3. A Mathematical Model Designing to Achieve Cost Management in Value Chain with Combinational Approach of AHP & GP

(Case Study: Home Appliance Industries)

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Abstract:
The purpose of this study is to develop a model for designing and explaining Cost Management Strategies in the home appliance industry in Iran. It has also implemented organizational resource–based view to limit the research domain and focus on organizational actions; then it has used porter value chain (1985) to analyze the cost structure of the company which supports strategic decision making and inter–organizational verifications. Since the life of most industries is dependent on its ability at increasing the accuracy of cost management, the authors try to present a mathematical porter's value chain framework to get a correct understanding of firm's cost behavior and strategic activities. Surveys show that if one considers the supply chain activities and product and development of product activities in value chain model, he will have more optimistic sight of organization activities and more comprehensive tool for analyzing cost structure leading to stable competitive advantages. To test the proposed model, first, a mathematical programming model based on multi objective decision-making model was developed. Then, an active home appliance data is used to assess the validity of the mathematics model and, finally, model results show that the proposed solution improves the use of resources, marketing, and advertising cost, ware-housing cost, optimal budget allocation, raw material and transportation costs.

Keywords:
Resource Based View ,Value Chain ,Cost Leadership ,Multiple Objective Decision Making (MODM) ,Mathematical Model ,Goal programming, Analytical Hierarchy Process (AHP)

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1. Introduction

Global competitive pressures, the growth of service industries, and the development of manufacturing and information technologies have changed the nature of economic activities and have caused many manufacturing and service industries to set up some changes in their own production and marketing processes. These changes, in turn, have led companies to use innovative ways to manage their own costs; in fact, they proceed towards creating distinctions in their activities. Today, the thing which can be seen more than anything else in relation with businesses, profit, and even nonprofits organizations is paying attention to different costs of organizations or, to be more precise in costing management. Because in today's competitive world, various organizations, to maintain their survival and competitive power, should be aware of their costs compared with actual or potential competitors, and actively compete in the cost dimension. Despite the fact that each organization, based on its long-standing traditional attitudes, starts cost management, with the aim of maintaining the lowest possible cost and examining how to decrease it, many management scholars, including Porter, believe that what guarantees to get this purpose in the short term (i.e. decreasing costs level) and long term (i.e., achieving a competitive cost), is nothing but a strategic cost analysis. Since the life of many industries depends on their abilities to increase careful costs management, high global competition, cost pressures, and the need to produce goods and services at competitive prices have forced companies to manage their costs systematically. So, the necessity to formulate competitive strategies based on strategic analysis is felt more than before in different countries.

In this study, to limit the research scope, and to focus on organizational activities, resource-based views are taken; then, the value chain model, which was first introduced by Porter (1985), was used to analyze and understand the behavior of costs and the cost structure of firm. In fact, in this study, by developing Porter's model, it was tried to achieve a mathematical model in value chain in order to understand the behavior of the institute cost and its strategic activities efficiently. However, for various reasons, which are going to be discovered, these programs are not successful and do not have a systematic and scientific system. The main objective in this case study is as follows: In the home appliance industry, in order to achieve a competitive advantage due to the strategic cost model optimization, the factors (activities) which must be considered to formulate the model are used, so that leads to the benefits increase of company through minimizing its cost activities.

2. Literature Review

The literature review, because the subject is extensive, is divided into both cost management and the value chain, and, in the end, the authors will have an overview of the research done in this area.

2.1. Cost Management

Cost management system includes a set of methods developed for cost planning and controlling cost creating activities of an organization to achieve its goals. This system is a kind of planning and controlling system that reviews the optimization of the process (Shabahang, 2010, 14). Berinke (2009) defines cost management as "a set of techniques and methods to control and develop activities and processes, and products and their services". Of the most important cost management tools are: activity-based management, activity-based costing, activity-based budgeting, target costing, Kaizen costing, and quality costing. Atkinson and Kaplan (2012), in a research, studied strategic cost management to create a competitive advantage. They believe that "cost management is precisely a set of guidelines and procedures for the efficient management and taking effective decisions, and in the broad sense, is a ring and attitude and a set of mechanisms to create greater value and lower cost"(Rahnamay Roud Poushti, 2008). Cooper and Slagmulder (2008) believe that strategic cost management is" an application of cost management techniques to improve the company's strategic position along with the reduction of costs". They tried to obtain the relationship between company's strategy, cost structure, and causal relationship between activity levels and resource requirements (like cost motivators).

