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A Model for the Enhancement of Research Team Effectiveness for Research Team at Guangdong University of Petrochemical Technology, China

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Abstract:- *Team research has attracted attention in the relevant field for many years. This research output is a requirement for academic faculty and is related to promotion and successful advancement. To help accomplish this requirement, many researchers work as a team. The effectiveness of the team plays a crucial part in the research output. The purpose of this study was to develop a model for research teams at Guangdong University of Petrochemical Technology, China, the study had five objectives. 1) To explore the desired team leadership competencies needed to drive research teams. 2) To identify the level of team leadership competencies and academic leadership behaviors of research team members at Guangdong University of Petrochemical Technology, China. 3) To determine the significant impact between team leadership competencies and academic leadership behaviors that affect research team effectiveness.4) To develop a model to enhance research team effectiveness at the Guangdong University of Petrochemical Technology, China. 5) To develop a proposed model to enhance research team effectiveness at Guangdong University of Petrochemical Technology, China. The findings of qualitative and quantitative research presented the following key conclusions. Ten team leadership competencies were obtained from the qualitative analysis. From the developed instrument, the current level of team leadership competencies (M=4.08, SD=0.41) and academic leadership behaviors (M=4.06, SD=0.45) were obtained, and they were evaluated to be high. A two-way ANOVA was used to analyze the effects of team leadership and academic leadership behavior on team effectiveness. The p-value for team leadership competencies was .006, and the p-value for academic leadership behaviors was .003, indicating a significant relationship. The multiple coefficients showed that r = .642, p=.000, R^2 for this model was .412, which indicated that Team Leadership Competencies and Academic Leadership Behaviors predict 41.2% of Research Team Effectiveness. Based on the above research findings, a model to improve research team effectiveness was proposed and validated by six experts. Model implications and implementation are discussed and recommended.*

Keywords: Model; Enhancement; Research Team Effectiveness

Introduction

As the center of education, universities are at the top of the education system and the primary source of high-level national talent. The fundamental feature of a university is academics, and doing research is one of the essential social functions of a university. There is no doubt that the university research team is the basic organizational structure of research and a necessary part of scientific and technological innovation construction. In scientific research and innovation activities, the university research team plays an essential role in improving the quality of talent training and scientific research. As Wang & Zhou (2012) stated, the university research team was a core team composed of multiple researchers to conduct scientific research with academic problems as the link and scientific and technological innovation as the purpose. It can be concluded that the research team has become a vital carrier in the discipline construction and talent training of higher education institutions. Progressively more universities also regard research performance as an essential index to measure their reform and development. Relying on establishing institutions of higher learning, outstanding research teams emerge in an endless stream (Hesselbein et al., 1996; Duttweiler and Hord, 1987; Bennis and Nanus, 1985).

The University of Michigan Scientific Research Team, the Massachusetts Institute of Technology (MIT) Lincoln Laboratory, and the University of Cambridge Cavendish Physics Laboratory are the best examples. It can be seen that the university research teams have contributed a lot to the university's world-renowned scientific research achievements. The critical role of the research team in optimizing scientific resources in universities or cultivating and introducing high-level talents cannot be

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underestimated. Thus, how to improve the effectiveness of research teams in universities is an essential focus for scholars.

As the only petrochemical university in southern China, developing effective research teams at the Guangdong University of Petrochemical Technology can reference other science and technology universities. At the same time, it represents the development level of higher education in Maoming, Guangdong Province. This research aims to develop a model to improve leadership in research teams to enhance research output for higher education institutions in China, especially in Maoming, Guangdong province.

Research Objectives

1. To explore the desired team leadership competencies needed to drive research teams.
2. To identify the level of team leadership competencies and academic leadership behaviors of research team members at Guangdong University of Petrochemical Technology, China.
3. To determine the significant impact between team leadership competencies and academic leadership behaviors that affect research team effectiveness.
4. To develop a model to enhance research team effectiveness at the Guangdong University of Petrochemical Technology, China.
5. To develop a proposed model to enhance research team effectiveness at Guangdong University of Petrochemical Technology, China.

