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GENETIC ALGORITHM AND ANALYTIC HIERARCHY PROCESS BASED EQUIPMENT SELECTION METHOD FOR CONSTRUCTION PROJECT USING MATLAB TOOL:A COMPARTIVE STUDY

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Abstract

Equipment selection is a key factor in modern construction industry. As it is a complex factor, current models offered by literatures fail to provide adequate solutions for major issues like systematic evaluation of soft factors and weighting of soft benefits in comparison with costs. This paper aims at making a comparative study between GA and AHP by utilising MATLAB as a tool. It is a convenient tool offering an orderly methodical thinking. It guides them in making consistent decisions and provides a facility for all necessary computation.

Keywords: Methodical Thinking, Soft Factors, Equipment Selection.

1. Introduction

Construction equipment planning aims in identifying the construction equipment to carry out project tasks, assessing equipment performance capability, forecasting datawise requirements of numbers and types of equipment. Finally one has to think about a particular method for selecting equipment which will be more productive and less expensive and more profitable. There are several methods pertaining to this topic are available in MATLAB tool box out of which genetic algorithm is considered in this paper.

2. Review of literature

Aviad Shapira and Marat Goldenberg (2005) present a selection model based on analytic hierarchy process a multi attribute decision analysis method, with a view of providing solutions for two issues. The model has the capability to handle a great number of different criteria in a way that truly reflects the complex reality to incorporate the context and unique conditions of the project and allow for manifestation of user experience and subjective perception. The model was implemented in an in-house developed system that was improved and validated through testing by senior professionals. The main academic contribution of the study is the modification of AHP to corresponded with the nature of equipment selection and in its utilisation as an effective means for the formalization of knowledge by competent experienced practioners. On the side the proposed model offers an efficient convenient tool and that forces the users into orderly methodical thinking, guides them in making logical, consistent decision and provides a facility for all necessary computations. This study aims at providing an equipment selection that will both overcome the limitations of the existing models and provide solutions for the prevalent issues as identified in current practices.

Atac Bascetin (2003) has directed the research of an optimal loading-hauling system in an open pit mine. There are many factors affecting equipment selection in this process. There are both quantitative and qualitative according to the structure of the selection. This paper deals with analytic hierarchy process for equipment selection in open pit mining. For this study involves with the selection of an optimal loading-hauling system from mine to the power station to be established in an open pit coal mine. The optimum alternative has been found as shovel-in-pit crusher belt conveyor.

Haridar et al (1999) describe the feasibility of applying artificial intelligence methodologies to the optimization of excavating and haulage operations and the utilization of equipment in open cast mining. The decision to select equipment is often based on past experience, location, and different organisational pressures as well as complex numerical computations. Therefore this study developed a open cast mine equipment (XSOME) which was designed using a hybrid knowledge based system and genetic algorithms. The knowledge based with in XSOME is a decision making task utilizing a decision that represents several nested production rules. The knowledge base mainly relates to the selection of equipment is broad categories. XSOME also applies advanced genetic algorithms search techniques to find the input variables that can achieve the optimal cost. Four case studies are analysed.

Marat Goldenberg (2007) describes about the awareness of soft consideration in equipment selection for construction projects. It aims at increasing awareness to the nature, variety and richness of soft factors, to their significant role and potential impact and outcome of decision making and to the inherent difficulty of evaluating and integrating them with in a comprehensive selection process. This paper explains about two considerations hard and soft factors. The first one is tangible quantitative formal considerations etc. This class includes typical factors like technical specification of the equipment, physical dimensions of site and constructed facility and cost calculations they are termed as hard factors. The second one is soft factors. This includes other factors like intangible, qualitative and informal in nature. Random examples include safety considerations, company policies recording purchase/rental, market fluctuations and environmental constrains.

Sabah Alkars (1993) describes about the ingredients of an integrated computer system environment concerting operations. The ingredients include a description of the integration process between expert system and other management software such as base and spread sheet; an operational; definition making program an equipment selection may be presented, the factors that need to be considered representations of construction expertisers.