Among the studies conducted on the value chain is the paper "Strategic Analysis of cost and value chain" by Mehran Rezvani (2002) refers to the dependent costs and shows that the main task of strategic cost analysis is comparing various costs of activities of the institute with similar costs of key competitors as well as learning the fact that which issues are the origin of competitive and non-competitive costs. Another study by Kambiz Shahroudi (2006) entitled "Modeling value chain in Iran automotive industry in order to achieve cost leadership strategy" whose major emphasis is to achieve cost leadership advantage by focusing on the resources within the organization. In order to analyze the cost structure of firms and contribute to strategic decisions, Porter's value chain model has been used. In order to test, the proposed model is a mathematical model of multi-objective decision. The results of solving model shows that using proposed model improves the costs of resource use, maintaining costs, allocation of funds, the initial cost and the shipping cost(Shahroudi et al,2005).

From among the most recent investigations, the thesis by Mahdi Shaghaghi (2009), entitled generalizing Porter's value chain to the activities of special libraries and the effect of information technology of it" can be noted. In this study, the activities of special library are generalized into five core activities and values of Porter's model and the effects of information technology on any of the activities of the main chain have been studied (Shaghaghi, 2009). So the present study has been implemented, in order to fill the research gaps and optimize Porter's value chain model, and to provide a mathematical model, based on the combination of AHP and GP models that will be applied in supply chain model of this study.

In the following, the general model of cost management in Porter's value chain is examined which has further been developed as a basis of this research. The figure (1) is a value chain model which was first raised in 1985 by Porter. In order to understand the cost behavior of the institute and potential or existing sources of institute, value chain is divided into related strategic activities (Pearce and Robinson, 2010: 136).

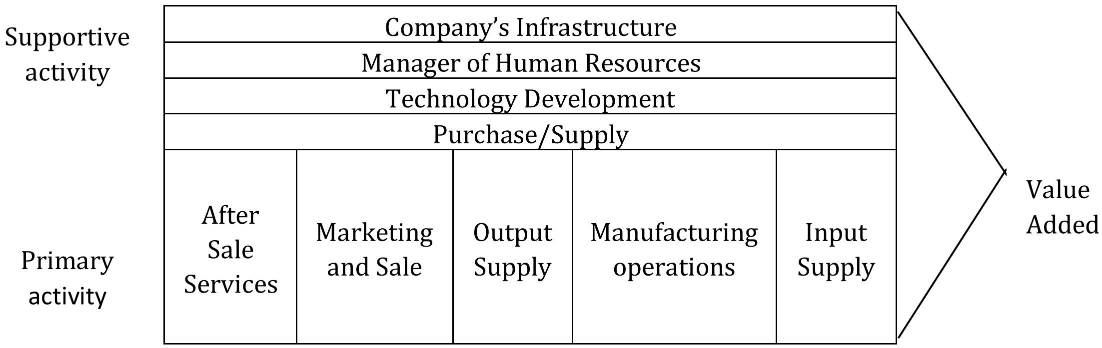

Figure 1 - General model of Porter's value chain (Source: Porter, 1998)

This model is a valuable framework for achieving this goal, and considering the strategic relationship between the tasks/activities within the organization. The fundamental principle of value chain analysis is that all tasks/activities of an organization can be classified into two parts (Porter: 1985)

Primary Activities (Main)

As already mentioned, these activities are divided into five categories as follows:
Internal Services: including receiving and storage activities.
Operations/construction: including the activities about the conversion of raw materials to the final product.
External Services: including all activities after the production of final good
Marketing and Sales: encouraging customers to buy products.
Services: preserving or enhancing product value after the sale was done.

Supportive Activities

These activities are divided into the following four categories:
Provisioning (purchasing): including activities such as purchasing raw materials, office supplies, consumable items, and buying assets, etc.
Development of the Technology: how to do tasks, technical procedures are required in each activity and value chain, etc.
Managing Human Resources: selecting, promoting and placement, evaluating performance, reward presentation, management development, labor relations, etc.
Company's Infrastructure: general, planning, finance, accounting, legal managements are quality management. The primary objective of the analysis of the main/supportive activities is finding potential areas (activities) in order to create and earn value (Hitt et al., 2008: 148).
Since generalizing Porter's model using mathematical modeling techniques and operation research is very time consuming, this study only focuses on the mathematical modeling of supporting activities in buying and supplying, through supply chain and sales and marketing executive activities.

3. Research operation techniques

Researchers have applied different operation techniques in single from or integration form to apply in supplier selection researches, material allocation, value chain modification and etc.

