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LINEAR PROGRAMMING AND PERSONNEL MANAGEMENT OF CONSTRUCTION FIRMS IN PORT HARCOURT

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ABSTRACT

This study examines the relationship between linear programming and personnel management of construction firms in Port Harcourt. This study adopted a correlational survey research design. The population of the study consisted of 20 constructions firms in Port Harcourt as retrieved from Nigerian business directory. 3 respondents which include logistic mangers, procurement manager and branch manager were selected from each firm multiplied by 20 firs give us a total of 60 respondents. Structured questionnaire was used in data collection. The result of the Cronbach's Alpha reliability test indicates .800 which is above .70 which implies that the items are reliable. Pearson product moment correlation was used to test the hypotheses using SPSS (statistical package social sciences). The study revealed that there is a significant relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt. There is a significant relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt. There is a significant relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt. The study concluded that Linear programming provides a systematic approach to optimizing resource allocation in construction firms, leading to improved efficiency and profitability. The study recommended that construction firms should implement training programs for staff on how to use linear programming tools effectively in personnel management.

Background of the Study

Linear programming is a mathematical method used to determine the best possible outcome in a given mathematical model for a set of linear relationships. It involves optimizing a linear objective function subject to linear equality and inequality constraints. The Simplex method, Criss-cross algorithm, and Ellipsoid method are popular techniques used in solving linear programming problems (Oyediran, & Adenuga, 2018). The Simplex method is one of the most widely used algorithms for solving linear programming problems. It was developed by George Dantzig in 1947 and has since become a fundamental tool in optimization theory. The method works by moving from one feasible solution to another along the edges of the feasible region until an optimal solution is reached. The Criss-cross algorithm is another approach to solving linear programming problems. It was introduced by Harold Kuhn in 1955 as an alternative to the Simplex method. The algorithm works by iteratively updating the basic variables in such a way that they move towards an optimal solution. The Ellipsoid method is a more recent development in linear programming, proposed by Leonid Khachiyan in 1979. This method uses ellipsoids to approximate the feasible region and iteratively refines these approximations until an optimal solution is found (Ogunlana, et al.,2006).
Aibinu and Jagboro (2002) Personnel management in construction firms plays a crucial role in ensuring the successful completion of projects on time and within budget. Effective

personnel management involves recruiting, training, motivating, and retaining skilled workers to meet project requirements. In Port Harcourt, Nigeria, where construction activities are prevalent, efficient personnel management practices are essential for the success of construction firms operating in the region. Overall, the study on linear programming techniques such as the Simplex method, Criss-cross algorithm, and Ellipsoid method can provide valuable insights into optimizing resource allocation and decision-making processes in construction firms in Port Harcourt. By applying these mathematical tools alongside effective personnel management strategies, construction firms can enhance their operational efficiency and achieve better project outcomes.

Statement of the Problem

The study on linear programming and personnel management of construction firms in Port Harcourt may face several challenges or areas that could be problematized: Complexity of Construction Projects: Construction projects often involve multiple variables and constraints that can make linear programming models complex and challenging to solve efficiently. Dynamic Nature of Construction Industry: The construction industry is characterized by its dynamic nature, with changing market conditions, project requirements, and workforce dynamics. This can pose challenges for personnel management strategies within construction firms. Resource Constraints: Limited availability of resources such as skilled labor, materials, and equipment can impact both linear programming solutions for project optimization and personnel management decisions within construction firms (Oyediran & Adenuga, 2018).

The specific socio-economic context of Port Harcourt may influence the applicability of traditional linear programming models and personnel management practices within construction firms operating in the region. Integration of Technology: The integration of technology such as Building Information Modeling (BIM) or project management software can enhance both linear programming solutions and personnel management practices in construction firms but may also require additional skills training for employees. Overall, addressing these challenges requires a comprehensive understanding of both the theoretical principles of linear programming and effective personnel management strategies tailored to the unique characteristics of the construction industry in Port Harcourt.

