A Suggested Mathematical Model for Project Financial Performance Evaluation

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ABSTRACT. Due to the fact that investment project contribute to the economic process in general, it is necessary to select the more profitable one based on performance.

The purpose of this study is to suggest a mathematical model to measure the financial performance of economic firms, whether the model is economically viable along with its assumptions, or in measuring such performance through the used controlling criterion.

The suggested model contributies to evaluate such performance fundamentally, and achieving acceptable results, away from personal judgment and to help in the decision making process to choose the most profitable project.

The researcher used what is called the "Statistical Package of Social sciences" (SPSS) to measure the financial performance. One example of this type of measurement is the use of "Factor Analysis", as a method used to analyze number of variables (Financial Ratios) and relations. (SPSS) is the most suitable computer software, which helps users to grasp and understand the suggested mathematical model and removes the often burdensome of time consuming and effort.

The empirical results indicate the logic of the model in measuring a firm's financial performance, is due to its dependency on concepts used in the fields of finance and statistics. The study also reveals that the model may be considered as a predictor for a firm's financial performance in the future.

Introduction

Projects often appear to be mysterious. It may be difficult to define exactly what a project is, and to workers in the average organization they may appear to arise suddenly. They are very diverse and may range from one or two people making an effort over a few days or even hundreds of people working over a period of years.

Projects rarely proceed smoothly through a series of well–ordered and well organized phases to a perfect condition. Nevertheless, there is value in having a model for project financial performance, or involve prototypes which may then be developed.

All projects take place in an atmosphere with at least some risk. The occurrence of adverse circumstances may mean that extra time, cost or some reworking of the project plans are required in order to complete the project.

Even in the best-organized and run projects distinction between phases is not always clear-cut: design may overlap to some extent with development, development with implementation, and implementation with operations.

Everyone involved in project approval should ensure that each new project will be able to benefit from future evaluation process. An evaluability assessment must be incorporated at the design stage, and project documents submitted for approval should include the logical Framework and other elements that ensure "evaluability".

Evaluability assessment provides decision – makers with vital information for those in charge of project approval and those involved in the project's execution.

1-What is a project?

Projects vary so much that they are difficult to define. A project is a unique venture with a begining and an end, conducted by people to meet established goals within parameters of costs, schedule and quality. (Boddy & Buchanan, 1992, P. 8). A project has dedicated resources, a single point of responsibility, clear boundaries across which resources and deliverables move, limited duration, it is a one-off task and has objectives. It is a useful way of organizing work. Projects don't arise without deliberate intervention.

The simplest form of a project is a discrete undertaking with defined objectives often including time, cost and quality (performance) goals. All projects evolve through a similar "life-cycle" sequence during which there should be recognised start and finish points. In addition the project objectives may be defined in a number of ways, e-g financial, social and economic, the important point being that the goals are defined and the project is finite.

2- The Challenge of the Environment

The environmental conditions facing firms in the economy today differ from those firms faced previously. Technological changes and the explosion in information-gathering and processing capabilities demand more timely and effective competitive actions and responses. The rapid sociological changes occurring in many countries affect labor practices and the nature of product demanded by increasingly diverse consumers. The internal and the external environment influences the firm's strategic options, as well as the decisions made in light of them. The firm's understanding of the external environment is matched with knowledge about its internal environment. Matching the conditions of the two environments is the foundation the firm needs to form its strategic intent, to develop its strategic mission, and to take strategic actions in the pursuit of strategic competitiveness and above-average returns (Nader & Tushman, P. 103).

The Internal Environment Analysis

The decisions managers-in terms of resources, capabilities, and core competencies have a significant influence on a firm's ability to develop competitive advantages and earn above-average returns. Making these decisions-that is identifying, developing, deploying and protecting resources, capabilities, and core competencies-may appear to be a relatively easy task. In fact, how ever this work is as challenging and difficult as any other with which managers are involved, and it is becoming increasingly internationalized and linked with the firm's success. The challenge and difficulty of making effective decisions is implied by preliminary evidence suggesting that one-half of organizational decisions fail. (Wheelen & Hunger, P.53). Recognizing the firm's core competencies is required before the firm can make important strategic decision, including those related to entering or exiting markets, investing in new technologies, building new or additional manufacturing capacity, and forming strategic partnerships. Patterns of interactions between individuals and groups that occur as strategic decisions are made affect decision quality as well as how effectively and quickly they are implemented. (Archibald, P. 51).