For example, Ghodsypour and Obrien (1998) used integration of AHP & MP, Demirtas and Ustun (2009) used integration of ANP, MOP, and MIP. In decision making texts, we deal with two types of methods (Keramatpanah, and et al, 2013): Hard techniques or methods, Soft techniques or methods. Hard operation research techniques include linear programming, integer and Goal programming, Game theory, path Analysis, Non Linear programming, and etc.

As we use tangible data and apply complex mathematical system, the technique is hard, on the other hand, techniques such as Topsis, Electre, AHP, ANP, DEMATEL, Drama Theory, ISM, SCA, are soft operation research and Decision making techniques which are less tangible and expert-based judgment values(Azar, 2014).On the whole, it is essential to note that we apply soft Decision Making methods for non-constraint models and hard Decision Making methods for constraint-based models(Azar,2003).

At the end, the purpose of this paper is to manage and minimize Pars-Khazar company value chain activities costs in constraint mode using Analytical hierarchical Process, Goal Programming, Multi-objective programming as soft and hard Decision Making techniques and tool in Multi-Criteria problems.

4. Research Methodology

In the current study, the authors used the survey methodology in pursuit of the objectives which, regarding development, is applicable, a framework using techniques and research models in operations or mathematics are provided. To collect data, personal interviews with 13 Corporation experts of company providing pair comparison through questionnaire of hierarchical analysis of cost indices in the objective function were implemented; and, in the following, to collect data on the company's manufacturing constraints and for model parameters the accounting records and database of company we revisited. Since the presented model is a multi-objective decision model (MODM), to solve the model, the LINGO and SUPER DECISION software, which are component software to solve multi-objective and multi-criteria decision-making issues, are used. In the following, the complex algorithm of research methodology is presented in Figure 4.

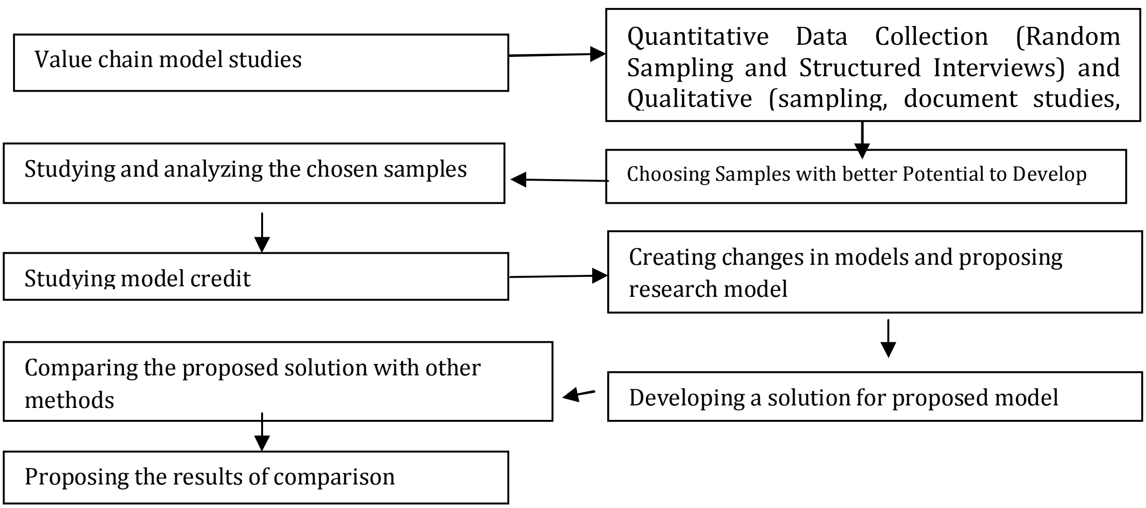

Figure 4: Complex algorithm of research

5. Proposed model

5.1. Parameters

Parameters that have been used in our mathematical model summarize limitations and objectives of model as bellow:

