

Modeling Investment Project Portfolio Selection for Job Creation in Uganda

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Abstract: Investment projects for human resource skills development towards job creation can be selected on the basis of a clear economic base for making investment decisions. In this study, we propose a zero-one integer programming model to determine the optimal decisions for the selection of job creation project portfolios in Uganda; where project selection is based on several time periods in the future. The objective is to determine whether to undertake a project or not; so that the net present value of investment returns on selected projects are maximized. A numerical example is presented for illustration; demonstrating the optimal choice of job creation projects under budget constraints. The zero-one integer programming model provides a feasible solution; given the competing nature of capital budgets prior to project implementation. The proposed model can be efficient; where limited funds among competing job creation projects serve as a basis for project selection criteria.

Keywords: investment; job creation; modeling; portfolio; project

Highlights

- We study the investment project portfolio selection problem for job creation in Uganda
- Project selection is made under limited budgetary expenditure
- Using zero-one integer programming, the optimal investment projects are chose
- The performance of the proposed model is provided using a numerical example

1. Introduction

Job creation projects are vital for the population all over the world; supporting the livelihood of vast numbers of people. The scientific base of such projects supports its rapidly increasing use as a vital tool in implementing job creation initiatives; especially on the side of the youth. The financial gap between the cost of providing job creation projects and sources of funding has raised greater public concern among policymakers worldwide; having long-term budgetary implications. In evaluating and selecting projects for job creation, the best subset of a larger set of possible alternatives may be chosen subject to an overall limited budget. Therefore; innovative financing options appropriate to particular projects are deemed vital as well as the analysis of appropriate roles of donors and national awareness as stakeholders. The implementation of job creation projects often brings more benefits than expected; considering the unemployment gaps among the youth in national and global economies worldwide. It is, therefore, necessary to understand the challenges and opportunities countries face in assessing financial resources necessary to ensure the long-term ability of job creation at sufficient levels of quantity and quality over time. In practical terms, job creation faces tremendous investment needs worldwide. This is crucial in order to meet a number of human resource development initiatives for the workforce in several

countries worldwide. However, financial shortcomings are usually common in managing job creation projects. This may be due to a lack of financial capacity in some countries and regions of the world. This anomaly has led to situations in which challenges relating to job creation are not sufficiently being addressed; leading to missed opportunities for human resource and skills development. It is therefore critical to identify when financial resources are required in order to sustain job creation initiatives as well as the potential resources to meet these financial needs. Therefore, sustainable funding models for development programs in job creation are needed in order to foster a conducive environment for investment in human resources and skills development for productive and sustainable economies at the national and global levels.

The paper is organized as follows: After reviewing the related literature in §2, the problem is described in §3. The model is thereafter formulated in §4; indicating the key notation and major assumptions are taken. In §5, a numerical example is presented and solved using the zero-one integer programming model. The results obtained are discussed and interpreted; indicating the optimal decisions for the selection of job creation projects in regions. Lastly, conclusions and future research follow in §6.

2. Literature Review

According to Gori[1], linear and goal programming can be used to make rational and consistent portfolio selections of a set of projects in the Durban metropolitan region. The LP model balances capital funding and cash flow restrictions against developmental preferences and the desire to achieve a healthy mix between revenue-generating and job creation projects. Raad and Shirazi [2] proposed a framework by which universities can define and implement projects that transform into entrepreneurial universities. This is done to help decision makers identify suitable goals and strategies, gather a list of projects to fulfill the goals and strategies and prioritize the projects and form a portfolio. Results propose a portfolio of projects that aims to transform a traditional university into a third-generation one. In a related world bank report [3], a project composed of financial support to micro, small and medium enterprises address access to finance gaps among (MSMEs) in Egypt and encourages greater private sector participation, risk capital for innovative startups, and high growth SME's in the territory of the borrower and associated management cost as well as business and capacity development through the provision of training, mentoring, coaching and business development services. A report by ILO [4] addresses the design, formulation, implementation, and evaluation of policies and programs in order to address unemployment and underemployment. This is done through public investment; typically in infrastructure development. Institutional and operational capacity is built to provide productive and decent work that has an economic, environmental, and social impact. Parikh and Shakya[5] explored the job portfolio by providing an analysis of the job portfolio for Nepal covering world bank operations as well as development partners' activities. Individual project interventions are reviewed and the balance of the portfolio as a whole. This is done to see how they align with national priorities and incorporate job-related outcomes. Cao Le and Nguyen [6] provided a better understanding of the practical and academic literature about project portfolio selection; study current practices in Vietnam and proposed a framework that is beneficially adaptable to these private corporations. Interesting insights on investment project portfolio selection by Rebiasz, Gawel, and Skalna[7] propose a hybrid framework where the parameters of the model are described using both probability distributions and fuzzy numbers. Stochastic dependencies are taken into account between model parameters and as a result, a set of Pareto optimal solutions is determined. Project support on the agricultural and services value chains [8] suggests strategies to broaden employment and income opportunities in Dakar. The study provides for the creation of 156 integrated agricultural, and poultry farms to solve unemployment. In a related report by OECD[9], five policies are undertaken in the financing, the business environment, technology, management capabilities, and access to markets to foster job creation, output and productivity growth with special focus on small and medium enterprises. In a related project by UNDP [10], unemployment reduction is sought by encouraging the creation of small

