Designing and Explaining a Sustainable Model for the Allocation of Educational Resources at Iran's Railway Engineering Faculty Using a Robust Optimization Approach

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In the present study, an attempt was made to develop a robust decision model for optimal allocation of resources in the educational planning system of the Faculty of Railway Engineering in Iran. Considering the need to meet the educational demand in Iranian railroad industry and the annual expenditure of the Iranian Railway Engineering University, the main objective of the current study is to design and explain a sustainable model for allocating available resources according to the demand of Iranian railway community. The corresponding offer in the Faculty of Railway Engineering is based on minimising the total fixed and variable costs for educational groups using an optimization approach. Due to the lack of sufficient information on the critical features of budgeting in line with detailed planning, the level of demand and conventional resources are considered as non-deterministic components. Finally, the robust counterpart of the proposed model is compared with the deterministic model, and the results of the sensitivity analysis are presented.

KEYWORDS
~ Educational resources allocation
~ Iranian railway engineering faculty
~ Robust optimization

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1. INTRODUCTION

One of the biggest challenges for policy makers and educational planners in the railroad industry is the increasing competition to meet educational requirements and achieve organizational excellence through this method (Buraima et al., 2023). The development and progress of the railroad industry is made possible by raising the level of education and improving the quality of the teaching and learning process. The Faculty of Railway Engineering is the most important official Iranian training center in the field of railroad industry. There are four main sources of funding for this college:

1. Financial resources: this category includes assets, endowments and investments held by educational institutions.
2. Financial services: This refers to the costs associated with providing services to businesses and government organizations.
3. Government grants: This refers to financial resources provided by government agencies to support various initiatives.
4. External sponsors for educational development: This includes funding from international institutions and other external sponsors to promote educational development.

The Faculty of Railway Engineering is in intense competition with other universities and educational institutions to attract the best students. Moreover, studying at this university is free of charge and students are obliged to serve after their admission. By choosing to study at this university, the applicant undertakes to serve free of charge in disadvantaged areas of the country for up to three times the duration of their education. Furthermore, admission to the Faculty of Railway Engineering does not dependent on gender, and women and men have the same opportunities to study regardless of their ethnicity and social status. The Faculty of Railway Engineering's management style is semi-centralized, and the Ministry of Science, Research and Technology, as the upstream authority, only supervises and manages it by issuing regulations. In addition, the Ministry of Science stipulates educational standards, subject areas and curriculum contents based on the needs of the railroad industry, which the Faculty of Railway Engineering must comply with. In other cases, such as the formulation of educational strategies, resource management, performance evaluation and the like, the Faculty of Railway Engineering of Iran has the freedom of execution and independence. However, most of the resources available to the faculty are limited, which creates many problems for the administration of the faculty. According to the higher laws of the Ministry of Science, students are not allowed to be charged tuition fees. In addition, due to the high degree of specialisation of railroad subjects, it is necessary to employ professionals from the railroad sector for the practical courses.

In the last ten years, the income of Iranian families has risen in proportion to the rising inflation rate, while the number of public schools has decreased due to changes in the population structure. This effect has been further accentuated by the migration of some of the best national entrance exams (Sadeghi et al., 2020). On the other hand, due to limited financial resources and the decline in the share of higher education in the national budget and GDP, there is an increasing demand for admission to Iranian universities for many reasons and motivations. The Iranian Faculty of Railway Engineering, despite the financial resources, is less able to meet the requests despite the financial resources. Therefore, providing financial resources and allocating educational resources is one of the most important challenges for the Faculty of Railway Engineering in Iran (Jalali Aliabadi et al., 2022). The researchers in this study aim to determine the optimal allocation of financial and human resources to effectively fulfil the academic requirements within a given time frame in the Faculty of Railway Engineering in Iran. Their aim is to ensure that the minimum requirements for rail transportation as specified in the course curriculum are satisfactorily met.

In the Faculty of Railway Engineering of Iran, one of the most important components is the allocation of experienced professors in the field of railroad science and qualified human resources, which constitute a large part of the budget. The specific position of Iranian technical and engineering universities in terms of location, space, structure and also the semi-centralised management system, taking into account demographic considerations and the limitation of financial resources; Many researchers have been motivated to present a model to reduce costs in this regard (Hamdhaidari et al., 2018). However, there is no research that specifically examines the elements, dimensions and challenges of railroad engineering education in higher education institutions. Therefore, the decision variable of the present problem is the level of demand for railroad engineering education and the objective function is to minimise the cost considering the limitations of the financial system of higher education in Iran. Meanwhile, many researchers in their studies try to balance the utilisation of resources in higher education and universities by assuming that the environmental components are constant (Arab Salehi and Hatampoor, 2017).