c_m:Unit cost of advertising in media (M).
Y_{pmt}:Decision variable corresponding to number of advertisements for product (p) in media (m) at time period (t).
B_t:Budget of advertisement at time period (t).
N_{pt}:Maximum number of advertisement for product (p) per month at time period (t).
Z_{pt}:Minimum Number of advertisement for product (p) in Mass media at time period (t).
R_{pt}: Minimum Number of potential Customers was under advertising Coverage of product (p) at time period (t).
$H_i t$: Unit inventory holding Cost of part (i) which is purchased from supplier j, transferring from time period (t).
S_{ij}: Capacity Constraint of warehouse for part (i) at time period (t) (m^3).
b_{ijt}: Purchasing price of part (i) for supplier (j) at time period (t).
F_t: Budget Constraint of manufacturing plant (Pars Khazar) at time period (t).
X_{ijt}: Number of manufactured product (i) in production unit (j) at time period (t) (Decision variable)
C_{ijt}: Transportation unit Cost of product i from supplier (j) at time period (t).
K_t: Total weight Constraint of transportation at time period (t) (kg)
$\acute{k}_t$: Space constraint of transportation at time period t (m^3).
U_i: Weight of purchased product (i) (kg).
V_i:Capacity usage of warehouse for product (i) purchased from supplier j (m^3).
A_{ijt}Contractual fees show non-use of the capacity of production (I) by the manufacturer (G) for the period (T).
P_{ijt}: Production capacity of product (i) by manufacturer (j) at time period (t).
D_{it}: Demand of product (i) supplied by supplier (j) at time period (t).
I_{it}: Inventory level of part (i) Transported from time period (t) to (t+1).

Notations and Definitions:

i:Sets of manufactured parts by suppliers
j:potential supplier

t:Set of time period
p:Set of End products by plant (Pars Khazar).
m:Set of media Sources for advertisement.

5.2. Proposed multi-objective programming model

$$Minz_1 = \sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T} H_{ijt}.X_{ijt}$$

$$Minz_2 = \sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T} (C_{ijt} + b_{ijt}).X_{ijt}$$

$$Minz_3 = \sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T} A_{ijt}(1-\frac{X_{ijt}}{P_{ijt}})$$

$$Minz_4 = \sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T} C_m Y_{pmt}$$

s.t:

1) $\sum_{j=1}^{J} X_{ijt} \geq D_{it} \qquad i = 1,2,\ldots,I \quad j = 1,2,\ldots,J \quad t = 1,2,3,\ldots,T$

2) $\sum_{j=1}^{K} V_i(X_{ijt}) \geq S_{it} \qquad i = 1,2,\ldots,I \qquad t = 1,2,3,\ldots,T$

3) $X_{ijt} \geq P_{ijt} \qquad i = 1,2,\ldots,I \quad j = 1,2,\ldots,J \quad t = 1,2,3,\ldots,T$

4) $$\sum_{i=1}^{N}\sum_{j=1}^{K}(b_{ijt}.X_{ijt}) \le F_t \qquad t=1,2,3,\dots,T$$

5) $$\sum_{i=1}^{N}\sum_{j=1}^{K}U_i.X_{ijt} \le K_t \qquad t=1,2,3,\dots,T$$

6) $$\sum_{i=1}^{N}\sum_{j=1}^{K}V_i.X_{ijt} \le K'_t \qquad t=1,2,3,\dots,T$$

7) $$\sum_{m=1}^{N}\sum_{p=1}^{K}C_mY_{pmt} \le B_t \qquad t=1,2,3,\dots,T$$

8) $$\sum_{m=1}^{K}Y_{pmt} \ge N_{pt} \qquad p=1,2,3,\dots,P \qquad t=1,2,3,\dots,T$$

9) $$Y_{pmt} \ge Z_{pt} \qquad m=1,2,\dots,M \qquad p=1,2,3,\dots,P \qquad t=1,2,3,\dots,T$$

10) $$\sum_{m=1}^{K}W_mY_{pmt} \ge R_{pt} \qquad p=1,2,3,\dots,P \qquad t=1,2,3,\dots,T$$

5.3. Definitions of objectives and equations related to model

The first objective minimizes the total cost of part (i) inventory holding purchased from supplier (j) at time period (t). The second objective minimizes the total cost of transportation related to parts (i) purchased from supplier (j) at time period (t). The third objective minimizes the total cost of unused production capacity in production line. The fourth objective minimizes the total cost of advertisement related to products in mass media (m) at time period (t).Equation (1) expresses that the number of products (i) manufactured and transported from suppliers to factory warehouse should be more than or equal to demand of factory for parts at time period (t). Equation (2) expresses that the inventory level of parts purchased from supplier (j) should be less than or equal to the total capacity constraint of warehouse. Equation (3) expresses that overall parts production capacity of supplier (j) should be equal or less than required parts using in final production of Pars-Khazar Company. Equation (4) expresses that budget and expenditures on purchasing parts from supplier (j) should be less than or equal to (F_t). Equation (5) expresses that the weight of parts transported from suppliers (j) to factory warehouse should be less than or equal to weight constraint of transportation (kg). Equation (6) expresses that the total volume of parts transported from suppliers (j) to factory warehouse should be less than or equal to space constraint of transportation (m^3). Equation (7) expresses that the budget constraint of advertisement through different channels (m) for finished home appliances products should be less than or equal to the total budget constraint for advertisement (b) at time period (t). Equation (8) expresses that the number of advertisement through different channels for finished home appliances products Y_{pmt} should be more than or equal to the maximum Npt. Equation (9) expresses that the number of advertisement through TV media for finished home appliances products Y_{pmt} should be more than or equal to the maximum Zpt. Equation (10) expresses that the number of potential viewer watching advertisement through different channels should be more than or equal to the Rpt at time period (t).

