ACSIJ Advances in Computer Science: an International Journal, Vol. 3, Issue 1, No.7 , January 2014
ISSN : 2322-5157
www.ACSIJ.org

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3D-Diagram for Managing Industrial Sites Information

Hamoon Fathi[1], Aras Fathi[2]

[1]Stractural engineering Department of Kurdistan University- ASCE member
Sanandaj, IRAN
hamoon.fathi@gmail.com

[2]Food Technology engineering Department of Islamic Azad University
Science and research Branch, Tehran, IRAN
arasfathi@yahoo.com

Abstract

This paper proposes a 3D-model for managing industrial sites informations with coding and prioritizing the sources. Managing the industrial and construction site information are organized by PMBOK standard in this study. This model investigated on three different construction sites and factories including a building site, a tractor assembling factory and a food production factory. The results show, the 3D-model has floating act in the different problems. The proposed model is in good agreement with site information results.

Keywords: *3D-modeling, industrial site, information management, PMBOK standard.*

1. Introduction

3D-diagram is one of the new automate methods for managing the industrial information and risk management. Many models used for managing the construction of projects are based on systematic structure [1-5]. Some researches tried to develop experience and knowledge of modeling the construction management [6-8]. The main purpose of 3D-diagram is managing and estimating the risks of the project. However, this information can build a way for analyzing the future of the project. Many researchers studied the risk of construction operation analysis [9-18]. Some of these studies discussed about industries risk and cost management [18-25]. Reduce cost and time and improve the quality are object of engineering simulations. Site information and source data are the feed of engineering simulations. This study assemblage the site information and source data in the 3D-diagrams. This information is gathered from the industrial sites. Several researches tried to simulate the site information with computer systems [26-31]. Computer software and models help to simulate the project dynamically. Large scale projects belong to classify the complex dynamic systems. Traditionally, formal modeling tools are not dynamic so the 3D-models are used to improve and build dynamic management. Furthermore, producing schedules for a project by computer needs a uniform format for translating the information to the managers. 3D-diagrams' algorithm supply the uniform format for managing site information. This study proposes a 3D-diagrams' algorithm for risk, cost and time management. Three different industrial projects tested by 3D-diagrams for different kinds of source management. The manager limitations defined with PMBOK standards.

2. Methodology

This study proposes a 3D-model for managing the industrial site information. Methodology of the model is focused on PMBOK standards. These methodologies combine the sources by coding and prioritizing. Source types in different projects are categorized with same standards. Cost, timetable, communication, risk and limitations are some parts of the uniform management at PMBOK standards. Human sources and quality are prioritized with the other sources at the same level (Fig1).

Fig. 1 Uniform management at PMBOK standards

2.1 Cost management

Budget sources are one of the important parts of the projects and the other sources have direct relation with cost. Cost management needs estimating, predicating and controlling all duration of the project's time. Cost is one of the dimensions at this methodology and growing with uniform gradient. Estimating techniques for cost of the activities need to combine all the sources and contractor's responsibilities for their works however normal project cost would be predictable by suitable sub programs.

2.2 Time management

Most of the projects are programed with time, whereas managing the project time has relationship with cost. Most projects have a simple diagram for estimating the costs or incomes. However, all the sources' information is used for simulating cost-time diagram. The other sources are installed by coding and prioritizing in the third direction of this methodology. In fact, the normal cost-time diagram is

unqualified for balancing between time and budget alone. Because, the cost behaviors are usually not linear over the full range of activities and the cost go up in the inactive parts.

3. Algorithm of the 3D-model

Most of the uniform management stabilized on the timetable. Time is the determination factor for calculating project improvement in 2D-modeling. Controlling by timetable has some limitations such as: time doesn't have negative form and growing without any activities. Human management and quality are two activities which have cost, even while the project has stopped, so the total cost can be another factor for calculating project improvement.