In a study conducted by Bikmoradi et al. (2015), researchers provided practical strategies in the real environment of universities by using the heuristic algorithm and the simulated refrigeration method to face the shortcomings related to balanced budget allocation. In a study conducted by Daneshfard (2015), the researcher utilized a zero-one integer decision model combined with data from geographic information systems to cluster institutions and higher education centers. This approach yielded satisfactory results for optimizing the spatial distribution of universities. In a study by Mirzamani et al.

(2022), integer linear programming was used to analyze the effectiveness of resource allocation in Iranian universities. The researchers optimized a series of data using a continuous network model through a zero-one linear programming approach. in the study of Najafi Shojaie (2015), researchers have studied the allocation of resources in Iran's higher education at the university level based on student preferences and the needs of Iran's labor market. In a study conducted by Ohene & Essuman (2017), researchers simulated a static competition among higher education agents through the generalized ordinal logit model. in this approach, a specific scenario of factors shaping the university framework such as policies, expected efficiency from the university location, university tuition, and student preferences was discussed. in the study conducted by Appiah (2020), the researcher designed and explained a decision support system that can use the distribution distance of the student population as a criterion for assigning resources to universities. in a study conducted by Newfield (2021), the researcher used the Dynamic multi-period data envelopment analysis model to examine the resources' allocation to universities according to the size and scope of each university and the number of its facilities. in the mentioned study, researchers have analyzed the complexities of university resource planning using a weighted linear combination model. The analysis of decision variables in the mentioned model explained the location and capacity of the university to minimize education costs.

In a study conducted by Boateng (2017), the researcher utilized the meta-heuristic ant colony approach to address the Weber problem (P-Median). The goal was to enhance student access to higher education centers by minimizing the total distance in the location model. in another study conducted by Gumport (2020), researchers considered the conflicting interests of active actors in the teaching-learning process, such as professors, department heads, students, etc., through a multi-criteria decision-making model, educational allocation and resource allocation to universities were studied, and finally, using Pareto optimization, parametric programming was performed to maximize the efficiency of the objective function. In some studies, such as the study by Sifuna (2015), the researcher has addressed other dimensions of higher education costs, such as access and transportation. In the aforementioned study, while referring to the internal balance of educational cycles and requirements, the issue of allocating professors' teaching hours has been explained about budget constraints and transportation operations. in the present study, the orientation of the process of allocating financial resources received from government and non-profit organizations to the Iranian Railway Engineering Faculty concerning demand and capacity has been considered by the researchers. also, the presented model in this research, the balance of supply and demand in the university has been considered, which has integrated the model structurally concerning common limitations. By optimizing the total costs, the structure of the system is optimized in terms of academic courses the number of classes, and budget allocation. therefore, in the present study, after stating the problem, the variables, parameters, and functions describing the optimal model are explained and finally, the results and suggestions derived from it are discussed.

2. SUBJECT LITERATURE

The Faculty of Railway Engineering is considered one of the most prestigious public universities in the history of Iranian higher education. This university has been one of the best universities in Iran for many years. To provide financial resources, this university not only receives direct funding from the Iranian government, but also earns money through research contracts with railroad transportation institutions, tuition fees and other sources. As shown in Table 1, the financial resources and budget distribution methods in Iran's railway engineering faculty have different functions, so a large part of the funding depends on the efficiency and performance of the university.

Depending on the number of courses and students, up to three-quarters of the total financial resources	Governmental Budget line allocated based on performance	Allocation of foreign financial resources (governmental budget)
Depending on the reception of the rail industry, up to a quarter of the total financial resources	To a large extent definitive and based on effectiveness	Internal financial resources Allocation (tuition, research contracts, etc.)

Table 1. Allocation of internal and external resources of the Faculty of Railway Engineering of Iran

Although the exact relationship between the success of a college and its financial resources is not clearly defined, various factors play an important role in the allocation of funds. Reliable funding of fixed costs, such as staff salaries and wages, is crucial to support the college's academic system (Jalali Aliabadi et al., 2022). Performance-based budgeting approaches at universities link the allocation of resources, such as funding, to specific outcomes, such as the number of graduates or research performance. This funding method aims to link financial support to the college's success in scientific research and to maximize efficiency (Mirzamani et al., 2022). The research report shows that in the higher education sector, planning models and the allocation of financial resources are often evaluated on the basis of effectiveness formulas. This approach evaluates which resource allocation framework delivers the best possible outcomes (Caiyan, 2022). However, such models have shortcomings in establishing a complete link between the inputs and outputs of the education system and may not have the required efficiency (Brown et al., 2020). Therefore, a significant part of the application of operational research topics in education management is devoted to measuring efficiency and improving its level in educational processes. The level of education in the academic system provides a suitable basis for performance evaluation. one of the conventional criteria for measuring the efficiency of the education system is financial relationships and ratios (Mirzamani et al., 2022). One of the most important applications of operations research in education systems is the optimization of consumption to achieve minimum value (Ben-Tal et al., 2018). On the other hand, the study of efficiency and optimal performance of the higher education system has gained importance in the face of the noticeable budget slump due to strict sanctions, economic conditions and the recession. The research efficiency of universities and colleges is primarily measured by the number of publications and research activities. However, research performance is a decisive factor in determining university rankings. As a side effect, higher education institutions can be associated with various knowledge products that facilitate teaching and learning, research and the provision of vocational training courses through their interaction with society as an output (Baranov et al., 2018). On the other hand, the technique of multi-criteria decision making is one of the important research tools for analyzing educational components that affect the characteristics of resources in universities, which has been mentioned in numerous studies (Ismail et al., 2021).