Sometimes, mistakes are made when a firm conducts an internal analysis. Managers might, for example, select resources and capabilities as the firm's core competencies that do not, in fact, yield a competitive advantage. When this occurs, decision makers must have the confidence to admit the mistake and take corrective actions. A firm can still grow through well-intended errors. Indeed learning generated by making and correcting mistakes can be important to the creation of new competitive advantages. Moreover, from the failure resulting from mistakes, firms learn what not to do when seeking competitive advantages.

To facilitate the development and use of core competencies managers must have courage, self-confidence, integrity, the capacity to deal with uncertainty and complexity, and a willingness to hold people accountable for their work and to be held accountable themselves.

Difficult managerial decisions concerning resources, capabilities, and core competencies are characterized by three conditions: uncertainty, complexity and intraorganizational conflicts. Environmental uncertainty increases the complexity and the range of issues to examine when studying the internal environment.

External Environmental Analysis

Most firms face external environments that are growing more turbulent, complex and global-conditions that make interpretation increasingly difficult. To cope with what are often ambiguous and incomplete environmental data and to increase their understanding of the general environment, firms engage in a process called external environmental analysis. The process which should be conducted on a continuous basis includes four activities, scanning, monitoring, forecasting and assessing. Those analysing the external environment should understand that completing this analysis is a difficult, yet significant activity.

An important objective of studying the general environment is identifying opportunities and threats. An opportunity is a condition in the general environment that may help a firm achieve strategic competitiveness. The fact that no more than one billion of the world's total population of (6) billion has anything close to cheap access

to a telephone appears to be a huge opportunity for global telecommunications firms. (Chicken, P. 105).

A threat is a condition in the general environment that may hinder a firm's efforts to achieve strategic competitiveness.

In light of the Internet's growing use and promise, some graduate business schools are offering master's degree focusing on electronic commerce, as a means of competitive survival and the development of a competitive advantage.

The firm's external environment is challenging and complex. Because of the effect the external environment has on performance, the firm must develop the skills required to identify opportunities and threats existing in that environment. Therefore, effective environmental analysis assumes a nationless and borderless (i.e. global) business environment.

Through the external environment analysis the firm identifies three major parts:

1- The general environment (elements in the broader society that affect industries and their firms), 2- The industry environment (factors that influence a firm, its competitive actions and responses and the industry's profit potential), and 3- the competitor environment (in which the firm studies each major competitor's future objectives, current strategies, assumptions and capabilities). Firms attempt to understand the external environment by acquiring information about competitors, customers, and other stakeholders. In particular, firms seek to gain information to build their own base of knowledge and capabilities (Harrison, P. 201).

3- What is SWOT Analysis

A merging of the externalities with the internalities results in an assessment of the firm's opportunities. This merging is frequently called SWOT analysis because it brings together the firm's strengths, weaknesses, opportunities, and threats in order to identify a strategic niche that the firm can exploit. Having completed the SWOT analysis, the reassesses its mission and objectives. For example, as the demand for film continues to rise worldwide, managers at Kodak have developed plans to begin selling "yellow boxes of films" in countries have yet to take their first picture. Although risk is associated with this venture, company executives feel that they have to exploit this strategic niche and take advantage of an opportunity in the external environment (Stephen & David, 2001, P a5).

In light of the SWOT analysis and identification of the firm's opportunities management re-evaluate its mission and objectives. Are they realistic? Do they need modification? If changes are needed in the firm's overall direction, this is where they are likely to originate. On the other hand, if no changes are necessary, management is ready to begin the actual formulation of strategies.

The objectives that were established in a strategy formulation should certainly be used to measure corporate performance once the strategies have been implemented.

