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Virtual collaboration in MMOG: Lessons for improving team relationships and player engagement

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Abstract

Although players actively form teams to participate in games, research on the stability and development of relationships within gaming teams remains insufficient. The factors influencing the stability of these relationships are still unknown. This paper investigates the factors influencing the stability of team relationships (TR) in MMOG, with a focus on trust, shared goals, cooperative attitudes, and team cohesion. Using the Social Identity Theory framework, the study explores how these factors contribute to successful virtual team collaboration. Structural equation modelling was employed to analyze data collected from MMOG players. The results indicate that trust, shared goals, cooperative attitudes, and team cohesion significantly enhance the stability of team relationships. In MMOG, simulating environments that reflect real-world team challenges provides a valuable model for studying virtual collaboration. The findings offer practical insights for game developers and organizations aiming to improve virtual team efficiency. By emphasizing trust-building and goal alignment, developers can enhance player engagement and team performance in MMOG. Professionals in fields such as corporate management and educational environments can apply these findings to optimize virtual team collaboration. This study extends the existing literature by demonstrating the relevance of gaming platforms in understanding and improving the stability of virtual teams.

Keywords: Massively multiplayer online games (MMOG), Team cohesion, Team relationships, Team trust, Virtual teams.

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1. Introduction

As the internet has spread worldwide, the number of active video game players has increased dramatically, with the current estimate around 3.09 billion people being gamers, with the gaming market expected to reach \$385 billion in 2023 [1]. MMOG applications are especially prevalent in this expanding landscape, as MMOG applications depend heavily on cooperative gameplay mechanics [2]. Categorizing the subject matter of team-based games into both solving skill practices and building relationships [3] plays into both development of day-to-day soft skill abilities and connection-building. Teamwork is essential in such environments, highlighting the importance of the stability of team dynamics in maintaining long-term player engagement [4].

Because of the impact that VT can have on the behavior of players, new studies have focused on maximizing player loyalty and team performance [5, 6]. However, most of this work has been mostly limited to improving performance in the context of single player leadership, team integration, and VT effectiveness [7, 8]. The fact that TR have been assessed in relation to their long-term stability in particular in MMOG [7] but have been studied quite sparsely is therefore surprising. This is particularly the case for the roles of trust, cooperative attitudes, and shared goals within virtual gaming teams [8].

At a hypothetical level, trust and cooperation are pivotal to the success of VT in multiple domains of the digital landscape [9, 10]. Because trust encourages transparency and the willingness to share information, it underlies successful collaboration; more specifically, cooperative-oriented attitudes determine how responsibilities are divided as well as similarities in problem-solving strategies [9]. This is particularly true in the context of MMOG, where success or failure is often determined by the strength of trust and collaboration among teams [11]. It applies the interpersonal dynamics of trust and cooperation to the inner workings of teams in MMOG, which has profound implications in understanding the larger picture of team dynamics in virtual environments [12].

Virtual teams are characterized by the leader-member interaction occurring over a distance, often relying upon virtual tools to connect team members, which can result in varying team structure in terms of virtuality and performance in terms of effectiveness depending on leader-member interactions. Despite the fact that studies about team relationships are many, little research exists on the inter-dynamics driving the stability and durability of team relationships [13]. Second, shared entrainment has strong effects on people's experiences in games, as teams are generally more successful than individuals in fulfilling players' innate psychological needs, leading to improved satisfaction from games and ultimately increasing long-term participation, however, at the moment there is relatively little empirical research available for this dynamic in MMOG [14]. Research integrating these dimensions of shared goals and trust and cooperation into a unified framework of team relationship stability will greatly benefit theoretical contributions to the fields of teamwork and virtual collaboration.

The real-world implications of these dynamics are enormous. MMOG mage complex, immersive environments where teams face constant challenges under pressure with decision-making, communication and problem-solving. As such, they are excellent experimental domains for examining how virtual teams evolve in real time that matching the challenges seen in work environments, including corporate teams, military simulations and scientific collaborations. This potential makes MMOG an unmatched testbed for studying the complex interactions of trust, cooperation, and common goals that can lead to either stability or destabilization of virtual teams.

To fill this gap in the literature, the current study is based on the Social Identity Theory framework to examine how trust, cooperative attitudes, common goals and team cohesion influence stability in team relationships in MMOG. Using a quantitative research method, this research collects online data and uses structural equation modelling using Smart PLS software to build and verify theoretical models. This paper starts with a extensive literature review and research hypotheses. Next, it describes the research methodology and data collection process followed by a detailed analysis of the results. The paper is concluded by summarizing its contributions to virtual team relationship literature and presenting opportunities for further research.