3. METHODOLOGY

In this study, the limitations of the model are first explained. Some limitations of the study are related to the regulations and procedures, others to the general structure of the Iranian higher education system. Therefore, as a first step, it is necessary to examine the demand for higher education in the rail transportation industry. In the first phase, only the national exam is available to students in this field, without the possibility of specialized exams. For some subjects, the coefficients can be adjusted. In the second phase, the number of teaching hours per week is extended based on the start of the semester of each subject as approved by the Office of the Supreme Development Council of the Ministry of Science. The third phase is about the admission of postgraduate students determined by the applications of the railroad university, as well as the number of professors and the budget allocated for each student, including the formats for day and evening classes. Therefore, we can simultaneously examine some other factors that affect the allocation of resources in the university and on this basis determine which areas of transportation and railroad transportation are economically and socially unprofitable and can be closed and which can be. It can continue its activities or areas can be established according to the need for railroad transportation in Iran. Optimization of resource allocation in universities requires consideration of spatial constraints, distribution of students, quality of higher education, teaching-learning process and other influencing factors (Malekzadeh et al., 2019). Therefore, a model for the human geography of the university is created for these constraints, in which some areas can be created, closed or combined depending on the conditions in order to minimize costs (Ali et al., 2019). Based on the spatial criteria and the extent to which the demand for graduates in railroads is met, it is necessary to establish a training group within the Iranian Railway Engineering Faculty for each main sector of the rail transportation industry within the Iranian Faculty of Railways. The training system of the Iranian Faculty of Railway Engineering consists of the following training levels, each of which forms a separate training cycle:

- First: kardani (two years) – associate degree
- Second: lisans (four years) - Bachelor
- Third: fogh lisans (two years) – Master's degree
- Fourth: doktraye takhsosi (four years) – specialized doctorate

Therefore, the inputs of the model presented in the current research can include resources, college capacity, costs, educational demands, etc. with the provided data, we can calculate the number of classes based on several factors: the existing infrastructure, the educational and personnel costs (variable costs), the fixed and variable costs associated with establishing courses, the capacity of each course, the maximum number of students allowed in each class, and the total capacity of the Iranian railway faculty. The proposed model assumes that it is possible to meet the educational requirements in the short to medium term. Therefore, the following assumptions were made in developing the model:

- the input data to the model is determined on the basis of a full academic year.
- It will be possible to meet the demand for each part of the rail industry through a specific training group. Due to the diversity of sectors in the rail industry, a malus for the objective function is included in the model.
- If the results of the decision model indicate that a specific field remains open, then it is necessary to include it in a degree program in the Faculty of Railways, and its sequence in higher degree programs (master's and doctorate) should be continuously considered.
- Due to the existing infrastructure in the railway faculty, the formation of overlapping classes is limited and fixed at a certain point.
- The number of classes for each educational group is fixed and organized based on the existing infrastructure of the Faculty.
- The distribution of students by academic status in each educational group is integrated and balanced.
- Compliance with the teaching procedures at the Faculty is required based on the requirements of the higher authorities and the Ministry of Science. However, each educational group may offer extraordinary classes depending on the academic program.

- The number of students in each class is less than or equal to the upper limit established for each group, which is determined based on the dimensions of educational quality.

In this study, the robust optimization approach was used, which takes into account the uncertainty in the fulfilment of some parameters of the model. Therefore, after testing the robust optimization method, a robust model for educational resource allocation and problem solving is presented.