Conceptual Framework

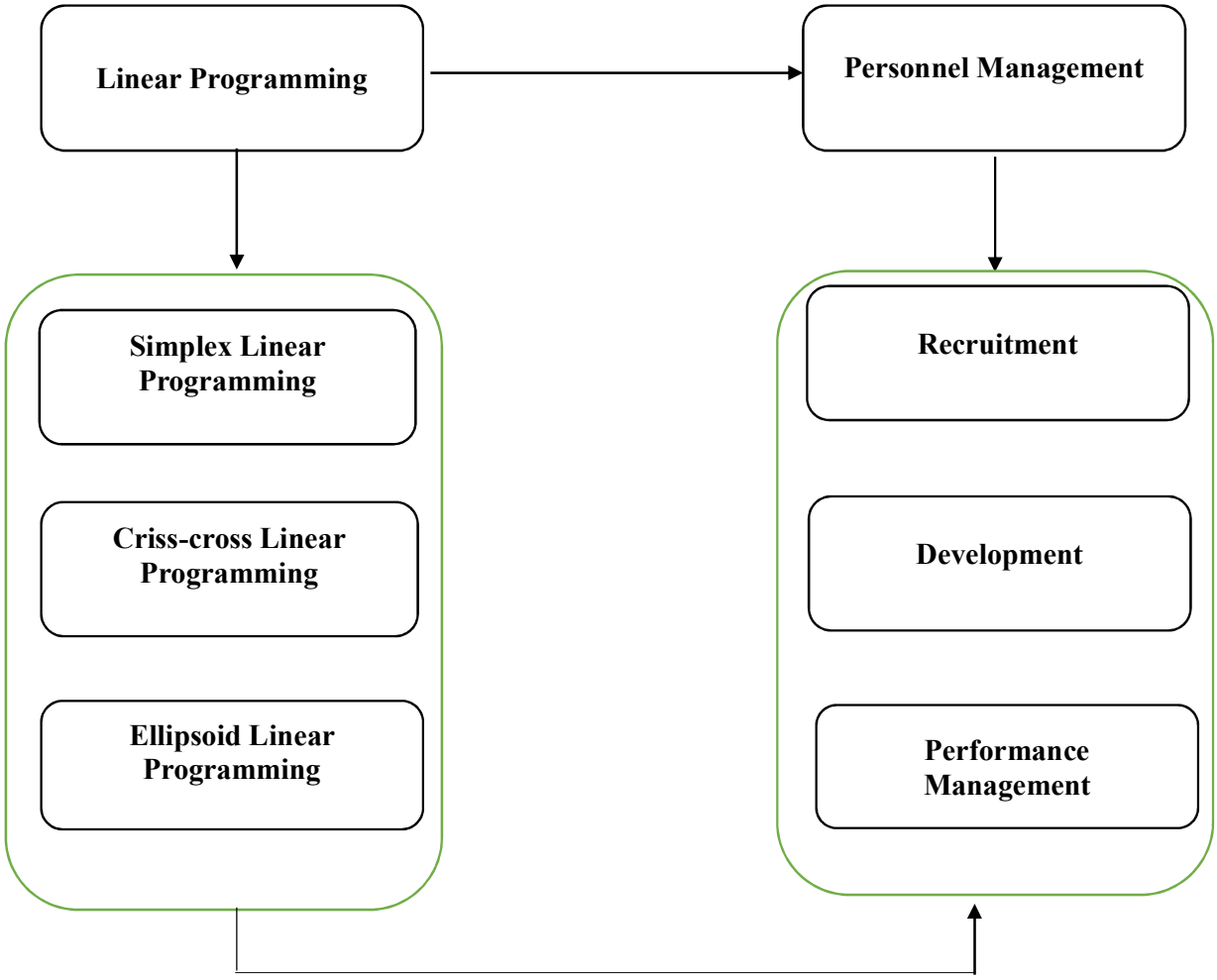

Figure 1: Conceptual framework on linear programming and personnel management of construction firms in Port Harcourt
Source: Adapted from Cascio, (2017) & Armstrong (2019).

