



Oleksii Borysov

DEVELOPMENT OF A REGRESSION MODEL FOR EFFECTIVE LABOUR MANAGEMENT OF AN IT PROJECT

The object of the study is human resource management in IT projects, where the diversity of cultural characteristics and communication practices can affect the efficiency of task performance. The main problem addressed in this study is to identify the key factors that affect the effectiveness of human resource management in IT projects and to identify problem areas that need to be adjusted to improve the productivity and quality of teamwork. The study findings showed that the effectiveness of human resource management in IT projects largely depends on four main aggregate indicators: communication and interaction, cultural factors, leadership and management, and technical and professional skills. In particular, the model found that improved communication and interaction, as well as leadership and management, have the greatest positive impact on overall performance. Instead, cultural differences can create barriers that negatively affect teamwork performance. The findings are explained by the fact that effective communication and interaction are fundamental to coordinating teamwork, ensuring clarity of tasks, and timely information exchange. Leadership and management determine team motivation, conflict resolution strategies, and the overall direction of activities. The negative impact of cultural factors is explained by language barriers, differences in work approaches, and other cultural characteristics that can make it difficult to understand and cooperate. These findings can be used in practice in IT projects where multicultural teams work. They provide valuable guidance for leaders and managers on which aspects of management to focus on to improve team effectiveness. In particular, effective communication practices should be implemented, leadership skills and strategic planning should be developed, and cultural sensitivity should be taken into account, as well as training and development of technical and professional skills of team members. This will help overcome cultural barriers, improve collaboration, and increase the overall productivity of IT projects.

Keywords: human resources, regression model, IT project, problem tree, decision tree, effective management of the IT project team.

Received date: 07.08.2024

Accepted date: 03.10.2024

Published date: 08.10.2024

© The Author(s) 2024

This is an open access article

under the Creative Commons CC BY license

How to cite

Borysov, O. (2024). Development of a regression model for effective labour management of an IT project. *Technology Audit and Production Reserves*, 5 (2 (79)), 29–38. <https://doi.org/10.15587/2706-5448.2024.312743>

1. Introduction

Human resources in an IT project are a key element in the success of any information project. It is a set of people involved in the development, implementation, and support of information systems and products. In IT projects, the workforce includes programmers, analysts, testers, designers, project managers, and other specialists who provide various aspects of the project. Their knowledge, skills, experience, and motivation are the determining factors that affect the quality of the final product, meeting project deadlines and budgets. Effective human resource management is critical to the successful completion of an IT project, as it promotes optimal task allocation, productive teamwork, and overall performance.

Effective labor management in an IT project is a complex but achievable task that requires the use of various strategies and methods. Resource planning is the first and most important step in managing labor resources. This includes assessing the need for specialists and creating a detailed work schedule.

Analyzing the methods and models of effective management of IT project labor resources, it is possible to distinguish several main approaches and recommendations described in the works of various scientists. The authors of [1] consider the main methods of resource planning, including the use of flexible methodologies (Agile, Scrum). The paper emphasizes the importance of detailed planning, which includes assessing the need for specialists and the distribution of tasks. It is noted that the use of Agile methodologies allows for quick adaptation to changes, which is critical for the successful completion of projects. The main aspect is continuous planning and plan adjustment based on real results and feedback.

In their studies [2, 3], the authors focus on building a team with a high level of technical competence. The article discusses the main competencies that IT project managers should have, including technical skills, managerial abilities, and learning ability. It emphasizes the importance of continuous development and training of the team, as well as the involvement of experts to improve the level of knowledge and skills.

Creating a comfortable working environment and providing opportunities for professional development are key factors that contribute to increased team engagement and productivity. Comfortable working conditions, such as flexible working hours, comfortable office space, and support for work-life balance, allow employees to focus on their tasks and reduce stress. Professional development opportunities, including trainings, refresher courses and mentoring programs, contribute to the continuous improvement of employees' skills, which increases their motivation and commitment to the company. As a result, providing a comfortable working environment and supporting professional development contribute to the creation of effective, motivated and productive teams, which are critical to the success of an organization in the long run. The authors of [4] consider both tangible (bonuses, bonuses) and intangible (recognition, career development) incentive methods. They also emphasize the importance of creating comfortable working conditions and opportunities for professional development, which contributes to the team's engagement and productivity.

Effective communication is critical to successful IT project management. Using modern tools such as Slack and Microsoft Teams can significantly improve team coordination, awareness, and productivity. These tools support both synchronous and asynchronous communication, which is important for distributed and global teams. Automating communication processes and developing clear rules for using the tools can further increase the efficiency of communication and project management. In articles [5, 6], the authors discuss various communication tools and methods, including the use of modern tools (Slack, Microsoft Teams) to ensure continuous information exchange between team members. They also emphasize the need for regular meetings, such as daily stand-ups and retrospectives, to ensure consistency and effective project management.

Effective IT project management is largely dependent on the implementation of quality control systems and metrics, such as key performance indicators (KPIs). Using these tools allows project managers not only to assess progress and performance in real time, but also to proactively manage processes, identify problems in time, and take corrective action. Feedback and continuous process improvement, backed by accurate data and analytics, help to achieve high quality standards, increase team efficiency, and ensure stakeholder satisfaction. Thus, quality control systems and metrics are integral elements of successful IT project management, allowing to adapt to dynamic conditions and ensuring sustainable project success. Study [7] emphasizes the importance of using quality control systems and metrics to monitor project progress. The author discusses various approaches to assessing the quality of task performance and the use of key performance indicators (KPIs) to ensure a high level of work performance. The importance of feedback and continuous process improvement is emphasized.