2. Literature Review

2.1. Virtual Teams (VT)

Unlike conventional teams, members in virtual teams (VT) tend to be scattered over multiple continents or time zones, which mitigates the number of in-person interactions per team member [15]. Communication, Collaboration, and Doing Work: Rather than relying on face-to-face interaction for communication, collaboration, and task completion, we use the Internet and information technology (IT) as our main tools. In that regard, the advent of VT has deeply changed the way organizations function and has eroded some organizational borders [16, 17]. VT represents a powerful yet specific tool to enable organizations of all kinds to effectively meet challenges unique to their industries. However, the strategic benefits of using VT are deemed necessary in the international market [18]. In recent years, VT has become integral to the daily operations of many organizations, attracting significant attention from scholars in fields such as sociology and organizational psychology [19-21].

IT forms the backbone of collaboration in VT and is critical to maintaining team communication and cohesion [22]. Particularly since the COVID-19 pandemic, researchers and experts have increasingly focused on virtual teams, with a growing interest in online gaming teams. Virtual work provides a new experience for accomplishing organizational tasks, facilitated by computer-mediated communication [23]. The mode of communication influences team engagement, and virtual work offers more opportunities for interaction and connection, factors which may vary depending on team members' physical locations. Garro-Abarca, et al. [21] define virtual teamwork as collaboration and communication across time and space.

Morrison-Smith and Ruiz [24] on the other hand, defines virtual team collaboration as coordination and interaction to achieve a shared goal. Mysirlaki and Paraskeva [25] argue that in the context of multiplayer online games (MMOG),

teamwork significantly impacts both the common goal and task distribution among members. This variability in definitions highlights the evolving understanding of virtual teamwork.

2.2. Virtual Teams in MMOG

The MMOG provide a persistent virtual world that allows users to communicate across different channels [26]. In these games, players craft virtual avatars to form virtual teams and show considerable organization and cooperation in terms of the division of labor and coordinated effort [27].

According to recent research, collaboration in MMOG not only improves players' performance in the game, but also helps improve cooperation skills that can be learned and used in real-life situations [28]. For instance, in MMOG, players tend to transfer the skills related to communication and teamwork into their work environments, demonstrating better teamwork and leadership skills [29]. This means that virtual teamwork has the potential to bring different viewpoints and approaches to building real-world teamwork.

In addition, VT in MMOG has a considerable dynamic. The lifetime of a team can last from some seconds to years based on the complexity of the game objectives and the cooperation between its members [25]. Players spontaneously organize and adjust team structures flexibly, highlighting the potential for social interaction and collaboration within virtual settings [30]. In cooperative multiplayer games such as *League of Legends*, the coordination within a team has a direct impact on the outcome of the match [31].

2.3. Team Relationships (TR)

The stability of TR is essential for the success of VT. Research suggests that successful teams often invest time in developing trust and fostering cohesion among members [32]. In MMOG, the development of TR is particularly challenging, as player interactions largely depend on informal communication within the virtual environment [9]. For instance, in-game conversations, task assignments, and implicit coordination during teamwork significantly influence team cohesion [11].

However, because communication opportunities are often limited, interactions between players tend to focus on task assignments and reporting outcomes. This restricted level of interaction makes it more difficult to build trust, which is one of the key challenges faced by VT [33]. Studies have also found that team leaders in MMOG play a vital role [27]. Through frequent, routine communication, they monitor the well-being of team members and effectively adjust team morale, thereby strengthening team cohesion [34].

Additionally, incentive mechanisms in MMOG are not solely dependent on material rewards; they must also satisfy psychological needs, such as self-fulfillment and a sense of contributing to the team [35]. In games like *World of Warcraft*, team members experience a sense of achievement by reaching shared objectives, which in turn boosts team loyalty and their willingness to cooperate [28]. Furthermore, these players are afforded greater chances to establish connections with other players, while having the perception of in-game social relationships as genuine, hence leading to more robust social interactions [36].

3. Conceptual Model and Determinants

3.1. Team Trust (TT)

Team trust refers to the belief among members that each individual will act in the best interest of the team and provide mutual support [37]. Trust forms the foundation of teamwork, and when there is a high level of trust between members, they are more willing to share information, exchange ideas, and collaborate effectively. Additionally, trust reduces defensive behaviors and communication barriers, fostering more open and efficient collaboration [38].

Trust not only contributes to internal harmony but also strengthens team cohesion. Research indicates that trust enhances members' commitment and loyalty to the team, increasing its stability [39]. In virtual teams, trust is particularly critical, as members cannot interact face-to-face; trust helps overcome the challenges posed by physical distance, strengthening relationships among members [40]. Therefore, we propose the following hypothesis:

Hypothesis 1: Team trust positively influences team relationships within virtual teams.