Aims & Objectives

This study examines the relationship between linear programming and personnel management of construction firms in Port Harcourt. The specific objectives were to:

1) Determine the relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt.
2) Determine the relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt.
3) Determine the relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt.

Research Questions

The following research questions were raised to guide the study

1) What is the relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt?

2) What is the relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt?
3) What is the relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt?

Hypotheses

The following null hypotheses were formulated and tested at a significant level of 0.01

HO_1: There is no significant relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt.

HO_2: There is no significant relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt.

HO_3: There is no significant relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt.

REVIEW OF RELATED LITERATURE

Conceptual Review

Concept of Linear Programming

Oyediran and Adenuga (2018) Linear programming is a mathematical method used to determine the best possible outcome in a given mathematical model for a set of linear relationships. It involves optimizing a linear objective function subject to linear equality and inequality constraints. In the context of construction firms in Port Harcourt, Nigeria, linear programming can be utilized to optimize various aspects of their operations such as resource allocation, project scheduling, cost minimization, and profit maximization. In summary, linear programming techniques such as Simplex, Criss-cross, and Ellipsoid can offer significant benefits to construction firms in Port Harcourt by helping them optimize resource allocation, project scheduling, cost management, and overall operational efficiency (Armstrong, 2019).

Dimensions of Linear Programming

Simplex Linear Programming

The Simplex method is one of the most widely used algorithms for solving linear programming problems. It starts at an initial feasible solution and iteratively moves along the edges of the feasible region towards the optimal solution. In the case of construction firms in Port Harcourt, simplex linear programming can be applied to optimize resource allocation for various construction projects, ensuring that materials and labor are efficiently utilized to minimize costs and maximize profits (Aibinu, & Jagboro, 2002).

Criss-Cross Linear Programming

Criss-cross linear programming is a variant of the Simplex method that aims to improve computational efficiency by reducing the number of pivot operations required to reach the optimal solution. This approach can be particularly beneficial for large-scale construction projects undertaken by firms in Port Harcourt, where efficient resource allocation and scheduling are crucial for project success (Aibinu & Jagboro, 2002).

Ellipsoid Linear Programming

Oyediran, and Adenuga (2018) Ellipsoid linear programming is another optimization technique that uses ellipsoids to approximate the feasible region and iteratively refine this

approximation to converge towards the optimal solution. This method is particularly useful for high-dimensional problems where traditional methods like Simplex may struggle. Construction firms in Port Harcourt could benefit from ellipsoid linear programming when dealing with complex projects involving multiple constraints and variables (Armstrong, 2019).

Personnel Management

Adewale (2017) personnel management in construction firms in Port Harcourt involves various aspects such as recruitment, development, and performance management. These functions are crucial for ensuring the success of construction projects and the overall growth of the organization. In this discussion, we will delve into each of these areas in the context of construction firms operating in Port Harcourt. Noe, et al., (2019). Overall, personnel management plays a crucial role in the success of construction firms operating in Port Harcourt. By focusing on recruitment, development, and performance management strategies tailored to the needs of the construction industry, organizations can build a skilled workforce, foster employee growth and satisfaction, and achieve their business objectives effectively(Gatewood, et al.,2010).

Measures of Personnel Management

Recruitment

Cascio and Boudreau (2016) Recruitment is a critical function in personnel management as it involves attracting, selecting, and appointing suitable candidates for various positions within the organization. In the construction industry, recruiting skilled workers is essential to ensure that projects are completed on time and within budget. Construction firms in Port Harcourt may face challenges in recruiting qualified personnel due to factors such as competition from other industries, limited availability of skilled workers, and the need for specialized skills in construction projects (Adewale,2017).