Literature Review

1. Team Leadership

In recent years, with the rapid external environment changes, teams played an increasingly important role in organization management. Hong (2005) proposed the concept of team leadership of senior executives. He believed that team leadership refers to all team members exerting their influence to promote task completion and interpersonal interaction, achieve the team's common goal, and share responsibility for the success or failure of the work. Similarly, Morgeson, Lindoerfer & Loring (2010) pointed out that team leadership was a process rather than a person. Based on leadership development, Qiao (2012) defined team leadership development as all team members playing their leadership to achieve the team's shared goals and share responsibility for the success or failure of the work. These studies all meant that team leadership is not about how the team leads but how the leader leads the team.

Then, naturally, the leadership competencies of team leaders also attracted public attention. Kozlowski et al. (2009) stated that team leadership is in the process of dynamic change and development. Based on this, it is a process of focusing on the key competencies of team development. Furthermore, like Burke, Diaz Granados & Salas (2011) stated, team leadership included the formulation of emotional, cognitive, and behavioral processes needed to promote performance management and team development. Given the centrality of these requirements for team performance, team leadership can be regarded as satisfaction with team needs (the ultimate goal is to improve team efficiency). Anyone (inside or outside the team) who was responsible for meeting the team's needs can be regarded as assuming the role of team leader.

2. Academic Leadership

Askling & Stensaker (2002) stated that academic leadership has a long tradition of being valued in higher education. It is one of the foundations for the establishment of higher education institutions. The earliest description of academic leadership is about academic freedom in research, publications, teaching, and civil rights (Blackburn & Gerber, 1974). Later, Ramsden (1998) defined academic leadership as the normal process of promoting, managing, developing, and encouraging academic staff. He also pointed out that "leadership in research" was of the stable characteristics of academic leadership. Similarly, Spendlove (2007) demonstrated that academic leadership is the process by which the influence of goals can be achieved in higher education. The study identified that effective leaders should have the main characteristics of attitudes, knowledge, and behavior. It indicated the academic leadership behaviors of leaders affected the development of higher education.

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3. Research Team Effectiveness

Tjosvold, D., Poon, M., & Yu, Z., (2005) put forward that team effectiveness is how a team can effectively serve customers, including team performance, member attitudes, and behaviors. Furthermore, Research productivity, member satisfaction, and member friction are three core indicators to measure team effectiveness. Omar & Ahmad (2014) examined the impact of three input factors (team climate, workload, and team leadership on research project team effectiveness, notably measuring this team effectiveness by publication productivity, team member satisfaction, and member frustration. They also provided a potentially helpful framework for building effective research project teams in academic settings following the input-process-output classical system model—measuring research productivity by publication productivity. The study also pointed out that to measure research productivity; they usually use the number of publications. Chikersal et al. (2017) defined member satisfaction — as the satisfaction of research team members. According to Hackman (1987), working in a team can be frustrating because it requires them to work together and take collective action and decision-making, which may not be easy to achieve due to conflicts between team members. It meant that members might experience frustration within the research team.

Conceptual Framework

The research, A Model for the Enhancement of Research Team Effectiveness for Research Team at Guangdong University of Petrochemical Technology, China. we set the research conceptual framework as follows:

Conceptual Framework	
Hong (2005)	team leadership refers to all team members exerting their influence to promote task completion and interpersonal interaction, achieve the team's common goal, and share responsibility for the success or failure of the work.
Morgeson, Lindoerfer & Loring (2010)	team leadership was a process rather than a person.
Kozlowski et al. (2009)	team leadership is in the process of dynamic change and development. Based on this, it is a process of focusing on the key competencies of team development.
Askling & Stensaker (2002)	academic leadership has a long tradition of being valued in higher education. It is one of the foundations for the establishment of higher education institutions.
Ramsden (1998)	academic leadership as the normal process of promoting, managing, developing, and encouraging academic staff.
Tjosvold, D., Poon, M., & Yu, Z., (2005)	team effectiveness is how a team can effectively serve customers, including team performance, member attitudes, and behaviors.
Chikersal et al. (2017)	member satisfaction — as the satisfaction of research team members.

Methodology

Research Design: The design of this study is a combination of qualitative and quantitative methods. Firstly, to collect relevant data on research objective one, the researcher used the qualitative results obtained through the literature review and developed a questionnaire. Then, the statistical analysis included mean, standard deviation Two Way-ANOVA, and multiple regression to analyze the quantitative data of research objectives 2 to 4. Finally, the model for the enhancement of the research team effectiveness at Guangdong University of Petrochemical Technology was developed based on the above research findings.

