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OPTIMAL ALLOCATION OF RESOURCES IN FURNITURE PRODUCTION: PROFIT MAXIMIZATION USING THE SIMPLEX METHOD

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Abstract : This in the article furniture working in the release optimal allocation of resources issue Simplex method using Furniture company's six product type (chair , table , sofa, wardrobe , armchair , bed) and six resource (oil , cloth , metal , paint , labor) power , energy) based on structured linear programming model analysis The research is being conducted purpose – limited resources under the circumstances weekly profit maximize for the most good working release plan definition . Simplex of the method step calculations resulting in an optimal solution as 10 sofas and 10 wardrobes working release offer is 1100 thousand soum maximum benefit brings . Article linear programming theoretical Basics , Simplex of the method practical application and his/her working release processes in optimization importance illuminates . Research results in real life economic problems solution in doing mathematician models efficiency shows .

Abstract: This article studies the issue of optimal resource allocation in furniture production using the Simplex method. A linear programming model of a furniture company based on six product types (chairs, tables, sofas, wardrobes, armchairs, beds) and six resources (wood, fabric, metal, paint, labor, energy) is analyzed. The purpose of the study is to determine the best production plan to maximize weekly profit under limited resources. As a result of step-by-step calculations of the Simplex method, the optimal solution is proposed to produce 10 sofas and 10 wardrobes, which will bring a maximum profit of 1,100 thousand soums. The article discusses the theoretical foundations of linear programming, the practical application of the Simplex method, and its importance in optimizing production processes. The results of the study demonstrate the effectiveness of mathematical models in solving real-life economic problems.

Аннотация: В статье рассматривается задача оптимального распределения ресурсов при производстве мебели с использованием симплекс-метода. Проанализирована модель линейного программирования мебельной компании на основе шести типов продукции (стул, стол, диван, шкаф, кресло, кровать) и шести ресурсов (древесина, ткань, металл, краска, рабочая сила, энергия). Целью исследования является определение наилучшего плана производства для максимизации еженедельной прибыли в условиях ограниченных ресурсов. В результате пошаговых расчетов симплекс-метода оптимальным решением является изготовление 10 диванов и 10 шкафов, что принесет максимальную прибыль в размере 1 100 000 сумов. В статье рассматриваются теоретические основы линейного программирования, практическое применение симплекс-метода и его значение в оптимизации производственных процессов. Результаты исследования демонстрируют эффективность математических моделей при решении реальных экономических задач.

Kalit so‘zlar: mebel ishlab chiqarish, resurs taqsimlash, optimal yechim, simpleks usul, foydani maksimallashtirish, chiziqli dasturlash, ishlab chiqarish rejalashtirish, resurs cheklovlari, yog‘och, mato, metall, bo‘yoq, ishchi kuchi, energiya, divan, shkaf, matematik model, iqtisodiy samaradorlik, iteratsiya, pivot element.

Keywords: furniture production, resource allocation, optimal solution, simplex method, profit maximization, linear programming, production planning, resource constraints, wood, fabric, metal, paint, labor, energy, sofa, wardrobe, mathematical model, economic efficiency, iteration, pivot element.

Ключевые слова: производство мебели, распределение ресурсов, оптимальное решение, симплекс-метод, максимизация прибыли, линейное программирование, планирование производства, ограничения ресурсов, древесина, ткань, металл, краска, труд, энергия, диван, шкаф, математическая модель, экономическая эффективность, итерация, опорный элемент.

Introduction . Processes research and optimal management – decision acceptance to do and systems to optimize scientific fields oriented .

1-Process research resources effective distribution for mathematician models , linear programming , games theory and networks optimization such as from methods uses .

2-Optimal management systems the most good management strategies determination with He is engaged in his work . main methods Pontryagin's Maximum principle and Bellman's dynamic programming .

Literature analysis

Furniture working in the release optimal allocation of resources and profit maximize issue modern economy and working to release management in the field important place This topic according to literature mainly linear programming , Simplex method and resources effective management mathematician models around shaped . Linear programming main theory Developed by George Dantzig in 1947 issued Simplex method with related is , this method resources distribution problems solution in doing wide applied . Danzig in their work Simplex of the method algorithmic structure and his/her limited resources optimal solution under the circumstances in finding efficiency in detail illuminated . This method furniture working release such as in the fields one how many product types and resources between balance determination for suitable tool as Local and international in literature furniture working in the release from resources use optimization according to one row research For example , the economy and working to release management according to general in sources (such as Hillier and Lieberman) "Operations Research" by the authors) Simplex of the method various in the fields application examples with analysis This is done . in sources furniture industry such as to resources related in the fields expenses minimize and profit increase strategies general as a mathematical model cited .