3D-model applies the both factors of cost and time for managing the industrial site informations. The proposed model estimates the project's behavior with using combinations of cost and time. PMBOK standards present the usual curve between total cost and time in normal constructions (Fig 2). Total cost and time in the project have relationship, and this relation is depended on the other activities and sources.

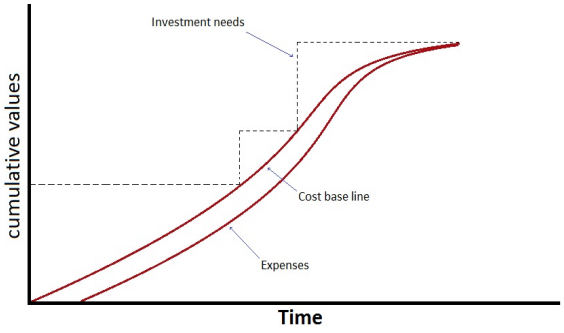

Fig. 2 Cost –Time curve

3.1 Algorithm

The algorithm of the 3D-model of management site is simple and each activity divided in the branch with specified height and those items are input in the algorithm with priority (Fig 3). Each activity has a millstone and work break structure (WBS). Sub management of the WBS is characterized with codes for the items. Whole way of the project started from the meet point of cost and time vectors and ended at the opposite point at the total cost and time (Fig 4).

3D-diagram is a profile with three dimensions. Cost is arranged by one of the axis and time by the other one. The third axis pertains to the other sources. A project's approach begins from the origin of the coordinate time-cost curve to the end point. Direct platform from the start point to the end of the project constitute an S-form shape which have been defined by PMBOK standards. This approach conducts the managers to the shortest vector. Managers shift the project's approach to control cost or time.

Normally, value of weight-cost items is important in critical and risk points in project management. Items which have some parts under the budget cover in the 3D-diagram are financed by the other sources. Items which are completely out of the budget line are contract and part-time items. It should be considered that the budget of these items depends to the contract's type. Many design software are used for estimate the project behavior. However, most of these programs are based on time and lost budget. The 3D-model algorithm can be used by mathematical software beside the other managing project softwares.

3.2 3D-models

Perfect project has activities with lag and lead relationship which they categories in the same level with different codes. The main algorithm is not including the temporary and limit works, subcontracts and accidents, so the 3D-model forecasts these items on the costs vector automatically. Actually, the 3D-model shows balance and optimizes the ways between the budget and cost points of the project at different times. Figure 5, provides a colored 3D-model of a sample project. Risk management and managing the critical conditions are based on cost and time perform by changing the vector of the project from start point to end point. In fact, the changing of the project vector is used for decreasing the time or cost of the project.

These reductions participate with erasing some parts of the activities or growing the cost or time. One of the most important abilities of the 3D-model management is estimating the effect of cost on the project duration. For example, Figure 5 shows the sample project with recession on the cost sources. These methods are used by commander and senior of the project. The sector managers have a WBS for their own activities and input them in the special diagrams.

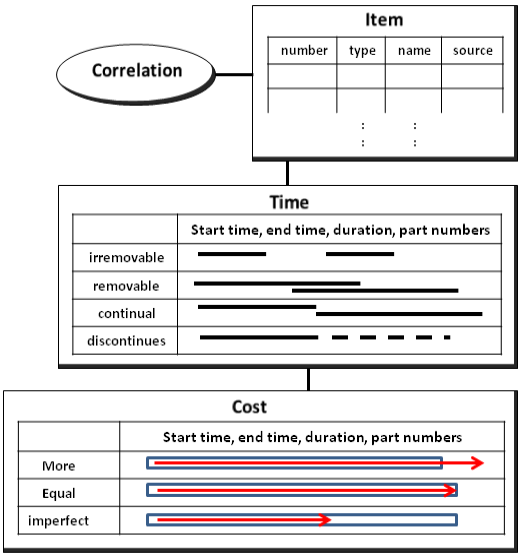

Fig. 4 The algorithm of WBS (subprogram)

