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Prioritizing Students Needs and Insights from a Research Team using Multi Objective Optimization on the Basis of Ratio Analysis (MOORA) Approach

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Abstract:

Research is an essential component of higher education institutions, contributing to knowledge generation and innovation. This article discusses how the utilization of a Multi Criteria Decision Making (MCDM) Approach - Multi Objective Optimization on the basis of Ratio Analysis Method (MOORA) assists in understanding students' requirements, leading to the enhancement of college-level research teams and ultimately elevating the reputation of the institution. To begin with, it centres on the perspectives and fundamental requirements of students within the research team. Secondly, it underscores the importance of utilizing MOORA to rank these needs. Following the ranking procedure, its apparent that among all the criteria, Collaborative Efforts and Networking Strategies should be given a higher priority and least for Personal Interests or Hobbies. The study's outcomes also suggest that the implementation of a prioritization strategy could proficiently address a varied range of obstacles and shortcomings within the research team.

Keywords: Prioritization, MCDM, MOORA, Entrepreneurship, Ranking and Scoring.

1. Introduction

In the realm of educational institutions and scholarly pursuits, research teams play a pivotal role in cultivating a dynamic and intellectually stimulating environment. These teams often consist of students who are not only eager to contribute to the realm of knowledge but are also invaluable resources for shaping the future of academic inquiry. This research paper delves into the perspectives of students engaged in research teams, aiming to uncover their viewpoints, identify the challenges they encounter, and discern the advantages they experience. Through a comprehensive analysis, the study also seeks to introduce Prioritization approach to address these challenges and enhance the overall quality of the research team environment.

This study is based on the investigation that revolved around conducting interviews with a group of research-oriented students. In total, 70 students were engaged in this study. The process unfolded in two distinct stages. Initially, the focus was on the interviews themselves, wherein each student from the research team was individually interviewed. Following this data collection phase, the second stage involved a comprehensive analysis. The data obtained from the interviews was meticulously scrutinized and evaluated. To enhance the efficacy of the research team, MOORA technique was employed in the analysis. This method facilitated a structured approach to discerning and categorizing the various insights and ideas shared by the interviewed students. Ultimately, this endeavour aimed at bolstering the research team's performance and effectiveness through a thoughtful and systematic evaluation of the gathered information.

Academic satisfaction is essential for universities because it helps to forecast and enhance student satisfaction, which influences program development and improves all aspects of the educational experience (Aghaei et al., 2023). By incorporating clarity and practical strategies in course design, attempts that combine teaching strategies with learning science concepts aim to improve student achievement. By lowering frustration, assisting students in understanding how to learn well, and improving their odds of succeeding in college courses, this improves academic satisfaction (Ploran et al., 2023). Academic success depends on more than just classroom instruction; encouraging students to think like researchers is vital for increasing their profile and credibility. Academic institutions strive to promote research innovation through multidisciplinary collaborations, yet many academics find it difficult to identify areas of intersection and expertise within labs(Hendry & Giraldez, 2023). For societal advancement and higher education, it is critical to address the job and entrepreneurship issues faced by college students. As they are strongly linked to national economic stability and general well-being, authorities must conduct thorough analyses of these issues and put effective plans into place to promote a healthier and more sustainable society (Bangani & Dube, 2023). Many engineering graduates lack formal instruction in creative problem-solving and teamwork, which results in weaknesses in teamwork, group discussions, self-assurance, and writing abilities. While mentorship and group conversations with senior researchers promote learning and retain student enthusiasm, awareness of plagiarism ethics enhances research reading and writing practices (Sharma et al., 2020).

Academic entrepreneurship in the context of innovation and sustainability, underlining the need for increased collaboration in initiatives like the Innovation Incubator and financial issues in the implementation of innovations (Sieg et al., 2023). While entrepreneurship is an essential component of success in advanced countries, India's youth unemployment is caused by a lack of entrepreneurial knowledge and skill, examining student perceptions of the effect of entrepreneurship education in colleges is needed(Jena, 2020) and also creating an entrepreneurial environment that is innovative and failure-tolerant through the development of human, social, and psychological capital(Bu et al., 2023). While educational factors play an essential part in this process, entrepreneurship education enhances students' entrepreneurial inspiration, minimizing its positive

impact on the creation of an entrepreneurial mindset in higher education(Cui et al., 2021). Companies benefit from sustainable development because it lowers costs, generates income, and boosts competitiveness while minimizing environmental effect. It involves a business strategy that produces more than it consumes for the environment, the economy, and society, necessitating specialized solutions to handle its problems(Ptak & Lis, 2022).