3.2. Shared Goals (SG)

Shared goals refer to the clear objective that team members collectively pursue, which unites individuals into a cohesive group and promotes internal collaboration and communication [41]. Teams with a common goal tend to develop closer relationships, as members clearly understand their responsibilities and the importance of working together. This shared sense of purpose strengthens team cohesion, encouraging members to contribute to the overall team's success rather than focusing solely on personal achievements [42].

Research shows that shared goals not only enhance team performance but also reinforce trust and support among members. By clarifying the team's direction and vision, a common goal reduces internal conflicts and strengthens collaboration among members [41]. In virtual teams, a clearly defined common goal is particularly valuable, as it helps overcome the collaborative challenges posed by physical separation and fosters relationship development among team members [43]. Therefore, we propose the following hypothesis:

Hypothesis 2: Shared goals positively influence team relationships within virtual teams.

3.3. Cooperative Attitude (CA)

The attitude of cooperation is a vital element of the success of teamwork because it is the enthusiasm and willingness of a person to combine with the entire team and greatly affects team relations. A positive cooperative attitude creates a high probability of team members sharing resources, knowledge and experience promoting open communication and collaborative work [44]. This approach encourages trust and comprehension in the team while diminishing conflict and fostering peaceful working relationships [7].

In addition, working cooperatively can improve the team's collective performance. When team members have a high level of cooperation, SG is more likely to help them produce cohesion and efficient collaboration [34]. In virtual teams, the practice of cooperation is even more important, not only to overcome the obstacles of geographical distance, but also to enhance trust and stability among team members [11]. Therefore, we propose the following hypothesis:

Hypothesis 3: Cooperative attitude positively influences team relationships within virtual teams.

3.4. Team Cohesion (TC)

Team cohesion refers to the sense of identification with team goals and the mutual attraction between team members. It plays a central role in team relationships. Members of highly cohesive teams are more united, supportive of each other, and work together to achieve team objectives [7]. This cohesion fosters trust and a willingness to collaborate, reduces internal disagreements, and promotes harmonious relationships within the team [45].

Team cohesion not only improves team performance but also strengthens emotional bonds among members. Research shows that in highly cohesive teams, members are more willing to contribute to the team's success and exhibit greater responsibility and loyalty [46]. In virtual teams, despite the lack of frequent face-to-face interaction [47] cohesion remains essential to building strong TR. Through clear goals and effective communication, cohesion can bridge the challenges posed by physical distance [48]. Therefore, we propose the following hypothesis:

Hypothesis 4: Team cohesion positively influences team relationships within virtual teams.

3.5. Theoretical Foundation

According to social identity theory (SIT), the conformity behavior and attitude of people are largely influenced by the willingness to get recognition and approval from others [49]. Including those who desire social acceptance and adjust their behavior to the group standard to contribute to that. People adapt their activity to the requirements of the group or society [50] since this motivation to gain recognition encourages them. SIT is widely used to understand different types of social behavior, especially the areas of group processes, organizational development, and collective behavior [49].

SIT serves as a useful analytic lens for exploring our findings of player behaviors in TR within MMOG context [51]. In these games, players often cooperate with each other by joining force with a team (eg, player vs environment) or a guild (eg, player vs player, or teamwork aspect) that enables them to reach shared goal (SG), such as accomplishing difficult work (task) or beating powerful enemy (boss) [2]. In these types of teams, what each member values is visibility and validation from peers, particularly on the high-stakes activities where individual performance is visible. Within relevance to our article most high performing players are more likely to praise [26] which not only enhances their self-esteem but also enhances the cohesion and effectiveness of the total team.

These powerful insights also show that players are intrinsically motivated to play to the best of their ability but also need the social approval from their teammates, as per the in-game goals. So, SIT provides a helpful framework to explain the purposes of teammates' behaviors and moves towards a broader knowledge of team dynamics in MMOG. In addition, the theory may potentially assist in designing games that facilitate and simulate collaboration /more robust teamwork and contribute to the design of games.

To this end, this study applies Social Approval Theory to formulate a conceptual model designed to assess team relationships in MMOG. Specifically, it explores how factors such as team trust, shared goals, cooperative attitudes, and team cohesion influence team dynamics, as illustrated in Figure 1. The following hypotheses are proposed to guide this exploration, focusing on the impact of these variables on team relationships.