Development

Adeyemi, and Alabi (2015) Development is another important aspect of personnel management that focuses on enhancing the skills and knowledge of employees to improve their performance and contribute to the success of the organization. In the context of construction firms in Port Harcourt, employee development programs can include training sessions on safety procedures, technical skills training, leadership development programs, and opportunities for career advancement within the organization. Investing in employee development not only benefits individual employees but also helps construction firms build a skilled workforce that can meet the demands of complex construction projects (Lussier, & Hendon, 2016).

Performance Management

Cascio (2017) Performance management is a process that involves setting clear goals and expectations for employees, providing regular feedback on their performance, and recognizing and rewarding achievements. Mathis, et al., (2017) In construction firms in Port Harcourt, performance management systems can help identify areas for improvement, address issues affecting productivity and quality of work, and motivate employees to perform at their best. By implementing effective performance management practices, construction firms can enhance employee engagement, improve project outcomes, and achieve long-term success in a competitive market (Adewale,2017).

Empirical Review

One such study is by Ogunlana, Olomolaiye, and Harris (2006), which focused on the application of linear programming in the construction industry in Nigeria. The authors examined how linear programming techniques could be used to optimize resource allocation and improve project performance in construction firms. The study population consisted of construction firms in Nigeria, and data were collected through surveys and interviews with managers and employees. The data analysis method involved using linear programming models to optimize resource allocation based on various constraints and objectives. The findings indicated that linear programming could significantly improve project performance by optimizing resource allocation. The study concluded that the application of linear programming techniques could enhance decision-making processes in construction firms.

Another relevant study is by Aibinu and Jagboro (2002), who investigated the impact of personnel management practices on construction project performance in Nigeria. The authors examined how effective personnel management strategies could lead to improved project outcomes in the construction industry. The study population included construction firms in Nigeria, and data were collected through questionnaires administered to project managers and employees. The data analysis method involved statistical analysis to identify correlations between personnel management practices and project performance indicators. The findings suggested that effective personnel management practices positively influenced project performance in construction firms. The study concluded that investing in personnel management training and development could lead to better project outcomes.

Theoretical Review

Optimization Theory

Optimization theory was propounded by mathematicians and economists in the 20th century. The theory aims to find the best solution from a set of feasible solutions, considering certain constraints. It has applications in various fields such as economics, engineering, management, and more.

Assumptions of Optimization Theory:

1. Rationality: Individuals are assumed to make decisions that maximize their utility or benefit.
2. Consistency: Preferences are assumed to be transitive and consistent over time.
3. Constraints: There are limitations or constraints on resources available for decision-making.
4. Linearity: Many optimization problems assume linear relationships between variables.

Critiques of Optimization Theory:

1. Oversimplification: Critics argue that the assumptions made in optimization theory may oversimplify real-world complexities.

2. Unrealistic Assumptions: The assumption of perfect rationality and complete information may not hold true in practical scenarios.

3. Lack of Flexibility: Optimization models may not easily adapt to changing conditions or unexpected events.

4. Ethical Considerations: Some critics raise concerns about the ethical implications of optimizing outcomes without considering broader societal impacts.

5. Limited Scope: Optimization theory may not capture all aspects of decision-making, leading to suboptimal solutions in certain cases.

Relevance to Linear Programming and Personnel Management of Construction Firms in Port Harcourt: Optimization theory is highly relevant to linear programming, which is a mathematical method for determining a way to achieve the best outcome in a given mathematical model with linear relationships. In the context of personnel management in construction firms in Port Harcourt, optimization theory can be applied to optimize resource allocation, scheduling, cost minimization, and efficiency improvement. By utilizing optimization techniques, construction firms can streamline their operations, allocate resources effectively, minimize costs, and improve overall performance.

Resource Allocation Theory

Resource Allocation Theory was propounded by economist Richard M. Cyert and mathematician James G. March in their seminal work "A Behavioral Theory of the Firm," published in 1963. The theory focuses on how organizations make decisions regarding the allocation of resources to achieve their goals efficiently.