Performance is the end result of activity. Which measures to select to assess performance depends on the organizational unit to be appraised and the objectives to be achieved. Some measures such as (measuring profitability) through a mathematical model are appropriate for evaluating the firm's ability to achieve a financial objective.

A firm, therefore needs to develop measures that predict profitability or its financial performance.

A company can identify and prepare its people for important positions in several ways. One approach is to establish a sound performance appraisal system to identify good performance. A firm should examine its financial system to a given competitive strategy.

4- Project Proposals

Objectives are what the firm wants to achieve. The effort required to do so occurs within some period of planning, this year, over the next five years, over the next decade.

Turning objectives, the whats of an organization, into plans, which are the highest-level hows, is the next task. We all frequently have objectives we want to achieve, and there is almost always more than one way to achieve an objective.

One of the best ways to ensure the quality of any project, or any deliverable or product is to get the requirements for it right. If the requirements are not clearly and completely set out, any project or design based on them cannot succeed. And getting the requirements right at an early stage will prevent escalation of costs due to rework, client dissatisfaction and excessive changes during project execution and up dating of the product afterwards.

Getting the requirements right involves the successful identification of: (Michael et al.; P. 529).

- What constitutes acceptable and appropriate requirements.

- What constitutes an acceptable demonstration of each element of those requirements.

- The resolution of technical, financial or organizational conflicts of interest that may appear in the requirements.

- The agreement on and documentation of the requirements and demonstrations in the proposal.

A **requirement** is a statement of what is expected of a product or project. Drawing up the statement of requirements is one of the earliest steps in planning. A requirement is different from a **specification** in that the requirement is the starting point of a development and is an expression of those aspects which will define the thing to be done and the product to be developed.

A **requirement** must be appropriate and well defined. It is important to determine whether the proposed requirement is appropriate to real needs and expectations and to the value that potential project will put on it.

5- The Mathematical Model

Feasibility study is a study undertaken to assess whether something is achievable, this includes assessing economic, financial, human resources and technological factors that will influence whether something can be achieved and at what cost and to what benefit. Therefore to measure the financial performance we need to know its elements. The general equation is: (Brigham & Daves, P. 216), (Curwin & Slater, P. 41).

Financial Performance=Average (Profitability Ratios+Activity Ratios+Liquidity Ratios), or

FP(y) = Average (P_r + A_r + L_r) where
   y = The Financial performance.
   P_r = The profitability ratios.
   A_r = The activity ratios, (or Managerial Performance Ratios).
   L_r = The Liquidity ratios.

The statistical package for social sciences (SPSS) will be used to solve the equation. The main techniques that have been proposed for solving the above equation within the package is the "Factor Analysis" method, mainly used to express the interchangeable relations for many variables. (Frazer, P 215).

It is useful to formulate the mathematical model of "Factor Analysis" in terms of straight line equation, such as:

$$y = c_1 r_1 + c_2 r_2 + \ldots\ldots + c_n r_n + C$$

where:
   y = The financial Performance
   c_1 = The First coefficient value of the first ratio [through the package used.]
   r_1 = The first financial Ratio. (a number given).
   n = Numbers of variables element.
   C = Constant.

Calculating the Financial Performance:
To find the financial performance mathematically for many firms, we have to solve the equation mentioned above. The computation of the total value of the financial performance requires the following steps:

      i- Computing the actual value of the financial ratios
      ii- Calculating the degree of correlations between the ratios.
      iii- Defining the unrotated elements of the matrix [through a statistical package used].
   iv- Obtaining the Factor score, by implementing the following equation: (Hirschey & James, P. 305).

$$Zfi = B_1 Z_1 i + B2 Z_2 i + \ldots\ldots + B_n Z_{ni}$$

where:
   zfi = The Standard score for the Factor f , as (i) represent the numbers of Factors used.
   $Z_1 i$ = The Standard score of the first ratio to the first Factor.
   $Z_2 i$ = The Standard score for the second ratio to the first Factor.
   Bi = The coefficient Standard deviation of the first ratio.

Formulating the Mathematical Model
The main techniques that have been proposed for a generalization of the model is through the following steps.

