards common goals. This collaborative atmosphere, in turn, facilitates the free flow of information, integration of diverse viewpoints, and collective problem-solving, all of which are crucial for fostering innovation. The strong mediating effect observed in this study underscores the importance of focusing on both leadership and team processes to maximize innovative performance.

6. Conclusion

This study explored the impact of transformational leadership and team collaboration on team innovation within Shenzhen's software industry, a highly dynamic and competitive environment demanding continuous innovation. The findings demonstrate that transformational leadership significantly enhances team innovation both directly and indirectly through its positive influence on team collaboration. The strong direct relationship between transformational leadership and team innovation highlights the critical role of leadership behaviors in fostering a creative and innovative team environment. Furthermore, the positive relationship between transformational leadership and team collaboration underscores the importance of leadership in building cohesive, trust-based teams that are better equipped for effective knowledge sharing and problem-solving. The strongest relationship observed in the model between team collaboration and team innovation emphasizes the central role of collaborative dynamics in driving innovative performance, suggesting that effective teamwork is essential for integrating diverse skills and perspectives. The mediating role of team collaboration further reveals that the influence of transformational leadership on innovation is significantly amplified when a collaborative team environment is present, accounting for a substantial portion of the total effect. In conclusion, the results highlight the importance of prioritizing transformational leadership practices and fostering a collaborative team culture as strategic approaches to enhance innovation in Shenzhen's software sector. This research contributes to the existing literature by providing empirical evidence from the context of China's rapidly growing tech industry, offering valuable insights for both academic scholars and industry practitioners seeking to boost innovation through effective leadership and team dynamics.

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Conflict of Interest

The authors declare no conflicts of interest.

References

AlTaweel, I. R., & Al-Hawary, S. I. (2021). The mediating role of innovation capability on the relationship between strategic agility and organizational performance. *Sustainability*, *13*(14), 7564. https://doi.org/10.3390/su13147564

Cha, J., Kim, Y., Lee, J. Y., & Bachrach, D. G. (2015). Transformational leadership and inter-team collaboration: Exploring the mediating role of teamwork quality and moderating role of team size. *Group & Organization Management*, *40*(6), 715-743.

Cromwell, J. R., & Gardner, H. K. (2020). High-stakes innovation: When collaboration in teams enhances (or undermines) innovation in professional service firms. *Journal of Professions and Organization*, *7*(1), 2-26.

Du, J. (2020). *The Shenzhen experiment: The story of China's instant city*. Harvard University Press.

Eisenbeiss, S. A., Van Knippenberg, D., & Boerner, S. (2008). Transformational leadership and team innovation: integrating team climate principles. *Journal of applied psychology*, *93*(6), 1438.

Gaspersz, E. J. (2024). Influence of Transformational Leadership and Teacher Collaboration on Teachers' Ability in Implementing Interdisciplinary Learning. *Academy of Education Journal*, *15*(1), 718-733.

Gressgård, L. J. (2011). Virtual team collaboration and innovation in organizations. *Team Performance Management: An International Journal*, *17*(1/2), 102-119.

Gui, L., Lei, H., & Le, P. B. (2024). Fostering product and process innovation through transformational leadership and knowledge management capability: the moderating role of innovation culture. *European Journal of Innovation Management*, *27*(1), 214-232.

Hui, Z., Khan, N. A., & Akhtar, M. (2024). AI-based virtual assistant and transformational leadership in social cognitive theory perspective: a study of team innovation in construction industry. *International Journal of Managing Projects in Business*.

Khan, I. U., Amin, R. U., & Saif, N. (2022). Individualized consideration and idealized influence of transformational leadership: Mediating role of inspirational motivation and intellectual stimulation. *International Journal of Leadership in Education*, 1-11.

Klaic, A., Burtscher, M. J., & Jonas, K. (2020). Fostering team innovation and learning by means of team-centric transformational leadership: The role of teamwork quality. *Journal of Occupational and Organizational Psychology*, *93*(4), 942-966.

Porath, U. (2023). Advancing managerial evolution and resource management in contemporary business landscapes. *Modern Economy*, *14*(10), 1404-1420.

Sheehan, M., Garavan, T. N., & Morley, M. J. (2020). Transformational leadership and work unit innovation: A dyadic two-wave investigation. *Journal of Business Research*, *109*, 399-412.

Sidhu, K. B. (2024). *Potential of shared leadership on innovation effectiveness in enterprises: A qualitative exploration from leaders and team members* (Doctoral dissertation, FH Vorarlberg (Fachhochschule Vorarlberg)).

Su, Z. X., Wang, Z., & Chen, S. (2020). The impact of CEO transformational leadership on organizational voluntary turnover and employee innovative behaviour: the mediating role of collaborative HRM. *Asia Pacific Journal of Human Resources*, *58*(2), 197-219.

Sutisna, A., Khoriah, A., & Norman, E. (2024). Transformational Leadership and Team Synergy in Improving Communication and Collaboration in Educational Settings. *MES Management Journal*, *3*(3), 657-667.

Van der Voet, J., & Steijn, B. (2021). Team innovation through collaboration: How visionary leadership spurs innovation via team cohesion. *Public Management Review*, *23*(9), 1275-1294.

Wang, C., & Hu, Q. (2020). Knowledge sharing in supply chain networks: Effects of collaborative innovation activities and capability on innovation performance. *Technovation*, *94*, 102010.

Wen, H., Zhong, Q., & Lee, C. C. (2022). Digitalization, competition strategy and corporate innovation: Evidence from Chinese manufacturing listed companies. *International Review of Financial Analysis*, *82*, 102166.

Zou, M., Liu, P., Wu, X., Zhou, W., Jin, Y., & Xu, M. (2023). Cognitive Characteristics of an Innovation Team and Collaborative Innovation Performance: The Mediating Role of Cooperative Behavior and the Moderating Role of Team Innovation Efficacy. *Sustainability*, *15*(14), 10951.