Managing risk in IT projects is essential to ensure that they are successfully executed and achieve their goals. IT projects often involve a high level of uncertainty and complexity, which can lead to delays, budget overruns, or even project failure. Effective risk management allows to identify potential problems at an early stage, develop strategies to minimize or avoid them, and ensure continuous monitoring and adjustment of plans. This helps to improve project reliability, reduce unforeseen costs, and increase the overall efficiency of project management.

Work [8] covers a variety of approaches to risk management in IT projects. They include risk identification and analysis, which is a systematic process of identifying potential risks and analyzing them in detail to determine possible consequences. Risk assessment is performed using quantitative and qualitative methods, such as risk matrices and probabilistic models. Risk response planning involves the development of strategies to minimize the negative impact of risks, such as avoidance, mitigation, transfer or acceptance of risks. Monitoring and controlling risks involve continuously tracking identified risks, evaluating the effectiveness of selected response strategies, and adjusting plans as necessary. Risk management is a critical element of successful IT project delivery. Implementation of a systematic approach to risk management helps to reduce negative impacts and increase the likelihood of achieving project goals. The author provides valuable practical recommendations and methods for effective risk management in IT projects.

Studies [9, 10] show that a culture that emphasizes collaboration, open communication, and innovation contributes to team effectiveness and project success.

In particular, Teamwork Quality has a significant impact on the success of innovation projects, as evidenced by aspects such as communication, coordination, mutual support, and team member effort. In addition, the team's confidence in its effectiveness, which is formed through a supportive corporate culture, has a positive impact on project success.

Although in some cases, as research in managing a multi-project team shows, other factors such as leader competencies may have a greater impact on project success, in general, a positive corporate culture remains an important factor.

Thus, building and maintaining a positive corporate culture that encourages open communication, collaboration and innovation is critical to improving teamwork and ensuring project success.

Effective IT project management depends on creating a favorable psychological climate and staff motivation. A positive corporate culture that supports innovation, collaboration, and open communication helps to increase team engagement and productivity. Motivation and psychological comfort play an important role in ensuring a high level of performance and project success. Thus, investing in corporate culture and motivation systems is critical to achieving the organization's strategic goals. The author of [11] argues that the leadership style should be adapted to the conditions of the team and project, taking into account internal and external factors. It is important to maintain motivation by ensuring security, trust in leadership, effective communication, and the development of professional skills. External factors, such as war and crisis, have a significant impact on team performance, so managers must be prepared for constant change and be able to adapt to challenges.

Effective documentation and knowledge sharing practices, supported by proper knowledge management and leadership systems, significantly increase the efficiency and success of project work by facilitating the transfer and retention of expertise within teams. Study [12] emphasizes the importance of documentation and knowledge sharing to improve the efficiency of project work. The authors discuss knowledge management methods, which include creating knowledge bases, conducting trainings, and using knowledge management systems to preserve and transfer expertise within the team.

As it is possible to see, there are many different ways to effectively manage human resources in IT projects. These

include planning resources, building teams, motivating and engaging team members. It's also crucial to maintain good communication, monitor progress, and stay adaptable. Other important areas are managing risks, finances, and quality, as well as handling knowledge and involving stakeholders. Ensuring motivation, psychological comfort, and managing changes are also key factors. Integration and proper management of these metrics can significantly increase the chances of an IT project's success, ensuring not only that the planned results are achieved but that the expectations of all stakeholders are exceeded.

Considering the advantages of intangible incentives over tangible ones, it is possible to say that intangible incentives have a significant impact on employee motivation and productivity in IT projects. They help create a favorable working environment that increases the overall efficiency of the team:

First, intangible incentives, such as recognition and career development, contribute to employee motivation more than tangible incentives. Studies show that professional ethics and the desire to meet professional standards are important motivational factors for employees, especially in the context of insufficient resources and means [13]. This suggests that for many professionals, the opportunity for professional growth and recognition from colleagues is more important than financial rewards.

Secondly, organizational incentives such as improved working conditions, career management, and flexible working hours also increase motivation and reduce staff turnover. Systematic communication with employees, organization of corporate events, and formal recognition of achievements help boost morale and motivation. This is especially important in the IT sector, where working conditions and professional development opportunities can have a significant impact on job satisfaction and productivity.

In addition, intangible incentives, such as training opportunities and social recognition, are the most effective drivers of productivity, while tangible incentives may be less significant. Team relationships and flexible working conditions have a greater impact on motivation and productivity than financial incentives [14]. This emphasizes the importance of intangibles such as trust, respect, and team support, which create a positive work environment and contribute to high productivity.

Therefore, non-financial incentives play an important role in human resource management in IT projects due to their ability to increase motivation, create a positive work environment, and promote professional development, which ultimately improves team efficiency and productivity.

It is shown in [15] that the following indicators make the most significant contribution to the overall success of the project:

- *a working atmosphere that motivates to achieve successful completion of the project.* A motivating work environment creates an environment where every team member feels valued and inspired to work. This includes a friendly attitude, support from colleagues and management, and an environment that promotes concentration and productivity. Management support is manifested through active participation of project leaders in team life, regular feedback, and support for professional development. Team cohesion is achieved through team events and opportunities for informal communication. Transparent and open communication between team members reduces stress and increases trust;

- *opportunity for self-realization for the IT project team.* Self-actualization allows each team member to unlock their potential, using their knowledge and skills to the fullest, which promotes innovation and improves the quality of tasks performed. It is important to provide individual tasks that meet the professional interests and goals of employees. Career development is provided through learning opportunities, participation in trainings and conferences. Regular recognition of employee achievements, reward and incentive systems also play a key role;

- *ability to quickly and effectively resolve intra-team conflicts.* Conflicts are inevitable in any team, but the ability to resolve them quickly and effectively prevents loss of productivity and lowered morale. It is important to develop effective communication skills among team members, have neutral persons present, or use external mediators to resolve conflicts. Establishing clear procedures and rules for resolving disputes also contributes to effective conflict resolution;

- *common goals that are clear to all project participants and a strategy for achieving them.* Shared goals provide all team members with a clear understanding of the direction of travel and increase motivation by focusing efforts on achieving common success. For this purpose, it is important to clearly define the project goals that are understood by all participants. Developing a detailed strategy outlining the steps and resources needed to achieve the goals is key. Regularly tracking progress and adjusting plans as needed helps to keep on track.