All 268 instructors from the research teams of the Guangdong University of Petrochemical Technology were surveyed. A total of 268 questionnaires were distributed, and all were recovered. The study was conducted from July 2021 to August 2022.

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Research Instrument: The instrument consisted of four parts. Firstly, it was about the demographics, including age, gender, professional title, educational background, etc. Secondly, the researcher used the literature synthesis to develop a questionnaire on team leadership competencies, which included 40 items divided into ten dimensions, respectively: Communication skills, Empowering and Developing others, Setting Vision, Direction, and Goals, Cooperation, and Facilitation, Motivating, Inspiring and Building Trust, Managing Cultural Diversity, Decision-making, and Responsibility, Strategic Thinking, Emotional Intelligence, and Managing Resources. Thirdly, the questionnaire also adapted Ramsden's (1998) Academic Leadership Self-evaluation Questionnaire as part of the instrument. There are 16 items in the questionnaire, and the four dimensions of measurement are Leader, Research Team Leader, Political Animal (team member), and Staff Developer. Lastly, it contained 6 items divided into 3 dimensions, namely: Productivity, Member Satisfaction, and Member Frustration. All the items were evaluated by eight experts. The researcher adjusted the items according to the experts' CVI evaluation and arrived at the final draft of the instrument.

Results

1. Research Objective One: Firstly, the researcher conducted a systematic literature review to find the leadership competencies needed to drive research teams. Table 1 showed a summary of the research synthesis obtained from 19 sources of literature from the years 2001 to 2021 related to leadership competencies. Communication skills are considered the most critical team leadership competencies (TLC), which have appeared 14 times. In detail, the order of frequency from more to less is as follows: Communication skills (14 times), Empowering and Developing others (10 times), Setting Vision, Direction, and Goals (10 times), Cooperation and Facilitation (10 times), Motivating, Inspiring and Building Trust (9 times), Managing Cultural Diversity (9 times), Decision-making and Responsibility (6 times), Strategic Thinking (6 times), Emotional Intelligence (5 times), and Managing Resources (4 times).

Table 3 Summary of the Synthesis of Team Leadership Competencies

Factors	Margerison（2001）	Maduka al et. (2018)	Callaghan (2014)	Soon & Salamzadeh (2021)	Arends (2017)	Gilley et al. (2010)	Zhao & Cai (2016)	Yang (2010)	Zeng (2007)	Hajro & Pudelko (2010)	Lloyd& Härtel (2010)	Maneesawangwong (2012)	Moore& Rudd（2004）	Ahmed & Philbin (2020)	Hu (2002)	Yu (2003)	Kayworth & Leidner (2002)	Hassanzadeh al et. (2015)	Joshi & Lazarova (2005)	**Frequency Total**
Managing Resources	/		/						/			/	/					/		6
Emotional Intelligence										/		/		/	/					5
Strategic thinking											/	/	/		/					4

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Factors	Margerison（2001）	Maduka al et. (2018)	Callaghan (2014)	Soon & Salamzadeh (2021)	Arends (2017)	Gilley et al. (2010)	Zhao & Cai (2016)	Yang (2010)	Zeng (2007)	Hajro & Pudelko (2010)	Lloyd& Härtel (2010)	Mangeesawangwong (2012)	Moore& Rudd（2004）	Ahmed & Philbin (2020)	Hu (2002)	Yu (2003)	Kayworth & Leidner (2002)	Hassanzadeh al et. (2015)	Joshi & Lazarova (2005)	**Frequency Total**
Communication skills	/	/	/	/		/	/		/				/	/	/	/	/	/	/	14
Empowering and developing others	/	/			/	/				/			/	/		/		/	/	10
Cooperation and facilitating		/			/	/	/	/	/	/		/			/				/	10
Motivating, inspiring, and building trust		/	/	/	/	/	/	/		/			/						/	10
Setting vision and direction.		/	/		/					/	/	/	/	/					/	9
Managing cultural diversity		/			/					/	/				/	/	/	/	/	9
Decision-making and responsibility						/	/	/		/		/		/			/			6

2. Research Objective Two: The following tables showed the levels of team leadership competencies and academic leadership behavior.