4. ROBUST OPTIMIZATION

Mathematical models that optimize decision making aim to maximize and minimize the objective function by using decision variables in the justified range of the answer. In such problems, the input data is assumed to be accurate and certain; therefore, the effect of uncertainty on it is assumed to be ignored. However, it turns out that the values of the problem parameters are uncertain and in some cases unavailable, so their real values differ from the nominal values (Janak et al., 2012). In the real world of optimization problems and in many situations, the existence of uncertainty is inevitable (Guevara et al., 2023). In the optimization of the supply and demand chain in education to produce university outputs, the actual demand for educational resources has no certain amount, and therefore it is associated with the possibility of error and is considered as one of the sources of uncertainty in the model. In the existing models for the allocation of resources for the school education system, some parameters are determined by field surveys, and therefore, since the actual values differ from the estimated values; It leads to the creation of a gap between the nominal and real weight and is the source of uncertainty itself (Shen et al., 2023). Sometimes, small uncertainties in the input data or some parameters may cause problems in finding the optimal point. Therefore, using the robust optimization approach enables the search for optimal solutions for uncertain parameters (Pishvaee et al., 2015). On the other hand, the robust approach in optimization models can be seen as an attempt to find the solution that is closest to the optimal value by considering the constraints and fixing them in all situations (Wang et al., 2021). In the current research, the problem of resource allocation in the railway engineering faculty was formed based on a structure in which the curriculum was announced by the Iranian ministry of science and the activities of the educational groups have been localized. Within this framework, both the topics approved by the ministry of science and the annual budget of each educational group are considered, so it is necessary to set the objective function to achieve the goals considered by the decision makers of the Faculty of railroad engineering. However, the optimal allocation of resources is also faced with constraints, which include the activities to be allocated, legal, political and environmental obstacles, and so on. Therefore, the main concern of the researchers in this study is to design model bounds in a way that can be achieved given the uncertainty in the budget constraints and the objective function. Based on this, the general framework of the model is explained as follows (Ben-Talo et al., 2013):

$$\text{Min}\, Z = cx + dy$$

Subjected to:

$$\begin{cases} Ax = b \\ Bx + Cy = E \end{cases} \qquad (1)$$

$$x, y \geq 0$$

In the above relationship, there are two types of variables, namely design variables and control variables. In this relationship, variable x is considered as design variable and y is considered as control variable. In robust optimization, the problems mainly consist of a set of scenarios abbreviated as Ψ={1,2,3,…, Γ} (Bertsimas et al., 2011). In robust optimization, the problems mainly consist of a set of scenarios abbreviated as Ψ={1,2,3,…, Γ} (Bertsimas et al., 2011). In robust optimization, the problems mainly consist of a set of scenarios abbreviated as Ψ= {1,2, 3… Γ} (Bertsimas et al., 2011). In each scenario, the coefficients of the variables in each constraint are represented by $Q_\Gamma \in \Psi$, where Q_Γ is the probability of a scenario occurring and the sum of the probabilities is equal to the value one. Therefore, the area of optimization based on this research is the optimal allocation of educational resources in Iranian Railway Engineering Faculty. Since a robust optimization approach can be applied to any general problem, the structure of the problem can be specified and implemented with numerical data belonging to the uncertainty set (Gabrel et al., 2017). The robust counterpart of the linear programming problem for obtaining the optimal resource allocation in Iranian Railway Engineering Faculty is formulated in the form of a quadratic linear model according to the findings of previous studies. Therefore, the robust optimization model presented by Guo & Xu (2021) and Xiong (2019) was used in the current study. In the relationship presented, it is assumed that c, i, n and u are vectors, in this case, if A is an m × n matrix and b is a corresponding vector, then the linear programming of the following complex integer is on a set of n. The variable in which there are correct k values is as follows (Xiong et al., 2019):

$$Min\, c^T x$$

Subjected to:

$$Ax \leq b$$

$$l \leq x \leq u \qquad (2)$$

$$\in Z, i = 1,2, \ldots, k.$$

Therefore, if we assume that the uncertainty in the data affects only the elements of matrix A and the coefficients of c and has no effect on vector b, then a new variable called x_{n+1} is introduced. In this case, it can be written as follows:

$$Ax - bx_{n+1} \leq 0 \qquad (3)$$

$$l \leq x \leq u$$

$$0 \leq x_{n+1} \leq 1$$

The matrix A therefore contains the values of b on an ascending path. Therefore, the matrix A contains the values of b in an increasing path. Hazır & Dolgui (2016) have shown in their study that both the mean of a_{ij} and the range of $\hat{a}_{ij}$ can be calculated in general applications. it is difficult to obtain an accurate coefficient distribution of decision variables. It is also assumed that the coefficients of the objective function c_j and its estimation range in d_j are certain. In this case, according to the findings of the study by Bertsimas et al. (2011):

$$\min c^T x + z_0 \Gamma_0 + \sum_{j \in j_0} p_{0j} \qquad (4)$$

Subjected to:

$$\sum a_{ij} x_j + z_i \Gamma_i + \sum_{j \in j_i} p_{ij} \leq b_i \qquad \forall i$$

$$z_0 + p_{0j} \geq d_j y_j \qquad \forall j \in j_0$$

$$z_i + p_{ij} \geq \hat{a}_{ij} y_j \qquad \forall j \neq 0, j \in J_i$$

$$p_{ij} \geq 0 \qquad \forall i, j \in J_i$$

$$y_j \geq 0 \qquad \forall j$$

$$z_i \geq 0 \qquad \forall i$$

$$-y_j \leq x_j \leq y_j \qquad \forall j$$

$$l_j \leq x_j \leq u_j \qquad \forall j$$

4.1. Mathematical relationships

In this paper, a multi-criteria decision making model for the allocation of educational resources at the Iranian Railway Engineering Faculty is presented. Here, the optimization problem searches for solutions in the justified set of solutions according to certain criteria (Bairamzadeh et al., 2021). Therefore, considering the structure of the research, the mathematical model explains the problem as follows:

$$\max \sum_{i=1}^{N} \sum_{j=0}^{M} e_{ij} X_{ij}$$

$$\min \sum_{i=1}^{N} \sum_{j=0}^{M} c_{ij} X_{ij} \qquad (5)$$

Subjected to:

$$\sum_{i=1}^{N}\sum_{j=0}^{M} jX_{ij} \leq M$$

$$\sum_{j=0}^{M} X_{ij} = 1 \qquad \forall i$$

$$X_{ij} = 0 \; or \; 1 \quad \forall i,j$$

In the above relationship, the index i=1, 2..., N stands for the number of resources and j for the number of activities j=0, 1,2,..., M. N also indicates the total amount of resources. M is the sum of all activities, c_{ij} is the cost of the resources assigned to each activity, and e_{ij} is the efficiency of the resources in the case that activity i is assigned to activity j. In this case, the decision variables of the model are shown below:

$$X_{ij} \in \{1,0\} \qquad (6)$$

The relation number 6 shows the value of a state when the educational resources are assigned to activity i, and for other states the value of the binary variable X_{ij} is zero. In the above relationship, the objective function is to maximize the efficiency of all educational activities. The above constraint ensures that we cannot allocate more resources to the activities. The next constraint ensures that each resource can only be assigned to one activity. optimal alternatives are usually considered as a solution to a multi-objective problem. Therefore, to implement optimization algorithms, a module for optimizing and managing solutions is provided, which consists of two stages: the first stage involves evaluation based on objective functions, and the second stage monitors the optimization solutions. Therefore, a practical and functional solution for resource allocation in the education system is the multi-objective model problem, in which each part is assigned a state space. The allocation of the j-th resource to the i-th activity is referred to here as a dynamic allocation action, whose coordinates are denoted by V(I,j) and which can move from a state such as S1 to the state space S2, thus gradually completing the response space. In the following, while explaining the concept of uncertainty in linear planning, optimization under uncertain conditions for educational resource allocation of educational resources in the Iranian Railway Engineering Faculty is discussed. Thus, according to the uncertainty of data in linear optimization and according to the results of Ben Valley research, we have:

$$\min_{x}\{c^T x + d : Ax \leq b\} \qquad (7)$$

In the relation (7) $x \in R^n$ is the vector of the decision variables. In the above relationship, $c \in R^n$ and $d \in R^n$are also parameters of the objective function. A is a matrix with m×n constraints and $b \in R^m$ forms the value of the right-hand side of the vector. In the above relationship, the constant value d in the objective function affects the optimal value, but not the optimal solution. For this reason, it is usually ignored. In the structure of relation number 7, m is the number of constraints and n is the number of variables. On the other hand, the data of the problem are represented in the form of parameters (c, d, b, and A) that can form the elements of a (m+1) × (n+1) matrix, which is represented as relation (8).

$$D = \begin{bmatrix} c^T & d \\ A & b \end{bmatrix} \qquad (8)$$

Usually, all constraints in a linear programming problem are not predetermined and can be developed in different applications (Varas et al., 2017). Some general forms of constraints can be defined as $a^T x \leq cnst$x≤cnst and can be linearized with the mathematical symbol "≤". On the other hand, newer constraints can also be represented as "≥" (Balouka and Cohen, 2021). Therefore, it is assumed that in the case study of Iranian Railway Engineering Faculty, the bounds of the problem are only in the above form. In the real world, the data of linear optimization problems are often not certain and predetermined, and it is accompanied by a kind of uncertainty, some of the reasons for this are as follows (Nazari-Heris and Mohammadi Ivatloo, 2021):

First, some inputs, such as data related to the future needs of the higher education system, the efficiency of the educational system, educational elements, classes, etc., are usually not up-to-date, and sometimes they are provided when the time to use them has passed, and therefore lack objectivity in solving problems, 2024). The participation rate of a particular decision change such as x_j on the left side of a boundary of the decision model such as i, is the output of the training system such as $a_{ij}x_j$. With this information, the consequences of an implementation error show a change as $x_j \rightarrow x_j + \epsilon$, so the amount of error is assumed to be very small. However, it can be seen that an additional coefficient called $a_{ij}\epsilon$ is received on the left-hand side, which is in the noise equivalent queue $b_i \rightarrow b_j - a_{ij}\epsilon$ on the right-hand side of the relations, where the consequences of a normal implementation error such as $x_j \rightarrow (1+\epsilon)x_j$ are assumed to be ignored. Similarly, the implementation errors of additive and multiplicative changes on x_j changes in the target can be simulated by suitable noise values such as d and c_j. In linear optimization methods, small uncertainties in the classical data of less than 1% are ignored. In this case, it is assumed that the result matches the target value and the optimal option corresponds to the value determined in the calculations (Cui, 2023). Uncertainties are to be expected when working with limited data on the optimization function of the agent model. Thus, while it is important to proceed with the project and make minor adjustments to achieve the goal, it is also important to recognize the uncertainty associated with small data when addressing the issues involved (Sun, 2023). In the Iranian Railway Engineering Faculty, track and railroad structure engineering, railroad machinery engineering, railroad electrical engineering and railroad control and signaling engineering training groups are active and training resources are allocated to them. The aim of Table 2 is to present a plan that maximizes the efficiency of the resource performance of the Iranian Railway Engineering Faculty.

