DEVELOPING AN OPTIMAL MODEL FOR URBAN WASTE MANAGEMENT SYSTEMS WITH SUSTAINABLE DEVELOPMENT APPROACH: A CASE STUDY OF TEHRAN

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Abstract. Today, choosing an appropriate waste disposal option for cities, especially crowded cities such as Tehran, has become one of the important environmental issues. In fact, one of the areas where the reform can play an important role in promoting the municipal waste management system is the choice of the final disposal method of waste, since it is a multi-criteria and complex problem and has different environmental, social, technological and economic dimensions. In recent years, due to the increase in the production of municipal wastes in the metropolis of Tehran and the environmental consequences of their disproportionate disposal, and on the other hand, due to the disadvantages and advantages of any waste disposal method, including recycling, compost, waste incinerators and sanitary landfill, a variety of models and methods have been used to evaluate waste disposal systems in the city of Tehran and to select the best waste management options. But the problem of final disposal of waste from Tehran is still one of the main concerns of the environmental management of this metropolis. Because of the difference in the nature of waste materials in Tehran and its constituent parts, a waste disposal system for waste management in Tehran, is not a satisfactory solution, and in order to achieve high efficiency as well as covering all materials, several waste management and disposal units should be used in combination. On the other hand, each of these municipal waste disposal systems will also have costs and revenues. Therefore, considering this point, the percentage of input of waste to disposal systems is important. So in order to achieve this, in this research we have to provide an optimal model using PSO in order to achieve the optimal combination of municipal waste management systems and determining the optimal amount of waste for each of these waste disposal systems, in accordance with the waste analyzes in Tehran, in order to achieve the highest efficiency, reduce economic and environmental costs, and increase the income.

***Keywords**:* Urban Waste Management System, Optimal Pattern, PSO, Sustainable development, cost, revenue.

Introduction. Humans paid attention to the organization and management of waste due to its activities since it abandoned nomad life and chose to settle in the village and then the city. The most basic methods of waste management are the use of human and animal feces in agriculture. At that time, the type of waste generated in human societies was natural and easily returned to the natural cycle, and the material's shelf life was very short. With the growth of the population and the increase in human population density in residential areas, the amount of waste was added and nature simply could not be transformed in the past. Therefore, it was necessary to get away from the living environment. After the industrial revolution and the rapid growth of human artefacts and the production of chemicals, the quality of waste materials has changed, and more sustainable and non-degradable biodegradable waste has been added to urban waste. In this case, dealing with depletion needs more attention and the evolution of municipal solid waste management should be developed. The history of change in the management of municipal solid waste in industrialized countries dates back to the 1930s. At that time, in addition to collecting and transporting rubbish out of towns, landfills were covered with dirt. Until the 1970s, waste was seen as a distracting matter that should be repelled from urban environments. After the Arab oil crisis in 1970 and the environmental conference in Stockholm in 1972, energy saving and material recycling from urban waste was considered by industrialized countries and international fora. So recycling has a solid position in solid waste management systems. With time and progress in the thinking and recycling of materials, the processors were added to these systems. Today, processing and recycling, in addition to having a permanent position in waste management systems, is continuously under way from the beginning to the end of the systems, and the spirit of these systems is processing and recycling. In the past, solid household waste management in industrialized countries consisted mainly of collecting, disposing of land and waste incineration, and not paying too much attention to industrial waste disposal. Over time, environmental awareness increased due to the growth of environmental science and technology, and the relationship between the environment and the health of the people became more pronounced. On the other hand, the limitations of materials and land resources have become more pronounced due to population growth and over-exploitation, and have found that waste incineration and disposal on land have many problems and leave many environmental impacts. In addition, waste incineration and disposal on the land cannot solve the huge amount of waste generated. As a result, the concept of comprehensive waste management was gradually formed and it became clear that other methods, such as compost, could be used to manage solid waste.

Theoretical Perspectives On integrated management system of waste

Integrated Waste Management (IWM) is defined as follows: a system that manages waste, waste collection, and waste disposal and processing methods in interaction with each other, in such a way that the desired environmental, economic, and social goals in a given region to arrive. As stated in the previous section, sustainable waste management should be environmentally effective, economically feasible and socially acceptable. In more explicit terms, environmental performance, economic efficiency, and social acceptability are necessary. In addition, according to the viewpoint of thinkers, the most effective features of a sustainable waste management system are:

- Integrity of the system: the system should cover all types of materials and from any source.
- Market Orienteering: Any idea of the processing and retrieval of materials should take into account the market for the products of these processes.
- Flexibility: An effective system must have the flexibility to design, adapt, and execute, so that it does not lose its efficiency over time and under different conditions.
- Scale: The necessity of uniformity in the quantity and quality of recycled materials, compost or energy, the need for multiple management options and economic benefits all contribute to the preferences of larger and more regional and regional scales.
- Social Acceptance: An effective public waste management system is essential for public participation. People need to know and collaborate on their role in the system.

Production and composition of urban waste in the world

Waste production

According to the World Bank, the total amount of municipal waste production in 2012, based on available data, is 3532255 tons per day, taking into account the population of 2982 million people worldwide, per capita daily waste production equivalent to 1.19 kg per day. Production is projected to reach 60,669,705 tons by 2025, which is expected to reach 42.1 kg per day, according to a population of 4287 million inhabitants per year in the world. The table below shows the total waste generated by some countries in the world in 2012 and its estimate for 2025, according to the World Bank report, which shows that per capita waste production varies from city to country in the world. Developed countries continue to use more per capita consumption despite urban waste reduction plans, but for better management and higher levels of productivity and reuse of waste in recycling, they are much more than other cities in developing countries Are more successful.

Table 1: Waste produced in some countries of the world in 2012 and its estimated value in 2025

تخمین وضعیت در سال ۲۰۲۵			آمار موجود کنونی			کشور
کل پسماند تولیدی (تن در روز)	سرانه تولید پسماند (کیلوگرم بر نفر در روز)	کل جمعیت شهری	کل پسماند تولیدی (تن در روز)	سرانه تولید پسماند (کیلوگرم بر نفر در روز)	کل جمعیت شهری	
۷۰۱.۷۰۹	۳.۲	۳۰۵.۰۹۱.۰۰۰	۶۲۴.۷۰۰	۲۰۵۸	۲۴۱.۹۷۲.۳۹۳	آمریکا
۱۲۶.۶۳۳	۰۵.۲	۶۱۰۷۷۲۰۰۰۰	۱۳۷۰۸۱۶	۲۰۱۱	۶۰۰۵۳۰۰۲۱۶	آلمان
۴۶۰۷۵۹	۱.۲	۲۲۰۲۶۶۰۰۰۰	۳۶۰۱۶۴	۲۰۲۳	۱۶۰۲۳۳۰۶۶۴	استرالیا
۱۳۰۳۳۹	۲۰۱۵	۶۰۲۰۴۰۰۰۰	۱۳۰۲۸۸	۲۰۴	۵۰۵۲۶۰۰۳۳	اتریش
۶۹۰۱۷۹	۲۰۲	۳۱۰۴۴۵۰۰۰۰	۴۹۰۶۱۶	۲۰۳۳	۳۱۰۲۸۷۰۹۰۶	کانادا
۴۰۰۱۵۸	۰۰۶	۶۶۰۹۳۰۰۰۰۰	۷۰۱۹۷	۰۰۱۶	۴۶۰۲۱۹۰۲۵۰	ایران

Table 1 - Waste generated in some countries of the world in 2012 and its estimate in 2025 (table below).

کشور	آمار موجود کنونی			تخمین وضعیت در سال ۲۰۲۵		
	کل جمعیت شهری	سرانه تولید پسماند (کیلوگرم بر نفر در روز)	کل پسماند تولیدی (تن در روز)	کل جمعیت شهری	سرانه تولید پسماند (کیلوگرم بر نفر در روز)	کل پسماند تولیدی (تن در روز)
ایرلند	۲،۵۸۹،۶۹۸	۳٫۵۸	۹،۲۶۰	۳،۵۶۴،۰۰۰	۳	۱۰،۶۹۲
ایتالیا	۳۹،۹۳۸،۷۶۰	۲٫۲۳	۸۹،۰۹۶	۴۲،۲۰۵،۰۰۰	۲٫۰۵	۸۶،۵۲۰
ژاپن	۸۴،۳۳۰،۱۸۰	۱٫۷۱	۱۴۴،۴۶۶	۸۶،۴۶۰،۰۰۰	۱٫۷	۱۴۶،۹۸۲
هند	۳۲۱،۶۲۳،۲۷۱	۰٫۳۴	۱۰۹،۵۸۹	۵۳۸،۰۵۵،۰۰۰	۰٫۷	۳۷۶،۶۳۹
پاکستان	۶۰،۰۳۸،۹۴۱	۰٫۸۴	۵۰،۴۳۸	۱۰۴،۰۴۲،۰۰۰	۱٫۰۵	۱۰۹،۲۴۴
چین	۵۱۱،۷۲۲،۹۷۰	۱٫۰۲	۵۲۰،۵۴۸	۸۲۲،۲۰۹،۰۰۰	۱٫۷	۱،۳۹۷،۷۵۵
مالزی	۱۴،۴۲۹،۶۴۱	۱٫۵۲	۲۱،۹۱۸	۲۷،۱۸۷،۰۰۰	۱٫۹	۵۱،۶۵۵
اسپانیا	۳۳،۸۹۹،۰۷۳	۲٫۱۳	۷۲،۱۳۷	۳۷،۵۸۴،۰۰۰	۲٫۱	۷۸،۹۲۶
ترکیه	۴۸،۸۴۶،۷۸۰	۱٫۷۷	۸۶،۳۰۱	۶۷،۹۸۱،۰۰۰	۲	۱۳۵،۹۶۲
سوئد	۷،۶۶۲،۱۳۰	۱٫۶۱	۱۲،۳۲۹	۸،۵۲۵،۰۰۰	۱٫۸۵	۱۵،۷۷۱
سوییس	۵،۴۹۰،۲۱۴	۱٫۰۳	۱۴۹،۰۹۶	۲۰۶،۸۵۰،۰۰۰	۱٫۶	۳۳۰،۹۶۰
برزیل	۱۴۴،۵۰۷،۱۷۵	۱٫۳۷	۱۲،۴۹۳	۱۶۸،۹۰۰،۰۰۰	۱٫۷	۲۸،۷۱۳
شیلی	۱۳،۴۵۰،۲۸۲	۱٫۰۸	۱۴،۴۹۳	۱۷،۶۶۲،۰۰۰	۱٫۵	۲۶،۴۹۳
تانزانیا	۹،۴۳۹،۷۸۱	۰٫۲۶	۲،۴۲۵	۲۱،۰۲۹،۰۰۰	۰٫۵۵	۱۱،۵۶۶
مصر	۲۹،۸۹۴،۰۳۶	۱٫۳۷	۴۰،۸۲۲	۴۶،۴۳۵،۰۰۰	۱٫۸	۸۳،۵۸۳