Assumptions of Resource Allocation Theory:

1. Bounded Rationality: Organizations have limited cognitive abilities to process information and make decisions.
2. Satisficing Behavior: Organizations aim to achieve satisfactory rather than optimal outcomes due to bounded rationality.
3. Incremental Decision Making: Decisions are made incrementally based on past experiences and feedback.
4. Conflict and Coalition: Organizations consist of various interest groups with conflicting goals, leading to negotiation and compromise.
5. Adaptive Behavior: Organizations adapt their strategies over time in response to environmental changes.

Critiques of Resource Allocation Theory:

1. Oversimplification: Critics argue that the theory oversimplifies the decision-making process in organizations by focusing solely on bounded rationality.
2. Lack of Predictive Power: Some scholars question the theory's ability to predict organizational behavior accurately in complex real-world situations.
3. Neglect of External Factors: The theory may overlook the influence of external factors such as market dynamics and competitive pressures on resource allocation decisions.

Relevance to Linear Programming and Personnel Management of Construction Firms in Port Harcourt: Resource Allocation Theory can be applied to the study of linear programming in construction firms in Port Harcourt by providing insights into how these firms allocate resources such as labor, materials, and equipment to optimize project outcomes within constraints. The theory's emphasis on bounded rationality and incremental decision making can help understand how personnel management practices are shaped by organizational goals, group dynamics, and adaptive strategies.

METHODOLOGY

This study adopted a correlational survey research design. The population of the study consisted of 20 constructions firms in Port Harcourt as retrieved from Nigerian business directory which include Julius Berger Nigeria Plc, Cappa and D'Alberto Plc, Setraco Nigeria Limited, Reynolds Construction Company (RCC) Nigeria Limited, Gitto Costruzioni Generali Nigeria Limited, China Civil Engineering Construction Corporation (CCECC), Arab Contractors Nigeria Limited, Costain West Africa Plc, Bouygues Construction Nigeria Limited, Monier

Construction Company (Nigeria) Limited, Niger Delta Development Commission (NDDC), Levant Construction Company Nigeria Limited, Hitech Construction Company Limited, Lubrik Construction Company Limited, Interkel Group International Services Limited, Enerco Nigeria Limited, Adold Engineering Company Limited, Reynolds Construction Company (Nigeria) Limited (RCC), Sermatech Nigeria Ltd and P.W.Nigeria Ltd.

3 respondents which include logistic mangers, procurement manager and branch manager were selected from each firm multiplied by 20 firs give us a total of 60 respondents. Structured questionnaire was used in data collection. The reliability of empirical measurement is indicated by the internal consistency, One of the most commonly used indicators of internal consistency is Cronbach's alpha coefficient. Questionnaire item statements with Cronbach's alpha reliability coefficient below the 0.70 threshold were eliminated. the test-re-test method was used. 20 copies of the questionnaire instrument were issue and some later same copies were issue through electronic media. the results were used in computation using Cronbach's alpha test of reliability.

Table 1: Reliability Statistics

Cronbach's Alpha	N of Items
.800	6

Source: Researcher Computation via SPSS Version 25

The result of the Cronbach's Alpha reliability test indicates .800 which is above .70 which implies that the items are reliable. Pearson product moment correlation was used to test the hypotheses using SPSS (statistical package social sciences).

Data Analysis

HO_1: There is no significant relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt.

Table 2: Correlations on Simplex Linear Programming and Personnel Management

		Simplex Linear Programming	personnel management
Simplex Linear Programming	Pearson Correlation	1	.737**
	Sig. (2-tailed)		.000
	N	60	60
personnel management	Pearson Correlation	.737**	1
	Sig. (2-tailed)	.000	
	N	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlations on Simplex Linear Programming and personnel management revealed that there is a significant relationship between Simplex Linear Programming and personnel

management of construction firms in Port Harcourt where R. .737 = .000 leading to acceptance of the alternate hypothesis: There is a significant relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt.

HO_2: There is no significant relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt.