3. Genetic algorithm process

Genetic Algorithm process is a recently developed method. It is an artificial intelligence technique inspired by the theory of evolution and biogenesis. It is aimed at imitating the abilities of living organism of being consummate problem solvers through apparantly undirected mechanism of evolution and natural selection. They combine an artificial survival of the fittest approach with the genetic operators abstracted from nature to form a mechanism that is suited for a rarity of search problems.

Genetic algorithm optimization begins with an initial generation. The first generation produces a random population for the model number and the number of equipment related to the model. For each generation the cost is calculated and each activity is assigned a fitness based on it ability to meet constraints for the problem and achieve the minimum cost. The fittest activity is more likely to be next generation. There are three genes to the next generation. There are three main operators for the success of the process i.e., crossover, mutation and adaption.

Before planning about the equipment selection it is necessary that one has to take into account the various site conditions i.e., nature, size, floor conditions, haul distance, depth, soil conditions, ground pressure, material size, swell factor, job conditions, management conditions and weather conditions and also types of equipment. The most important point to be borne in mind is, make of equipment, model of equipment, number of equipment and operating life of equipment.

Here algorithms techniques is used for equipment selection. The use of algorithms techniques to define the make of equipment, number of equipment and operating life of the equipment that would produce the minimum total cost of the operation is shown in Fig.1.

3.1 Output

Genetic algorithms methods help the construction industries to select the equipment that produces the minimum cost. This tools procedures cover quickly on optimal solutions and make increased output when compared to other tools. The use of this method has shown benefits in many construction areas and provides a well structured method in solving the problem. It also forces the user to take into consideration different aspects of the problem that can be overlooked. This method also provides a foundation for further development i.e., a way of examining different problems and tackling them.

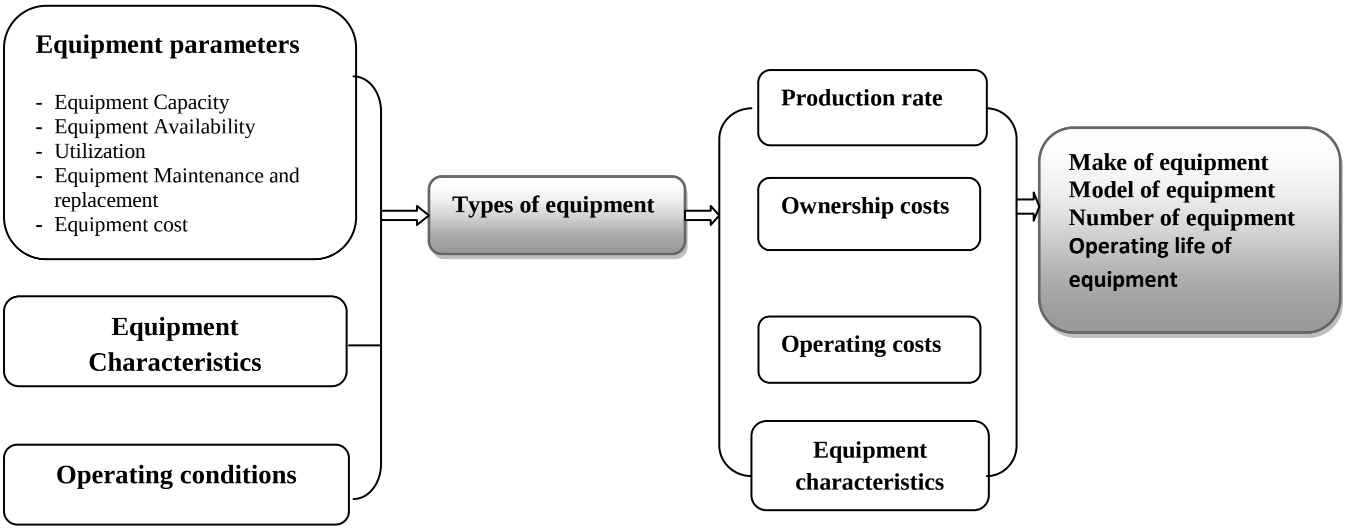

Fig.1 Genetic Algorithms Method of Equipment Selection

4. Analytic hierarchy process (AHP)

Selecting the right equipment has always been a key factor in the success of any construction project. This is even more so in today's complex, highly industrialized projects. This method has to develop an equipment selection model that will both overcome the limitations of existing models, as offered by the current literature, and provides solutions for the prevalent issues, as identified in current practices.