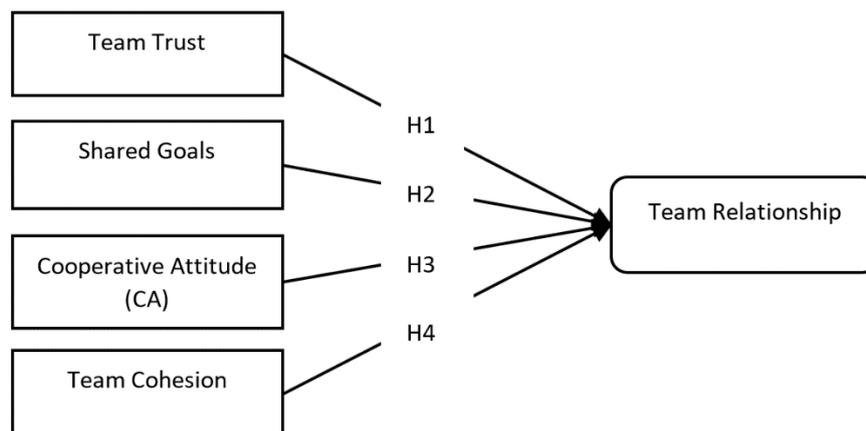


Figure 1.
Conceptual model.

4. Method

4.1. Research Design

This study employed a mixed-methods approach combining quantitative, interpretive, and cross-sectional research methodologies. Quantitative research was chosen due to the use of online questionnaires, allowing for mathematical data analysis [52]. Interpretive research helped explain the relationships between key variables affecting TR. The cross-sectional design provided a snapshot of TR at a specific time, offering insights into influencing factors. By considering variables like age, gender, and education, the study aimed to identify patterns that could enhance the understanding of team dynamics. This study allowed for efficient data collection within two weeks.

4.2. Sample and Data Collection

The study focused on modelling TR in VT within a Chinese MMOG context. As of 2023, China's gaming population exceeded 668 million [53] making it a suitable environment for rapid data collection. Convenience sampling was employed due to the large target population. Data collection occurred online, using links or QR codes shared on MMOG platforms and social media (WeChat and Weibo). Each respondent could only fill out the survey once, and it took no more than 10 minutes to complete.

During the data collection phase, 1,089 valid questionnaires were obtained, while 51 were deemed invalid due to missing data. This primary data collection meets the sample size requirements for PLS-SEM, as proposed by Hair, et al. [54]. Missing data is an unavoidable issue in questionnaire research, often complicating factor analysis in social science and behavioral research. However, the acceptable threshold for missing data is 5%, and the missing data in this study constitutes 4.6% of the total sample size, which is within the acceptable range and does not affect the validity of the results. Of these, specific demographic information is shown in Table 1.

Table 1.
Respondent Profile.

Demographic Characteristic	Option	Counts	Percentage
Gender	Male	578	55.68%
	Female	460	44.32%
Age	18-25 years	445	43.94%
	26-35 years	409	39.40%
	36-45 years	150	14.45%
	46-55 years	15	1.45%
	Above 56 years	10	0.96%
Education	High school or lower	239	23.03%
	College/ University	482	46.44%
	Graduate institute	317	30.54%
Weekly hours spent playing	< 5 h	192	18.50%
	≥ 5 and < 10h	231	22.25%
	≥10 and < 30 h	323	31.12%
	≥30 and < 50 h	234	22.54%
	≥50 h	58	5.59%
The massively multiplayer game you play most often is	Arena Of Valor	230	22.16%
	PUBG	397	38.25%
	Cross Fire	103	9.92%
	World of Warcraft	116	11.18%
	League of Legends	192	18.50%

4.3. Measurement Model

Before data collection, the questionnaire was adapted based on expert input, focusing on virtual team experiences related to TT, SG, CA, and TC. Adjustments were made to fit the specific gaming context (see Appendix A for details). Given the use of a single questionnaire, common method bias (CMB) was assessed. Variance inflation factor (VIF) values were 2.5, below the critical threshold of 3.5 [54]. These results indicate no significant CMB in the data.

5. Data Analysis and Results

This study used Partial Least Squares Structural Equation Modeling (PLS-SEM) to investigate the putative correlations. The reasons for adopting the PLS-SEM approach include that PLS-SEM is the best choice for theory development when studying how stable relationships are established between team members in a game [26]. Secondly, according to Sharma, et al. [55] PLS-SEM is suitable for prediction-oriented research and allows for superior overall model predictions through multiple quality tests such as Q^2 (predictive relevance), AVE (average variance extracted), and f^2 (effect size).

5.1. Measurement Model Testing

First, we conducted a reliability and validity test of the reflective structure, as shown in Table 2. Cronbach's alpha was used for reliability measurement, and the threshold value was >0.7 [56]. All five variables were above the threshold value, proving that each variable's data was reliable. Secondly, the minimum acceptable threshold for composite reliability should be higher than 0.6 [57] and the data results were above the threshold. The convergent validity of each variable was measured using factor loadings and average variance extraction (AVE). According to Hair, et al. [54] the AVE of each variable should be higher than 0.5, the AVE of the team relationship should be as high as 0.719, and all other variables should be more than 0.7 [56]. Therefore, the variable data collection is valid.