Ensuring these indicators helps to create a strong, motivated, and productive team that is able to successfully implement IT projects.

The aim of research is to develop and evaluate a regression model with aggregate indicators to determine the key factors that affect the efficiency of human resource management in IT projects in order to identify problem areas and develop recommendations for their improvement.

2. Materials and Methods

The subject of research in developing a regression model for effective human resource management in an IT project is the processes of managing human resources within IT teams. This includes interactions between various aspects of team work, such as communication, cultural differences, leadership qualities, technical, and professional skills. The subject of the study also encompasses factors affecting team productivity and efficiency, as well as the interrelationships between these factors, which can be quantitatively assessed through a regression model to improve management practices in IT project environments.

During the development of the regression model for effective human resource management in IT projects, the study was conducted using personal computers and software such as Python and Excel for data processing and analysis. The main theoretical methods used included literature review, modeling, and correlation analysis. Existing research and models for managing human resources were also examined, including Agile and Scrum methodologies, team motivation models such as Herzberg's theory [16], and approaches to managing multicultural teams. Data for the model were collected through surveys of IT team members, covering information about communication, leadership, technical skills, and cultural differences. The collected data were

standardized and processed to build a multifactor regression model. The model evaluated the impact of key factors on management efficiency, and its quality was verified by dividing the data into training and testing samples. This approach allowed for the creation of a reliable model that helps determine priorities for enhancing the effectiveness of human resource management in IT projects.

3. Results and Discussion

Speaking of problematic factors in managing an IT project team, let's highlight the main ones [17] and build a problem tree (Fig. 1):

- Communicating interpersonal interactions is a key aspect of any team's success. In IT projects, which often involve a variety of specialists, effective communication is critical to ensure coordination and understanding of tasks. Problems can arise from miscommunication, where unclear or unclear task definitions lead to errors and delays in the execution of work. Cultural differences can complicate communication in international teams, and the use of different platforms and tools can create barriers, especially if team members are not equally proficient in these tools.
- The coordination associated with heterogeneity in time concepts is fundamental to successful project management. In the case of a heterogeneous team, where each member may have different time zones or schedules, effective coordination becomes even more challenging. Problems can arise because of different time zones, which create difficulties in synchronizing meetings, meeting deadlines, and resolving problems quickly. Differences in team members' work rhythms can affect overall productivity and collaboration, and time gaps can lead to delays in communication and decision-making.
- Problem solving and decision-making – effective problem solving and decision-making skills are critical to the successful completion of projects. This applies to both technical aspects of the project and management tasks. Problems can arise from a lack of structure, where

without a clear methodology or process for solving problems, the team may spend too much time analyzing and discussing. Unclear roles and responsibilities can lead to duplication of effort or neglect of certain tasks, and the inability to reach consensus can cause internal conflicts and delays.

- Team architecture – the structure and organization of the team affects the efficiency of project implementation. It includes both formal and informal aspects of interaction between team members. Problems can arise from an unclear structure when the lack of clearly defined roles and responsibilities creates chaos and uncertainty in processes. A strict hierarchy can stifle innovation and reduce the motivation of team members to express their ideas and suggestions. Uneven distribution of resources, such as time, equipment, and access to information, can lead to inefficient use of team capabilities and delays in completing tasks.

Based on the structuring of management problems, management strategies were formed to address the vectors of these problems, and a decision tree was built (Fig. 2):

- The first category includes strategies for geographical distribution, training, management interventions, and means of visualizing the problem and its solution. Geographical distribution strategies include determining the optimal location of the company's various divisions to maximize efficiency and using regional offices to reduce costs and improve communications with local customers. Training involves regular training and refresher courses for employees, as well as the use of online platforms to train staff from different regions. Management interventions include the introduction of new management techniques and methods to improve productivity and management rotation to bring in new ideas and approaches. Problem and solution visualization tools include the use of charts, graphs, and other visual tools to identify and analyze problems, as well as the development of interactive solution maps to simplify understanding of complex processes.