businesses that will provide a living for successful entrepreneurs. The community works component tackles social exclusion and two fronts at once; offering unemployed people a chance to gain valuable working experience and improve their personal skills.

3. Problem Description

The decision problem involves the selection of potential project investments for job creation in regions; and the decision is sought whether or not to invest in a particular project. Since we cannot consider partial investment for job creation projects, the problem becomes an integer program; where the decision variables are taken to be $X_{jr} = 0$ or 1; indicating that the j^{th} project investment project in region r is rejected or accepted. The selected job creation investment project must be worked on over a specified time horizon; but only limited funds are available to accomplish the possible project investments. The problem then seeks to determine which subset of projects in regional areas the eligible for funding in order to maximize the Net Present Value (NPV),

4. Model Formulation

4.1 Notation

- n Total number of projects for job creation
- b_i Total amount of capital investment available in period i ($i = 1, 2, \dots, m$)
- r Regional focus for job creation
- C_{jr} Present worth of all future revenue from project j ($j = 1, 2, \dots, n$)
- d_{jr} Amount of capital required for project j ($j = 1, 2, \dots, n$) in region r
- X_{jr} Zero-one variable having a value of one if project j is selected, zero otherwise

4.2 Constraints

The first constraint indicates that the total capital on all job creation project investments undertaken is less than or equal to the capital available

$$\sum_{j=1}^n \sum_{r=1}^R d_{jr} X_{jr} \leq b_{jr} \quad (1)$$

($i=1, 2, \dots, m$ $r=1, 2, \dots, R$)

The coefficient d_{jr} represents the net cash flow from job creation project j in region r . If the project investment requires additional cash, then $d_{jr} > 0$ while if the project investment generates cash, then $d_{jr} < 0$. The right-hand side coefficient b_{ir} represent the incremental exogenous cash flows. If additional funds are made available in period i , then $b_{ir} > 0$;

while if funds are withdrawn in period i , then $b_{ir} < 0$. Therefore constraint (1) states that the funds for investment must be less than or equal to the funds generated from prior investments plus exogenous funds made available. The second constraint indicates that the project investment j in region r must be rejected ($X_{jr} = 0$) or accepted ($X_{jr} = 1$)

$$X_{jr} = 0 \text{ or } 1 \quad (j=1, 2, \dots, n ; r=1, 2, \dots, R) \quad (2)$$

4.3 Objective Function

The objective function seeks to maximize the Net Present Value (NPV) denoted by Z .

Maximize

$$Z = \sum_{j=1}^n \sum_{r=1}^R X_{jr} C_{jr} \quad (3)$$

4.4 Zero-One Integer Programming Model

Considering (1), (2) and (3), the associated zero-one integer programming model becomes:

Maximize

$$Z = \sum_{j=1}^n \sum_{r=1}^R X_{jr} C_{jr}$$

Subject to

$$\sum_{j=1}^n \sum_{r=1}^R d_{jr} X_{jr} \leq b_{jr}$$

$$X_{jr} = 0 \text{ or } 1$$

5. A Numerical Example

The study considers five (5) job creation projects in the central region (region 1) and five projects in the eastern region (region 2) of Uganda. The available capital required and the present worth of all future revenue are indicated in Table 1. The capital investment available (in million USD) = 35 for the central region and 25 for the eastern region. The problem seeks to determine the job creation projects that must be selected for funding in order to maximize the Net Present Value (NPV) of projects in the respective regions.