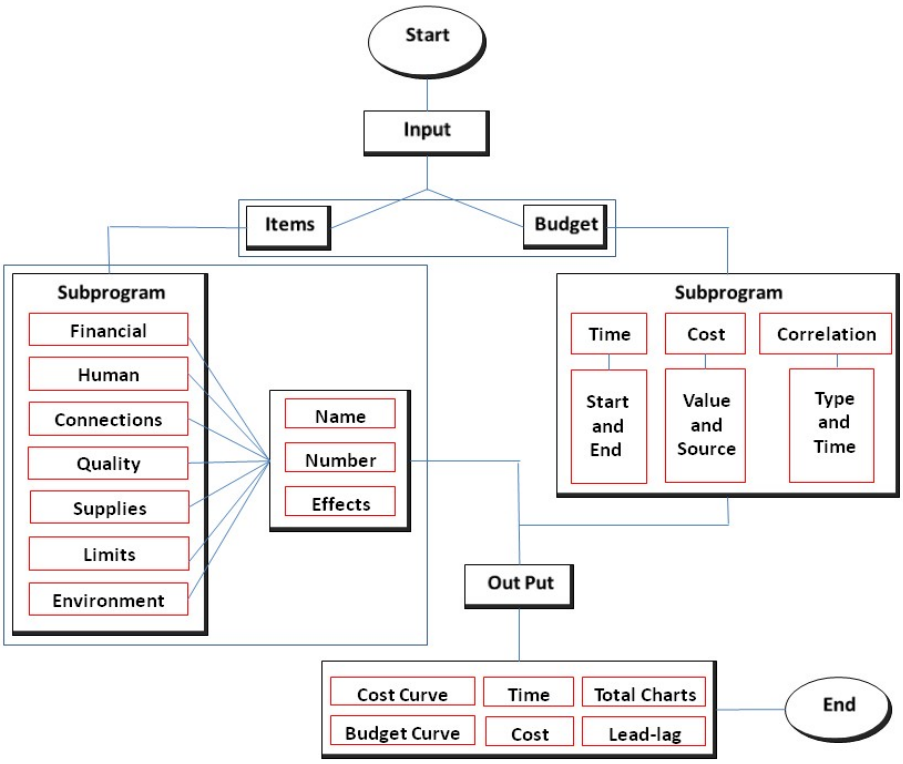

Fig. 3 The algorithm of the management site's 3D-model

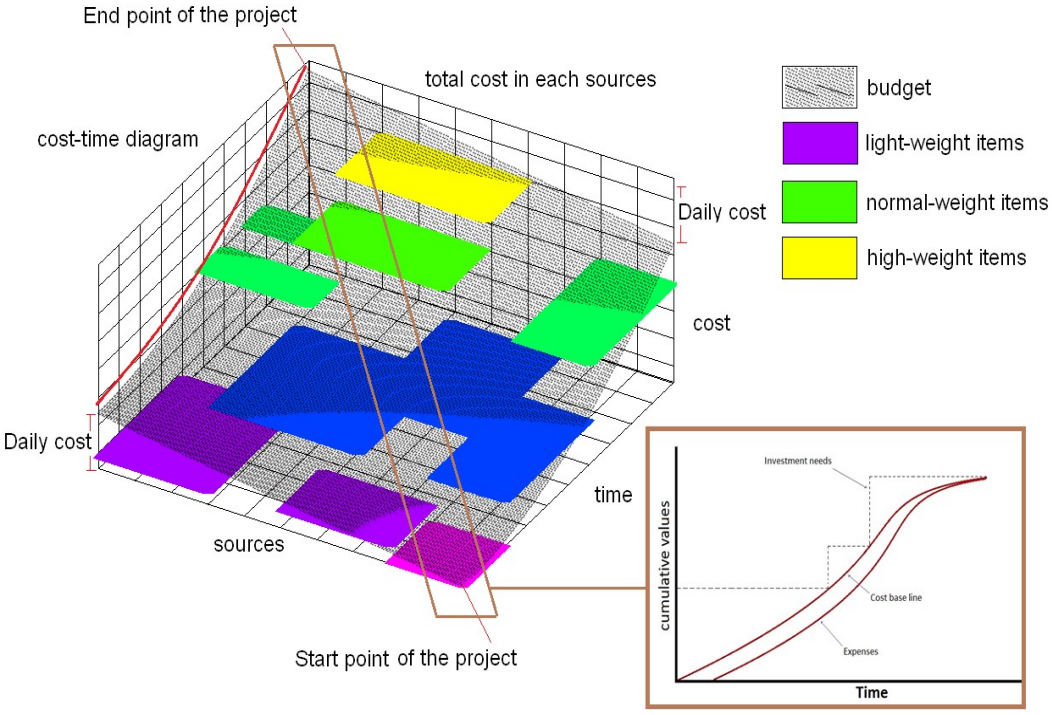

Fig. 5 3D-model of a sample project

4. Test Results and Discussion

These parts are discussing about 3D-modeling results and applications, on the real industrial site information. Data and information are used to develop the 3D-model in the third direction and the other directions are cost and time. The purpose of this model is to provide comprehensive guidance for information's bank on risk management.

4.1 building construction site

A residential tower with 80 houses is controlled by the cost-time 3D-model. These houses have the same infrastructures and been built in an apartment with 12 floors at Sanandaj city (Fig6). The project started at May 2009 and finished at March of 2013. Supply and producing materials in the building site is one of the important items. Table 1 is including some parts of the required materials, cost and budget, sources and storage capacity in the limited site at the center of a city (input data). The site environment had effect on the time and cost of the budget. Figure 7, presents the time of producing, type and value, sources and daily cost of the materials and some other information in the 3D-diagram. The 3D-diagram is including time, cost and materials. Materials of the construction project were classified into 16 groups on an axis. M1 to M5 groups are non-storable material and used upon receipt to the construction site.

M6 to M16 are storable material which assort according to use time and storage's maximum capacity. This diagram contains a large group of information, for example M14 group's material, are loaded in a constant specified amount from the project's start point (May 2009) to the end line (March 2013). Therefore the M14's unload and reload is a constant number. M14 determines water in this project. This project is a sample and some of the management results are:

- M15 and M16 material, are symbols for doors, valves, pipes and decoration's material that been logged in the last year of the project duration. As the storage capacity was not considered to them, so they temporary stored in some of the building's rooms. Accordingly, material purchasing postponed to construction of the building roofs, annual inflection causes increasing cost in material providing.
- Most parts of entering materials are stored discontinuously and new purchasing will be done after the most part of the material been used approximately. This process is able the managing team to assign a large part of the storehouse to expensive and importing material. However depletion of unsorted material could be counted as a risk and cause an increase in the project's duration.

4.2 Tractor assembling factory

This part investigated a tractor assembling factory at Sanandaj city with 3D-modeling management (Fig 8). The task of this factory is assembling and repairing their products. One of the important parts at the assembling factory is the human source management. Table 2 is including the work numbers, wages and abilities and some input information for 3D-diagram. The investigation results with 3D-modeling of the human sources management are shown (Fig 9). Daily workers' numbers, numbers of skilled workers and engineers, amount of overtime hours, upload and unload the employees are characterized in figure 9. This 3D-diagram categorizes the employees to nine groups. These groups are characterized with E1 to E9 symbols. Numbers of working days, row fiscal and start to end working periods are specified in the 3D-diagram by the means of numbers and percentages. Negative percentages replaced with zero number and positive percentages are cumulatively shown in the last step of the chart. This 3D-diagram submits the minimum to maximum salary increment for E1 to E9 groups while the E9 has the maximum payment. In fact, E9 is showing the manager team.

The E6 is related to night time shift workers with 70 % bonus adjust the salary base. Risk management is one of this diagrams consequences. The amount of personnel costs arrived to the critical point at autumn and winter of 2011, so one of the solutions could be reducing some parts of night time shifts in the mentioned seasons to decrease the total cost from the critical limitations by the mangers.