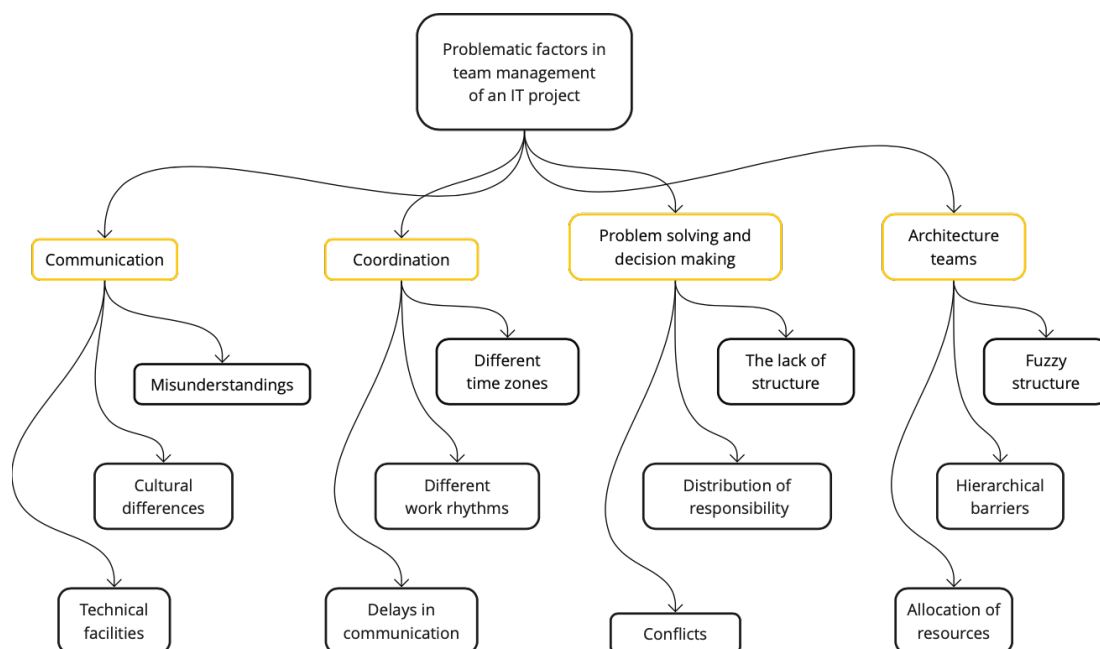


Fig. 1. Problem tree for managing an IT project team

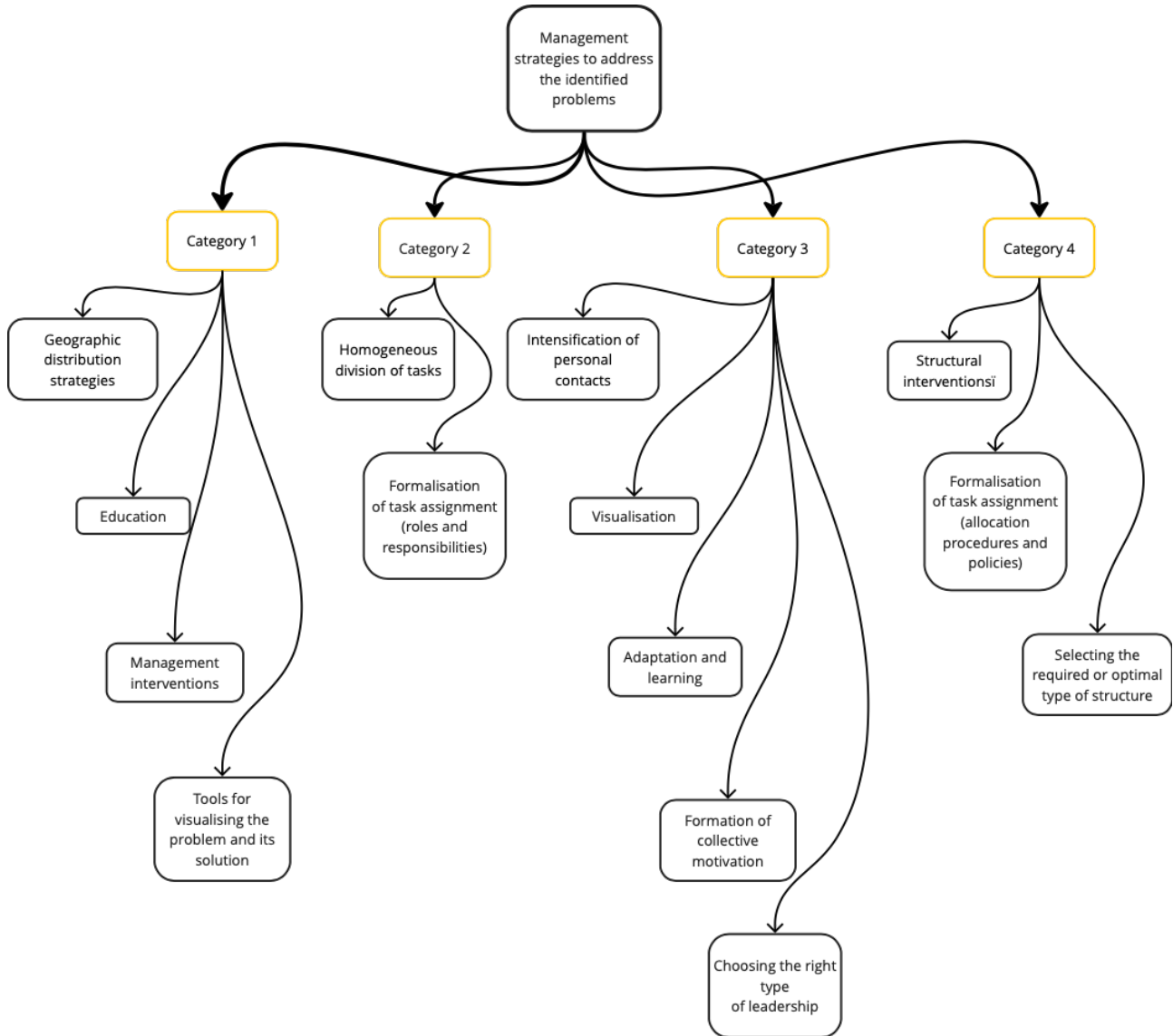


Fig. 2. Decision tree and IT project team management strategies

- The second category includes strategies for homogeneous task sharing in terms of time perception of distributed groups and formalization of task sharing. Homogeneous task division in terms of time perception by distributed groups includes synchronizing work schedules for different teams working in different time zones and using technology to support continuous communication and coordination between groups. Formalizing the distribution of tasks involves clearly defining the roles and responsibilities of each team member, as well as implementing standard operating procedures (SOPs) to simplify project management.
- The third category includes strategies for intensifying personal contacts, visualization, adaptation and training, building collective motivation, and choosing the right type of leadership. Intensification of personal contacts includes organizing regular meetings, both virtual and physical, to strengthen ties between employees, as well as programs for sharing experiences and working together on projects. Visualization involves using tools to create collaborative visual projects and visualizing key performance indicators (KPIs) to improve understanding