5.4. MOP with real parameters and variables

Data of an Iranian appliance industry company which named Pars-Khazar applied to put mathematical model of research into test:

First objective: minimizing Inventory holding cost

$$MINZ_1 = 2.85X_{111} + 2.4X_{121} + 2.5X_{211} + 3.22X_{221} + 1.5X_{311}$$

$$+2.4X_{321} + 2.45X_{112} + 2.2X_{122} + 3.3X_{212} + 2.48X_{222}$$

$$+2.65X_{312} + 2.15X_{322}$$

Second objective: minimizing total cost of transportation

$$MINZ_2 = 6.5X_{111} + 6.4X_{121} + 8.5X_{211} + 9.45X_{221} + 4.57X_{311}$$

$$+9.55X_{321} + 7.65X_{112} + 7.65X_{122} + 10.55X_{212} + 8.65X_{222}$$

$$+7.65X_{312} + 8.65X_{322}$$

Third objective: minimizing total cost of unused production capacity

$$MINZ_3 = \left(380000\times\left(1-\left(\frac{X_{111}}{350}\right)\right)\right)+\left(350000\times\left(1-\left(\frac{X_{211}}{4000}\right)\right)\right)+$$
$$\left(420000\times\left(1-\left(\frac{X_{311}}{3000}\right)\right)\right)+\left(360000\times\left(1-\left(\frac{X_{121}}{3600}\right)\right)\right)+$$
$$\left(300000\times\left(1-\left(\frac{X_{221}}{3800}\right)\right)\right)+\left(380000\times\left(1-\left(\frac{X_{321}}{3100}\right)\right)\right)+$$
$$\left(360000\times\left(1-\left(\frac{X_{112}}{3700}\right)\right)\right)+\left(420000\times\left(1-\left(\frac{X_{212}}{4500}\right)\right)\right)+$$
$$\left(340000\times\left(1-\left(\frac{X_{312}}{2800}\right)\right)\right)+\left(440000\times\left(1-\left(\frac{X_{122}}{3600}\right)\right)\right)+$$
$$\left(3880000\times\left(1-\left(\frac{X_{222}}{3500}\right)\right)\right)+\left(460000\times\left(1-\left(\frac{X_{322}}{3100}\right)\right)\right)$$

Four the objective: minimizing total cost of marketing and advertisement

$$MINZ_4 = 5500\left(Y_{111}+Y_{112}+Y_{211}+Y_{212}\right)$$
$$+1000\left(Y_{121}+Y_{122}+Y_{221}+Y_{222}\right)+1000(Y_{131}+Y_{132}+Y_{231}+Y_{232})$$

Constraints:

Demand constraint of plant (Pars-Khazar):

$$X_{111} + X_{121} \geq 7000$$
$$X_{211} + X_{221} \geq 7500$$
$$X_{311} + X_{321} \geq 5000$$
$$X_{112} + X_{122} \geq 6000$$
$$X_{212} + X_{222} \geq 6000$$
$$X_{312} + X_{322} \geq 5500$$

Warehouse capacity constraint:

$$0.2(X_{111} + X_{121}) \leq 2000$$
$$0.3(X_{211} + X_{222}) \leq 2900$$
$$0.1(X_{311} + X_{321}) \leq 2000$$
$$0.2(X_{112} + X_{122}) \leq 2900$$
$$0.3(X_{212} + X_{222}) \leq 3000$$
$$0.1(X_{312} + X_{322}) \leq 1000$$

Production capacity of suppliers:

$$X_{111} \leq 3500$$
$$X_{121} \leq 3600$$
$$X_{112} \leq 3700$$
$$X_{122} \leq 3600$$
$$X_{211} \leq 4000$$
$$X_{221} \leq 3800$$
$$X_{212} \leq 4500$$
$$X_{222} \leq 3500$$
$$X_{311} \leq 3000$$
$$X_{321} \leq 3100$$
$$X_{312} \leq 2800$$
$$X_{322} \leq 3100$$