Cumulative part of the salaries shows equality between the total and critical cost. The maximum value is due to repairing the tractor products on the assembly line. Actually, environmental condition and temperature affects the workers efficiency. For this reason, the factory needs to postpone the personnel adjustment or funding for staff salaries in previous months. One of the time-cost 3D-diagram's functionalities is to define the risks and finding best solutions.

4.3 Food production factory

Cost and quality are dependent parameters which they have direct effect on the find product and marketing (Fig 10). One of the most important parts of the food factories is quality control. Managing the quality attend to marketing results and healthy controls. Figure 11, suggests the optimum cost of investigation at the different properties of the final food product. This kind of 3D-diagram is mostly used by sales and marketing senior executives. These executives in cooperating with R&D, decide on the size, flavors, advertising and product titles. Results of this diagram, presents a long-term program for sale's improvement. Of course, these results are not available until the end of one complete sale period. Product's sale duration, total costs, consumer's feedback and other sale information, are forming the 3D-diagram.

Table 1: Materials information and input data

Material	*Name*	*Start point*	*End point*	*Budget*	*cost*	*Capacity*	*Value*
Concrete	M1	2009-10	2011-10	59000	3000	Non-storable	500
welding	M2	2009-10	2011-7	15000	3000	Non-storable	0
Plasticizer	M3	2009-10	2011-7	24600	3000	Non-storable	1100
Casing	M4	2009-5	2011-10	24000	3000	Non-storable	0
Installation	M5	2010-1	2011-1	12000	3000	Non-storable	0
Stucco	M6	2009-5	2012-12	21000	1000	8 parts	1000
Brickwork	M7	2009-10	2012-10	18000	1000	7 parts	1000
wiring	M8	2011-3	2012-8	8500	1000	6 parts	700
Tarry	M9	2010-9	2012-6	8500	1000	6 parts	700
Alabaster	M10	2010-1	2012-5	7000	1000	6 parts	500
Scoria	M11	2010-1	2012-5	7000	1000	6 parts	500
Calk	M12	2010-1	2012-2	5000	1000	5 parts	0
Crockery	M13	2011-4	2013-1	8500	1000	5 parts	500
Water	M14	2009-5	2013-3	10000	1000	10 parts	0
Window	M15	2012-10	2013-3	13000	1000	4 parts	1500
Door	M16	2012-10	2013-3	13000	1000	4 parts	1500

Fig. 6 A residential tower with 80 houses

Table 2: Employee's information and input data

Group	*Activity*	*Number*	*Working day*	*Wage*	*Start point*	*End point*
E 1	Guardsman	3	455	7	2011-1-1	2012-3-28
E 2	Journeyman	12	455	14	2011-1-1	2012-3-28
E 3	Serviceman	5	225	21	2011-2-15	2011-7-15
E 4	Repairman	5	180	21	2011-6-15	2011-9-28
E 5	Engineer	7	360	30	2011-3-1	2012-1-15
E 6	Night Workers	7	455	32	2011-1-1	2012-3-28
E 7	Engineer	5	270	37	2011-3-10	2011-10-1
E 8	Inspector	6	225	47	2011-3-1	2012-1-28
E 9	Manager	3	180	60	2011-7-1	2012-3-28