General state of use of disposal methods in different countries of the world

In general, waste disposal methods in the world can be divided into six categories of waste disposal, landfill, composting, recycling, energy recovery and other methods, the World Bank's 2012 statistics on the use of disposal methods Worldwide in the table below. According to statistics, countries such as Switzerland and Japan have the lowest landfill rates, and countries such as Norway, Switzerland, Sweden, Ireland, Hong Kong, Singapore and South Korea are considered as leading recycling agents. Japan, with 74 percent of energy recovery, is at the top of the country. It should be noted that the cost of waste management in the PSOle world was $ 205 billion in 2010, which is projected to reach $ 375 billion by 2025, due to population growth and welfare expansion.

Japan

In 1970, a law was passed in Japan, which was called the Public Waste Management Policy. It is a law that controls all dimensions and aspects of recovery, and the executives cite it to complete the recycling process. According to the law, wastes are divided into two parts, one of which is industrial waste and the other is urban waste. But if we want to categorize the types of wastes in a different way according to the type and type of recycling, we will come to a 20 classification. According to available statistics, from 1970 to the end of 1990, the volume of waste production in the United States and Japan has been rising due to rapid industrial and urban development. But after 1990 and the implementation of the laws passed in the countries surveyed, the rate of growth in waste production declined. Statistics show that there was no growth in waste production in Japan over the past ten years, due to the relative saturation of domestic and industrial markets with consumer goods. The issue of electronic waste in Japan is a matter of serious concern in the economic and industrial circles of this land. According to the Japanese government, the volume of urban waste in Japan over the past 15 years was 50 million tons, while more than 400 million tons of industrial waste was created in the country. The per capita production of municipal waste in this period was just over 900 pounds and the per capita industrial waste production was 7,300 pounds, down from 5% in 1990. In 2005, the share of household wastes in Japan was 67.2 percent of the total urban waste, equivalent to 35 million tons, and waste collection of 17 million tons was produced by stores and trade units.

America

The United States is one of the countries active in waste management. Since 1978, when the US Environmental Protection and Enforcement Code was approved, the issue of waste management has been stepped up in this country more seriously.

According to this law, waste in the country is divided into two categories: hazardous wastes and non-hazardous waste. In 2010, 43 million tons of hazardous waste was produced in the United States, which more than quadrupled its size since 1990. Statistics show that in 1990 hazardous wastes accounted for a very small proportion of the wastes in the United States, and the development of industrial machinery and life was added to the volume of hazardous wastes. Hazardous wastes include oil and acid waste, hospital waste and waste from materials used in industrial and chemical units. The non-hazardous waste has a very wide range, one of the most important parts of which is dry wastes. Last year, 7,245 million tons of dry wastes were produced in the United States, which produced 1800 pounds of dry waste per capita per year. Statistics show that the dry matter production in the United States has grown by 12% over the past twenty years, while the growth rate of hazardous waste production in that land has been 36%. In the United States, 63.5 percent of solid waste is buried in the United States, and only 5.3 percent of it is lost through irrigation, according to the Institute for Environmental Studies and Research. Of the total solid waste collected in this country, only 25.7% of them can be recovered and used in various stages of production.

England

Each English generates 1.2 kilograms of waste per day. Much of this waste is considered to be wet waste. In the UK, waste management is with municipalities, but they are obliged to hand over executive affairs to private sectors, which has created interesting competition for attracting and attracting people. In the UK, municipalities are responsible for collecting a certain amount of waste from citizens, which is additionally collected by the people themselves and at a charge to private companies. According to the decision of the High Council for the Environment, municipalities and local governments in the country are required to spend 1,000 pounds per person a year, some of which will be provided by the central government. Under this law, large waste producers, along with their contribution to the cost of this project, will make their profits available to waste management each year.

Portugal

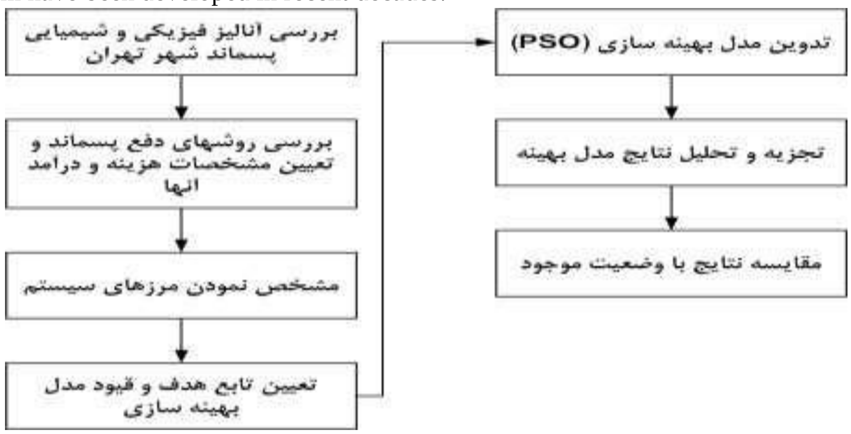
Studies by Alexandre Magrino and colleagues (2002) regarding the physical analysis of waste materials in Portugal showed that copper (41-33%), paper and cardboard (17-27%), textiles (3-5.5%), Plastic (10 to 14 percent), metals (2 percent), glass (3.5 to 6.5 percent) made of wood (0.7 percent) of urban waste. It was also found that in Portugal in 2002, about 72,000 tonnes of glass, 20,000 tonnes of paper, 5,000 tonnes of plastic and 1,000 tonnes of recycled metal were recovered.