5.1 Zero-One Integer Programming Model for the central region

Maximize

$$Z = 8X_{11} + 8X_{21} + 3X_{31} + 5X_{41} + 5X_{51}$$

Subject to:

$$10X_{11} + 15X_{21} + 6X_{31} + 8X_{41} + 7X_{51} \leq 35$$

$$X_{jr} = 0 \text{ or } 1$$

5.2 Zero-One Integer programming Model for eastern region

Maximize

$$Z = 10X_{12} + 5X_{22} + 3X_{32} + 2X_{42} + X_{52}$$

subject to:

$$11X_{12} + 5X_{22} + 2X_{32} + 4X_{42} + 3X_{52} \leq 25$$

$$X_{jr} = 0 \text{ or } 1$$

5.3 Results and Discussion

Solving the zero-one integer programming models in §5.1 and §5.2, the following results are obtained for the two regions

Central Region

$$X_{11} = 1 \quad X_{21} = 1 \quad X_{31} = 0 \quad X_{41} = 1$$

and $X_{51} = 0$ with maximum revenue of 33 million dollars (\$)

Note:

$$10X_{11} + 15X_{21} + 6X_{31} + 8X_{41} + 7X_{51}$$

$$= 10(1) + 15(1) + 6(0) + 8(1) + 7(0)$$

$$= 33 \text{ million dollars } (\$)$$

Eastern region

$$X_{12} = 1 \quad X_{22} = 1 \quad X_{32} = 0 \quad X_{42} = 1$$

and $X_{52} = 1$ with maximum profits of 23 million dollars (\$)

Note:

$$11X_{12} + 5X_{22} + 2X_{32} + 4X_{42} + 3X_{52}$$

$$= 11(1) + 5(1) + 2(0) + 4(1) + 3(1)$$

$$= 23 \text{ million dollars } (\$)$$

Results indicate that the available 35 million dollars (\$) for the central region can be allocated to promoting youth employment (project investment 1), cooperatives for strengthening empowerment (project investment 2) and small enterprise support (project investment 4), Microenterprise support (project investment 3) with medium enterprise support (project investment 5) are dropped.

This decision results in maximum revenue of $(10 + 15 + 8) = 33$ million dollars (\$) for the decisions taken in central region.

Considering the eastern region, results indicate that the available 25 million dollars (\$) can be allocated to apprenticeship and lifelong learning (project investment 1), decent work in the plantation sector (project investment 2), retail real estate development (project investment 4) and total action for progress (projects investment 5). County community development (project investment 3) is dropped. This decision results in a maximum profit of $(11 + 15 + 4 + 3) = 23$ million dollars (\$) for the decisions taken in eastern region. We note that the capital left over from 2 million dollars (\$) is insufficient to invest in dropped project investment 3; with higher capital requirements of 4 million USD.

6. Conclusion.

As a solution to project portfolio selection, job creation project investments under constrained capital expenditure,

and computational efforts of using zero-one integer programming provide promising results. The available capital can be optimally allocated in order to maximize revenue; given the competing nature of funding among job creation projects.

6.1 Future Work

The proposed model has considered independent projects of job creation as a criterion for project portfolio selection. It would be worthwhile to extend the proposed model in order to handle cases of concurrent projects during execution within the regions considered. Model extensions are also sought

in order to handle cases of project dependence as well as mutually exclusive projects for job creation initiatives.

Table 1:
Capital requirements (in million USD) and present worth (in million USD) of all future revenues for job creation project investments

Central Region (r=1)			Eastern Region (r=2)		
Job creation project (j)	Amount of capital required (d_{jr})	Present worth of future revenue (C_{jr})	Job creation project (j)	Amount of capital required (d_{jr})	Present worth of future revenue (C_{jr})
Promoting youth employment (1)	10	8	Apprenticeship and lifelong learning (1)	11	10
Cooperatives for strengthening empowerment (2)	13	8	Decent work at plantation sector (2)	5	5
Micro enterprise support (3)	6	5	County community development (3)	4	5
Small enterprise support (4)	8	5	Retail real estate development (4)	4	3
Medium enterprise support (5)	7	5	Total action for progress (5)	3	1
Capital investment available =35 million USD			Capital investment available =25 million USD		

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