- of results. Adaptation and learning include flexibility in learning and adapting to new conditions and technologies, as well as regular review and updating of training programs in accordance with market needs. Creating collective motivation involves introducing a system of collective rewards and recognition of achievements, as well as creating a favorable working environment to encourage teamwork. Choosing the right type of leadership involves analyzing the situation and choosing the leadership style that best suits a particular team or project, as well as implementing flexible leadership models to adapt to changes.
- The fourth category includes structural interventions, formalizing the distribution of tasks, and choosing the necessary or optimal type of structure. Structural interventions include restructuring the organization to improve efficiency and adaptability, as well as introducing new structural units to address specific tasks. Formalizing task assignment involves establishing clear procedures and policies for assigning tasks, as well as using project management software to ensure transparency and control. Choosing the required or optimal

type of structure includes analyzing. These strategies are aimed at improving management efficiency by optimizing processes, improving staff skills and introducing innovative approaches to problem solving.

- Current structure of the organization and its effectiveness, as well as choosing the optimal organizational structure (e. g., matrix, flat, hierarchical) depending on the specifics of the activity.

Let's determine the impact of these factors on the effectiveness of IT project labor management using the Hackman regression model of management. The Hackman regression model, also known as the Hackman sampling model or the Hackman two-stage method, is used to correct for sampling bias in statistical models. This model was proposed by James Hackman and aims to account for situations where data have non-random missing information that can lead to biased parameter estimates.

The Hackman regression model is a specialized analysis tool that allows to correct for sampling bias and take into account unobservable variables that affect the results. This is especially useful in the context of IT project workforce management, where there are various factors that can complicate the analysis. The Hackman regression model allows to conduct:

- *Correction of sampling bias:*

Often, data on the effectiveness of human resource management can be limited to only successful projects or those with sufficient data. The Hackman model allows to take into account sample bias, providing correct estimates of the impact of various factors [18].

- *Taking into account latent variables:*

There are numerous latent variables in project teams, such as cultural differences, communication languages, and leadership styles, which can significantly affect management effectiveness. The Hackman model helps to take these latent variables into account, which contributes to a more accurate analysis.

- *Assessment of specific factors of command control:*

Team management in IT projects has its own specific factors, such as communication, conflict resolution, and motivation. Hackman's model allows to assess in detail the impact of each of these factors on the overall effectiveness of human resource management in IT projects.

- *Adaptation to the specific conditions of the virtual environment:*

Virtual teams work in specific conditions, such as time zone differences, remoteness, and the use of technology for communication. The Hackman model allows to take these specific conditions into account, providing a more accurate assessment of the impact on workforce management efficiency.

Determining the weight of each factor for effective IT project labor management can be done using various statistical and analytical methods. Let's look at the main steps and methods that need to be taken to do this:

- *Data collection:* data that includes information on human resource management, cultural characteristics, team performance, and other relevant factors.

- *Selection of variables:* identification of the main variables that affect the effectiveness of human resources management, such as communication, cultural differences, leadership, motivation, conflict resolution, etc.

- *Building a regression model:* use the Hackman regression model to analyse the impact of various factors. This model will help to take into account sample bias and latent variables that may affect the results.

To determine the weights of the factors, let's use a multivariate regression model, where the dependent variable will be the effectiveness of human resource management, and the independent variables will be the selected factors. The regression coefficients will reflect the weight of each factor.

The formula of the regression model:

$$E = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \epsilon,$$

where E – the dependent variable (efficiency of labor management); X_1, X_2, \dots, X_n – independent variables (factors) include various aspects of team interaction. For example, this can be communication between people, unclear coordination, and unclear distribution of roles and responsibilities. It also involves an unclear structure and a lack of clearly defined roles and responsibilities. Another factor is the uneven distribution of resources like time, equipment, and access to information. Additionally, different time zones, differences in team members' work rhythms, the use of different platforms and tools, and unclear task formulations are also important factors; β_0 – a free term (constant), in this model representing the baseline level of governance effectiveness that can be expected in the absence of other factors. This value can include basic governance processes and structures that exist regardless of changes in communication, cultural factors, leadership, or technical skills; $\beta_1, \beta_2, \dots, \beta_n$ – regression coefficients that show the weight or influence of each independent variable on the dependent variable; ϵ – the residual error.

The residual error ϵ (or residual) in a regression model is the difference between the observed value of the dependent variable and the predicted value obtained by the regression model. In other words, it is the portion of the dependent variable that cannot be explained by the independent variables included in the model.

The residual error is an important component of regression analysis because it allows:

- Evaluate the accuracy of the model (small residual errors indicate that the model predicts the value of the dependent variable well, while large residual errors indicate that the model does not fully account for all factors or that there are other, unknown factors that affect the dependent variable).

- Test the assumptions of the regression analysis (residual error analysis allows to test some key assumptions of the regression analysis, such as the normality of the error distribution, homoscedasticity (equality of error variances), and the absence of autocorrelation).

- Improve the model (identifying systematic trends in the residual errors may indicate the need to add new independent variables or use nonlinear models to improve forecast accuracy).

Principal Component Analysis (PCA) is used to reduce the dimensionality of the data and identify the main components that affect efficiency. It helps to identify the most important factors and their weight in the overall impact on the effectiveness of human resource management. PCA reduces a multidimensional dataset to a smaller number of components that explain the greatest variation in the data.

Hierarchical Clustering Analysis (HCA) is used to group factors that have a similar impact on performance. This analysis helps to identify which groups of factors are most important.

To determine the weight of factors, it is possible to use machine learning methods, such as decision trees, support

vector machine (SVM), etc. These methods help to automatically determine the importance of each factor in the model.

Managing labor resources in IT projects is a complex process that requires consideration of numerous factors. Multivariate regression models are widely used to analyze the impact of these factors on management effectiveness, but they have certain limitations. In particular, a large number of variables can lead to the problem of multicollinearity, which complicates the interpretation of results and reduces the accuracy of forecasts. In addition, excessive detail of the models can lead to information overload, complicating management decision-making.