Literature review. Our country, Iran generates more than 50000 tons of solid waste per day, accounting for 800 grams of per capita waste, which is comparable to 292 kilograms per day per person per year compared to other countries in the world. The waste is the bulky artifact of human hands. More than 3.5 million tons of waste is produced every day around the world. In developed countries, 80 percent of the waste is recycled to the consumption cycle, and the remainder is sanitized or burned. In a study by Masud Daghahi and his colleagues in Zanjan, Zanjan citizens produced about 270 tons of solid waste per day per person, 0.77 kg, which is more than 0.13 kg per capita in Iran. The bulk of Zanjan's waste is organic (about 73 percent), and the share of dry wastes is rising relative to total waste. Executive solutions for management of solid waste in the city include: isolation and segregation of waste at source is much easier, requiring lower time and lower cost, untreated infected and less degradation recyclable materials than the separation of the management of solid materials more desirable, More efficient and practical. It has significant value to separate dry waste at source and dry waste from the waste production of energy from waste, in terms of environmental, health and the economy on the one hand and the need to bury the proper care and keep pace with other countries on the other hand, the adoption of appropriate strategy and appropriate executive plans for Zanjan city. Accordingly, two strategies for the separation and segregation of solid waste in the source and strategy of increasing the amount of processed waste are suggested. In a survey conducted in Gorgan, 2006, Digimi and colleagues have concluded that given the daily production of 200 tons of household waste in Gorgan, recycled materials for the preparation of compost 149.25 tons, 27.76 tons plastic, paper and cardboard 4 / 15 tons per day is estimated. Therefore, with existing potential, it is possible to modify the management of solid urban waste in Gorgan to recycle these materials. In this study, Mohammad Sadiq Hasanvand et al., Entitled "Analysis of Municipal Solid Waste in Iran" in 1387 compared to MSW composition of Iran and other countries, concluded that MSW properties in Iran MSW properties in the Low Countries Revenue is closer. On the other hand, a large part of the solid urban solid waste of Iran is organic, which is a potential for developing the compost industry in Iran. . Seyyed Ali Joshi and colleagues in a study titled the presentation of a rural waste management strategy by A'WOT in Minab showed that the strategy of "promoting public opinion through media propaganda and public awareness about waste pollution and management of them with the help of Dehayari "is considered as the most important strategy. Ali Akbar Roudbari, in a research entitled" The collection of waste from the source of production by the NGO and with the participation of people in Shahroud city in 2005, showed that in the first month of implementation of the project, 70 The percentage of people, in the second month, 87.8% of the population, and in the third month, 87% of their own waste A weekly follow-up helped make the scheme work better. Also, people's awareness of the importance of garbage collection and disposal has also been improved. Ali Shahriari et al., In a study titled Medical Waste in Hospitals of Gorgan, showed that the average amount of wastes produced in hospitals in Gorgan was 2143 kg per day, which is equal to the infectious, sharp, winner, and ordinary wastes respectively 47.4%, 1.2% and 51.38% respectively. The rate of hospital waste production for total waste, infectious, sharp and winner, and general was 2.53, 1.21, 0.015 and 1. 3 kg per bed per day. A high percentage of infectious wastes show that despite extensive efforts in the management of wastes, there is still a problem in the management of medical wastes, especially in waste disposal, which requires more attention. Recommend that training seminars be organized to increase staff awareness about the proper separation of medical wastes. It is important to note that the success of management of medical waste is not possible without the collaboration of different groups of medical professionals. Simonetto etal (2007) studied path optimization. They used the research methodologies (OR) to develop a toolkit to optimize the route of waste carriers etal (2007) (Simonetto. Simonetto etal (2007) studied path optimization. They used research methodologies (OR) to develop a utility to optimize the route of waste carriers etal (2007) (Simonetto. In a study by Rathi (2007)), a linear programming approach to develop An optimization model for waste management in Bombay was used in India, in which various economic and environmental costs related to urban waste management were considered (Rathi, 2007). Abou najm et al (2002) Research has presented an optimal model for the management of a comprehensive regional waste management system as a backup decision support system In order to manage waste, along with socioeconomic and environmental considerations, development was then applied. This model, the post production rate of Waste, composition, collection, processing, disposal, the potential environmental impacts of municipal waste management techniques. It also monitors linear programming with a dynamic optimization framework. This model can be used as a tool for evaluating various municipal waste management alternatives and for obtaining the optimal combination of technologies for disposal through sustainable development. The sensitivity of different waste management policies has also been shown in this study. (Abou najm et al, 2002). (Fiorucci et al (2003) provided a support model for a nonlinear integral integer decision to assist planners in decisions regarding total waste management in the city. Using this model, the optimal number of landfills And processing devices, optimal quantities and waste properties that should be sent to processing, landfilling and recycling devices. Several types of constraints were addressed in the problem set-up, including those related to the minimum requirements for recycling, Burning process requirements, sanitary landfill conservation and volume balancing . The objective function in this model consists of the cost of recycling, transport and retention. Fiorucci etal, 2003)). Costi etal. (2004) conducted a study in the municipality of Genoa in Italy, and supported a non-linear integral integer planning decision to assist municipality decision makers in developing comprehensive burning, disposal, processing and recycling programs They made in this model, several plant and equipment were considered. Separators, waste-generating machines (RDFs), waste incinerators with energy recovery, organic material handling equipment and sanitary landfills are among these. The main objective of this model is to: plan for management of urban waste, determine waste flow, determine the optimal number, types and locations of devices that should be active. Some of the decision variables in this binary model are. While other variables in this model are continuous. The objective function includes all possible economic costs. Also, the pollution and effects of the overall urban waste management system were addressed by setting burning restrictions, publications and harmful effects of disposal and other operations, such as the RDF chemical composition. (Costi etal, 2004) Badran et al (2005) studied the optimization of waste management systems using operational research methodologies and presented a model for urban waste management systems in the Egyptian port of Sa'id, which included the use of aggregate sites Is being developed. The integer integer programming was used to model the system and its solution was obtained using MPL, V 4.2. The results of this study showed that the best model includes 27 collection stations for 15 tons of daily capacity and 2 1 collecting stations for 10 tons of daily capacity. (Badran et al., 2005). Nganda (2007) developed and then presented two mathematical models as a tool for waste planners in decisions related to waste management in the municipality. The presented models were arranged in the form of integer linear programming and linear integer integer programming. The choice between these models depends on the user-view point and the technology used. A user may prefer to measure transportation costs at a cost per path traveled from a waste source, in which case the first model is more appropriate. In this case, the coefficients of the decision variables in the objective function are replaced with the total cost per traveled distance from the waste collection point and at the same time, instead of measuring the amount of waste using a variety of modules which according to their capacity in this field Alternate variables can also be used to measure the amount of waste that goes directly to machines and landfills. In this case, the integer linear problem is transformed into a linear integer integer that provides better estimates of total costs and more accurate measurements of the amount of waste. (Nganda, 2007)

Research method: In the first stage, this study examined the physical and chemical analysis of waste produced in Tehran. Then, the cost and income functions are specified for all waste processing and disposal units. These functions include constraints that are determined by the current conditions and economic conditions of these units . In the next step, the objective function and the functions of the model constraints are written . optimization Algorithm PSO For these functions written and functions are defined in it.

In the next step, the model is implemented and the optimal amount of waste allocation is obtained on the basis of optimization of costs and revenues. Finally, these results are analyzed and the final optimal model is developed.
Optimization methods and algorithms are categorized into two groups of exact algorithms and approximate algorithms. Accurate algorithms are capable of finding the optimal answer accurately, but they do not work well on difficult optimization issues, and their time of resolution in these issues increases exponentially. Approximate algorithms are capable of finding acceptable (near optimal) solutions at short time solving for difficult problems. Approximate algorithms are also grouped into three groups of innovative algorithms and metaphysical and supra-innovative algorithms. In the following, the PSO optimization model is briefly explained. The two main problems are innovative algorithms, their location in local

optimizations, and their inability to apply in a variety of issues. Fractional algorithms are presented to solve these problems with innovative algorithms. In fact, meta-meta-algorithms are one of a kind of approximate optimization algorithms that have the best-of-breed solutions from a local optimization and can be applied to a wide range of issues. Various categories of this type of algorithm have been developed in recent decades.



Flowchart of Research Method

Optimization. Optimization is an important activity in determining the structural design. When designers will be able to produce better designs that they enable optimization methods in the time and cost saving design. Many of optimization problems in engineering, which are naturally more complex and more difficult than conventional methods such as optimization of mathematical programming method and the like are solved. Combinatorial optimization) , Searching for the optimal point of the functions with discrete variables, Respectively. Many combinatorial optimization problems, often including issues with non-degree polynomial (NP-Hard) which are approximated by the computers are solved. Among the solutions in dealing with such problems,are the use of algorithms or initiatives. These algorithms do not guarantee that the best answer is to just spend a lot of time can be achieved relatively accurate and in fact, depending on the time taken to accurately answer changes.

The purpose of optimization. The goal of optimization is to find the best answer acceptable, given the constraints and needs of the problem. For one thing, there may be different solutions to compare them and choose the optimal solution, the objective function is defined. The choice of this function depends on the nature of the problem. For example, travel time or cost, including transportation network optimization is common goals. However, the selection of appropriate objective function is an important step optimization. Sometimes multi-objective optimization is considered at the same time, these kinds of optimization problems that involve multiple objective functions are called multi-objective problems. The simplest way to deal with these issues is to form a new objective function as a linear combination of the main objective functions, in which the effect of each function is determined by the weight assigned to it. Each optimization problem has a number of independent variables, which are called design variables, which are represented by the n dimension vector x.The goal of optimization is to determine the design variables, so that the objective function is minimum or maximum.

Various issues in optimization is divided into two categories:

A) without constraint optimization problems: The target issues, maximum or minimum of the objective function without any restrictions on the design variables.

B) optimization problems with constraints: optimization in many practical problems due to limitations done; restrictions on the behavior and performance of a system, and behavioral limitations and restrictions that there is a problem in the physics and geometry, geometrical constraints are called either side.

May be equal or unequal equations represent the constraints that, in each case, the optimization method is different. However, constraints, determines the acceptable design. Generally, optimization problems with constraints can be shown as follows:

Minimize or Maximize: F (X) (1)
Subject to:
Minimize or Maximize : F(X))1(

Subject to : $g_i(x) \leq 0$ I = 1,2,3,…,p

$h_j(x) = 0$ j = 1,2,3,…,q

$$X_k^{\min} < X_k < X_k^{\max} \qquad k = 1,2,3,\ldots,n$$

where in $x_1, x_2, x_3, \ldots, x_n \}$ X={ Vector design and high regard as unequal limits, acceptable range for design variables are equal.

Types of optimization methods

Numerical methods

The method of counting (Enumerative Method), in each iteration only one point in space is to evaluate the function. The methods to implement, other methods are simpler, but requires considerable computing. In this way there is no mechanism for narrowing the search range and scope of the search space in this way is too large. Dynamic Programming is a good example of counting methods. This method is quite unintelligent and that is why today is rarely used alone.

Computational methods (mathematical search or - Calculus Based Method)

These methods use a sufficient set of requirements that are relevant to the optimization problem. The presence or absence of optimization constraints plays a major role in these methods. For this reason, these methods are divided into two categories of constraint and unrestricted methods. Unlimited optimization methods are according to the number of variables including the optimization of functions of a univariate and multivariate. Optimization method functions, the three methods of zero-, first- and second-order divided. The zero-order methods only need to calculate the target function at different points, but the first order methods use the objective function and its derivative and second-order methods from the objective function and its first and second derivatives. In optimizing the multivariate functions that have a great application in engineering issues, minimizing or maximizing a quantity with a large amount of design variables takes place.