Parameters	Line engineering and railway structures	Railway machine engineering	Electric railway engineering	Control engineering and railway signals
Personnel costs (per capitation cost of academic staff, per capitation cost of non-academic faculty, per capitation cost of teaching fees, per capitation cost of management)	6005	1495	3018	1093
General support costs (per capitation cost of maintaining the educational space, per capitation cost of maintaining educational aids, per capitation cost of maintaining open educational spaces, per capitation cost of consumables and administrative and educational necessities, per capitation cost of light and motorized transportation services, per capitation cost of energy (without considering dormitories), per capitation cost of facilities and maintenance of facilities (without considering dormitories)	7899	1814	2118	1056
Costs of cultural-student services (per capitation cost of maintaining welfare spaces, per capitation cost of food subsidy, per capitation cost of student commuting, per capitation cost of sports activities, per capitation cost of health and treatment, per capitation cost of cultural activities, per capitation cost of dormitory energy consumption, per capitation cost of maintenance and management of dormitories)	5488	1076	3118	1057
The costs of research and technology activities (per capitation cost of academic faculty members' study opportunities, per capitation cost of academic faculty members' research credit)	8934	3356	3231	6383

Table 2. Data related to the per cost outputs of Iranian Railway Engineering Faculty for the academic year of 2015

The results show that the largest share of expenditure in the total per capita expenditure of student education in Iran Railway Engineering faculty is related to educational costs (personnel). As the level of education improves, the per capita cost of students increases, which is mainly related to the cost of research and technology. Therefore, the use of robust models to determine and allocate resources in universities leads to compliance with distributive justice and increased efficiency in resource allocation, which can support cost management in terms of performance indicators in addition to transparency in university budgeting. The share of each cost centre in Iran Railway College can therefore be expressed as follows: The share of educational services cost in the total cost of the university is about 70%. The share of ancillary services cost (welfare students) in the total cost of the university is about 4% and finally, the share of research and development cost in the total cost of the university is 29%; on the other hand, the government's financial support for the railroad university is realised in the form of a model in the form of educational, research and capital budgets.

5. DISCUSSION

Some structural and content resources needed for the implementation of educational processes at the Iranian Railway Engineering Faculty are shown in Table 3.

Resources needed by the railway faculty	Cost per unit of resources	A representative of each resource, such as A per-resource unit

Personnel services	283	%283
General support services	71	%72
Cultural - student services	91	%102
Research and technology activities	52	%63

Table 3. Structural and content-related resources required by the Faculty of Railway Engineering for the implementation of the teaching process

The educational resources required by the Railway Engineering Faculty in Iran for the implementation of curriculum planning are listed in Table 4.

Staff University professor budget (by hours)	Staff University professor budget (by hours)	Educational equipment and technologies	The capacity to use educational resources in the university
10455894	1600	4000	2000

Table 4. Educational resources needed by the Iranian Railway Engineering Faculty for the implementation of educational planning

According to the principles of linear programming, the mathematical relationships of the planning cost centers in the Iranian Railway Engineering Faculty can be described as follows:

$$Z = Min\ 283x_1 + 71x_2 + 91x_3 + 52x_4 + 1600R_1 + 4000R_2 + 2000R_3 \qquad (9)$$

Subjected to:

$$0/283x_1 + 0/72x_2 + 0/102x_3 + 0/63x_4 \geq 0$$

$$R_1 + R_2 + R_3 \leq 1600$$

$$71x_1 + 91x_2 + 0/102x_3 + 52x_4 \leq 4000$$

$$283x_1 + 71x_2 + 91x_3 + 52x_4 \leq 104955894$$

$$R_1 + R_2 + R_3 + \ x_1 + x_2 + x_3 + Rx_4 \geq 0$$

In this problem, the linear programming model has 7 variables. The maximum possible value for the variables x1 to x4 in this situation is 1600. The value that results from the linear optimization relationships according to the relationships between the variables is as follows:

Z=-992000;