So, Academic institutions can cut expenses, generate new revenue streams, improve their competitiveness, and fit with the overarching objectives of sustainable development if they prioritize sustainable research techniques. In terms of money, it's important to consider the culture of good investment, involvement, and collegiality that they foster within the institute because it can assist reduce possible losses from disengagement, decreased productivity, and member attrition(Hendry & Giraldez, 2023). Students take up the position of the scientific director in this study. Fostering creativity in group cooperation by investigating how to assist success and the execution of creative ideas during difficult tasks in a computer-supported environment(X. Wang et al., 2015). Stress has an impact on employee creativity at work, with role ambiguity (RA) having a negative effect and role conflict (RC) exhibiting a positive correlation(Y. Wang et al., 2021). Examining the relationship between requesting critical feedback and improving performance and learning while considering the mediation or moderating effect of revision and the influence of students' mindsets(Cutumisu & Lou, 2020) Enhancing CT in educators can potentially foster critical thinking skills in nursing students, leading to the generation of innovative ideas and improved learning outcomes (Martínez-Momblan et al., 2023). By encouraging self-analysis, inspiring productive discussions, fostering growth in individual contributions and team processes, effective student feedback enhances productivity and optimizes the performance(Petkova et al., 2021).

While educators struggle to evaluate the integration of both academic work and enterprise creation, students struggle to strike a balance. The difficulty lies in efficiently coordinating students' substantial venture creation activities with academic assessment and scheduling evaluations(Haneberg et al., 2022). The importance of identifying future entrepreneurs based on their subjective goals and interests in addition to the beneficial effects of entrepreneurship education on risk management and decision-making(Hong et al., 2012). College students are the ones who drive innovation and entrepreneurship; thus, it is vital to encourage their entrepreneurial willingness. The regulatory environment has a crucial role, and identifying essential aspects for the first time, such as policy support, entrepreneurship education, and social network support(Huang & Bu, 2023). Interdisciplinary teams that are successful are formed rapidly, projects are managed by experts, and decisions are made based on milestones. Collective knowledge acquisition, adaptability, and teamwork are key characteristics which accelerate innovation and produce comprehensive discoveries. These teams are expected to be effective in current and future endeavours, offering plenty of knowledge as well as benefits(Brown et al., 2023). Three main methods of data collecting were used in the action research process: group discussion, structured observation of participants, and written responses, this study involves data collection through interviews(Knox, 2022).

Data can be triangulated using interviews, activity recordings, curricular materials, and student media and findings provide evaluation insights by demonstrating the growth of creativity and entrepreneurship in real-world problem-oriented maker programs throughout the course of learning(Weng et al., 2022). Investments in innovative ICT resources, teacher training, and classroom design should be prioritized by higher education institutions. Using the most modern technology enables maintaining relevancy as well as providing students the most effective learning opportunities(Hanaysha et al., 2023). Teachers play a key role in developing students into holistic individuals through promoting environmental consciousness in addition to knowledge and abilities. Faculty members should encourage teacher development, apply a wide range of learning activities, and shift their attention from teacher-centric to student-centric to enhance engineering students' understanding of sustainability and to build positive behavioural changes(Mohd-Yusof et al., 2015).

2. Methodology

Considering the dynamic and engaged nature of the Research Cell within the engineering college, characterized by its active participation in a range of research disciplines where they formed 7 specialized teams. These teams have notably excelled in various competitions and have presented their research findings effectively and conscientious effort was undertaken to amplify team productivity and discern avenues for advancement.

Recognizing the inherent value in gathering perspectives, an interview initiative was orchestrated to capture the students' viewpoints. The intent behind this endeavour lies in recognizing that the insights of the students hold the potential to illuminate critical needs and areas of refinement. By closely attending to their feedback and channelling efforts toward fulfilling their requirements, it is anticipated that the research teams' outcomes will experience positive transformation, effectively contributing to the overarching enhancement of the Cell's research pursuits. The illustrated process flow, detailing the adopted methodology, can be observed in Figure 1. The methodology unfolded in two distinct phases. Initially, interview for the students in the 7 research teams, encompassing areas such as Energy, Vehicle Development, Power Conversion and Storage, Bioscience, Software, Garage, and Robotics, was acknowledged. These teams comprised students spanning various academic years (1st, 2nd, 3rd, and final year). Individual interviews were then meticulously conducted with 70 students, designed to extract insights into the advantages, disadvantages, student needs, and opinions related to their respective teams' environmentally focused research. These interviews not only enriched the teams' understanding but also laid the groundwork for strategic enhancement.