This method first presents the essence of AHP, its suitability for the equipment selection problem, and its solution mechanism. This method introduces the proposed selection model, with a focus on two modules.

The proposed AHP based equipment selection model does not constitute merely a technical solution for an isolated problem, but rather represents a comprehensive concept of the entire selection process. The model comprises three central modules i.e., cost evaluation of selections, benefit evaluation of selections and total evaluation of selections.

The selection process starts with the preliminary, yet critical phase of information gathering and generation of feasible alternatives i.e., those satisfying all threshold requirements. Although the current study does not treat this phase specifically, one aspect of it must be stressed, as it might affect the ensuring phases as well as the outcome of the entire selection process. Since the ultimate goal is the best overall production system possible, the scope of the process extended beyond the mere generation of different equipment selections, and should include also an investigation of the possible revision of construction methods.

4.1 Benefits

This method is best suited for the selection of equipment in modern construction industries, as it solves most of the problems of equipment selection. This method provides many feasible solution for the existing industries. It is a typical trial and error process.

This model of equipment selection aims to offer a comprehensive solution for the systematic evaluation of qualitative decision factors. This method has the capacity to handle the great number of different criteria in a way that truly reflects the complex reality without losing its practicality. It incorporates the contexts and unique condition. Its convenient and efficient evaluation makes the engineer's work easy. This method is proved to be a convenient tool for the users. Its built in facility to force the user into orderly, methodical thinking and its inherent capacity to unveil the tacit knowledge and competence of the users. This method therefore constitute a effective means for formulation of knowledge. It is considered to be the best suited method as it poured knowledge by providing a categorized selection making idea and makes the users in taking sound and logical decisions.

5. Matlab features

MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. Using the MATLAB product, one can solve technical computing problems faster than with traditional programming languages, such as C, C++, and FORTRAN.

MATLAB can be used for wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modelling and analysis, and computational biology. Add-on toolboxes (collections of special-purpose MATLAB functions, available separately) extend the MATLAB environment to solve particular classes of problems in these application areas.

6. Genetic algorithm tool box

Genetic Algorithms (GAs) are adaptive heuristic search algorithm based on the evolutionary ideas of natural selection and genetics. Genetic algorithms are a part of Evolutionary computing, a rapidly growing area of artificial intelligence (AI). GAs are inspired by Darwin's theory about Evolution - Survival of the Fittest. GAs represent an intelligent exploitation of a random search used to solve optimization problems. GAs, although randomized, exploit historical information to direct the search into the region of better performance within the search space. In nature, competition among individuals for scanty resources results in the fittest individuals dominating over the weaker ones.

6.1 Advantage of Genetic Algorithms

It is better than conventional AI ; It is more robust, unlike older AI systems, the GAs do not break easily even if the inputs changed slightly, or in the presence of reasonable noise. While performing search in large state-space, or multi-modal state-space, or n-dimensional surface, genetic algorithms offer significant benefits over many other typical search optimization techniques like - linear programming, heuristic, depth-first, breath-first.

Genetic Algorithms are good at taking large, potentially huge search spaces and navigating them, looking for optimal combinations of things, the solutions one might not otherwise find it in a lifetime.

6.2 Flow Chart for Genetic Programming

The flow chart showing the various steps of genetic programming is shown in Fig.2