Additionally, we conducted interval validity testing using cross-loadings and the Fornell-Larcker criterion. The measurements showed that the cross-loadings for each item exceeded the threshold value of 0.7 [55]. We then used the Fornell-Larcker criterion to evaluate the discriminant validity of latent variables in the structural equation model. The square root of the average variance extracted (AVE) for each construct will be greater than its correlation with other constructs. As shown in Table 3, most of the data met the required criteria. However, the correlation between TR and TT was 0.860, which exceeded the AVE of 0.848. This suggests that these constructs are "closely related" or share overlapping dimensions. This does not necessarily imply a lack of validity but indicates that these constructs may have common underlying factors. Moreover, in teamwork research, it is expected that TR and TT, being conceptually similar, would exhibit a high correlation. Minor deviations from the standard do not invalidate discriminant validity. Therefore, the results indicate that the reflective constructs in this study meet the required research standards.

Table 2.
Measurement Model Testing.

Construct	Item	Loading	Cronbach's alpha	Composite reliability (rho a)	Composite reliability (rho c)	Average variance extracted (AVE)
CA	CA1	0.842	0.896	0.896	0.923	0.705
	CA2	0.846				
	CA3	0.836				
	CA4	0.835				
	CA5	0.842				
SG	SG1	0.853	0.869	0.869	0.910	0.717
	SG2	0.848				
	SG3	0.839				
	SG4	0.848				
TC	TC1	0.867	0.879	0.879	0.917	0.734
	TC2	0.852				
	TC3	0.852				
	TC4	0.854				
TR	CA	0.833	0.869	0.870	0.911	0.719
	SG	0.860				
	TC	0.834				
	TT	0.864				
TT	TT1	0.846	0.914	0.914	0.933	0.700
	TT2	0.839				
	TT3	0.831				
	TT4	0.835				
	TT5	0.836				
	TT6	0.831				

Note: TT = Team Trust, TR = Team Relationship, SG = Shared Goals, CA = Cooperative Attitude, TC = Team Cohesion

Table 3.
Fornell-Larcker criterion.

Construct	CA	SG	TC	TR	TT
CA	0.840				
SG	0.609	0.847			
TC	0.586	0.631	0.857		
TR	0.832	0.860	0.834	0.848	
TT	0.634	0.671	0.617	0.844	0.836

Note: TT = Team Trust, TR = Team Relationship, SG = Shared Goals, CA = Cooperative Attitude, TC = Team Cohesion

5.2. Structural Model Testing

Next, we performed structural modelling tests, using 5000 bootstrap operations to test the structure, as shown in Table 4. The T-statistic of each path is more significant than 1.96 [56]. The P-value tests the internal structural model, and a value of less than 0.001 is considered highly substantial [57]. The structure of each hypothesized path is specified as follows: TT (H1: $\beta=0.3, p<0.001$) is significant for the TR path. SG (H2: $\beta=0.299, p<0.001$) holds for the TR path. CA (H3: $\beta=0.289,$

$p \leq 0.001$) has a significant relationship with the variable TR. TC ($H4: \beta = 0.29, p \leq 0.001$) There is a positive relationship for TR. The specific relationship of each variable is hypothesized, as shown in Figure 2. The paths of hypotheses H1, H2, H3, and

H4 are significantly significant. Hence, our proposed hypothesized model is valid.

Table 4.
Structural Model Testing.

HYP	PLS Paths	Original sample (O)	Standard deviation (STDEV)	T statistics (O/STDEV)	Bias	2.50%	97.50%	P values	Decision
H1	TT -> TR	0.300	0.003	89.698	0.000	0.294	0.307	$p \leq 0.001$	Yes
H2	SG -> TR	0.299	0.003	89.516	0.000	0.293	0.306	$p \leq 0.001$	Yes
H3	CA -> TR	0.289	0.003	89.259	0.000	0.283	0.296	$p \leq 0.001$	Yes
H4	TC -> TR	0.290	0.003	98.024	0.000	0.285	0.296	$p \leq 0.001$	Yes

Note: TT = Team Trust, TR = Team Relationship, SG = Shared Goals, CA = Cooperative Attitude, TC = Team Cohesion