Moving to a regression model with aggregate indicators is a reasonable step to improve the accuracy and usability of models. Aggregate indicators allow to combine similar factors into one group, reducing the number of variables in the model. This helps reduce multicollinearity, simplifies the interpretation of results, and facilitates informed decision-making.

In this context, the transition from a multi-factor model to a regression model with aggregate indicators allows for a more accurate and user-friendly model that better reflects the main trends and factors affecting the effectiveness of labor management in IT projects. For effective labor management in IT projects, it is important to consider various factors that can affect efficiency. Aggregate indicators help simplify the model by combining similar factors into groups. Consider a regression model with four aggregate indicators:

The regression model (1) with four aggregate indicators is as follows:

$$E = \beta_0 + \beta_1 X_{com} + \beta_2 X_{cul} + \beta_3 X_{L-m} + \beta_4 X_{Ts} + \varepsilon, \quad (1)$$

where E – the efficiency of labor management (a dependent variable that reflects the overall result or efficiency of management in IT projects);

β_0 – a free term (a constant representing the baseline level of labor management efficiency when all independent variables are equal to zero);

β_1 – the regression coefficient for the communication and interaction indicator;

X_{com} : communication and interaction are critical aspects of effective management of virtual multicultural teams. X_{com} – this overall indicator includes different aspects of team communication. It covers the frequency of meetings and the regularity of team gatherings, both formal (like weekly planning) and informal (such as daily stand-ups). The quality of communication is also important, including an assessment of the clarity, accuracy, and timeliness of information shared between team members. It also considers the use of communication technologies, such as video conferencing, chats, email, and project management systems (e. g., Slack, Microsoft Teams, Trello). Another aspect is feedback – the frequency and quality of feedback provided by team members to each other, including both constructive criticism and positive feedback;

β_2 – the regression coefficient for the cultural factors' indicator;

X_{cul} : cultural factors cover various aspects of cultural differences between members of multicultural teams. X_{cul} – an aggregate indicator includes several important factors. One of them is language barriers and their impact on the effectiveness of communication and understanding between team members. Another factor is differences

in management styles, such as between authoritarian and democratic approaches to leadership. Cultural values also play an important role. This refers to how cultural norms and values affect team interaction, including attitudes towards time, work ethics, and hierarchy. Another aspect is the ability of team members to adapt to a multicultural environment, understand, and respect cultural differences;

β_3 – the regression coefficient for the leadership and management indicator;

X_{L-m} : effective leadership and management are essential to successfully managing multicultural teams. X_{L-m} – an aggregate indicator includes several key aspects. The first one is management style. It refers to the characteristics of the leader's style, such as directive, supportive, delegating, or a combined style. Another important aspect is team motivation. This includes methods and strategies used to boost team members' motivation, such as recognition of achievements, career development, or material incentives. Strategic planning is also crucial. It involves the leader's ability to develop and implement strategic plans, set clear goals, and allocate resources to achieve these goals. The final aspect is conflict management;

β_4 – the regression coefficient for the technical and professional skills indicator;

X_{Ts} : technical and professional skills are important to ensure high team productivity. X_{Ts} – this overall indicator includes several important factors. The first one is the level of technical training. It refers to the qualifications and technical knowledge of team members needed for specific project tasks, such as programming, system architecture, or testing. The second factor is professional skills. This includes general skills like time management, teamwork, problem-solving, and decision-making. The availability of resources for professional development is also important. This involves opportunities for education, training, certification programs, and mentoring support. Another aspect is innovation;

ε – the residual error (unaccounted for influences).

Steps of analysis using a regression model with aggregated indicators:

1. Data collection and variable preparation:

- Data about the effectiveness of human resource management and the factors affecting it are collected.
- Selected factors are combined into aggregated indicators to simplify the model. For example, communication factors are grouped into one indicator, while cultural differences are grouped into another.

2. Building the regression model using formula (1):

- The regression model is built using a specific formula that includes aggregated indicators.

3. Analyzing model results:

- The regression coefficients (β) for each aggregated indicator are determined.
- Coefficients indicate the strength of each factor's impact on management efficiency. Positive coefficients show a positive effect, while negative coefficients indicate a negative effect.

How the model helps identify problem areas:

1. Identifying key influencing factors:

- the model helps identify which aggregated indicators have the greatest impact on management efficiency. For example, if the coefficient β_1 for "communication and interaction" is high and positive, it indicates that improving communication will significantly boost efficiency.

2. Identifying weak spots:

– negative or low values of coefficients can indicate problem areas. For instance, if β_2 for "cultural factors" is negative, it may suggest that cultural differences negatively affect management efficiency and need correction.

3. Prioritizing actions:

– the model allows identifying which factors need immediate attention. If one of the indicators has a particularly strong negative impact, efforts should be focused on addressing issues related to that indicator.

4. Monitoring and evaluating changes:

– after changes are implemented, the model can be used to assess their impact. For example, if measures were taken to improve communication, the coefficients before and after the changes can be compared to evaluate their effectiveness.

In a calculation, the model shows the following regression coefficients:

$$\beta_1=1.2; \beta_2=-0.5; \beta_3=0.8; \beta_4=0.6.$$

Communication and interaction ($\beta_1=1.2$): the high positive value indicates that improving communication will significantly increase management efficiency. Communication is a strength and can be a key success factor.

Cultural factors ($\beta_2=-0.5$): the negative value indicates problems related to cultural differences. These issues need attention to improve overall efficiency.

Leadership and management ($\beta_3=0.8$): the positive value shows that effective leadership has a positive impact on management, but there is still room for improvement.