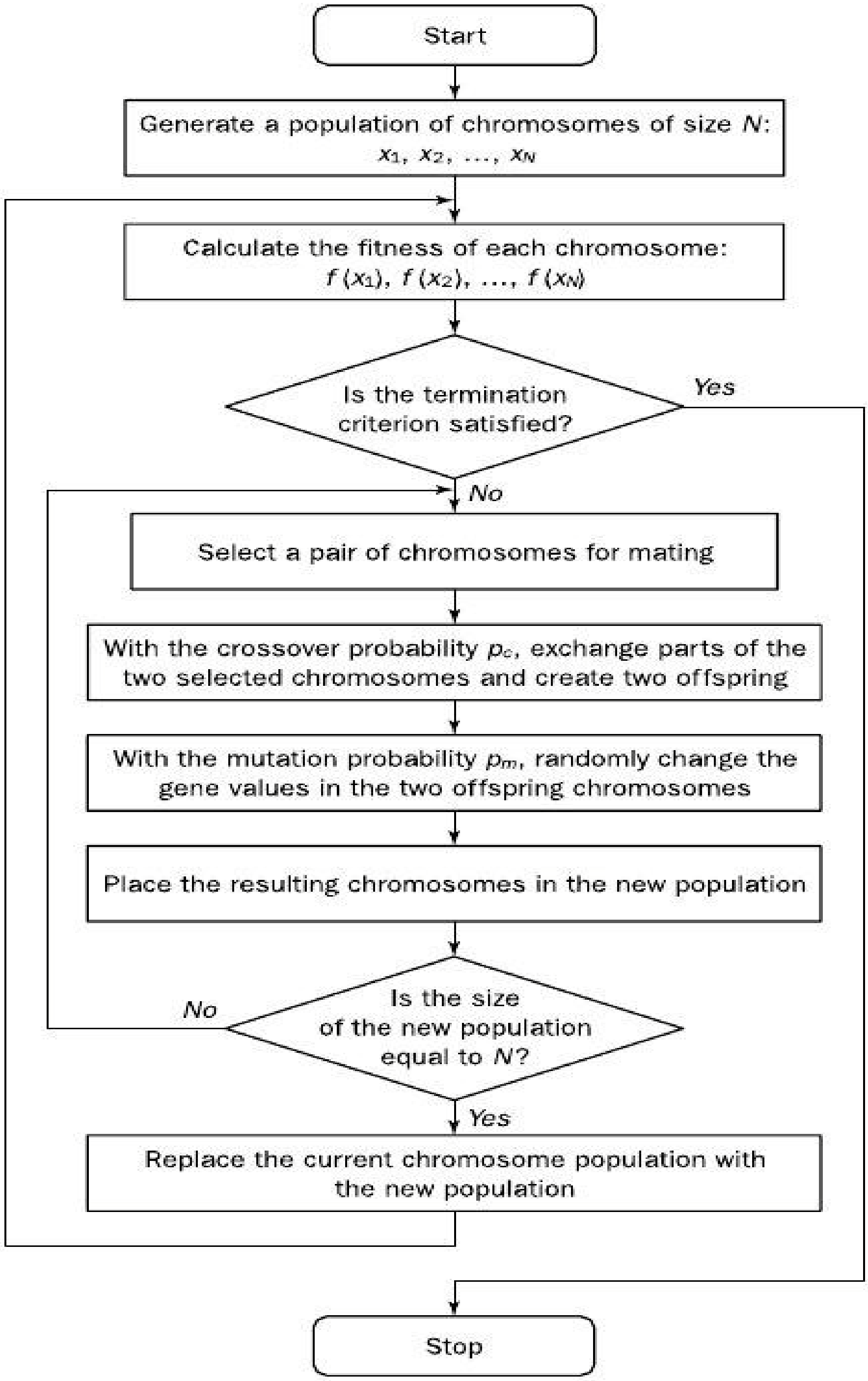

Fig. 2 Flow Chart for Genetic Algorithm

7. Analytic hierarchy process tool box

Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can be related to any aspect of the decision problem tangible or intangible, carefully measured or roughly estimated, well or poorly understood anything at all that applies to the decision at hand.

Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them with one another two at a time, with respect to their impact on an element above them in the hierarchy. In making the comparisons, the decision makers can use concrete data about the elements, but they typically use their judgements about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations.

The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques.

In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action.

7.1 Analytic Hierarchy Process

It can be seen in the material that follows, using the AHP involves the mathematical synthesis of numerous judgments about the decision problem at hand. It is not uncommon for these judgments to number in the dozens or even the hundreds. While the math can be done by hand or with a calculator, it is far more common to use one of several computerized methods for entering and synthesizing the judgements. The simplest of these involve standard spreadsheet software, while the most complex use custom software, often augmented by special devices for acquiring the judgments of decision makers gathered in a meeting room.