Financial Performance = Total Elements.

A number of packages included is linear programming used to find the total elements which represent the outputs of the computer. Two important questions remain: How do we select the Rotated factors which represent the computer calculation output, and how do we choose the number of the ratios to solve if we are currently working on this pruned? To answer both questions we will assume that the numbers of the rotated factors, and the ratios chosen are given as (7,20) respectively, then we compute the equation as follows,

$$y = F_1 + F_2 + F_3 + F_4 + F_5 + F_6 + F_7$$

where (F) is the total elements which can be equall for example to (Fi). Then:

$$F_I = f_1 z_1 + f_2 z_2 + f_3 z_3 + \ldots\ldots + f_{20} z_{20}$$

where:

f = The Coefficient of the Factors ranking, and
z = The Standard Ratio which can be calculated as

$$z = \frac{\text{Ratio} - \text{Mean of ratio}}{\text{Ratio's Standard deviation}},$$

Hence, we set the equation for all Factors in terms of:

$$Fj = \sum_{i=1}^{n} f_{ij} z_i, \text{ where}$$

F = The total Factors, (as stated before)
j = 1, 2, …., 7
n = 20 Financial Ratios

Therefore the Financial Performance will be stated as:

$$y = \sum_{i=1}^{20} \sum_{j=1}^{7} f_{ij} z_i$$

Simplification of the equation can be expressed in terms of

$$y = \sum_{i=1}^{20} \sum_{j=1}^{7} f_{ij} z_i = \sum_{i=1}^{20} \sum_{j=1}^{7} f_{ij} (r_i - m_i) / Q_i$$

where:

m = Average, or (The Mean).
Q = Standard deviation

we my simplify the equation by setting:

$$y = \sum_{i=1}^{no} \sum_{j=1}^{7} f_{ij} \, r_i / Q_i - \sum_{i=1}^{20} \sum_{j=1}^{7} f_{ij} m_i / Q_i$$

partitioning the equation into: $(- \sum_{i=1}^{20} \sum_{j=1}^{7} f_{ij} m_i / Q_i = c)$ and,

$(\sum_{i=1}^{7} f_{ij} / Q_i = c_i)$, then

such propositions yielding that:

$$y = \sum_{i=1}^{20} c i r_1 + c$$

By substitution process we can express the equation in the following form:

$$Y = c_1 \, r_1 + c_2 \, r_2 + \ldots + c_{20} \, r_{20} + C$$

6- Testing the model:

Models can provide a description of situations or phenomena that are difficult to examine in any other way. Most business situations of significance will be complex. Our need to understand this complexity will depend on our role within the business and how we choose to solve problems. As a manager we may need to model operational matters like financial performance of a project or a firm.