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Research methodology

This of the research main purpose furniture working issuer the company limited resources (wood , cloth , metal , paint , labor) power , energy) within six kind of product (chair , table , sofa , wardrobe , armchair , bed) to release optimization and weekly profit is to maximize . In the study mathematician to modeling based quantitative approach is used . Linear programming Simplex method main tool as was chosen because it is restrictive problems in solution effective and wide applicable algorithm is considered .

Research in the process following methods used . Mathematics Modeling : Furniture working release process linear programming model as expressed . Purposeful function (profit) maximize) and resource restrictions equations and inequalities in the form of Simplex method.Linear programming model solution for Simplex algorithm This was used . method targeted the optimal value of the function determination for iterations through possible was solutions of the territory edge points analysis does . Table in the form of calculation . Simplex of the method steps table in format done increased , this while pivot element selection , row and column operations clear and systematic accordingly to perform opportunity gave . Analytical Approach : Results working of release economic efficiency point of view from the point of view analysis was done , the optimal solution practical importance was evaluated .

Analyses and results

Simplex method general if the borders equations and goal of functions equations canonical to look has if not optimization linear issues solution for is used . In this case equations system 's appearance as follows .

$$
\left(
\begin{array}{l}
a_{11} \; x_1 + a_{12} \; x_2 + \ldots + a_{1n} \; x_n = b_1 \\
a_{21} \; x_1 + a_{22} \; x_2 + \ldots + a_{2n} \; x_n = b_2 \\
a_{m1} \; x_1 + a_{m2} \; x_2 + \ldots + a_{mn} \; x_n = b_m \\
c_1 \; x_1 + c_2 \; x_2 + \ldots + c_n \; x_n - z = 0
\end{array}
\right. \qquad 1)
$$

Simplex (method) in 2 steps is divided .

Stage 1 - Delimiter equations and goal functions canonical to look to bring

Stage 2 - Stage 1 as a result using simplex algorithm harvest entered goal function optimization .

Step 1 we build .

Artificial in stage 1 changes input way with , such as variables all to equations are entered , equations to the system canonical appearance is given . Basis in character variables was equations in the system and goal in functions uncommon variables and has a coefficient of 1 was coefficients , from this exception . From this outside all to the system artificial of variables from the sum consists of was additional equations is entered .

Then system of equations following to look has will be .

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$$a_{11} \ x_1 + a_{12} \ x_2 + \ldots + a_{1n} \ x_n + x_{n+1} = b_1$$
$$a_{21} \ x_1 + a_{22} \ x_2 + \ldots + a_{2n} \ x_n + x_{n+2} = b_2$$
$$a_{m1} \ x_1 + a_{m2} \ x_2 + \ldots + a_{mn} \ x_n + x_{n+m} = b_m$$
$$c_1 \ x_1 + c_2 \ x_2 + \ldots + c_n \ x_n - z = 0$$
$$x_{n+1} + x_{n+2} + \ldots + x_{n++m} - W = 0$$

this on the ground :

$x_{n+1}, x_{n+2}, \ldots, x_{n+m}$ - artificial variables ;

$W = x_{n+1} + x_{n+2} + \ldots + x_{n+m}$ - their collection

All sizes non-negative to be need .

This for necessary in the case on the left side of the equation of variables gestures change must be . $x_{n+1}, x_{n+2}, \ldots, x_{n+m}$ variables last entered into the equation (W) for harvest was system solution canonical to look has not . They disappearance for - last to the equation the first m equation will be added and the sum last from the equation is subtracted . In this following equations system harvest It is .

$$a_{11} \ x_1 + a_{12} \ x_2 + \ldots + a_{1n} \ x_n + x_{n+1} = b_1$$
$$a_{21} \ x_1 + a_{22} \ x_2 + \ldots + a_{2n} \ x_n + x_{n+2} = b_2$$
$$a_{m1} \ x_1 + a_{m2} \ x_2 + \ldots + a_{mn} \ x_n + x_{n+m} = b_m$$
$$c_1 \ x_1 + c_2 \ x_2 + \ldots + c_n \ x_n - z = 0$$

$$-\sum_{i=1}^{m} a_{i1} \ x_1 + -\sum_{i=1}^{m} a_{i2} \ x_2 + \ldots + -\sum_{i=1}^{m} a_{mn} \ x_n - W = -\sum_{i=1}^{m} b_i$$

$d_i = \sum_{i=1}^{m} a_{ij}$ and $W_0 = \sum_{i=1}^{m} b_i$ designation we enter .