Plant (Pars-Khazar) budget constraint:

$$11X_{111} + 14X_{121} + 25X_{211} + 26X_{221} + 14X_{311} + 11X_{321} \leq 520000$$
$$12X_{112} + 14.5X_{122} + 27X_{212} + 26X_{222} + 17X_{312} + 12X_{322} \leq 500000$$

Transportation capacity (kg):

$$\left(X_{111} + X_{121}\right) + 1.2\left(X_{211} + X_{221}\right) + 1.4\left(X_{311} + X_{321}\right) \leq 24000$$
$$\left(X_{112} + X_{122}\right) + 1.2\left(X_{212} + X_{222}\right) + 1.4\left(X_{312} + X_{322}\right) \leq 22000$$

Vehicle capacity constraint (kg/m^3):

$$0.2\left(X_{111} + X_{121}\right) + 0.3\left(X_{211} + X_{221}\right) + 0.1\left(X_{311} + X_{321}\right) \leq 5000$$
$$0.2\left(X_{112} + X_{122}\right) + 0.3\left(X_{212} + X_{222}\right) + 0.1\left(X_{312} + X_{322}\right) \leq 4100$$

Advertisement budget constraint:

$$5500(Y_{111} + Y_{211}) + 1000(Y_{121} + Y_{221}) + 1000(Y_{131} + Y_{231}) \leq 15000$$
$$5500(Y_{112} + Y_{212}) + 1000(Y_{122} + Y_{222}) + 1000(Y_{132} + Y_{232}) \leq 15000$$

Maximum Number of advertisement constraint:

$$Y_{111} + Y_{121} + Y_{131} \geq 12$$
$$Y_{211} + Y_{221} + Y_{231} \geq 10$$
$$Y_{112} + Y_{122} + Y_{132} \geq 14$$
$$Y_{212} + Y_{222} + Y_{232} \geq 10$$

Minimum number of advertisement at T.V constraint:

$$Y_{111} \geq 8$$
$$Y_{112} \geq 6$$
$$Y_{211} \geq 6$$
$$Y_{212} \geq 8$$

Potential customers whom have seen advertisement constraint:

$$70000Y_{111} + 5000Y_{121} + 50000Y_{131} \geq 50000$$
$$70000Y_{112} + 5000Y_{122} + 50000Y_{132} \geq 45000$$
$$70000Y_{211} + 5000Y_{221} + 50000Y_{231} \geq 50000$$
$$70000Y_{212} + 5000Y_{222} + 50000Y_{232} \geq 45000$$

5.5. Goal programming model

The authors present a goal programming model in order to implement a set of Constraints while satisfying the predetermined transportation, advertisement, and Inventory holding and unused production capacity cost goals. Note that, the priority of goals is Calculated using the pairwise comparison from Analytic Hierarchical Process (AHP) technique. Following above, the obtained goal preferences are unused production capacity cost minimization, transportation cost minimization, advertisement cost minimization, Inventory holding cost minimization goal, respectively. Then the goal programming parameters are described as follows: (Note that the parameters in the previous section (MOP) aren't described again).

Priority 1 (P_1): unused production capacity goal

Priority 2 (P_2): Transportation goal

Priority 3 (P_3): Advertisement costs goal

Priority 4 (P_4): Inventory holding costs goal.

W_1: Relative weight for unused production capacity goal

W_2: Relative weight for transportation goal

W_3: Relative weight for advertisement costs goal

W_4: Relative weights for inventory holding cost goal

U_1: Deviation variable for over achieve of 1th goal (priority 1)

U_2: Deviation variable for over achieve of 2th goal (priority 2)

U_3: Deviation variable for over achieve of 3th goal (priority 3)

U_4: Deviation variable for over achieve of 4th goal (priority 4)

d_1: Deviation variable for under achieve of 1st goal (priority 1)

d_2: Deviation variable for under achieve of 2st goal (priority 2)

d_3: Deviation variable for under achieve of 3st goal (priority 3)

d_4: Deviation variable for under achieve of 4st goal (priority 4)

b_1: Aspiration level of 1th goal (priority 1)

b_2: Aspiration level of 2th goal (priority 2)

b_3: Aspiration level of 3th goal (priority 3)

b_4: Aspiration level of 4th goal (priority 4)

Note: The purpose of goal programming model is to minimize all unwanted deviations (U_1, U_2, U_3, U_4)

As mentioned, the relative weights of goals in the objective functions, obtained from the AHP, are as follows:

$$W_1 = 0.432 \quad W_2 = 0.24 \quad W_3 = 0.207 \quad W_4 = 0.112$$

The aspiration levels of predetermined goals are as follows:

b_1 =310260b_2 =345320b_3 =225540b_4= 71450

Now using above data suggested goal programming models are as follows:

5.6. Goal programming model

Min= $P_1W_1D_1$+ $P_2W_2D_2$+ $P_3W_3D_3$+ $P_4W_4D_4$

Constraints:

1) $$\sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T} A_{ijt}(1-\frac{X_{ijt}}{P_{ijt}})+U_1-D_1=b_1$$

2) $$\sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T}\left(C_{ijt}+b_{ijt}\right).X_{ijt}+U_2-D_2=b_2$$

3) $$\sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T} C_m Y_{pmt} U_3-D_3=b_3$$

4) $$\sum_{i=1}^{N}\sum_{j=1}^{K}\sum_{t=1}^{T} H_{ijt}.X_{ijt}+U_4-D_4=b_4$$

It is also noted that hard constraints were presented in the previous section.

5.7. Goal programming model with real parameters and variables

Target function:

Min= 0.432 U_1+ 0.247 U_2+0.207 U_3+ 0.112 U_4

Constraints:

Unused production capacity cost minimization goal

$$MINZ_1 = \left(380000 \times \left(1 - \left(\frac{X_{111}}{350}\right)\right)\right) + \left(350000 \times \left(1 - \left(\frac{X_{211}}{4000}\right)\right)\right) +$$
$$\left(420000 \times \left(1 - \left(\frac{X_{311}}{3000}\right)\right)\right) + \left(360000 \times \left(1 - \left(\frac{X_{121}}{3600}\right)\right)\right) +$$
$$\left(300000 \times \left(1 - \left(\frac{X_{221}}{3800}\right)\right)\right) + \left(380000 \times \left(1 - \left(\frac{X_{321}}{3100}\right)\right)\right) +$$
$$\left(360000 \times \left(1 - \left(\frac{X_{112}}{3700}\right)\right)\right) + \left(420000 \times \left(1 - \left(\frac{X_{212}}{4500}\right)\right)\right) +$$
$$\left(340000 \times \left(1 - \left(\frac{X_{312}}{2800}\right)\right)\right) + \left(440000 \times \left(1 - \left(\frac{X_{122}}{3600}\right)\right)\right) +$$
$$\left(3880000 \times \left(1 - \left(\frac{X_{222}}{3500}\right)\right)\right) + \left(460000 \times \left(1 - \left(\frac{X_{322}}{3100}\right)\right)\right) + U_1 - D_1 = 335430$$

Transportation cost minimization goal:

$$MINZ_2 = 6.5X_{111} + 6.4X_{121} + 8.5X_{211} + 9.45X_{221} + 4.57X_{311}$$
$$+9.55X_{321} + 7.65X_{112} + 7.65X_{122} + 10.55X_{212} + 8.65X_{222}$$
$$+7.65X_{312} + 8.65X_{322} + U_2 - D_2 = 355320$$

Advertisement costs minimization goal:

$$MINZ_3 = 5500(Y_{111} + Y_{112} + Y_{211} + Y_{212})$$
$$+1000(Y_{121} + Y_{122} + Y_{221} + Y_{222})$$
$$+1000(Y_{131} + Y_{132} + Y_{231} + Y_{232}) + U_3 - D_3 = 225540$$

Inventory holding costs minimization goal:

$$MINZ_4 = 2.85X_{111} + 2.4X_{121} + 2.5X_{211} + 3.22X_{221} + 1.5X_{311}$$
$$+2.4X_{321} + 2.45X_{112} + 2.2X_{122} + 3.3X_{212} + 2.48X_{222}$$
$$+2.65X_{312} + 2.15X_{322} + U_4 - D_4 = 71450$$

As noted, hard constraints were presented in the previous section so they would not need to put in this section.

6. Solution results of model

As expressed in pervious sections, the model is a multiple goal programming.

So, the problem defined in large-scale and the model was solved using LINGO software which is appropriate for complex modelling. Final results by using hard operation research technique (MOP) are presented in table 1 and 2.

Table.1: MOP cost savings values and percentages of model

No	**Objective function**	**Actual value (Rials)**	**Optimal value (Rials)**	**Cost saving percentage**	**Cost saving value (Rials)**
1	Unused production capacity	4156500000	3133590000	24%	997560000
2	Transportation	3556300000	3018140000	15%	533445000
3	Advertisement	2836500000	1720000000	39%	110623500
4	Inventory holding	1453200000	947350000	34%	494088000
Total		12002500000	8819080000	27%	2135716500

According to table (1), actual and optimal costs are derivated from MOP and documents. Then, Table also presents the cost saving percentages for each goal. The results show that the optimal solution of our first objective function which was minimization of unused production capacity in the value chain of Pars-Khazar Company is 3133590000 Rials showing 24 percent of saves in comparison with actual cost value. For second objective function, transportation cost minimization, the model presented 3018140000 Rials as optional value which leads to 15 percent of cost saving. It also achieved a 39 percent and 34 percent of cost saving percentages for third and fourth adjective functions. According to the obtained actual values of costs and optimal costs through model, a total amount of 2135716500 Rials cost savings was achieved.