New and innovative techniques (Random search)

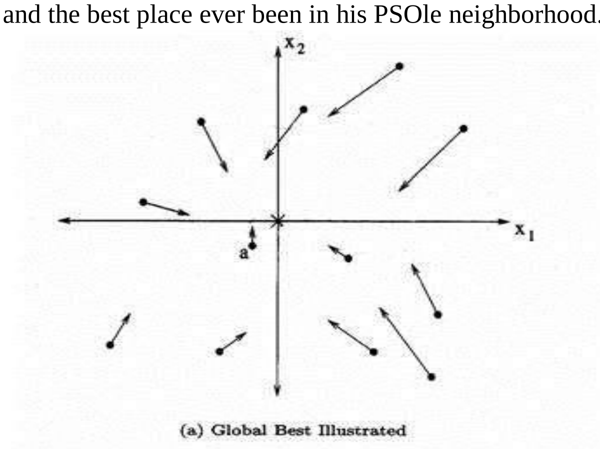
A heavy-handed methods for solving optimization problems is a combination of all possible solutions considered and objective functions related to the calculation and finally, select the best answer. It is clear that the method of counting, ultimately leads to exact problem, but in practice because of the large number of possible solutions, it is impossible. Due to the problems of enumeration technique has always been focused on creating methods more effectively. In this context, there is the most famous examples of different algorithms, simplex method for solving linear programming and branch and bound method for solving linear programs with the correct variables. For large-scale problems, Simplex method of performance is good, but Bank branch and loses its effectiveness and better performance of not count.

Particle swarm optimization

Particle swarm optimization method is, a social search algorithm which is modeled on the social behavior of birds category. The first flight of the same algorithm to detect patterns of birds and sudden changes of direction and optimal transformation was applied. At PSO , particle in the search space are ongoing. Shift particle in the search space, they are influenced by their experience and knowledge of themselves and their neighbors . So another position particle by Swarm is how to search one particle affects.

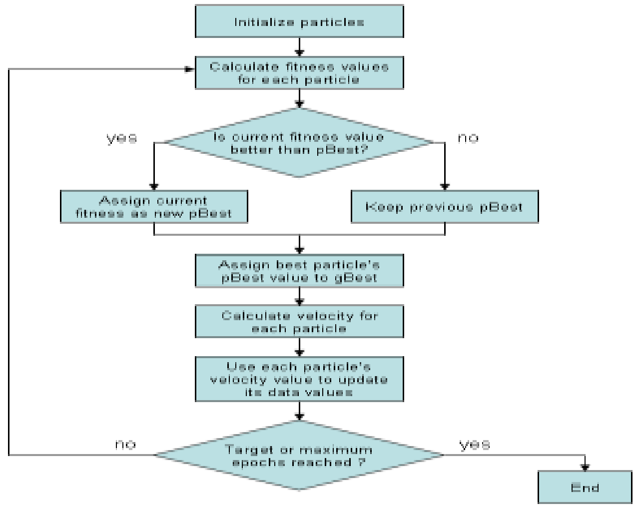
Applied form of **PSO in mathematics**

The basis of PSO work is based on this principle that at any moment each particle is set in their location in the search space according to the best place and the best place ever been in his PSOle neighborhood.

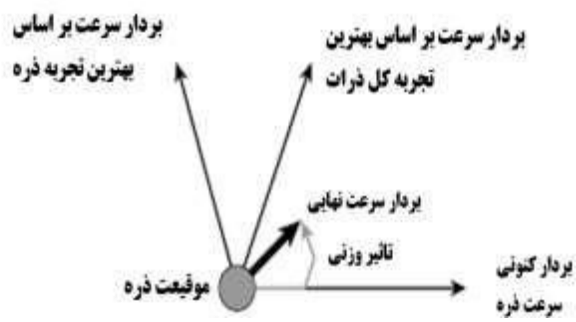


Location of particles in the environment

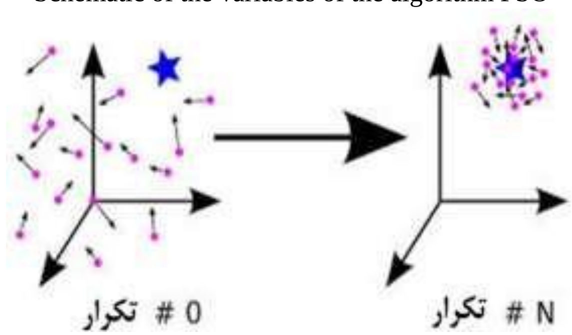
Suppose we want to obtain a regular pair (x, y) so that the function F (x, y) = x2 + y2 is minimized. First, we select the points randomly in the search space on the x-y page. Suppose we divide this Swarm into 3 neighborhoods that interact with each other in each neighborhood. In each neighborhood each of the points moves to the best point in that neighborhood and the best place that that point has been in so far. To solve a multi-variable optimization problem, one can use Swarm, which each swarm does something special.



Flowchart Algorithm PSO



Schematic of the variables of the algorithm PSO



Repeat in the algorithm PSO

In PSO the members of the population (particles) have the memory of the best (according to the objective function) where they were in the past of their own virtues , pbest Visited . In addition, the particles have access to the best location of each other in their network . The two locations (the best bit at the same time, each network will be) in the search space is absorbed in congestion . Each particle repeatedly space adjacent to the absorption near or responsible, which themselves are up to date or if the overall best and / or particulate best that each particle should be drawn update . Several networks have tried to star topology or fully connected network, a popular choice for functions Remain single view. In this network, each particle swarm share information with each other so that a particle The best gbest Global Attraction On behalf of the best location found by all categories . Particles with a speed that is influenced by the updated position with regard to the break with a simple motion of the particles are gay.

$$\mathbf{v}(t+1) = \mathbf{v}(t) + \mathbf{a}(t+1)$$
$$\mathbf{x}(t+1) = \mathbf{x}(t) + \mathbf{v}(t+1)$$

where in a , V , X And t As acceleration, speed, position and time (repeat counter) are . Relation 1 , 2 Similar to the dynamics of particles in the simulation swarm , but particles PSO Do not follow a smooth path, instead, in a move known as a fly moving Fill responsible. (Note that time DT The increase is due to this loss of rules). These particles experience linear or spring attraction such as gravity, the weights of a random number (the particle mass is united) to each attraction . Convergence does not follow this dynamic for a good solution . Flying particles must be gradually . This contraction by Kennedy and Clarke And with contraction factor 1> and implemented For our purposes here, Clarke and Kennedy PSO Conventional considered as congestion; Replacing other energy sources in the literature is like reducing inertia and closing speed . In addition, congestion position, with proof of convergence, although the fascinating fixed (Although some theoretical and empirical support for convergence in the rush to cross there where particles can move absorbers) . It is clear that the momentum k ra i At Equation 1 Determined by :

$$\mathbf{a}_i = \chi[c\epsilon \cdot (\mathbf{p}_g - \mathbf{x}_i) + c\epsilon \cdot (\mathbf{p}_i - \mathbf{x}_i)] - (1-\chi)\mathbf{v}_i$$

(3)

where in is there Vector of random numbers from a uniform distribution U [0,1], c> 2 , Fixed leap and pi, pg Particles and absorbents are universal . The formula selected from the dynamics of particles is clearly showing contraction as a frictional force, and in the opposite direction, and proportional to the speed selected . Clarke And Kennedy extracted a relationship for (c) : Standard values