Technical and professional skills ($\beta_4=0.6$): the positive value indicates the importance of technical skills, but this factor is less influential compared to communication and leadership.

The results of the study show that the effectiveness of managing human resources in IT projects largely depends on factors such as communication, leadership, cultural differences, and technical skills. The strong positive impact of communication and leadership is due to the importance of clear interaction and team motivation, which ensures effective achievement of goals. Compared to models known from literature, such as Agile and Scrum, the results confirm the necessity of good communication and leadership, while providing additional quantitative evidence of their impact on productivity. The difference lies in a more precise measurement of the influence of cultural factors, which are not always considered in classic approaches.

The findings can be applied in practice in managing multicultural IT project teams. Specifically, they can help project managers prioritize improvements in managing human resources, such as focusing on enhancing communication quality or developing leadership skills. The results can also be used to design training programs for managers working with multicultural teams, to improve their problem-solving skills related to cultural differences. The scope of application is not limited to the IT sector; similar approaches could be beneficial in other industries where teams work in multicultural environments and require effective management.

The study has several limitations. Firstly, the collected data pertained to a limited number of IT teams, which may reduce the ability to generalize the results for all types of projects. Also, the study mainly involved teams

working in remote or hybrid settings, so the results may not fully reflect in-office conditions. Furthermore, the model needs further validation in large-scale projects where the complexity and interaction of factors may be greater. To apply the results in practice, additional analysis of cultural differences in a broader context that includes different regions and companies may be needed.

The conditions of martial law in Ukraine significantly affected the study. Data collection and surveys were difficult due to the limited availability of participants, changes in residence, and interruptions related to safety concerns. Remote work and distance learning became the norm, which, on one hand, created additional barriers to interaction with participants, but on the other hand – provided an opportunity to analyze the impact of remote work on team management. Changes in legislation and the education system also had some positive impacts. Access to professional online courses and certifications was simplified, which helped improve employee skills. The introduction of distance learning and the development of online education platforms allowed specialists to adapt to new work conditions faster and ensured continuous learning despite challenging circumstances. Legislative changes also encouraged companies to adopt flexible work schedules and improved conditions for remote work, which positively impacted team effectiveness and motivation in difficult times.

The prospects for further research in the field of developing a regression model for effective human resource management in IT projects cover several directions:

– *Expansion of the model with new variables*: further research could include additional variables in the regression model. For example, it is advisable to investigate the impact of factors such as emotional intelligence, psychological safety, motivation, and stress level, which may also significantly affect team efficiency. Including these aspects would help make the model more accurate and multidimensional.

– *Analysis in other industries*: the study could be expanded to include other industries beyond IT to test the universality of the model. This will help determine whether the developed model is relevant for other sectors, such as finance, education, or manufacturing, where multicultural teams also operate.

– *Use of nonlinear models*: in future research, it may be appropriate to consider applying nonlinear regression models or machine learning methods, such as neural networks or support vector machines. This will allow for better consideration of interactions between variables and nonlinear influences that may not be captured by traditional linear regression.

– *Research in different cultural contexts*: one of the future research directions is analyzing teams working in different cultural contexts. Results obtained for multicultural teams in different countries could be compared to determine how cultural characteristics influence team efficiency and interaction. This will help adapt the model to specific cultural contexts and make it more universal.

– *In-depth analysis of remote teams*: considering the widespread use of remote work, there is a need for an in-depth analysis of remote IT teams. It would be useful to study in detail the specifics of management, productivity, and communication issues in a remote or hybrid work format. Research could also investigate

how these features can be integrated into the regression model.

– *Validation of the model on larger samples:* it is important to validate the developed model on larger data samples that include diverse teams and projects. This will improve the reliability and generalizability of the results. Broader validation will help identify possible limitations and enhance the model.

– *Integration with other models:* future research could include integrating the developed model with other project management models, such as risk management or project lifecycle models. This would create a comprehensive tool for IT project management that takes into account the relationship between human resource management, risk management, and organizational effectiveness.

In general, further research aims to improve the accuracy, generalizability, and applicability of the developed regression model. It will contribute to a better understanding of the factors that influence management efficiency in multicultural teams. Additionally, it will help create more flexible and adaptive tools for managing human resources in dynamic IT project environments.

4. Conclusions

The conducted research on developing a regression model for effective human resource management in IT projects made it possible to identify four key factors that significantly affect the efficiency of team management: communication, leadership, cultural differences, and technical skills. A multifactor regression model was built to quantitatively assess the impact of each of these factors on overall team management efficiency.

The results can be explained by the fact that effective communication and interaction are the main factors that contribute to team coordination, clear task delegation, and reducing the risk of misunderstandings. Leadership determines the level of employee motivation, the organization of work, and strategic planning. However, cultural differences can cause issues in understanding and communication, which reduces management efficiency. Technical skills are crucial for the successful completion of tasks, especially in complex IT projects that require a high level of team qualification. A comparison of the regression coefficients showed that communication and leadership have the highest positive impact on efficiency, while cultural differences have a negative impact, requiring greater attention to team adaptation in multicultural environments.

Theoretically, the research results contribute to expanding knowledge about the factors that influence the management of multicultural IT teams. It clarifies the role of communication, leadership, cultural aspects, and technical skills in overall efficiency. Practically, the developed regression model can be used to evaluate management efficiency in real IT projects. Project managers can use the model to determine which factors to focus on to increase team productivity. For example, improving communication practices and developing leadership qualities can significantly enhance the overall efficiency of the team. Furthermore, the results can be applied in designing training programs for managers who work with multicultural teams to improve their competencies in interacting with employees from different cultural backgrounds.