As discussed, the goal programming model is solved using the basis of unwanted and wanted deviations to provide the best solution under a varying amount of resources and priorities of the goals. It is also noted that, the values are obtained on the basis of company's annual financial planning and budgeting documents.

According to the results of goal programming shown in Table 2, it is found that transportation costs are over target value by 170020000 Rials (unwanted deviation) which implies that budget savings plans and programs should be considered efficiently.

Table.2: Goal Programming cost savings values

No	Target	Over (d)	Under (u)	Actual costs	Cost saving percentage
1	**Unused production capacity**	750130000	0	3102600000	24%
2	**Transportation**	0	170020000	3353200000	-
3	**Advertisement**	744600000	0	2255400000	33%
4	**Inventory holding**	283580000	0	714500000	39%

Results also reveal the success rate of cost savings for three priorities (unused capacity costs, advertisement costs, and inventory holding costs) amount to 7501530000 and 744600000 and 283580000 as wanted deviations respectively. Thus, obtained actual results of these three goals demonstrate the potential and capability of the company in minimizing costs.

7. Conclusion and Suggestions for Future Research

Many companies change their strategic plans because of a fundamental mismatch between the needed and actual devoted resources to support the implementation of value adding strategies. This paper proposed a hybrid AHP-GP & MOP methodology as a new integrated approach to better understand the critical connections between value chain activities, and the resources supporting those strategies.

The general structure of the proposed methodology and value chain discussed in the paper was followed by a numerical example to present its application under conditions of resource allocations and minimization of costs. The obtained results show the capability of the proposed method and operation research techniques in decision making between actual and recommended costs as well as cost minimization for each priority and goal.

Designing and defining cost management strategies cover a wide range; so, in order to do this, value making factors determined this type of strategy which is different for companies and industries. Identifying and quantifying the effects of the cost stimulus and showing mathematical relations between them to prove their effectiveness is essential and hard work. According to the mathematical model developed, which is based on the proposed conceptual model of the value chain as well as the results of the mathematical model solved using Lingo software, it was found that the mathematical model is developed model of a multi-objective decision-making model. The authors can show, based on the concepts of management cost, ideal targets for appliance parts and assemblies in an ideal programming model. As the strategy of cost management requires efficient consumption of different sources, so, the developed mathematical model determined the optimal use of the resources. Identifying and quantifying the resources of the company in terms of goals and constraints caused to determine the model parameters of company's competitive resources through the sensitivity analysis. In order to reduce the cost, the optimum combination of production was determined so that, by the sensitivity analysis of the model coefficients and parameters of functions and limitations, various resources can be allocated. Researchers who are interested in this field can prioritize different important activities of chain value using AHP and ANP techniques and then making model out of it. One of the other fields can be making models fuzzy. Also, the other research topics include adjusting and generalizing this model for other companies in different industries.

Formulation and Designing of cost management strategies includes different dimensions. In order to reach these comprehensive dimensions, we conducted the survey. Then we entered them in an interactive modelling as presented in the survey. Accordingly we reached the below results;

1. The final developed model proved to be a multiple decision making oriented model.
2. On the basis of cost management concepts, we presented a goal programming model in which we could result in optimized goals of home appliances production parts quantity and …etc. for production line orders.
3. Our model presented optimized values and quantities of resources as a confirmation for regarding of objectives and equations related to model.
4. Making factory resource objective by shaping and inserting them in goals and constraints labelled to determine the competitive resources more efficient than previous evaluations.
5. We finally reached an optimized production elements model enabling us to minimize the cost through Sensitivity Analysis coefficients & function parameters.

Future Orientation

1. Formulation and designing of a check list for cost factors are required and more over a continuous observation for mentioned factors are part of the scheduling.
2. Appointment of a strategically cost management committee to perform the special functions of the extracted model with formulated strategies of the model on the basis of contingent conditions are essential program for future.
3. Formulation of an action plan in order to activate the model in the real situation is also suggested.
4. Finally we suggest managers to conduct an Evaluation of model implementation along with documentation of all qualitative and quantitative result for future improvements of action plans.

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