Table 2 Level of Team Leadership Competencies (n=268)

Team Leadership Competencies	Mean	Std. Deviation	Level
Communication skills	4.13	0.56	High
Empowering and Developing others	4.07	0.62	High
Setting Vision, Direction, and Goals	3.91	0.61	High
Cooperation and Facilitation	4.23	0.51	High

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Team Leadership Competencies	Mean	Std. Deviation	Level
Motivating, Inspiring, and Building Trust	4.19	0.54	High
Managing Cultural Diversity	4.02	0.62	High
Decision-making and Responsibility	4.13	0.58	High
Strategic Thinking	4.01	0.59	High
Emotional Intelligence	4.05	0.56	High
Managing Resources	4.06	0.56	High
Overall Level	**4.08**	**0.41**	**High**

Table 2 showed the levels of team leadership competencies of the respondents. The competency with the highest mean was Cooperation and Facilitation, with a mean of 4.23, and the lowest was 3.91, Setting Vision, Direction, and Goals. The overall means obtained were classified as high according to the interpretation table.

Table 3 Level of Team Leadership Competencies (n=268)

Team Leadership Competencies	Mean	Std. Deviation	Level
Communication skills	4.13	0.56	High
Empowering and Developing others	4.07	0.62	High
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Cooperation and Facilitation	4.23	0.51	High
Motivating, Inspiring, and Building Trust	4.19	0.54	High
Managing Cultural Diversity	4.02	0.62	High
Decision-making and Responsibility	4.13	0.58	High
Strategic Thinking	4.01	0.59	High
Emotional Intelligence	4.05	0.56	High
Managing Resources	4.06	0.56	High
Overall Level	**4.08**	**0.41**	**High**

Table 3 depicted the levels of Academic Leadership Behavior. Staff Developer received the highest mean of 4.13, while Leader received the lowest mean in this group of 3.96. Overall, all the means were considered high.

Table 4 Level of Research Team Effectiveness. (n=268)

Research Team Effectiveness	Mean	Std. Deviation	Level
Productivity	3.66	0.48	High
Member Satisfaction	3.74	0.44	High
Member Frustration	2.31	0.24	Low
Overall	**3.70**	**0.32**	**High**

As presented in Table 4, there were three dimensions of Research Team Effectiveness. Productivity and Member Satisfaction are in the high range at 3.66 and 3.74, respectively. Member frustration was at a low level of 2.31, which meant members were not frustrated with their research teams. The overall level of research team effectiveness was high.

3. Research Objective Three: A two-way ANOVA was used to analyze the effects of team leadership and academic leadership behavior on team effectiveness. Table 5 showed the combined Team Leadership Competencies and Academic Leadership Behaviors' effects on Team Effectiveness. The p-value for TLC (Team Leadership Competencies) is .006, and the p-value for ALB (Academic Leadership Behaviors) is .003, indicating they significantly impact Research Team Effectiveness. However, the p-value for the interaction between TLC*ALB is .396, indicating that the interaction effect between team leadership competencies and academic leadership behaviors was not significant.

4. Research Objective Four: A multiple regression analysis was conducted to determine the degree to which team leadership competencies and academic leadership behaviors impact Research Team Effectiveness.

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Table 6 Multiple Regression Results for the Team Leadership Competencies' and Academic Leadership Behaviors' Impact on Research Team Effectiveness (n=268)

Model	R	R Square	Adjusted R Square
1	.642	.412	.380

a. Dependent Variable: Research Team Effectiveness
b. Predictors: Team Leadership Competencies, Academic leadership behaviors

Table 7 ANOVA Results for the Team Leadership Competencies' and Academic Leadership Behaviors' Impact on Research Team Effectiveness (N=268)

Model	Sun of Square	df	Mean Square	F	Sig.
1. Regression	10.375	2	5.187	82.291	.000[b]
Residual	16.705	265	.063		
Total	27.080	267			

a. Dependent Variable: Research Team Effectiveness
b. Predictors: Team Leadership Competencies, Academic leadership behaviors

Table 18 Significant Factors for Predicting Research Team Effectiveness.