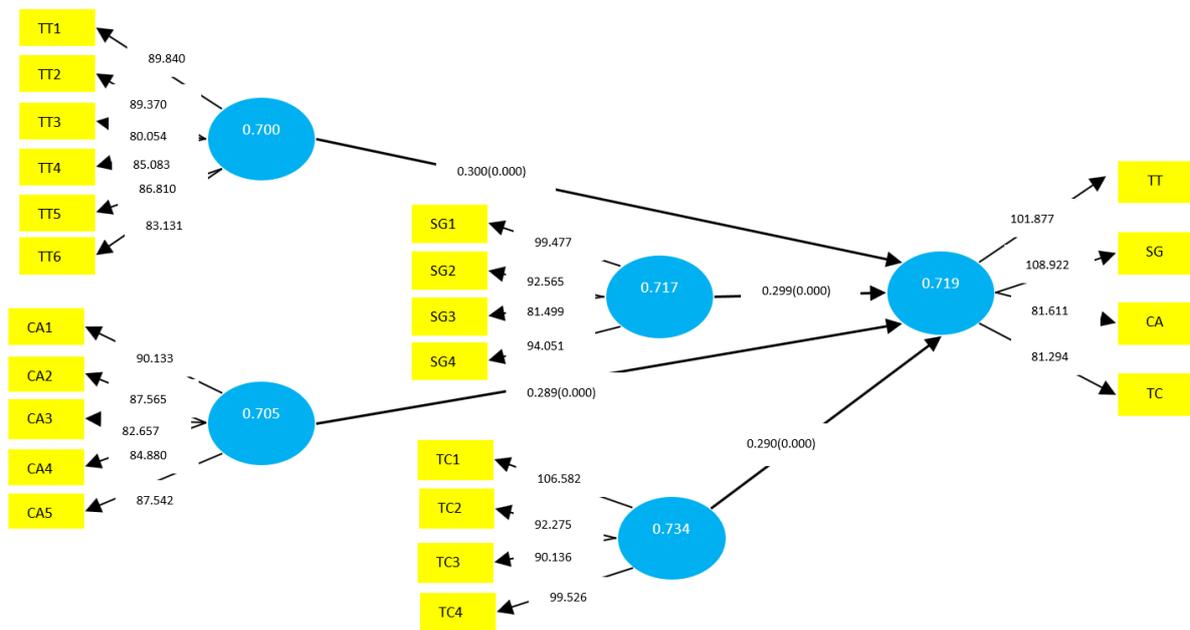


Figure 2.
Result of hypotheses testing.

5.3. Predictive Relevance and Effect Size

Calculating predictive relevance through Stone-Geisser's Q^2 value provides an objective indication of whether the endogenous variables align with the structural model [54]. When Q^2 is greater than 0, it suggests that the structural model is predictively relevant, and when it is not, the model lacks predictive relevance. In Table 5 ($Q^2 = 1 - SSE/SSO$), the final Q^2 values for cross-validation under each variable are all greater than 0.

Furthermore, the effect size (f^2) evaluates the influence of exogenous variables on structural variables. The effect size refers to the magnitude of difference caused by various factors and is independent of sample size. Effect sizes are classified as strong, medium, or weak when they exceed 0.35, 0.15, and 0.02, respectively. As shown in Table 6, the effect size coefficients for TT, SG, CA, and TC with TR exceed 0.15, indicating that all have a significantly positive impact on TR. This once again confirms the validity of the study's hypotheses.

Table 5.
Predictive Relevance.

Construct	SSO	SSE	$Q^2 (=1-SSE/SSO)$	Predictive Relevance
CA	5190	2330.733	0.551	$Q^2 > 0$
SG	4152	1998.944	0.519	$Q^2 > 0$
TC	4152	1892.639	0.544	$Q^2 > 0$
TR	4152	1990.631	0.521	$Q^2 > 0$
TT	6228	2648.082	0.575	$Q^2 > 0$

Note: TT = Team Trust, TR = Team Relationship, SG = Shared Goals, CA = Cooperative Attitude, TC = Team Cohesion

Table 6.
Total Effect (f^2)

Construct	CA	SG	TC	TR	TT
CA				0.289	
SG				0.299	
TC				0.290	
TR					
TT				0.300	

Note: TT = Team Trust, TR = Team Relationship, SG = Shared Goals, CA = Cooperative Attitude, TC = Team Cohesion

5.4. Importance Performance Map Analysis (IPMA)

The importance-performance map analysis (IPMA), also known as priority analysis or importance-performance matrix, combines the average score of latent variables (performance) with path coefficients (importance) to evaluate results. This analysis specifically compares the mean score of the latent constructs, which range from 0% to 100%, with the overall impacts in the structural model. According to Sarstedt, et al. [52] the primary purpose of IPMA is to assess and compare the importance and effectiveness of all relevant external components in endogenous constructions.

Given the consideration of average importance and performance, the IPMA map is divided into four quadrants. Typically, constructs in the lower right quadrant should be prioritized for improvement followed by the upper right, lower left and upper left quadrants [57]. Figure 3 shows that the mean values of importance and performance of team relationships are 0.295% and 59.485% respectively. TT should be improved first, followed by SG, TC and CA, which shows that TT improvement is more important than other factors.