After the interview phase, the amassed opinions and requirements were subject to careful analysis and categorization, unveiling recurrent themes that spanned across teams. A prioritization matrix was thoughtfully formulated, integrating pivotal variables such as sustainability impact, feasibility, and alignment with overarching institutional goals. This matrix steered the process of decision-making, facilitating the distinction between high-priority and low-priority actions. High-priority

concerns catalysed the development of strategic action plans aimed at addressing critical issues, while low-priority aspects were acknowledged and infused into overarching enhancement strategies. This convergence of paths

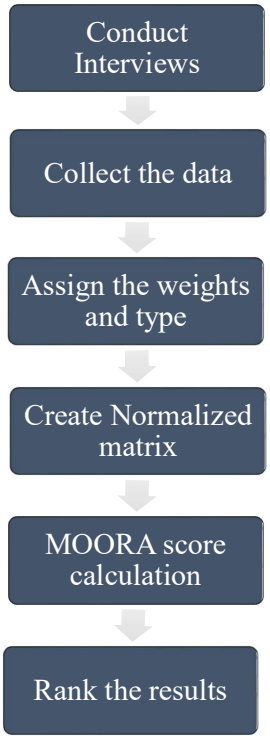

FIGURE 1 Methodology flow of enhancing research team productivity.

culminated in a shared commitment to heighten research productivity while nurturing an entrepreneurial mindset among student researchers. In essence, this meticulously designed methodology serves as a conduit for channelling student insights into actionable strategies, effectively aligning the Research Cell's ongoing initiatives with sustainability goals and propelling impactful transformation within the college's research endeavours.

3. Results and Discussions

3.1 Phase 1: Data collection (perspectives of students) through interviews

This segment presents the outcomes of student interviews and arranges their responses through a prioritization matrix. This matrix highlights the needs of the students that should hold greater significance and those that can be accorded lesser importance. A faculty member conducted individual interviews with students from the research team to gather insights into their opinions and requirements. The research division consists of seven separate groups: energy, software, power conversion and storage, garage, bioscience, vehicle development, and robotics. Each team is dedicated to sustainable initiatives, striving to conduct research and derive conclusions in manners that preserve the environment. While they are currently exerting their utmost efforts, there remains room for enhancement in productivity. By further augmenting the research teams, they can devise solutions for their existing problem statements. Therefore, there is a need for ongoing improvements. In each of these teams, 10 students were selected to partake in interviews and requested to rate the problem on a scale from 1 to 10. Ultimately, a total of 20 distinct problems and challenges pertaining to the enhancement of the research cell's functionality were discerned and listed in Table 1.

Through the utilization of interviews, the process of identifying and prioritizing the issues within the research team of an autonomous college was carried out. This assessment was further facilitated by employing three distinct project prioritization

TABLE 1. List of Criteria.

Criteria	Description	Weights	Type
C1	Technical Enrichment Sessions	0.05	Benefit
C2	Striking a Balance Between Research and Academics	0.05	Benefit
C3	Faculty Assistance and Direction in Research Endeavours	0.05	Benefit
C4	Guidance Provided by Team Lead	0.05	Benefit
C5	Enhancing Participation in Conferences and Competitions	0.05	Benefit
C6	Extended Work Hours and Over-Time Considerations	0.05	Benefit
C7	Expansion of Workspace Requirements	0.05	Benefit
C8	Enhancing Safety Measures	0.05	Benefit
C9	Effective Time Management Strategies	0.05	Benefit
C10	Developing Effective Communication Skills	0.05	Benefit
C11	Ice-Breaking and Team-Building Activities	0.05	Benefit
C12	Stress Management Techniques and Approaches	0.05	Benefit
C13	Fostering Effective Team Coordination	0.05	Benefit
C14	Personal interest or hobbies	0.05	Benefit
C15	Project Delays Due to Limited Experience	0.05	Benefit
C16	Challenges in Accessing Resources and Facilities	0.05	Benefit
C17	Institutional Funding Support and Initiatives	0.05	Benefit
C18	Collaborative Efforts and Networking Strategies	0.05	Benefit
C19	Navigating Unforeseen Challenges	0.05	Benefit
C20	Managing Diverse Expectations	0.05	Benefit

frameworks: the Prioritization Matrix, the Moscow method, and the Scoring model(Raji et al., 2023a)