The procedure for using the AHP is given as follows:

- Model the problem as a hierarchy containing the decision goal, the alternatives for reaching it, and the criteria for evaluating the alternatives.
- Establish priorities among the elements of the hierarchy by making a series of judgments based on pair wise comparisons of the elements. For example, when comparing potential real-estate purchases, the investors might say they prefer location over price and price over timing.
- Synthesize these judgements to yield a set of overall priorities for the hierarchy. This would combine the investors' judgments about location, price and timing for properties A, B, C, and D into overall priorities for each property.
- Check the consistency of the judgments.
- Come to a final decision based on the results of this process.

7.2 Evaluation of the Hierarchy

Once the hierarchy has been constructed, the participants analyze it through a series of pair wise comparisons that derive numerical scales of measurement for the nodes. The criteria are pair wise compared against the goal for importance. The alternatives are pair wise compared against each of the criteria for preference. The comparisons are processed mathematically, and priorities are derived for each node.

An important task of the decision makers is to determine the weight to be given each criterion in making the choice of a best Machine. Another important task is to determine the weight to be given to each machine with regard to each of the criteria. The AHP not only lets them do that, but it lets them put a meaningful and objective numerical value on each of the criteria.

7.3 Establish Priorities

Priorities are numbers associated with the nodes of an AHP hierarchy. They represent the relative weights of the nodes in any group. Like probabilities, priorities are absolute numbers between zero and one, without units or dimensions. A node with priority 0.200 has twice the weight in reaching the goal as one with priority 0.100, ten times the weight of one with priority 0.020, and so forth. Depending on the problem at hand, "weight" can refer to importance, or preference, or likelihood, or whatever factor is being considered by the decision makers.

Priorities are distributed over a hierarchy according to its architecture, and their values depend on the information entered by users of the process. Priorities of the Goal, the Criteria, and the Alternatives are intimately related, but need to be considered separately.

By definition, the priority of the Goal is 1.000. The priorities of the Alternatives always add up to 1.000. Things can become complicated with multiple levels of Criteria, but if there is only one level, their priorities also add to 1.000 (Fig..3).

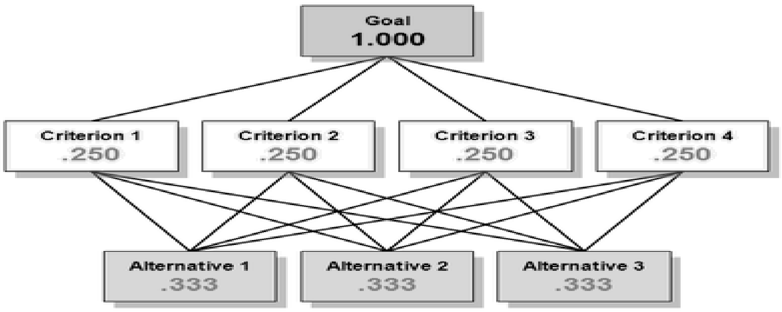

Fig.3 Typical Analytic Hierarchy Process

The priorities are those that of any information can be entered about weights of the criteria or alternatives, so the priorities within each level are all equal. They are called the hierarchy's default priorities. If a fifth Criterion were added to this hierarchy, the default priority for each Criterion would be 0.200. If there were only two Alternatives, each would have a default priority of 0.500.

Two additional concepts are applied when a hierarchy has more than one level of criteria: local priorities and global priorities. Consider the hierarchy shown in Fig.3, which has several sub criteria under each Criterion.

The local priorities, shown in gray, represent the relative weights of the nodes within a group of siblings with respect to their parent. One can easily see that the local priorities of each group of criteria and their sibling sub criteria add up to 1.000. The global priorities, shown in black, are obtained by multiplying the local priorities of the siblings by their parent's global priority. The global priorities for all the sub criteria in the level add up to 1.000.

The rule is this: within a hierarchy, the global priorities of child nodes always add up to the global priority of their parent. Within a group of children, the local priorities add up to 1.000.

8. Input data format for genetic algorithm and analytic hierarchy process

8.1 Required Information

The following data available for each of the machinery used in the project is considered.