C = 2.05 And =0.729843788

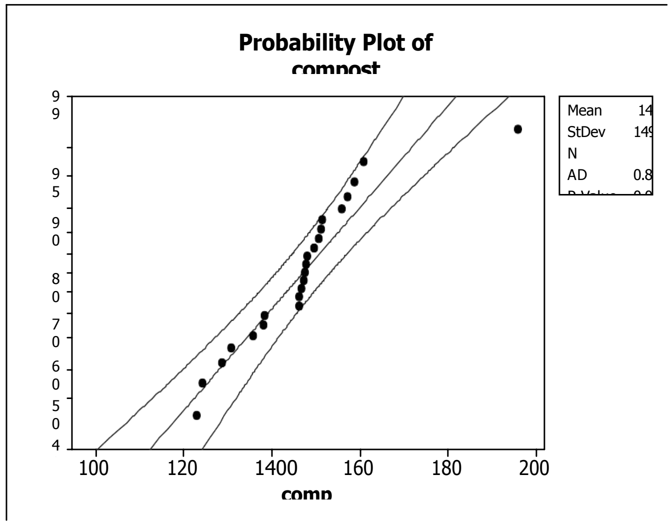
Discussion and Conclusion

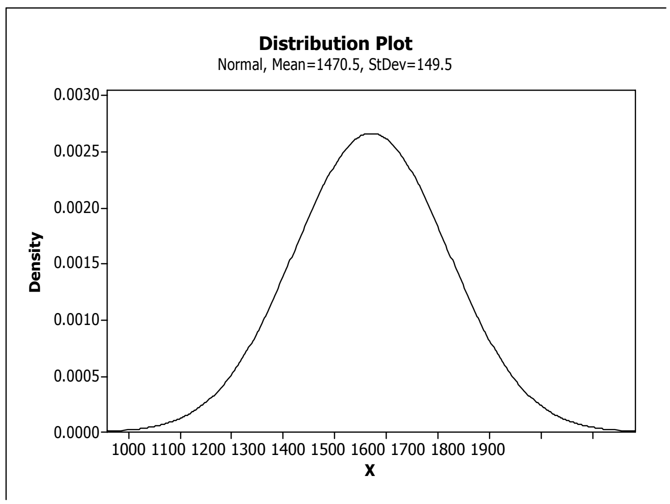
statistical analysis

Increased population, urban over-development, urban development, increased immigration, mistaken patterns of consumption of citizens, increased use of various types of goods and products through mass media, the increasing variety of products and goods, in particular packaging they and many other factors today have aggravated the problems of urban life and have been one of the most prominent health and environmental problems, especially in metropolitan areas. The problem is almost completely intangible, and it there is nothing but an upswing in the production of solid waste. Today, it's no longer a metropolis The country, especially the supermarket like Tehran, has been governed by traditional methods of non-scientific and engineering management, and it requires a method that looks at the issue with a comprehensive view. In Tehran every day an average of about 7,000 tons of waste is produced. Each of the municipal waste products, whether domestic or non-domestic, is responsible for the share of waste management, depending on the amount and type of waste produced. Urban management also needs adequate information about the quality and quantity of these wastes for efficient and optimal management of the waste. The city of Tehran with an area of 700 square kilometers is the largest city in the country. This city is located on the southern slopes of central Alborz and faces serious climate problems such as the air inversion phenomenon. Based on urban divisions, the city now has 22 municipalities. Each of these areas is divided into several regions based on population density, urban texture, size and some other parameters. In this area 9 with 2 regions and area 1 with 10 areas respectively have the smallest and most number of areas of the city, respectively. In total, the total number of districts in Tehran is 123 districts. Each of the 123 districts has the mayor of the area, and most of its activities are all kinds of urban services, such as waste collection, walkways and road tracks, urban elements cleaning, green space maintenance, dormancy, table painting and gardening, streets and passages. In the following, the results of statistical analyzes and calculations are presented. In this section, the amount of dispersion of the physical components of the waste is examined and displayed according to the average of the different areas. The following are shown in Figures below. Most of the various distributions of waste follow a normal distribution and have a definite relationship between them Is on

Test of mu = 294.1 vs > 294.1

Variable	N	Mean	StDev	SE Mean	95% Lower Bound	T	P
compost	23	1470.5	149.5	31.2	1416.9	37.73	



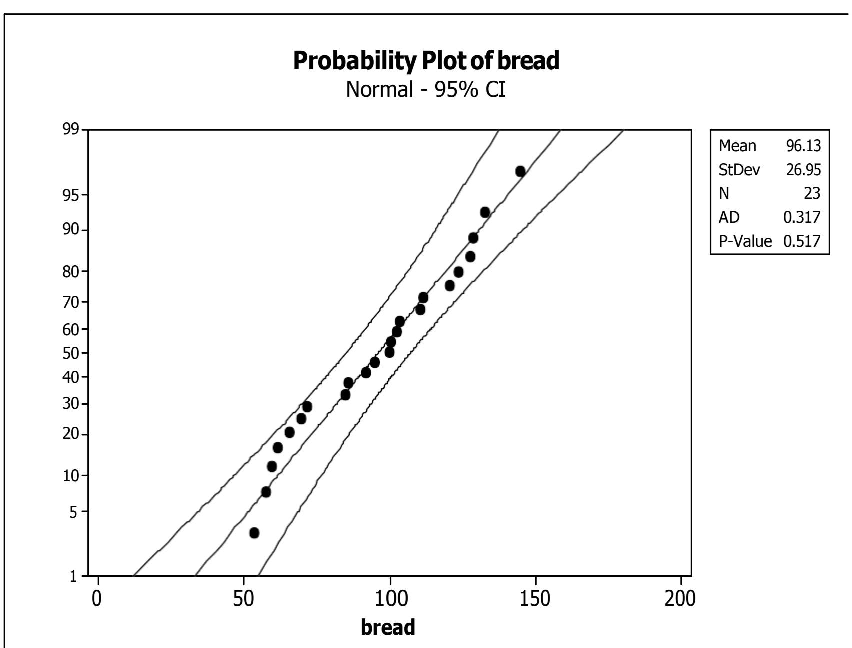


One-Sample T: bread

Percent

Test of mu = 19.2
vs > 19.2

Variable	N	Mean	StDev	SE Mean	95% Lower Bound	T	P			
							bread	23	96.13	26.95



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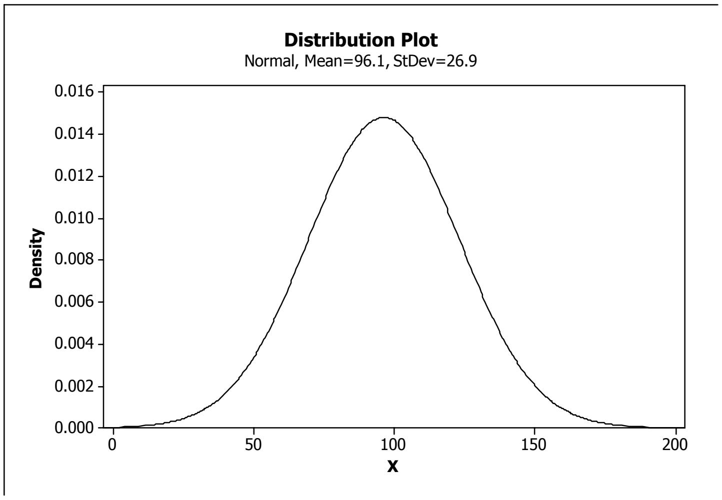
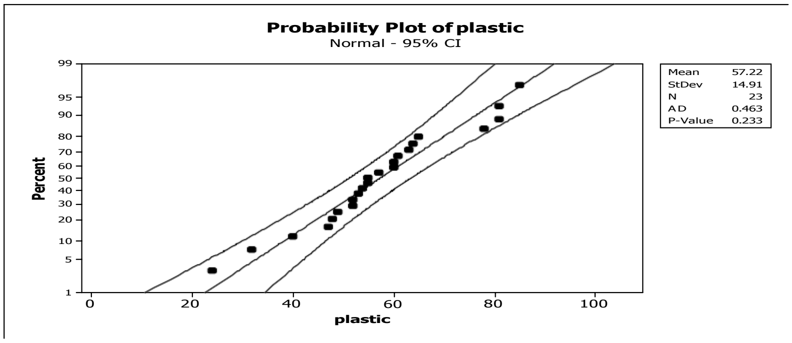
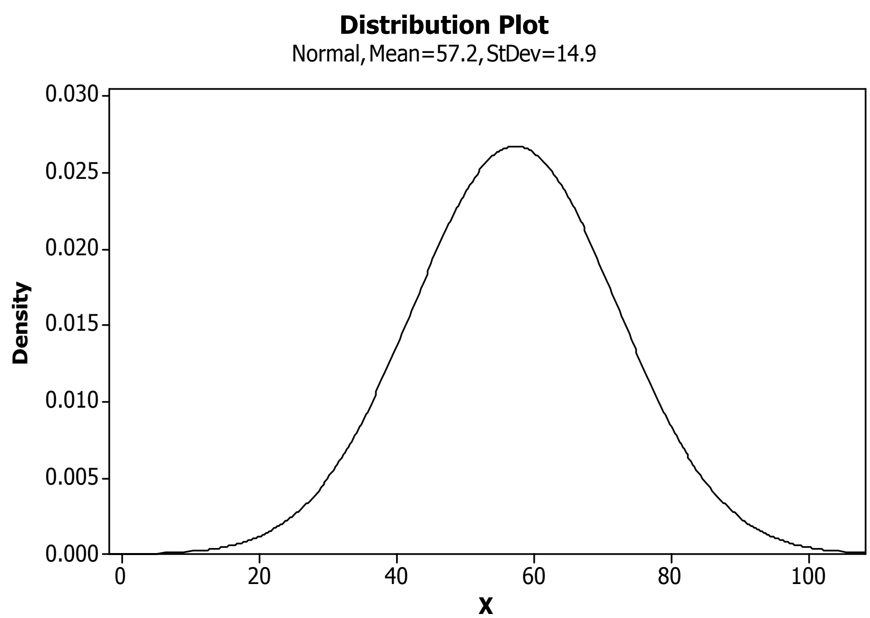


Test of mu = 11.4 vs > 11.4

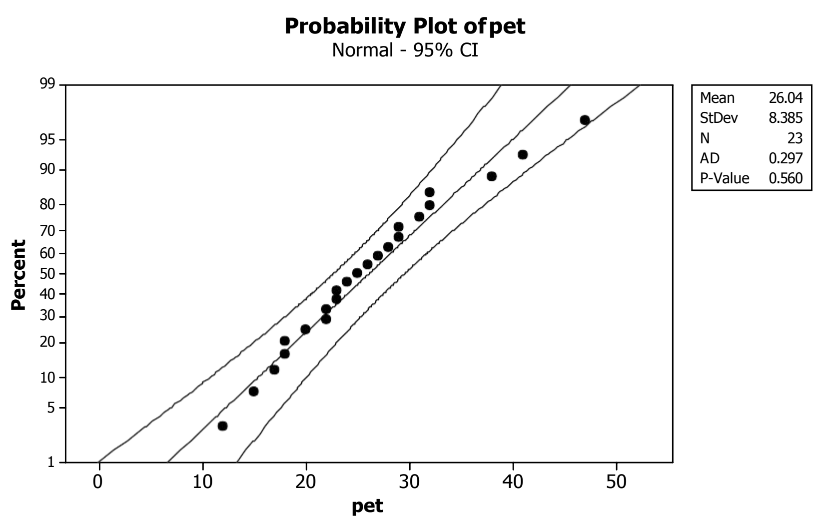
Variable	N	Mean	StDev	SE Mean	95% Lower Bound	T	P
plastic	23	57.22	14.91	3.11	51.88	14.74	0.000