	Unstandardized Coefficients		**Standardized Coefficients**		
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	1.433	.183		7.825	.000
CS	.046	.037	.081	1.254	.211
ED	.007	.033	.014	.222	.824
SVD	-.014	.033	-.027	-.428	.669
CF	.028	.040	.045	.701	.484
MIB	.092	.041	.156	2.268	.024*
MCD	.041	.034	.080	1.199	.232
DMR	.027	.034	.049	.787	.432
ST	.040	.033	.074	1.202	.230
EI	.082	.038	.144	2.178	.030*
MR	-.042	.038	-.073	-1.093	.275
L	-.005	.032	-.010	-.168	.867
RTL	.087	.034	.160	2.553	.011*
TM	.096	.033	.171	2.870	.004*
SD	.067	.035	.119	1.889	.060

*sig.<0.05

a. Dependent Variable: Research Team Effectiveness
b. Predictors: (Constant), Communication skills (CS), Empowering and Developing others (ED), Setting Vision, Direction, and Goals (SVD), Cooperation and Facilitation (CF), Motivating, Inspiring, and Building Trust (MIB), Managing Cultural Diversity (MCD), Decision-making and Responsibility (DMR), Strategic Thinking (ST), Emotional Intelligence (EI), and Managing Resources (MR), and Academic leadership behaviors including Leader (L), Research Team Leader (RTL), and Team Member (TM) and Staff Developer (SD)

The multiple coefficients of determinations showed that r = .642, p=.000, R^2 for this model was .412, which indicates that Team Leadership Competencies and Academic Leadership Behaviors predict 41.2% of Research Team Effectiveness.

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The significant factors of Team Leadership Competency that affect Research Team Effectiveness were MIB (Motivating, Inspiring, and Building Trust with a significance level of .024; EI (Emotional Intelligence) with a significance level of .030. The Academic Leadership Behaviors that affect Research Team Effectiveness are RTL (Research Team Leader) with a significance level of .011; and TM (Team Member) with a significance level of .004.

5. Research Objective Five

Based on the multiple regression analysis results, the significance rank of β scores suggested the emphasis should focus on improving Team Members (TM) (β=.096, p=.004); Research Team Leader (RTL) (β=.087, p=.011), Motivating, Inspiring, and Building Trust (MIB) (β=.092, p=.024) and Emotional Intelligence (EI) (β=.082, p=.030). The proposed model was sent to experts for evaluation and validation. As a result, six higher education experts from the Guangdong University of Petrochemical Technology were validated to develop the final model. With these considerations, As shown in the figure, 10 other-sub variables are added to the proposed model to improve the effectiveness of the research team to ensure feasibility.

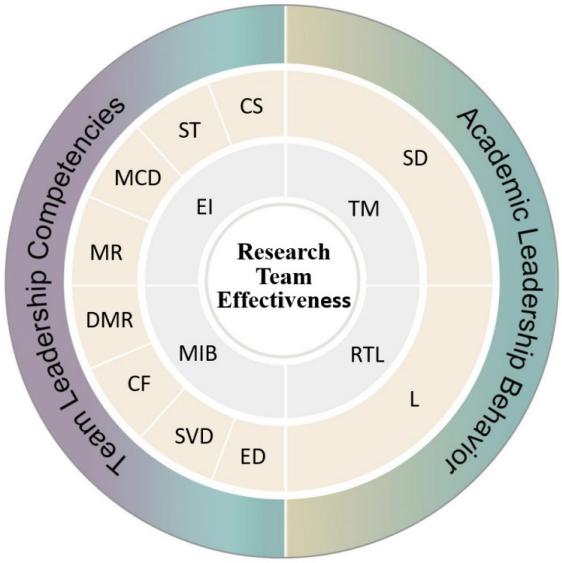

Figure 1 The Model for the Enhancement of Research Team Effectiveness for Research Teams at Guangdong University of Petrochemical Technology, China

Conclusions

According to the systematic literature review, ten dimensions of team leadership competencies that are needed to drive research teams were extracted from the literature synthesis: (1) Communication Skills (CS), (2) Empowering and Developing Others (ED), (3) Setting Vision, Direction, and Goals (SVD), Cooperation and Facilitation (CF), Motivating, Inspiring and Building Trust (MIB), Managing Cultural Diversity (MCD), Decision-making and Responsibility (DMR), Strategic Thinking (ST), Emotional Intelligence (EI), and Managing Resources (MR).