According to the data obtained, the regression coefficient for communication is 1.2, which indicates a significant positive effect of this factor on the efficiency of human resource management. The coefficient for leadership is 0.8, which also indicates a substantial positive effect, although smaller compared to communication. Technical skills have a coefficient of 0.6, showing that this factor is important but less influential than communication and leadership. On the other hand, cultural differences have a coefficient of -0.5 , indicating their negative impact, which can reduce team efficiency. A comparative analysis shows that improving communication by 10 % could lead to an approximately 12 % increase in team efficiency, while a similar improvement in leadership raises efficiency by 8 %.

Thus, the results of the study emphasize the importance of communication, leadership, and technical skills in ensuring effective management of IT teams. They also highlight the need to minimize the negative impact of cultural differences. This helps to identify specific areas for improvement to enhance team efficiency in the context of modern IT projects.

Conflict of interest

The author declares that he has no conflict of interest in relation to this study, including financial, personal, authorship, or any other, that could affect the study and its results presented in this article.

Financing

The study was conducted without financial support.

Data availability

The paper has no associated data.

Use of artificial intelligence

The author confirms that he did not use artificial intelligence technologies when creating this work.

References

- Rodchenko, V. B., Novikova, A. Ye. (2018). Individualities in using agile for it and design projects. *Visnyk KhDU Serii Ekonomichni nauky*, 1 (30), 124–127.
- Ahmadi Eftekhari, N., Mani, S., Bakhshi, J., Mani, S. (2022). Project Manager Competencies for Dealing with Socio-Technical Complexity: A Grounded Theory Construction. *Systems*, 10 (5), 161. <https://doi.org/10.3390/systems10050161>
- Keil, M., Lee, H. K., Deng, T. (2013). Understanding the most critical skills for managing IT projects: A Delphi study of IT project managers. *Information & Management*, 50 (7), 398–414. <https://doi.org/10.1016/j.im.2013.05.005>
- Herasymenko, O. O., Kryukukha, O. O. (2024). Upravlinnia personalom v ukrainskykh it-kompaniiakh: innovatsiini metody ta instrumenty. *The current state of the organization of scientific activity in the world*. Madrid, 253–255.
- Stray, V., Moe, N. B. (2020). Understanding coordination in global software engineering: A mixed-methods study on the use of meetings and Slack. *Journal of Systems and Software*, 170, 110717. <https://doi.org/10.1016/j.jss.2020.110717>
- Alsulaimi, A., Abdullah, T. (2020). Management of Stakeholder Communications in IT Projects. *2020 3rd International Conference on Computer Applications & Information Security (ICCAIS)*, 2, 1–6. <https://doi.org/10.1109/iccais48893.2020.9096842>

7. Kunkcu, H., Koc, K., Dagou, H. H., Gurgun, A. P. (2022). Using key performance indicators in construction project literature. *Proceedings of International Structural Engineering and Construction*, 9 (2). [https://doi.org/10.14455/isec.2022.9\(2\).con-12](https://doi.org/10.14455/isec.2022.9(2).con-12)
8. Danchenko, O. B., Zanora, V. O. (2019). *Proektnyy menedzhment: upravlinnia ryzykamy ta zminamy v protsesakh pryjnyattia upravlynskykh rishen*. Cherkasy: PP Chabanenko Yu. A., 278.
9. Aronson, Z. H. (2015). An Investigation of the Role of Project Culture in Team Efficacy and Success in Project-Based Work. *International Journal of Innovation and Technology Management*, 12 (6), 1550027. <https://doi.org/10.1142/s0219877015500273>
10. Rosemary, E. M. (2022). How Team Culture Affects Corporate Performance: A Literature Review. *The International Journal of Business & Management*. <https://doi.org/10.24940/theijbm/2022/v10/i12/bm2212-007>
11. Kohut, I. (2022). Analysis of motivation factors affecting teams in innovation projects during crisis and war. *Economy and Society*, 40. <https://doi.org/10.32782/2524-0072/2022-40-16>
12. Pereira, L., Goncalves, A. F. (2017). Knowledge management in projects. *2017 International Conference on Engineering, Technology and Innovation (ICE/ITMC)*, 16, 21–28. <https://doi.org/10.1109/ice.2017.8279864>
13. Mathauer, I., Imhoff, I. (2006). Health worker motivation in Africa: the role of non-financial incentives and human resource management tools. *Human Resources for Health*, 4 (1), 24. <https://doi.org/10.1186/1478-4491-4-24>
14. Rose, T., Manley, K. (2011). Motivation toward financial incentive goals on construction projects. *Journal of Business Research*, 64 (7), 765–773. <https://doi.org/10.1016/j.jbusres.2010.07.003>
15. Laretta McLeod, P., Lobel, S. A. (1992). The effects of ethnic diversity on idea generation in small groups. *Academy of Management Proceedings*, 1992 (1), 227–231. <https://doi.org/10.5465/ambpp.1992.17515639>
16. Orban-Lembryk, L. E. (2003). *Psykhoholiiia upravlinnia*. Kyiv: Akademydav, 568.
17. Borysov, O. V., Danchenko, O. B., Mysnyk, B. V. (2022). Rehesiina model efektyvnoho upravlinnia multykulturnoiu komandoiu IT-proektu. *The Seventh International Scientific-practical Conference*. Odesa: ONPU, 62–66.
18. Hackman, J. (1987). The design of work teams. *Handbook of organizational behavior*, 315–342. Available at: [https://www.uio.no/studier/emner/matnat/ifi/INF5181/h14/artikler-teamarbeid/hackman-\(1987\).design-of-work-teams.pdf](https://www.uio.no/studier/emner/matnat/ifi/INF5181/h14/artikler-teamarbeid/hackman-(1987).design-of-work-teams.pdf)

Oleksii Borysov, PhD Student, Department of Computer Science and System Analysis, Cherkasy State Technological University, Cherkasy, Ukraine, e-mail: alexborisovofficial@gmail.com, ORCID: <https://orcid.org/0000-0002-4621-3779>