Models are unlikely to give perfect answers. What models allow the user to do is work through various assumptions about the business situation and see the possible consequences. We can always test and improve our models by simulating the problem and then returning to the original problem situation. The graph method has been very successful to test the strength of the model, according to the three components of the financial performance (i.e. Profitability, Activities or Managerial performance and Liquidity). The technique that is used is through the comparison between these ratios and the mathematical values obtained according to this model. In other words the comparison between the actual ratio's values and the calculated values according to the model are used. Hence four sequence of graphs are required for each firm, such as:
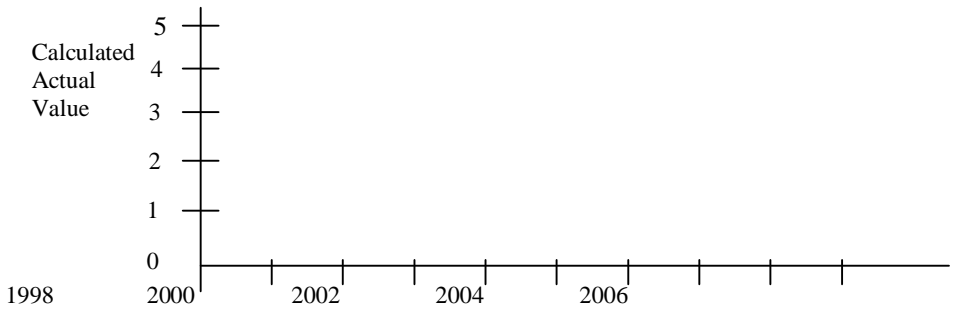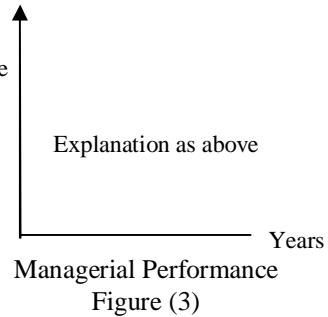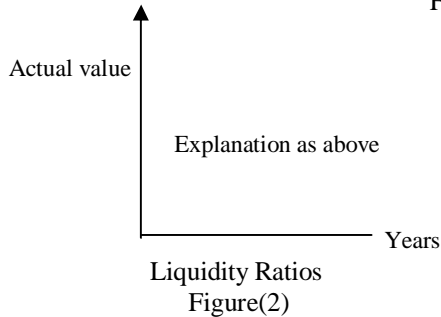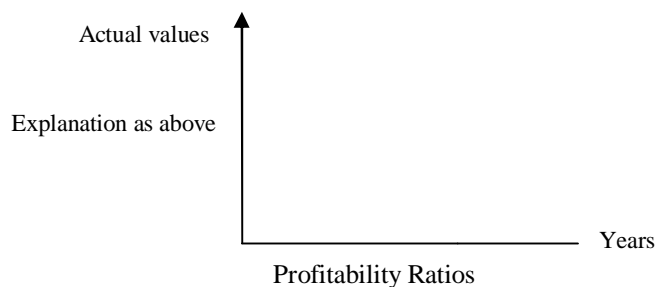
Figure (1)

Liquidity Ratios
Figure(2)

Managerial Performance
Figure (3)

Actual values

Explanation as above

Years

Profitability Ratios
Figure (4)

The outcome of a scoring model depends on how the scoring has been done. Upon such analysis three groups of firms can be identified:

    i- Above – average performance.
    ii- Average performance.
    iii- Below – average performance.

We can calculate the financial performance for many firms following the sequence of operations such that:

No. of Firm	Profitability	Activities / Managerial Performance	Liquidity	Mathematical Calculations	Model Sequence	Firm's Sequence
1	Average	Above-Average	Average	Average	Average	(2)
2	Below-Average	Below-Average	Average	Below-Average	Below-Average	(3)
3	Above-Average	Above-Average	Average	Above-Average	Above-Average	(1)

Conclusions

Projects have to be planned. Indeed, a firm must plan to have project financial evaluation. By evaluating we mean the process of formulating an organized method of achieving objectives. Projects do not take place in isolation, they have an environment which gives birth to them and with which they interact for the rest of their lives. This study attempts to generate a financial evaluation of a project through a mathematical model in a marketing firm.

An early step in planning is the gathering of information about the environment in which a firm operates-the market, the economy, the technology and the legislative and regulatory climate. Knowing the market implies understanding the present market a firm and its operations have, and forecasting markets for financial evaluation.

Once the firm has identified the ranked objectives and strategies at the organizational level and analysed major problems and their causes, made decision about which to pursue further, and set out the firm's requirements and specifications, the next step is to identify those potential strategies which should be surveyed to see how feasible (how profitable "do-able") they are. This stage is referred to as a financial evaluation study. Financial evaluation may be undertaken through a mathematical model and the result of such evaluation may be used to decide which proposals to pursue. Such evaluation may enhance the economic development process, however, it is important for any firm to understand the processes by which proposals are evaluated and assessed.

Assessing the feasibility of a project requires an understanding of many elements (Factors) involved, in other words evaluation of a project financially is a method of gathering information about the different interrelated projects and therefore enhancing the planning process.

No matter what size and nature of a project, the methods of evaluation are always the same, the specification of costs and benefits is an important stage. This means identifying, specifying and evaluating the costs for the project and therefore identifying, specifying and evaluating the benefits of the project in a scientific model and not on personal judgment.