3.2 Phase 2: Prioritizing feedback using MCDM Methodology

In Phase 2, MOORA a MCDM technique is employed to evaluate and rank the responses provided by students. There are a total of 20 distinct focus areas identified, and all seven research teams are tasked with evaluating these areas using a 1 to 10 scale to reflect their individual opinions and specific requirements. Once the scoring by students is completed, we aggregate the scores for each of the seven teams for each category and calculate the total score. This meticulous procedure is repeated for all 20 points. Finally, we rank the points in descending order based on their total scores, resulting in a prioritized list from highest to lowest scores. This approach allows us to objectively assess and rank the contributions of each team, facilitating informed decision-making and improvements in our research efforts.

3.2.1 Multicriteria Decision Making Techniques (MCDM)

In this study, MOORA, a Multiple Criteria Decision-Making model is chosen. This model is chosen because they are computationally compatible with drainage geomorphometry, possess algorithms that make it feasible to integrate multiple input

TABLE 2. Criteria and their scoring.

S.No	Criteria	Energy team(A1)	Power conversion system team(A2)	Software team(A3)	Robotics team(A4)	Bioscience team(A5)	Vehicle development team(A6)	Garage (A7)
1	C1	8	8	5	6	8	8	8
2	C2	9	8	8	8	9	8	8
3	C3	8	7	5	3	8	6	6
4	C4	6	7	10	8	8	4	6
5	C5	7	8	6	8	8	7	8
6	C6	9	9	8	8	9	8	8
7	C7	8	10	9	8	9	7	7
8	C8	7	10	4	6	6	5	7
9	C9	9	9	8	9	8	8	9
10	C10	8	9	8	9	8	8	8
11	C11	8	8	7	8	7	7	7
12	C12	8	8	7	8	7	8	8
13	C13	9	9	8	7	8	9	8
14	C14	5	4	5	4	4	5	5
15	C15	9	9	9	8	9	9	8
16	C16	10	10	9	10	9	10	9
17	C17	10	10	10	9	9	10	10
18	C18	10	10	9	10	10	10	10
19	C19	8	7	8	8	8	7	7
20	C20	7	7	6	7	7	8	7

parameters, and can be effectively adapted for spatially explicit analyses. Table 2 shows a list of the criteria and their corresponding scores.

3.2.2 Multi Objective Optimization based on Ratio Analysis (MOORA)

Due to the effectiveness in multi-criteria analysis, introduction of multi-objective optimization through ratio analysis is frequently used in operational research. Despite its benefits, its use of ecology resource planning is still limited.

The MOORA method, which Brauers first developed in 2004, is a effective Multi objective optimization tool that has been successful in resolving challenging decision-making issues in manufacturing settings. Steps to be followed in MOORA method is referred from (Raji et al., 2023b)

Step 1: Build a Decision Matrix

The Decision Matrix is also known as the Xij matrix, where 'i' stands for the number of criteria (m) and 'j' stands for the number of alternatives (n). This decision matrix is mathematically represented in Equation 1.

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & x_{13} & . & x_{1n} \\ x_{21} & x_{22} & x_{23} & . & x_{2n} \\ x_{31} & x_{32} & x_{33} & . & x_{3n} \\ . & . & . & . & . \\ x_{m1} & x_{m2} & x_{m3} & . & x_{mn} \end{bmatrix} \quad (1)$$

Step 2: Normalization of Decision Matrix

According to Brauers (2008), the square root of the sum of the squares of each criteria per alternative is used to calculate the base for normalization in this stage. This ratio can be stated numerically as follows:

$$r_{ij} = x_{ij} / \sqrt{\sum_{i=1}^{m} x_{ij}^2} (j = 1,2,3,4, \ldots . , n) \quad (2)$$

Step 3: Optimizing the alternative:

These normalized outputs are increased in the event of maximization (for favourable criteria) and lowered in the case of minimization (for unfavourable criteria) in multi-objective optimization. The optimization task then is:

$$y_i = \sum_{j=1}^{g} r_{ij} - \sum_{j=g+1}^{n} r_{ij} \quad (3)$$

Where yi is the normalized value of the criteria value against all alternatives, g is the number of alternatives to be maximized, (n-g) is the number of alternatives to be minimized. It is sometimes seen that certain criteria are more significant than others. The trait may be increased in significance by multiplying it by the weight that is appropriate (coefficient of significance). When the crietria weight is taken into account, , equation 3 becomes

$$y_i = \sum_{j=1}^{g} w_j r_{ij} - \sum_{j=g+1}^{n} w_j r_{ij} (j = 1,2,3,4, \dots \dots, n) \quad (4)$$

where wj is the weight of the jth choice.

TABLE 3. Normalization matrix.

S.No	Criteria	Energy team	Power conversion system team	Software team	Robotics team	Bioscience team	Vehicle development team	Garage
1	C1	0.21685	0.21103	0.14624	0.17220	0.22214	0.23017	0.22942
2	C2	0.24396	0.21104	0.23398	0.22961	0.24990	0.23017	0.2294
3	C3	0.21685	0.18466	0.14624	0.08610	0.22214	0.17263	0.17206
4	C4	0.16264	0.18466	0.29248	0.22961	0.22214	0.11509	0.17206
5	C5	0.18974	0.21104	0.17549	0.22961	0.22214	0.20141	0.22942
6	C6	0.24396	0.23742	0.23399	0.22961	0.24990	0.23017	0.22942
7	C7	0.21685	0.26380	0.26323	0.22961	0.24990	0.20140	0.20074
8	C8	0.18974	0.26380	0.11699	0.17220	0.16660	0.14386	0.20074
9	C9	0.24396	0.23742	0.23398	0.25831	0.22214	0.23017	0.25809
10	C10	0.21685	0.23742	0.23398	0.25831	0.22214	0.2301	0.22942
11	C11	0.21685	0.21104	0.20473	0.22961	0.19437	0.20140	0.20074
12	C12	0.21685	0.21104	0.20473	0.22961	0.19437	0.23017	0.22942
13	C13	0.24396	0.23742	0.23398	0.20090	0.22214	0.25895	0.22942
14	C14	0.13553	0.10552	0.14624	0.11480	0.11107	0.14386	0.14339
15	C15	0.24396	0.23742	0.26323	0.22961	0.24990	0.25895	0.22942
16	C16	0.27107	0.26380	0.26323	0.28701	0.24990	0.28772	0.25809
17	C17	0.27106	0.26380	0.29248	0.25831	0.24990	0.28772	0.28677
18	C18	0.27106	0.26380	0.29248	0.25831	0.24990	0.28772	0.28677
19	C19	0.27106	0.26380	0.26323	0.28701	0.27767	0.28772	0.28677
20	C20	0.21685	0.18466	0.23398	0.22961	0.22214	0.20140	0.20074

Step 4: Depending on the decision matrix's maximal (favourable criteria) and minimal (unfavourable criteria) values for yi, the value of yi may be positive or negative.

The final preference is shown by yi's ordinal rank. Since the worst criteria has the lowest Yi value, the best criteria has the highest Yi value.

The Normalization matrix can be seen in Table 3, and the Normalized weighted matrix is presented in Table 4. Yi's values are listed in Table 5, and the results of the criteria after the ranking process are given in Table 6.

TABLE 4. Weighted Normalised Matrix.