The measurement of the levels of both Team Leadership Competencies and Academic Leadership Behaviors was high for the respondents. As the respondents were all members of research teams at the university, they had high levels of these leadership competencies and behaviors. This demonstrated that, to an extent, the respondents were thriving and effective in their teams. In addition, the score obtained from the research team effectiveness levels was also high. Respondents reported that overall productivity or research output was high, that they were satisfied, and that overall frustration levels were low. Therefore, it can be implied that this group of respondents is operating effectively in their roles as research team members.

The two-way ANOVA confirmed the relationship between the variables that influenced research team effectiveness. Consequently, this confirmed relationship also meant that a regression analysis could be conducted to determine what specific sub-dimensions significantly affected research team effectiveness. Four

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sub-variables of team leadership competencies and academic leadership behaviors significantly impacted research team members' team effectiveness. They were TM, RTL, MIB, and EI were the most significant variables affecting research team effectiveness. The significant sub-dimensions such as Research Team Leader, which is related to an individual who can administrate and manage the team, delegate, and make themselves apparent, seem to be those characteristics that would make the team efficient, and it is not surprising that it is one of the most significant sub-dimensions. The same can also be said of having the ability to motivate others. People with high levels of emotional intelligence can see others' perspectives and respond and act accordingly to others, which can be a motivating behavior.

Discussion

In this section, the researcher would like to discuss the findings of the study, based on the researchers' observations, in combination with relevant theories and other research literature.

Team Leadership Competencies

The literature review concluded ten key research team leadership competencies, which is a more comprehensive classification. The results also indicated the importance of the above critical types for research team leadership competencies. However, the research members' cooperation and facilitation are expected to improve more in the future, though their overall team leadership competencies are high. As Zhang (2019) stated, a behavioral trust mechanism must be established to achieve practical cooperation among team members, guaranteeing the teams' success. Of course, this also requires team members to strengthen their Communication Skills to ensure the team's positive development rather than misunderstanding due to communication errors. According to Yuan, Guo & Wu (2009), a lack of scholarly communication among research team members in universities, the construction of team culture was weak, and the cooperation among various disciplines tended to be superficial and lacked practical administrative guidance.

Similarly, team members should have high-level emotional intelligence and be responsible for the team, reflected in their resource management. In addition, team leaders should have strategic thinking, which is also one of the necessary leadership competencies of team leaders. It can guide the team's long-term practical behavior in the future so that members can complete tasks more clearly and in a planned way. The above studies were highly consistent with the conclusions of this study.

Academic Leadership Behavior

This study revealed the interaction effect between team leadership competencies and academic leadership behaviors concluded to be statistically significant, and they both impacted the research team members' team effectiveness. It was interesting that the interaction effect between team leadership competencies and academic leadership behaviors was not significant. The discussion on academic leadership behavior can focus on the corresponding actions members should take during team development or at different stages. The members of the scientific research team in Chinese universities are unique as knowledge-based talents. Antony (2017) suggested that academic leaders not only pay attention to the change of management but also the personal modesty and professional will of leaders in the implementation. Similarly, Su &Liang (2019) stated that research team leaders should respect the dominant position of the team members and adopt more incentive methods to motivate their behavior. Relying on the spontaneous behaviors of team members is more conducive to team development and scientific research performance than imposing scientific research tasks on team members. Both the team members themselves and others regarded the team, and the members influenced each other when completing tasks.

Research Team Effectiveness

Team effectiveness, as measured by publication productivity, team member satisfaction, and member satisfaction frustration (Omar &Ahmad, 2014). Mainly, the satisfaction of team members determines whether they are committed to the team's success. In addition, the study also pointed out that the number of publications is usually used to measure research productivity. The researchers' willingness to publish research papers also reflected their satisfaction with the team. Hackman (1987) explained that working in a team can be frustrating because it requires the team to work together and take collective action and decision-making, which may not be easy to achieve due to conflicts between teams. This meant that members might experience frustration within the research team. Furthermore, member frustration has also become essential to measure team effectiveness. The team frustration in this study was low, showing that team members were generally willing to express their opinions and make decisions to complete team research tasks.

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