Every project has to be financed. To determine whether the project is economically viable the suggested model is therefore vital in evaluation to know revenues will be, otherwise there is no way of deciding whether a project will be worthwhile as an investment.

The dependence of financial evaluation through a mathematical model is appropriate to decide what is the most beneficial result accurately, and the use of united procedures for similar firms, without difficulties.

Conversely, to try to evaluate a project over too long a period means that one may be trying to justify an investment from benefits that are so far in the future that they may never happen. The longer the timescale, the greater is the possibility of a wrong decision being taken to pursue a project, therefore the need for a model is due to the increasing possibility of business problems, there is a greater likelihood that assets in use will become less reliable and economic to run and could require replacement, market factors could change significantly, and risk and uncertainty upset forecasts.

Financial evaluation using a mathematical model develops a scenario and a functional specification (what the new or revised system should do), and identify whether the project is technically feasible, and financially feasible.

References

Archibald. D., (1992), *Managing high-Technology Programmes and Projects*, 2nd Ed, John Wiley and Sons, U.S.A.

Boddy. D and **Buchanan. A.,** (1992), *Take the lead*. Prentice-Hall, London.

Brigham. E, and **Daves. P.,** (2001), *Intermediate Financial Management*, 7th Ed, South-western, U.S.A.

Curwin. J, and **Slater. R.,** (2002), *Quantitative Methods For Business Decisions*, Thomson learning, U.K.

Chicken, C.,(1994), *Managing risks and Decisions in Major projects*, (Chapman& Hall, Londod)

Frazer, M., (1992), *Understanding Financial Statement*, Englewood Cliffs, NJ, U.S.A.

Hirschey. M., and **James, P.,** (1996), *Managerial Economics*, The Dryden Press, NJ, U.S.A.

Harrison, L., (1992), Advanced project Management, 3rd Ed, Aldershot; U.K.

Michael. H et al., (2001), Strategic Management, 4th Ed, South-Western College Publishing, U.S.A.

Nader. A and **Tushman, M.,** (1997), *Competing by Design*, Oxford University Press. Ny, U.S.A.

Stephen. R, and **David. D;** (2001), *Fundamentals of Management*, 3rd Ed, Prentice- Hall, NJ, U.S.A.

Wheelen. T, and **Hunger. J.,** (2000), *Strategic Management Business Policy*, 7th Ed, Prentice-Hall, NJ. U.S.A.

نموذج رياضي مقترح لتقييم الأداء المالي لمشروع

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فرع أبوظبي – دولة الإمارات العربية المتحدة

المستخلص: تساهم المشاريع الاستثمارية بصورة عامه في عملية التنمية الاقتصادية وبالتالي فإنه يستوجب اختيار المشروع الأكثر ربحية حسب الأداء.

يهدف البحث إلى اقتراح نموذج رياضي لقياس الأداء المالي للمنشآت الاقتصادية ولإمكانية استخدامه، الافتراضات التي يعتمد عليها ومنافعه في قياس مثل هذا الأداء من خلال معايير الرقابة المستخدمة.

يساهم النموذج الرياضي المقترح في تقييم مثل هذا الأداء بصورة جوهرية والحصول على نتائج مقبولة بعيدة عن الحدس الشخصي والمساعدة في عملية اتخاذ القرارات لاختيار المشروع الأكثر ربحية.

تم الاعتماد على ما يسمى المجموعة الإحصائية للعلوم الإنسانية(SPSS) لقياس الأداء المالي حيث استخدمت طريقة تحليل العوامل (Factor Analysis) لتحليل العلاقات المتداخلة لمجموعة من المتغيرات (النسب المالية). إن استخدام برامج الحاسوب الملائمة والمتاحة ستسهل استخدام النموذج وفهمه لتوفير الوقت والجهد.

وقد أظهرت الدراسة منطقية النموذج الرياضي المقترح لتقييم الأداء المالي للمنشآت نظرا لاعتماده على أسس مستخدمة في مجال الإدارة المالية والإحصاء، كذلك يمكن استخدامه للتنبؤ بأداء المنشأة المالي في المستقبل.