S.No	Criteria	Energy team	Power conversion system team	Software team	Robotics team	Bioscience team	Vehicle development team	Garage
1	C1	0.0542	0.0528	0.0366	0.0431	0.0555	0.0575	0.0574
2	C2	0.061	0.0528	0.0585	0.0574	0.0625	0.0575	0.0574
3	C3	0.0542	0.0462	0.0366	0.0215	0.0555	0.0432	0.043
4	C4	0.0407	0.0462	0.0731	0.0574	0.0555	0.0288	0.043
5	C5	0.0474	0.0528	0.0439	0.0574	0.0555	0.0504	0.0574
6	C6	0.061	0.0594	0.0585	0.0574	0.0625	0.0575	0.0574
7	C7	0.0542	0.0659	0.0658	0.0574	0.0625	0.0504	0.0502
8	C8	0.0474	0.0659	0.0292	0.0431	0.0417	0.036	0.0502
9	C9	0.061	0.0594	0.0585	0.0646	0.0555	0.0575	0.0645
10	C10	0.0542	0.0594	0.0585	0.0646	0.0555	0.0575	0.0574
11	C11	0.0542	0.0528	0.0512	0.0574	0.0486	0.0504	0.0502
12	C12	0.0542	0.0528	0.0512	0.0574	0.0486	0.0575	0.0574
13	C13	0.061	0.0594	0.0585	0.0502	0.0555	0.0647	0.0574
14	C14	0.0339	0.0264	0.0366	0.0287	0.0278	0.036	0.0358
15	C15	0.061	0.0594	0.0658	0.0574	0.0625	0.0647	0.0574
16	C16	0.0678	0.0659	0.0658	0.0718	0.0625	0.0719	0.0645
17	C17	0.0678	0.0659	0.0731	0.0646	0.0625	0.0719	0.0717
18	C18	0.0678	0.0659	0.0658	0.0718	0.0694	0.0719	0.0717
19	C19	0.0542	0.0462	0.0585	0.0574	0.0555	0.0504	0.0502
20	C20	0.0542	0.0528	0.0366	0.0431	0.0555	0.0575	0.0502

TABLE 5. Yi list.

S.No	Criteria	Maximum	Minimum	Yi Max- Min
1	C1	0.3571	0	0.3571
2	C2	0.4071	0	0.4071
3	C3	0.3002	0	0.3002
4	C4	0.3447	0	0.3447
5	C5	0.3648	0	0.3648
6	C6	0.4137	0	0.4137
7	C7	0.4064	0	0.4064
8	C8	0.3135	0	0.3135
9	C9	0.421	0	0.421
10	C10	0.4071	0	0.4071
11	C11	0.3648	0	0.3648
12	C12	0.3791	0	0.3791
13	C13	0.4067	0	0.4067
14	C14	0.2252	0	0.2252
15	C15	0.4282	0	0.4282
16	C16	0.4702	0	0.4702
17	C17	0.4775	0	0.4775
18	C18	0.4843	0	0.4843
19	C19	0.3571	0	0.3571
20	C20	0.4071	0	0.4071

TABLE 6. Rank of the Results.

S.No	Criteria	Results	Ranking
1	Technical Enrichment Sessions	0.3571	15
2	Striking a Balance Between Research and Academics	0.4071	8
3	Faculty Assistance and Direction in Research Endeavours	0.3002	19
4	Guidance Provided by Team Lead	0.3447	16
5	Enhancing Participation in Conferences and Competitions	0.3648	13
6	Extended Work Hours and Over-Time Considerations	0.4137	6
7	Expansion of Workspace Requirements	0.4064	10
8	Enhancing Safety Measures	0.3135	18
9	Effective Time Management Strategies	0.421	5
10	Developing Effective Communication Skills	0.4071	7
11	Ice-Breaking and Team-Building Activities	0.3648	13
12	Stress Management Techniques and Approaches	0.3791	11
13	Fostering Effective Team Coordination	0.4067	9
14	Personal interest or hobbies	0.2252	20
15	Project Delays Due to Limited Experience	0.4282	4
16	Challenges in Accessing Resources and Facilities	0.4702	3
17	Institutional Funding Support and Initiatives	0.4775	2
18	Collaborative Efforts and Networking Strategies	0.4843	1
19	Navigating Unforeseen Challenges	0.3571	12
20	Managing Diverse Expectations	0.4071	17

4. Conclusions

Conducting interviews with students to get feedback on the research team can be an effective approach to improve the team's overall efficiency. Better management can be adopted to improve several facets of the research team by obtaining insights into areas that need improvement and those where less attention is needed. The MOORA method offers a simple way to rank criteria, enabling decision-makers to take well-informed and efficient decisions and avoid wasting time and money.

It is evident from the ranking findings that Collaborative Efforts and Networking Strategies should be given top importance. After that, Institutional Funding Support and Initiatives should be carefully evaluated, whereas Personal Interests or Hobbies and Faculty Assistance and Direction in Research Endeavours could be given a lesser importance. This ranking approach makes it clear where greater focus should be placed, which ultimately boosts productivity for each team and the entire organization.

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