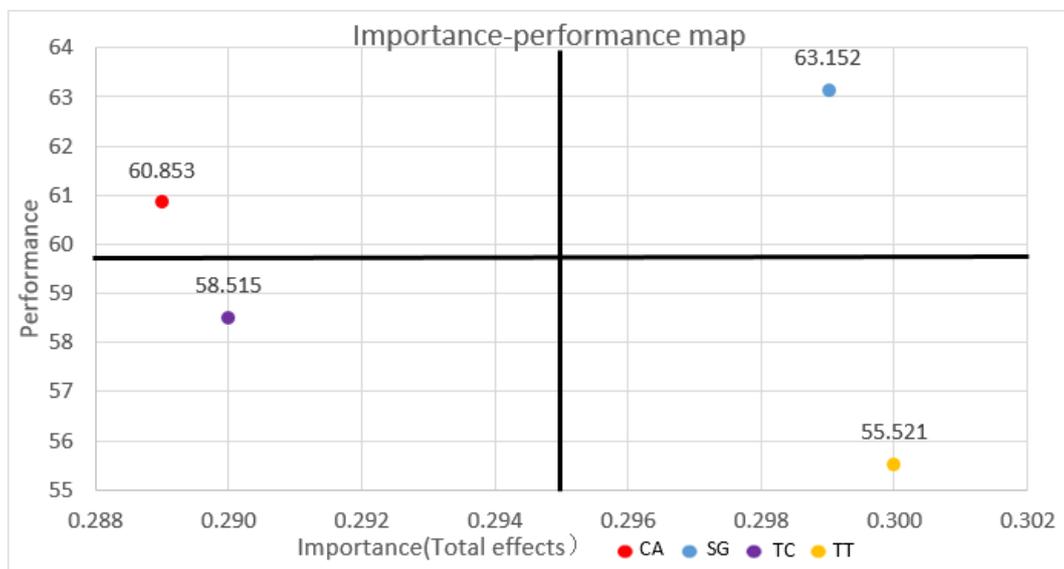


Figure 3.
Importance-Performance Map of Result.

6. Discussion

6.1. Findings

The results of this study highlight the critical role of TT, SG, CA, and TC in influencing the stability of TR in MMOG. These findings contribute to the literature on TR in virtual environments and expand the theoretical understanding of virtual collaboration by incorporating unique elements from the MMOG gaming context.

First, the results confirm that TT plays a key role in fostering stable and long-lasting TR in MMOG. As shown in the structural model, the effect size of team trust is the largest ($f^2=0.300$), indicating that trust is crucial for team cohesion and cooperation. In real-world gaming environments, trust helps mitigate the lack of face-to-face interactions, fostering confidence in teammates’ abilities and intentions. This finding previous work as well, which found trust to be an important factor related to team effectiveness [39]. The wide range of decision and coordination tasks encountered in, for example, MMOG (massively multiplayer online games) have a strong time pressure component [58]; thus, in many cases it is crucial for players to decide quickly and act based on their responses to each other rather than taking time to formally negotiate [9]. This process can be significantly enhanced by trust, which suggests that game designers could benefit from placing greater prominence on mechanisms that promote trust-building among colleagues.

Second, the findings illustrate that SG is also another important predictor of TR stability ($f^2=0.299$). SG is more likely with teams with higher levels of cohesion and stability [42]. This is especially relevant in MMOG, where complex actions frequently need to be performed collaboratively over time. Having clear goals and mutual understanding helps teams decide who, when, how, and where each task is achieved — which ensures reduced friction and internal conflict. It is like collaborative activity in real-world communities, such as corporate or military organizations, where members act toward

unified goals. As such, the mechanisms for team alignment in online gaming environments should be clearer around what goals there are and how progress toward them is being tracked.

Third, CA is one of the key findings, which greatly affects team stability ($f^2=0.289$). These findings indicate that a key factor driving VT's viability in certain gaming contexts is the willingness of each member of the network to cooperate. This result suggests that individual members' willingness to cooperate plays a vital role in the success and longevity of VT in gaming environments. CA facilitates resource sharing and knowledge exchange [44] making TR more harmonious and team performance more efficient. This is especially crucial in MMOG — a domain where cooperative involvement is often the make or break of a team. Research has found that cooperative behavior enhances team performance both in gaming environments and in working environments, including remote work and virtual project teams.