Fig. 8 Tractor assembling factory

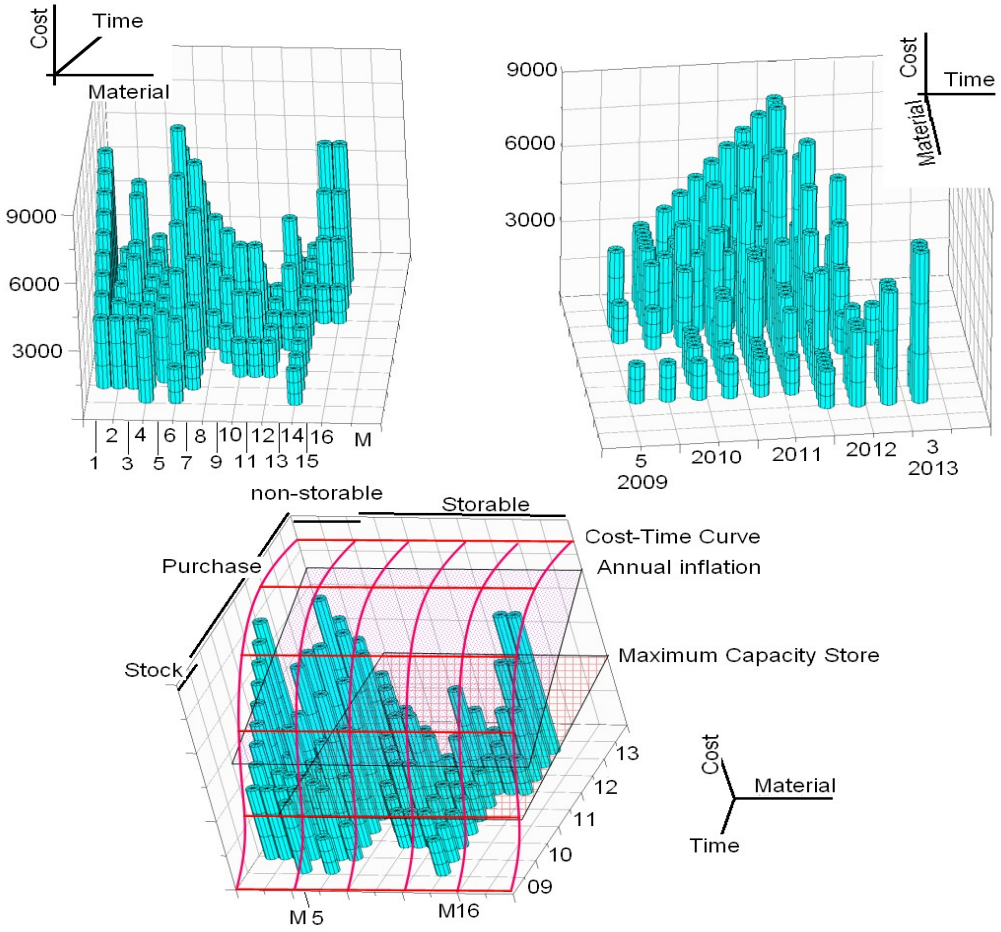

Fig. 7 The 3D-diagram of time, cost and materials

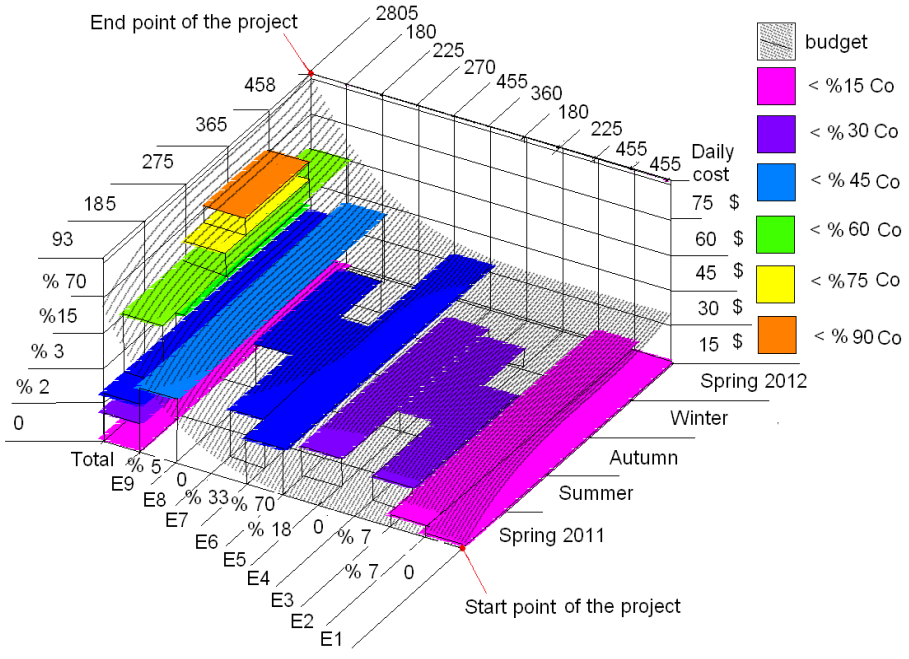

Fig. 9 3D-modeling of the human sources management

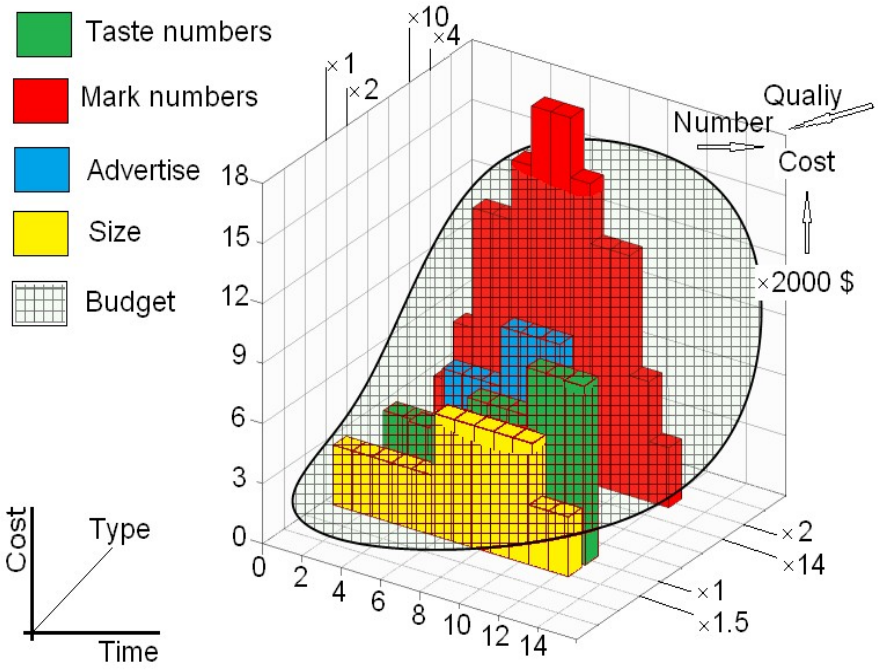

Fig. 11 3D-diagram of food production factory

Fig. 10 food production factory

For example, this diagram includes four items that each one has two equilibrium coefficients to balance the price and numbers. Presented coefficient proposes information to balance the items at a uniform mathematical form. Size and shape of the products is one of these marketing items. Results describe that alternative size does not have any significant effect on the sale rate firstly, however coincide sale of six different sizes together caused growing sale rate.

Helping to decide between repeats and diversity of advertisements is one of this diagrams consequences. Actually advertising is the main factor to recommend the product to consumers. Investigations show that efficiency of an advertisement decreases after a repeating period. The suitable time to change the advertisement could be taken from the 3D-diagram. In this case after 72 repeats of an advertisement, the sale's growing procedure stops denoting that more repeating could not be commodious anymore.

5. Conclusions

This study, investigated the feasibility of using 3D-diagrams for collecting the information of site project in a uniform format. The methodology of target reduces time and cost in the risk management. The results focused on real industrial information to analyze project conditions before and after constrictions. The following conclusions can be drawn from the experimental results and new model:

- The 3D-diagrams for risk management are rational and compatible with industrial results and informations.
- The 3D-diagrams analyses the project conditions with cost and time at the same level of valuation, so the diagrams estimate the future to manage the project and rid deleterious items.

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