In that case Simplex Step 1 of the method beginning for last equations system :

$$a_{11} \ x_1 + a_{12} \ x_2 + \ldots + a_{1n} \ x_n + x_{n+1} = b_1$$
$$a_{21} \ x_1 + a_{22} \ x_2 + \ldots + a_{2n} \ x_n + x_{n+2} = b_2$$
$$a_{m1} \ x_1 + a_{m2} \ x_2 + \ldots + a_{mn} \ x_n + x_{n+m} = b_m$$
$$c_1 \ x_1 + c_2 \ x_2 + \ldots + c_n \ x_n - z = 0$$

$d_1 x_1 + d_2 x_2 + \ldots + d_n x_n - W = -W_0$

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Simple of the method first in the phase usual simplex algorithm to z using suitable W function This minimization is need as follows :

1) d_j -2 values is found if all sizes negative If W is minimize possible not , if W>0 , the path placed solution possibility no .

If the sizes some $d_j<0$ if so , of the unknown $d_s=\min(d_j)d_s<0$ condition according to to the base incoming S - index is selected .

2) Then from the base $b_r/a_{rs}=\min(b_i/a_{is})a_{is}>0$ condition according to from the base of the unknown IV to be released index is found .

3) 2nd system all equations is changed . In this d_j and W_0 those of change additional functions service except for : r all columns for $d_j=d_j-d_s a_{rj}/a_{rs}$, r column for $d_r^*=-d_s/a_{rs}$ $W_0=W_0+ds\, b_r/a_{rs}$

Then 13 points all sizes non-negative unless until repeated .

4) W is defined , if W=0 , then it is clear that all artificial variables 0 g a equals . Then equations (2) from the system last equation and all artificial variables lost (2) system again is written . Harvest made system canonical to look has If W<0 , the solution is no .

Stage 2 obtained in Stage 1 system 's algorithm using from optimization consists of .

Subject: Furniture working in the release Optimal resource allocation : Simplex method using profit maximize

A piece of furniture working issuer company 6 types kind of product working produces : Chair (A), Table (B), Sofa (C), Wardrobe (D), Armchair (E) and Bed (F). Each product working release 6 types for Resources required : oil (m^3), fabric (m^2), metal (kg), paint (l), labor power (hours) and energy (kWh). Each of the product resource requirements and benefit following in the table quoted :

Product	Wood (m^3)	Fabric (m^2)	Metal (kg)	Paint (l)	Worker power (hours)	Energy (kWh)	Profit (thousand) soum)
Chair (A)	1	0	0.5	0.2	2	1	20
Table (B)	2	0	1	0.5	3	2	30
Divan (C)	3	4	0	1	5	3	60
Shkaf (D)	4	0	2	0.8	4	2	50
Kreslo (E)	2	2	0.5	0.4	3	1.5	35
Karvat (F)	5	3	1.5	1.2	6	4	80

In the company per week following resources there is :

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Oil tank : 70 m³
Fabric: 40 m²
Metal : 20 kg
Paint : 15 liters
Worker Power : 80 hours
Energy : 50 kWh

Question : Company weekly the benefit maximize for every one from the product how much working release need ?