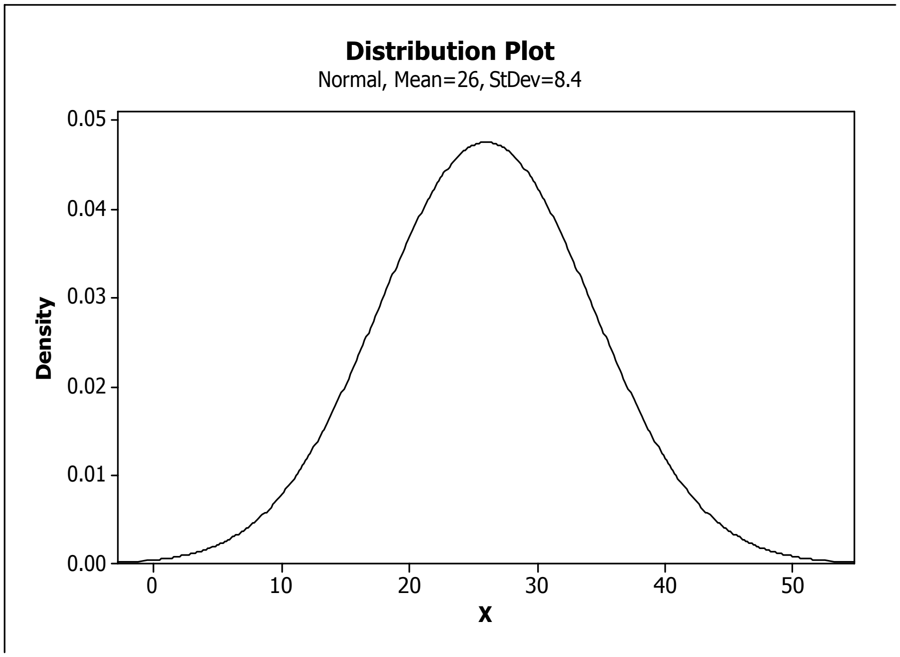




Test of mu = 5.2 vs > 5.2

Variable	N	Mean	StDev	SE Mean	95% Lower Bound	T	P
pet	23	26.04	8.39	1.75	23.04	11.92	0.000





Introduction of Optimization Model Components in Study

The first step in any optimization model is to determine the target function for optimization. In different models, according to the purpose of the research, the objective function is determined. In the study, considering the importance of the economic perspective in urban management matters and the effectiveness of this issue in management decisions, the objective function was determined as an economic function. Then with the help of the MATLAB program and the optimization method PSO, to solve the optimization model and the results of the model are presented. Given the evolutionary algorithm used, and the evolutionary optimization process, the model results are presented for the values of 100, 400, 1000 and 4000 times the model's repetition.

Calculating costs and revenues

Estimates of costs and revenues are based on the information collected from the relevant units .

Recycle

Aluminum (RA) , a_1 : Percentage of aluminum
Total cost : (kg / day / toman) a_1 x_1 300
Total Income : (kg / day / toman) a_1 x_1 9000
Carton (RC) , a_2 : Percentage Carton Coefficient
Total cost : (kg / day / toman) a_2 x_1 0.02 * 0.95 * 45 * + a_2 x_1 150
Total Income : (kg / day / toman) a_2 x_1 300
Pet (RPE) , a_3 : Prophet's coefficient
Total cost : (kg / day / toman) a_3 x_1 0.02 * 0.95 * 45 * + a_3 x_1 300
Total Income : (kg / day / toman) a_3 x_1 600
Recycled granule nylon (RN) , a_4 : The percentage of transparent and clean nylon percentages
Total cost : (kg / day / toman) a_4 x_1 0.02 * 0.95 * 45 * + a_4 x_1 350
Total Income : (kg / day / toman) a_4 x_1 400

compost

Total cost : (kg / day / ton) x_2 0.1 * 0.8 * 45+ x_2 100
Total Income : (kg / day / toman) x_2 150

Waste incinerator

The cost of building a unit of 100 tons : 40 , 000 , 000 , 000 USD
Shelf life : 10 years

Total waste volume in 10 years (100 tons per day): tons

Constant cost : USD per kilogram
Revenue per 100 tons of 2 megawatts per hour of electricity generated.
Every 1 kilowatt hour is sold at 578 USD

Income :
Total Income : (kg / day / toman) * x_3 277.44
Total cost : (Fixed cost + burial cost) x_3 0.15 * 45 * 0.7 + * x_3 145
Pyrolysis
The cost of building a unit of 100 tons : 28 , 000 , 000 , 000 USD
Shelf life : 10 years

Total cost : x_4 0.05 * 0.7 * 45 * + a_3 x_4 109
Income : For every 100 tons, 20 tons of diesel is produced, which generates 80 MW of electricity per day .

Total revenue : x_4 462.4
The cost of sanitary landfill is 45 USD per kilogram , which is dedicated to the surplus and the additional expenses of the above units and construction waste and items that do not rise to the units .

Results of model implementation
The model under study with the goal of maximizing profit is presented in the calculations and its results are presented in the form of the following tables and graphs. These values are calculated for a total load of 8000 tones.

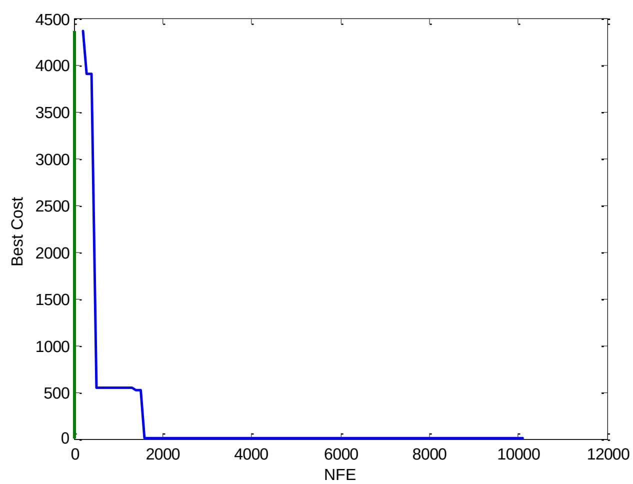


Fig. 2 shows the graph of the optimal value of the target function for 100 repetitions

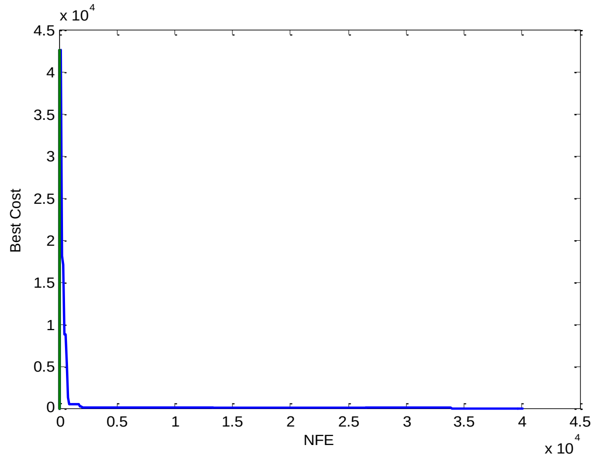


Fig. 2 shows the graph of the optimal value of the target function for 400 repetitions

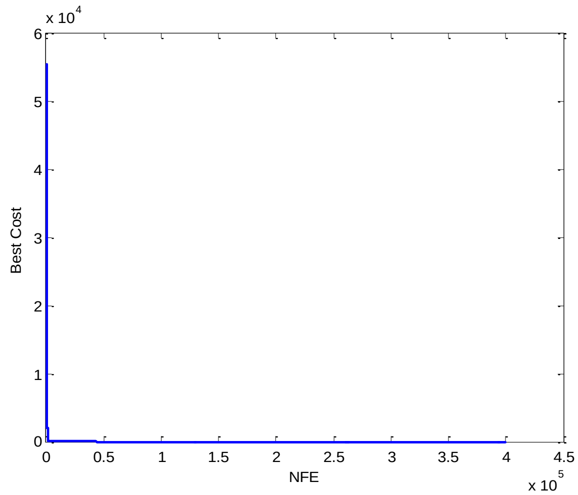


Fig. 2. Graph of the optimal values of the target function for 1000 repetitions

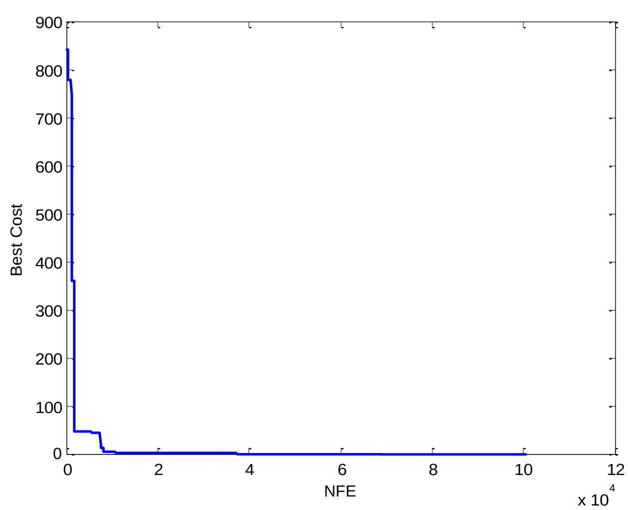


Chart 2 - Graph of the optimal values of the target function and for 4000 repetitions