Table 3: Correlations on Criss-Cross Linear Programming and Personnel Management

		Criss-cross Linear Programming	personnel management
Criss-cross Linear Programming	Pearson Correlation	1	.705**
	Sig. (2-tailed)		.000
	N	60	60
personnel management	Pearson Correlation	.705**	1
	Sig. (2-tailed)	.000	
	N	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3: Correlations on Criss-cross Linear Programming and personnel management revealed that there is a significant relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt where R. .705 = .000 leading to acceptance of the alternate hypothesis: There is a significant relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt.

HO_3: There is no significant relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt.

Table 4: Correlations on Ellipsoid Linear Programming and Personnel Management

		Ellipsoid Linear Programming	Personnel management
Ellipsoid Linear Programming	Pearson Correlation	1	.547**
	Sig. (2-tailed)		.000
	N	60	60
personnel management	Pearson Correlation	.547**	1
	Sig. (2-tailed)	.000	
	N	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4: Correlations on Ellipsoid Linear Programming and personnel management revealed that there is a significant relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt where R. .547 = .000 leading to acceptance of the alternate hypothesis: There is a significant relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt.

Discussion of Findings

Table 2: Correlations on Simplex Linear Programming and personnel management revealed that there is a significant relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt where R. .737 = .000 leading to acceptance of the alternate hypothesis: There is a significant relationship between Simplex Linear Programming and personnel management of construction firms in Port Harcourt. Table 3: Correlations on Criss-cross Linear Programming and personnel management revealed that there is a significant relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt where R. .705 = .000 leading to acceptance of the alternate hypothesis: There is a significant relationship between Criss-cross Linear Programming and personnel management of construction firms in Port Harcourt. Table 4: Correlations on Ellipsoid Linear Programming and personnel management revealed that there is a significant relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt where R. .547 = .000 leading to acceptance of the alternate hypothesis: There is a significant relationship between Ellipsoid Linear Programming and personnel management of construction firms in Port Harcourt.

Similarly, one such study is by Ogunlana, Olomolaiye, and Harris (2006), which focused on the application of linear programming in the construction industry in Nigeria. The authors examined how linear programming techniques could be used to optimize resource allocation and improve project performance in construction firms. The study population consisted of construction firms in Nigeria, and data were collected through surveys and interviews with managers and employees. The data analysis method involved using linear programming models to optimize resource allocation based on various constraints and objectives. The findings indicated that linear programming could significantly improve project performance by optimizing resource allocation. The study concluded that the application of linear programming techniques could enhance decision-making processes in construction firms.

Also, another relevant study is by Aibinu and Jagboro (2002), who investigated the impact of personnel management practices on construction project performance in Nigeria. The authors examined how effective personnel management strategies could lead to improved project outcomes in the construction industry. The study population included construction firms in Nigeria, and data were collected through questionnaires administered to project managers and employees. The data analysis method involved statistical analysis to identify correlations between personnel management practices and project performance indicators. The findings suggested that effective personnel management practices positively influenced project performance in construction firms. The study concluded that investing in personnel management training and development could lead to better project outcomes.

CONCLUSION

The study concluded that Linear programming provides a systematic approach to optimizing resource allocation in construction firms, leading to improved efficiency and profitability. By utilizing this mathematical tool, firms can make data-driven decisions that enhance project

outcomes and overall organizational success. In conclusion, integrating linear programming techniques into personnel management processes can significantly benefit construction firms in Port Harcourt by improving resource allocation, project planning, and overall performance. By embracing this quantitative approach, firms can gain a competitive edge in a dynamic industry landscape.

RECOMMENDATIONS

Based on the analysis of linear programming and personnel management in construction firms in Port Harcourt, the following recommendations were made:

1. Implement training programs for staff on how to use linear programming tools effectively in personnel management.
2. Invest in software solutions that incorporate linear programming algorithms for resource optimization.
3. Regularly review and update linear programming models to reflect changing project requirements and constraints.
4. Collaborate with academic institutions or consulting firms specializing in operations research to further enhance the application of linear programming in personnel management.

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