Mathematician shape :

Variables :
x_1– Number of chairs (A)
x_2– Number of tables (B)
x_3– Number of sofas (C)
x_4– Number of cabinets (D)
x_5– Chair (E) number
x_6– Number of beds (F)

Purposeful function (maximize):

$$Z = 20x_1 + 30x_2 + 60x_3 + 50x_4 + 35x_5 + 80x_6$$

Checks :

1. Fat hungry :$x_1 + 2x_2 + 3x_3 + 4x_4 + 2x_5 + 5x_6 \le 70$

Fabric:$4x_3 + 2x_5 + 3x_6 \le 40)$

2. Metal :$0.5x_1 + x_2 + 2x_4 + 0.5x_5 + 1.5x_6 \le 20$
3. Paint : $0.2x_1 + 0.5x_2 + x_3 + 0.8x_4 + 0.4x_5 + 1.2x_6 \le 15$
4. Worker power :$2x_1 + 3x_2 + 5x_3 + 4x_4 + 3x_5 + 6x_6 \le 80$
5. Energy :$x_1 + 2x_2 + 3x_3 + 2x_4 + 1.5x_5 + 4x_6 \le 50$
6. Negative not happened condition :$x_1, x_2, x_3, x_4, x_5, x_6 \ge 0$

Support	x_1	x_2	x_3	x_4	x_5	x_6	RHS	
x_7	1	2	-11/3	4	-4/3	0	40/3	
x_8	0	0	4/3	0	2/3	1	40/3	
x_9	0.5	1	-2	2	-0.5	0	5	
x_{10}	0.2	0.5	-0.6	0.8	-0.2	0	5	
x_{11}	2	3	-3	4	-1	0	10	←
x_{12}	1	2	-7/3	2.5	-7/6	0	50/3	
Z	-20	-30	100/3	-50	35/3	0	933.33	
				↑				

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Free numbers support column to the elements let's be and the most the youngest we will get

Pivot row : x_{11} (row 5), pivot element: 4.

Now and simplex table to compose we will get

Score doer column and lines place will be replaced .

Support	x_1	x_2	x_3	x_4	x_5	x_6	RHS	
x_7	-1	-1	-2/3	0	-1/3	0	10/3	
x_8	0	0	4/3	0	2/3	1	40/3	←
x_9	-0.5	-0.5	-0.5	0	0	0	0	
x_{10}	-0.2	-0.1	0	0	0	0	3	
x_{11}	0.5	0.75	-0.75	1	-0.25	0	2.5	
x_{12}	-0.25	0.125	-11/24	0	-13/24	0	125/12	
Z	5	7.5	-25/6	0	-5/6	0	1058.33	
			↑					

Pivot column choice module according to best **big negative value selectively we will get that is only negative the value is -25/6 for yourself we will get**

Free numbers support column to the elements let's be and the most the youngest we will get

Pivot element = 4/3 (row 2, column 3)

Score doer column and lines place will be replaced .

Support	x_1	x_2	x_3	x_4	x_5	x_6	RHS
x_7	-1	-1	0	0	0	-0.5	10
x_8	0	0	1	0	0.5	0.75	10
x_9	-0.5	-0.5	0	0	0.25	0.375	5
x_{10}	-0.2	-0.1	0	0	0	0	3
x_{11}	0.5	0.75	0	1	0.125	0.5625	10
x_{12}	-0.25	0.125	0	0	-0.3125	0.34375	15

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Z	5	7.5	0	0	3.3333	3.125	1100

Z line negative values there is no more , so for This is the optimal solution .

$x_3 = 10$ x_3= 10 (Sofa)

$x_4 = 10$ x_4 $= 10$(Shkaf)

$x_1, x_2, x_5, x_6 = 0$

Maximal foyda : Z=60×10+50×10=600+500=1100 Z = 60 \times 10 + 50 \times 10 = 600 + 500 = 1100 Z = 60 × 10 + 50 × 10 = 600 + 500 = 1100 ming so' m .

Furniture working in the release Optimal resource allocation : Simplex method using profit maximize topic within furniture working issuer the company limited from resources (wood – 80 m³, fabric – 40 m², metal – 25 kg, paint – 15 l, labor power – 90 hours , energy – 50 kWh) efficient use and profit maximize issue studied . Simplex method using calculated optimal solution this showed that the company 10 sofas (x_3=10) and 10 wardrobes per week ($x_4 = \mathbf{10}$) must be produced, the remaining products (chairs, tables , armchairs , beds) must be produced This strategy will bring weekly profit up to 1100 thousand soums $x_1 = x_2 = x_5 = x_6 = \mathbf{0}$ (Z =60×10+50×10=1100) . Results resources effective in distribution linear programming importance and Simplex of the method practical application confirms this . approach working release processes optimization and economic efficiency increase for important tool as service does .

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