Table 2: Variable values in different repetitions

Variable	x1	x2	x3	x4	x5	x6	x7	x8	Cost
Repeat 100	3040	2224	1440	1296	122	156	62	22	1.79
Repeat 400	3385	1840	1360	1415	98	103	14	35	1.89
Repeat 1000	3120	2080	1520	1280	37	89	46	78	1.82
Repeat 4000	3280	2320	1280	1120	102	81	52	24	1.85

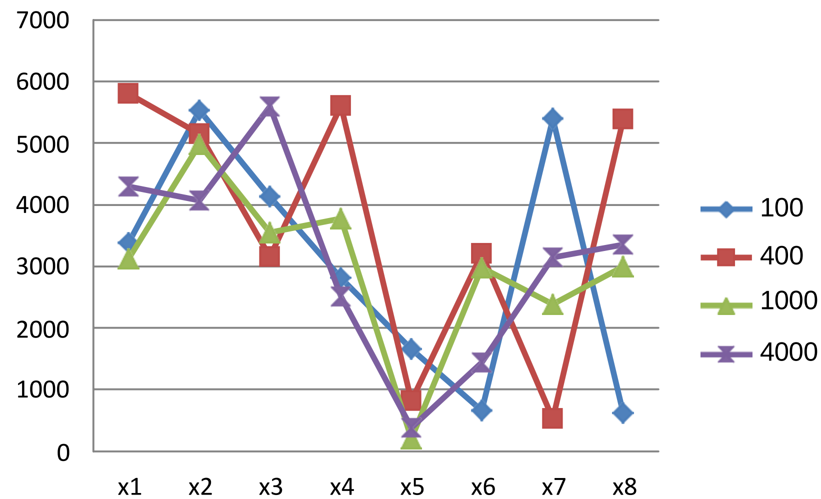
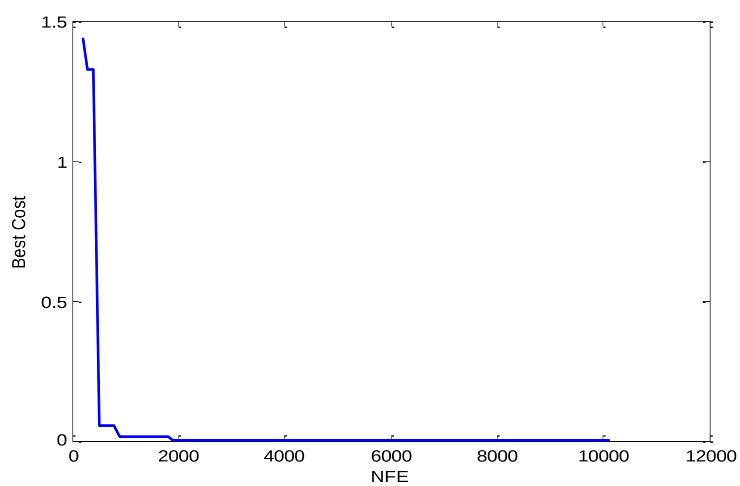


Fig. 2. Comparison of the values of variables in different repetitions of the model In this section, it is assumed that the total load is equal to 1 ton per day, and for this amount of model calculations, the results have been



presented for various repetitions.

Chart 2: The graph of the optimal value of the target function, which is repeated for 100 times and the total amount of 1 ton of total waste

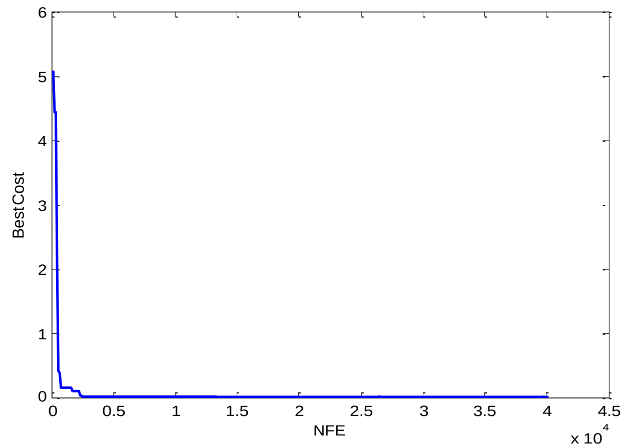


Chart 2: The graph of the optimal values of the objective function, which is repeated for 400 times and the total amount of 1 ton of total waste

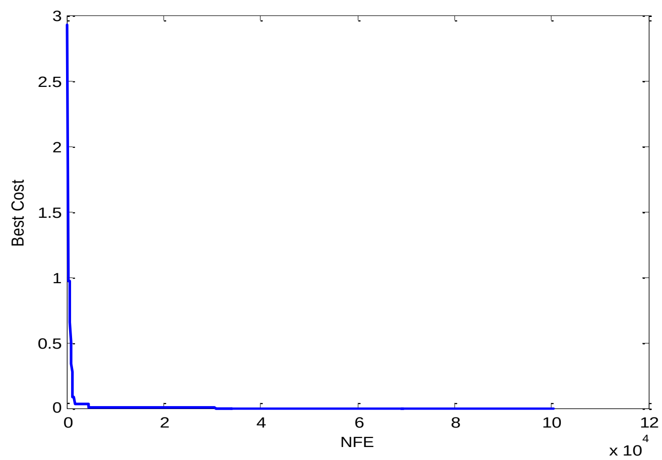


Figure 8: Graph of the optimal value of the target function, which is repeated for 1000 times and the total amount of 1 ton of total waste

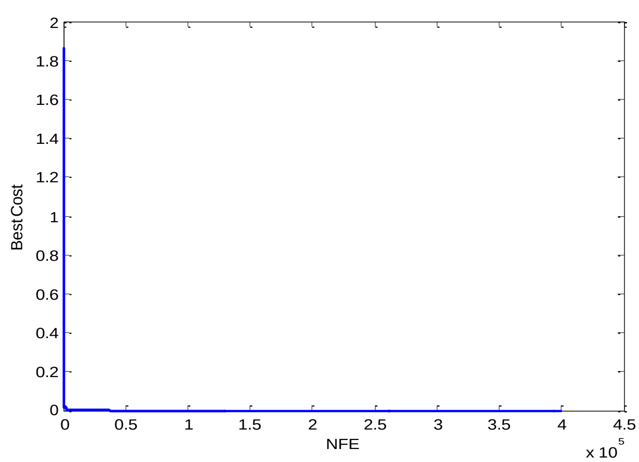


Chart 2 9-The graph of the optimal value of the objective function, which is repeated for 4000 times and the value of 1 ton of total waste

Table 2 - Variable values in different repetitions for a total load of 1 ton

Variable	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
Repeat 100	0.33	0.69	0.32	0.72	0.04	0.70	0.43	0.17
Repeat 400	0.69	0.27	0 0.60	0.75	0.29	0.56	0.10	0.25
Repeat 1000	0.62	0.56	0.59	0.76	0.12	0.43	0.30	0.61
Repeat 4000	0.78	0.31	0.72	0.64	0.31	0.35	0.41	0.21

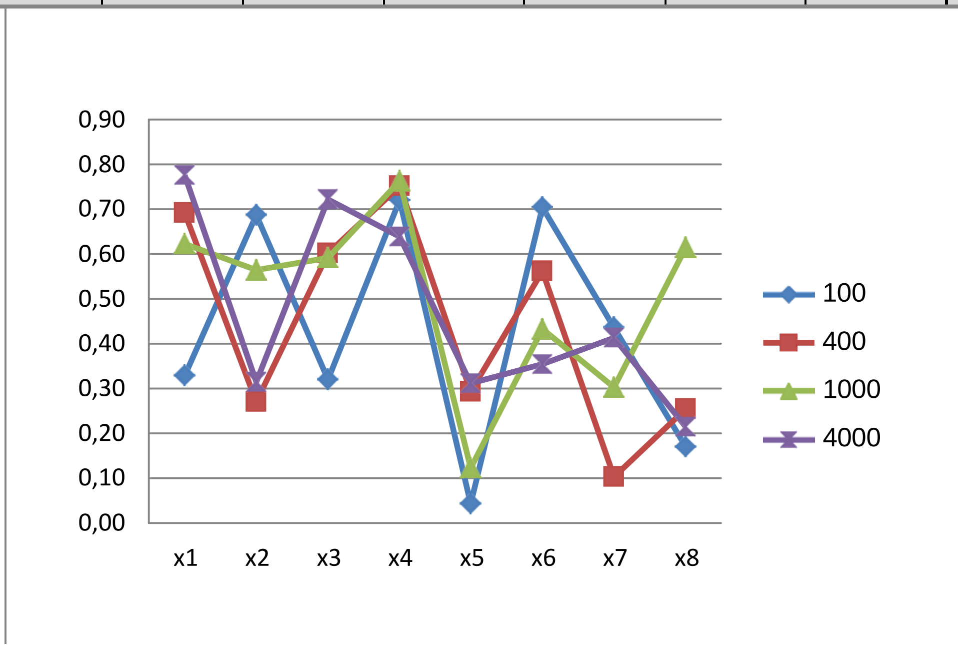


Chart 2 10-Compare the values of variables in different model repetitions for a total load of 1 t