X_1=0, X_2=5490/890, X_3=18/663, X_4=0

It is important to point out that both budget and other constraints outlined in the problem statement play an important role. The process of providing educational services within the Railway Engineering Faculty operates with a budget of 1049558940. For the relevant options in the space of justified answers, the optimal value is 9.9. It is clear that even for very simple problems, some data are not completely reliable. For example, in some social problems, the active factors in the input sources may not be accurate (Leyffer et al., 2023). In this particular problem, the accuracy is 0.283 when using the first source, 0.72 for the second source, and 0.102 and 0.63 for the other variables. The variables in the problem have different values within the limits defined for different constraints, so it is a reasonable assumption that the real fields of the problem variables and the factors controlling the resources are normally distributed around the nominal values of the variables. Therefore, $\alpha_1 = \frac{0}{283}, \alpha_2 = \frac{0}{72}, \alpha_3 = \frac{0}{102}\ \alpha_4 = \frac{0}{102}$ are the coefficients of the decision variables in the bounds. To increase accuracy, it is also assumed that α-1 should be shifted by a value of 0.8 around the limits. In this case, the value of α_1 is in the range of the response [0.283006, 0.000990]. Similarly, if α_2 moves in its value margin by 0.5, then its value lies in the solution space [0.0831, 0.0720]. In this case, the question arises to what extent the deviations caused by this distribution affect the active factors of the teaching-learning process in the railroad faculty. The optimal solution recommends that by adding 9.549 units to source number 2, 171 units from the first educational group (track engineering and railroad construction) can be covered. In this case, many random variations may affect the active content of the agent. The study of the content of source number 2 shows that the implementation of the option will be impossible with a probability of 0.8, which means that in the model in question, the content of source number one among the total inputs has a value lower than the expected value to cover the process. If the available resources for the implementation of the teaching-learning process are insufficient, this jeopardizes the efficiency of this process. In addition, the provision of educational services to other groups, such as railroad lines and construction projects, may become variable after applying this method. It becomes random within the closed interval with an initial value of 170/663 and takes on the value 170/312 in the confidence interval of 0.05. The assumption of uncertainty within a set enables decision making and the creation of a dependent flow that can be adjusted with a perturbation vector. The resulting perturbation set Z is defined as follows:

$$u = \left\{ \begin{bmatrix} c^T & d \\ A & b \end{bmatrix} = \begin{bmatrix} c_0{}^T & d_0 \\ A_0 & b_0 \end{bmatrix} + \sum_{\ell=1}^{L} \ell \begin{bmatrix} c_\ell^T & d_\ell \\ A_\ell & b_\ell \end{bmatrix} : \zeta \in \mathbb{Z} \subset \mathbb{R}^L \right\} \quad (10)$$

For example, the resources of the Railway Engineering Faculty have been transformed into a linear optimization relation under uncertain conditions, whose problem can be written as follows:

$$y = \{x_1;\ x_2;\ x_3;\ x_4\ ;\ R_1;\ R_2; R_3\} \quad (11)$$

With the above details, nominal data is shown as D_0, D_1, and D_2:

$$D_0 = \begin{bmatrix} 283 & 71 & -10560 & -9200 & 0 \\ -.05 & -.04 & 0.6 & .9 & 0 \\ 1 & 1 & 0 & 0 & 1600 \\ 0 & 0 & 130 & 180 & 4000 \\ 0 & 0 & 60 & 70 & 2000 \\ 283 & 71 & 1600 & 2000 & 200000 \\ -1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 \end{bmatrix}$$

In the following, we will have to deal with two fundamental shifts in the above matrix:

$$D_1 = 6.0e - 5 * \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

In the following, the value of matrix D_2 is shown as follows:

$$D_2 = 7.0e - 7 * \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

The search for a robust solution is somewhat easier for the reasons mentioned above. However, the educational system at the Railway Technical School faces challenges related to the uncertainty of its input sources. As a result, some data regarding the education groups are affected by this uncertainty, leading to adjustments in the coefficients x1 to x5. Therefore, the candidate alternative is robust only if it can satisfy all the existing constraints related to the different education groups. In the equilibrium restrictions, since the first to fourth sources have non-negative values, this is considered as the worst possible case of no equilibrium in the restrictions based on the uncertain coefficients α1 to α5 adjusted to the lowest possible values in the uncertainty set (this value is approximately 0.00884 and 0.0205, respectively, in the present study). This situation represents the worst-case scenario regarding the lack of equilibrium in the constraints when considering the uncertain coefficients α1 to α5. These coefficients were adjusted based on the lowest possible values within the uncertainty set, which in this study are approximately 0.00884 and 0.0205, respectively. Since the objective function is not affected by the uncertainty space, the stable values for the objective function remain the same as the original values. Consequently, the robust counterpart Rc is considered equivalent to the original value under absolute certainty. In linear optimization problems, the fixed costs are sometimes described as deductions from the nominal value of profits. The optimal value of 102955894 is about 49% higher than the robust value of 41982357.6 It is important to note that this increase is significantly less than the potential 25% reduction in actual profit that could occur when prioritizing optimal solutions based on real data. Furthermore, the structure and method of the robust optimal solution is completely different from that of the nominal optimal solution. By using a robust solution, we can provide the necessary resources while taking into account the additional cultural and similar needs of students with nominal amounts. The optimal solution provides a generally stable value for the uncertainty of the coefficients of variation αi for each active agent. However, it can be seen that α1 is smaller than α2 (7% vs. 5%), which can ultimately improve the utilization of resources. In the robust optimization method, the most important issue is the feasibility of the constraints to achieve the objective, assuming a stepwise implementation of the decisions under uncertainty conditions. The decision maker can satisfy the educational needs of the groups with higher costs to ensure that the constraints are satisfied in the case study of the Faculty of Railway Engineering in Iran, considering the shortage of educational resources. due to the diverse educational needs and the competition between different educational groups for resources and the goal of minimizing costs based on different decision levels and their effects, the issue of resource allocation becomes increasingly difficult. Consequently, meeting the constraints will be a complex process that has not been fully achieved, making it difficult to achieve the objective function. When there is a mutual correspondence between the members of two finite sets with uncertainty, these sets have small cardinality (Hu and Li, 2021). To achieve the optimal solution, linear programming methods are used. Therefore, to ensure the stability of the decision model, it is essential to have multiple scenarios available. Therefore, a stable structure has been proposed in the current research to overcome the challenges. In the following, the optimal formulation based on the principles of robustness and randomness was used to optimally allocate the resources for the educational processes of the Railway Engineering Faculty. In this study, the resources available to the railway engineering faculty should increase the productivity of the educational system through innovation and creativity. In addition, these resources should minimize waste within the department while ensuring the development of qualified human capital. It is important to adjust the consumption of resources and improve the knowledge and competence of professors in the department. This can be achieved by introducing admission restrictions and monitoring professors' research performance based on quantitative standards. This can be achieved by implementing registration restrictions and monitoring professors' research performance based on quantitative standards. In addition, improving their potential for process optimization can lead to better qualitative results. In this case, the university's research output leads to improved resource utilization in the railroad faculty and other economic benefits by creating a balance between students and professors. In order to utilize the educational resources efficiently, it is important to improve the logistics system of the railroad faculty. This can be achieved through improved internal management and resource planning, while respecting the principles and limits of economies of scale. It is important to fully utilize existing capacities and promote their sharing. The integration of academic disciplines and the reorganization of educational resources are therefore a solution to optimize the structure of the railway engineering faculty and professional development. From this point of view, optimizing the structure and allocating resources and personnel does not necessarily make sense. Therefore, considering that the centralized and decentralized educational resources in the teaching groups depend on the financial support from the upstream institutions, the release of resources depends on an appropriate combination of them. Figure 1 shows the analysis of resource allocation in the stable optimization method and the conventional optimization method.

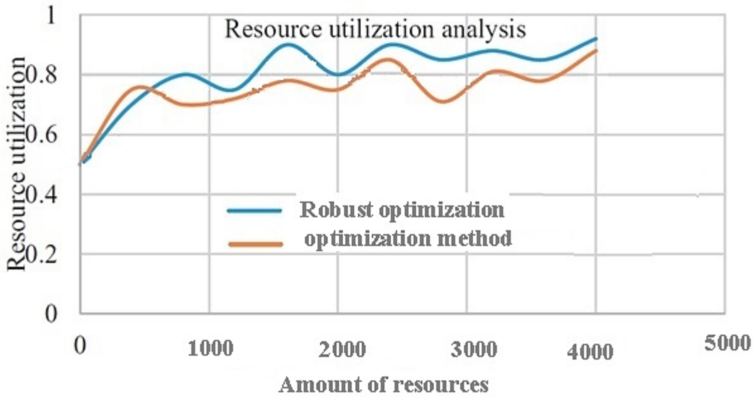

Figure 1. Analysis and comparison of resource utilization in the robust optimization method and the conventional optimization method

6. CONCLUSION

The framework presented in this study aims to find an optimal solution. Economic methods for educational planning, based on the principles of higher education economics, enable planners to allocate the necessary infrastructure, human resources and facilities to meet the needs of educational groups. These methods also help in managing the costs associated with education for each period. Each group should be allocated based on the number of students and professors according to the objectives. In this case study, the main incremental costs are determined by analyzing the optimal options for human capital allocation. In this study, the random fluctuations in the demand for education are not considered. Instead, the researchers have proposed a new model that accounts for uncertainty in demand using advanced algorithms, including random robust optimization techniques. Qualitative results were not considered essential for this study. Therefore, the model presented here focuses on the selection of variables and constraints relevant to the primary research question and the ultimate objective function of the railroad faculty. The elimination of a particular training group could affect the overall benefits of the railroad school to the rail transportation industry and increase costs, so the factors associated with this decision must be carefully weighed. Therefore, it is first necessary to assess the impact of using or saving a resource. The second step is to assess whether the use of these resources is compatible with the optimization of the objective function. The main task of this study is to analyze how the different sectors of the railroad industry affect the demand for training and the performance of the training groups in the railroad faculty. From a mathematical algorithm perspective, optimization techniques were used to address resource allocation issues in Iranian Railway Engineering Faculty, complemented by exploratory analysis methods.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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