Lastly, the results indicate the importance of TC in forming a stable team relationship ($\beta=0.290$). Cohesion provides trust and devotion among members which makes them more committed and dedicated towards the shared goals of the team [59]. MMOG teams endure pressure and competition, and cohesion expands team resilience, keeping members engaged. This aligns with research from the field of organizational behavior, which frequently correlates high TC with better performance and long-lasting stability. Perhaps even for creators of online games, a means of encouraging the building of a social bond within the game may increase team connectivity and engagement.

6.2. Practical Advice for Game Developers

6.2.1. Motivating Trust Building

1. Orient the reward system towards consistent reliable behavior, for example, cooperative resource sharing and tackling complex tasks together, or stepping up to help the team through hard challenges. These behaviors should be compensated so that they can induce active cooperation among players.
2. Provide active communication tools (like voice chat, when needed) or strategy prompts (when appropriate) to facilitate effective planning by players.
3. By tracking behavior that if a player is consistently behaving well wallet addresses can show a score (trustworthiness in cooperative missions here is known as reliability) or reward badges or in-game privileges to players that continue to serve their community loyally, rewarding good people for their good deeds.

6.2.2. Clear Goal Structure

1. The game should have a transparent and structured goal framework to minimize confusion and friction between team members.
2. Real-time, visual indications of collective progress (progress bars, task lists, notifications in the game, etc.)
3. Having customizable goals based on other playstyles (combat vs strategy for example) allows teams to work together more effectively in response to how they play.

6.2.3. Promoting Collaboration

1. Refine the reward structure to motivate members to actively engage with each other in collaborative practices. Elements that reward teamwork such as communal loot drops, bonus XP, or special abilities that are triggered by players working together can enhance the attractiveness of playing together.
2. This can be done through incorporating in game tutorials on how players can see or assess collaboration and teamwork strategies.
3. In-team cooperative strategies like shared routing choices, and simultaneous battlefield attacks by keeping track of both friendly and enemy forces during team confrontations.

6.2.4. Enhancing Team Cohesion

1. Implement systems that demand periodic team building activities — like working together in mini games, bonding over base builds, or periodically through team missions where all members must partake.
2. Give guilds or groups the tools to host events, chatting, and be rewarded for participation It assists teams in developing more meaningful relationships.

6.3. Limitation and Future Research

While this study provides valuable insights, it is important to acknowledge its limitations. The data were collected within the context of Chinese MMOG players, and the findings may not fully generalize to other cultural or regional gaming communities. Moreover, the study focused primarily on team-based gameplay, potentially overlooking the dynamics of individual player behavior within teams. Future research could explore how personality traits or leadership styles affect team stability in virtual environments. Additionally, longitudinal studies are needed to examine how TR evolve over time and in response to external stressors, such as changes in team composition or game mechanics.

7. Conclusion

This study provides significant insights into the stability of VT in MMOG, highlighting the importance of TT, SG, CA, and TC. These findings extend beyond gaming and offer valuable lessons for VT in professional and organizational contexts. The results underscore the fundamental role of trust in fostering effective communication and collaboration among distributed teams. Moreover, the importance of SG in enhancing team performance reflects broader human behavior patterns in virtual environments. Additionally, TC manifests as members' reliance on team identification. These findings

indicate that the improvement and stability of TR are positively influenced by all four factors. Consequently, this study supports managers in relevant teams or organizations in forming efficient teams, establishing long-term stable relationships, and achieving goals effectively.

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Appendix A.

Table A1.
Virtual Collaboration Questionnaire Items.

Construct	Item	Source	
Team Trust	I maintain close social relationships with some members of the virtual team.	Chiu, et al. [60]	
	I spent a lot of time interacting with some members of the virtual team.		
	I know some members of the virtual team on a personal level.		
	I have frequent communication with some members of the virtual team.		
	Shared Goals	I believe my team members will always try and help me out if I get into difficulties concerning the game.	Hau and Kim [61]
		I believe that my team members behave consistently.	
		I believe that my team members keep their promises.	
		I trust that my team members are truthful in dealing with one another.	
Cooperative attitude	My team members and I share the same goal of learning the game from one another and sharing what we know about the game.	Huang, et al. [62]	
	My team members and I share the same value that helping one another with the game is good.		
	My team members and I share the same vision of helping one another to solve problems related to the game.		
	My team members and I are enthusiastic about the collective mission of sharing knowledge concerning the game.		
Cooperative attitude	Our team members 'swim or sink' together.	Baruch and Lin [63]	
	Our team members want each other to succeed.		
	Our team members seek compatible attitudes in terms of teamwork.		
	Our teamwork goes smoothly.		
	When our team members work together, we usually seek a solution that is good for the team.		

Team cohesion	I feel that I belong to this team.	Garrison, et al. [64]
	I am content to be part of this team.	
	This team is one of the best anywhere.	
	I am happy to be part of this team.	