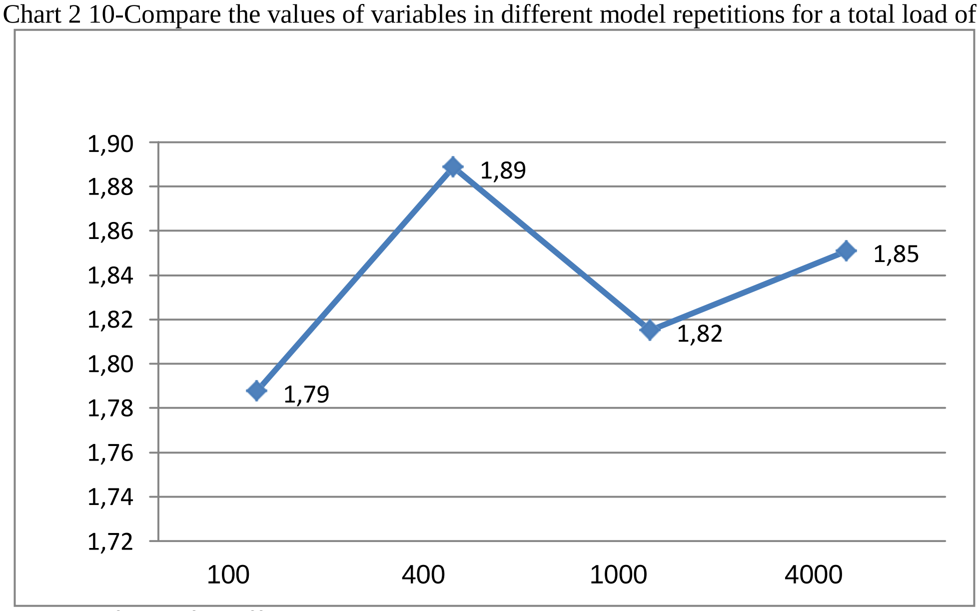


Chart 2 11- Comparison of costs for different repetitions

Conclusion

Analysis of urban waste management in Tehran based on model SWOT In some strategic planning patterns, external influential factors are seen only in threats and deterrent factors . While the opportunities in this category are completely in line with the threats, identifying and paying attention to these goals and the speed of the activities will be very fruitful . Identifying opportunities can help the system utilize 100% of its full potential, and if it does not pay attention to them, the amount of utilization and use of them may not be optimal . Regarding the studies on the status of waste management in the study area, we present the opportunities and threats in waste management system in Tehran .

Analysis SWOT Current status of waste management in Tehran

Row	Issue	internal factors		External factors	
		Strength	Weakness	the opportunity	Threat
1	System of trustee and organization	The municipality of Tehran is the main responsible for collecting and disposing of waste and is defined in the municipality as an area of urban services . .	In the organizational structure of the municipality, a distinct and distinct organizational division in this regard should be much more than predicted . Lack of implementation of Action Managerial Effective At Ground floor Garbage By Special Was not The system Record And Store Making And Processing statistics And Information Related To System Waste	The law on waste management adopted by the Islamic Consultative Assembly Working group as a waste group	Disregard for clean technology in Iran, so that even the issue has not been addressed in the municipalities and the Interior Ministry. Lack of Wide exploitation of the company By Private Trustee At Background levels Different Management Waste
2	Available storage and processing methods at the place of production	In some cases, garbage in plastic bags for garbage can be delivered to the municipal authorities in a package .	Inappropriate waste containers in some homes Non-separation of origin in the home and the source of production In some neighborhoods, city garbage is stored behind the door of the house and is stored there A lot of trash bins in the city Open the door of the lattice buckets and solidify and spill waste All waste produced is mixed in different places and places . No	The general willingness to participate in waste management programs	The existence of stray animals such as dogs and cats in some neighborhoods Uncontrolled use of packaging material and the prevalence of cultures and misconceptions about consumption, especially the widespread use of packs and plastic bags Low level of public awareness

			special processing is done		
3	Current status of collection and temporary storage	In many municipalities, municipalities have been installing different types of bins for garbage collection In other public spaces such as parks, trash bins are installed for use by pedestrians and visitors. All squares and main streets in this area are swept up daily	Alternate Total The product Garbage From Inside This Bucket The By Staff Municipality Should be more planned Door This Bucket The Open Been And Possible access Animals Insidious To They are Provide Is. Problem Main This Bucket Fixed to be This Bucket host Grid mesh buckets are generally not open and manually discharged Due to their size and number, they do not meet the needs of citizens At Market Fruit And You are Bar And Materials Protein You have to make arrangements Certain To Store Making the rubbish The And Debris Fruit The And the vegetables At Opinion Taken Do not be Absence of special waste containers in the city Top to be Per capita Production Waste At Area	Religious beliefs and their role in saving and correct consumption Possibility to use local audio and video networks to educate citizens about waste management	Because of the weakness of public culture, citizens often find that citizens leave their garbage on passage because of the distance between bins . In some cases, for the economic reasons of thieves' waste and the period of the holes, they try to trash bags to separate and recycle waste .
	Transportation of solid waste in the area	Covering all parts of the city The existence of a collection system from the door of the house The existence of mechanized vehicles transporting garbage Compressor Machines (Compactor)	Not suitable for some garbage collection and transportation vehicles Inadequate to be Number Tanks Garbage At Passages And Place By General City And Location False They are not Animated And Non mechanized to be Bucket By Total The product Garbage That Cause You can To be Agents Inevitably To Use From Hand To		The tightness of some tracks and the inability to drive garbage trucks

		The garbage collection in the oil industry is also carried out by the oil industry workers at night .	Discharge Garbage The To be		
	Collecting rubble		There should be a comprehensive, modernized program with the focus of modern technology to organize construction waste . Was not System Supervisory On Build And Instruments And Dig The And Management Debris By Structural	The location of the Hub Depo Building Materials Transformational and Urban Structure Development	Lack of supervisory system on construction and drilling and management of waste scum Failure to comply with landowners and building waste in some areas High build waste
	Check the current status of recycling and processing in the area	Contractor for the separation of recycled materials in the region	Combating Illegal Waste Disposal in the Municipality Area At present, executive management is not in a position to deal with the segregation of valuable waste components illegally, non-compliant and non-sanitary. Planning for valuable waste separation Getting out of the traditional to be Method By Case Use At System Management Waste and use From Technologies New and appropriate to the culture of the people of Tehran	The presence of significant amounts of recyclable components and the potential of deposition of recycling and composting systems Conduct plan components in some villages	Health or environmental standards are not respected in the separation of recyclable materials Separation of waste in the current state is carried out by non-sanitary methods and by non-responsible persons Uncontrolled use of packaging material and the prevalence of cultures and misconceptions about consumption, especially the widespread use of packs and plastic bags
	Current status Final disposal of solid waste in the region	Urban waste is now being transferred to pre-prepared municipality centers in various ways .	The latest standards and technologies for waste disposal should be considered in order to reduce its damaging effects on the urban environment and the ecosystem of the region .	Most of the lands are state owned and are considered as national resources . The topography of the mountainous regions of Tehran is such that we can use the valleys for the dumping of	There is no syndrome in my land " NIMBY [1] " In Iran Wild animals and birds travel freely in the courtyard The presence of animals in these areas

				waste.	
	Disposal of infectious wastes	The separation of infectious and non-infectious wastes from each other in all parts of the hospital Used and sharpened items such as blades and needles in boxes Safety Box Are collected	Lack of BB RISK all Waste Infectious Productive infectious wastes, which are mainly owned by private clinics, are deposited in the municipality without any risk and transferred to the landfill, and are buried together with other municipal wastes .	Hydroclave system for the purification of infectious wastes	Extreme levels of infectious waste production in the region Lack of knowledge and knowledge of hospital personnel about the proper separation of infectious and non-infectious wastes
	Current status of funding and funding sources	The cost of collecting and disposing of waste is not paid by people and businesses, businesses, and agencies	The lack of funds sometimes prevents the completion of shipping equipment and embankment equipment on landfilled wastes	The region's development and all-inclusive programs and the growing growth of de-desegregation and development programs	Heavy costs to the municipality And Organization Related to waste collection and disposal imposed To make
0	Check the current status of education and information programs	Activities undertaken in the field of culture and citizen participation, in connection with the time spent removing waste from homes as a basic step, should take place in the form of software hubs and mobile applications.	Comprehensive training program in the study area is more to be considered .	Increased education and environmental support in big cities, especially Turhan Religious Beliefs on Saving	The role of government agencies and non-governmental environmental groups in this regard is very small

Due to the size and population of the city, the city of Tehran, from the point of view of planning and urban management, needs more attention than any other city . In this way, one of the important issues is the perspective and economic approach in urban planning . One of the important issues in metropolitan cities is the management of urban waste . In recent years, there have been many studies in this field, each of which has, in its turn, been attempting to improve the management of urban waste management in Tehran and metropolitan areas, but the issue that remains ignored in this regard is the focus on economic optimization in this regard. is. In this study, the waste was first studied in Tehran . Next, based on the data, a statistical analysis was carried out on different wastes. In this study, by analyzing variance, the percentage of different elements of waste in different regions was investigated. According to this review all waste components have a significant difference in different regions . Also, with the help of the optimization model PSO a model has been designed and implemented. Considering different methods of using waste that includes recycling, compost, waste incineration and pyrolysis, variables were considered and based on them, the objective function is to maximize the profits from these methods. The optimal values of these variables were determined. The model has also been implemented for different repetitions, and their results have been compared with each other in terms of cost .

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