1. 15 Month Machine data of Availability.
2. 15 Month Machine data of Working Hours.
3. 15 Month Machine data of Diesel Consumption.

The above data collected for the project under consideration is given in Table.1

8.2 Format of Input

The input data has been prepared in Microsoft Excel format for ten machines, the sample of which is shown below:

<Machine _1> <Avail_ Hr s/ Month> <Working_Hrs/Month> <Idle_Hrs/Month><Diesel_Consmp/Month>

<Machine _2> <Avail_ Hr s/ Month> <Working_Hrs/Month> <Idle_Hrs/Month><Diesel_Consmp/Month>

<Machine _3> <Avail_ Hr s/ Month> <Working_Hrs/Month> <Idle_Hrs/Month><Diesel_Consmp/Month>

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<Machine _n> <Avail_ Hr s/ Month> <Working_Hrs/Month> <Idle_Hrs/Month><Diesel_Consmp/Month>

15 month data is taken for consideration. But here one month consumption is given as a random.

The performance data provide information about the actual productivity of each equipment for a period of 15 months. It shows the equipment's particulars, nature of work done, with detailed information about shift hours, available hours, running hours along with availability percentage, utility percentage and diesel consumption. The equipment productivity at the end of every month is shown in monthwise plant and equipment performance data are given in Table .1.

Table.1 Monthly Plant & Equipment Performance Data

Sl.No.	Description	Shift Hrs *	Break Down Hrs	Available Hrs	HMR Reading		Hrs Run for the month	Cum. Hrs Run **	Idle Hrs	Production Qty #	Availability Percentage	Utilisation Percentage	Consumables (ltrs)					
					Opening	Closing							Diesel	E. Oil	H. Oil	G. Oil	T. Oil	C. Oil
(A)	(B)	(C)	(D)	(E) = (C) - (D)	(F)	(G)	(H) = (G) - (F)		(I) = (E) - (H)	(J)	(K) = (E) / (C) *100	(L) = (H) / (E) *100	(M)	(N)	(O)	(P)	(Q)	(R)
1	Compressor 325 cfm(A)	520		520	1454	1567	113	1567	407		100%	22%	960					
2	Compressor 325 cfm(B)	300		300	623	660	137	660	163		100%	46%	980	15				
3	Concrete Pump, BP 350(A)	450		450	3503	3723	220	3723	230		100%	48%	900	10	35			
4	Concrete Pump, BP 350(B)	400		400	2956	3156	200	3156	200		100%	50%	360		20			
5	Concrete Pump, BP 1800(C)	480		480	4040	4290	250	4290	230		100%	52%	800					
6	Concrete Pump, BP 1800(D)	500		500	3328	3578	250	3578	250		100%	50%	850	20	40			
7	Concrete Pump, BP 350(E)	500		500	1585	1785	200	1785	300		100%	40%	500	15	200			
8	Concrete Pump, BP 350(F)	520		520	1461	1661	200	1661	320		100%	38%	850	12	50			
9	Concrete Pump, BP 250Kva(G)	500		500	5941	6121	180	6121	320		100%	36%	6000	20				
10	Concrete Pump, BP 160kVa(H)	500		500	4476	4666	190	4666	310		100%	38%	5000	45				
11	Concrete Pump, BP 160KVa(I)	400		400	4594	4774	180	4774	220		100%	45%	4500	20				
12	Concrete Pump, BP 160 Kva(J)	420		420	6700	6890	190	6890	230		100%	45%	4000	20				
13	Concrete Pump, BP 160kVa(K)	480		480	4246	4466	220	4466	260		100%	45%	5000	40				
14	Concrete Pump, BP 125Kva(L)	400		400	5560	5720	160	5720	240		100%	40%	3500	35				
15	Concrete Pump, BP 62.5KVa(M)	400		400	3657	3857	200	3857	200		100%	50%	600	20				

16	Concrete Pump, BP 250Kva(N)	400		400	332	512	180	512	220		100%	45%	500					
17	Concrete Pump, BP 160KVA(O)	400		400	2439	2639	200	2639	200		100%	50%	5000	20				
18	Escort Hydra Crane 12Ton	520		520	1723	1870	247	1870	273		100%	48%	205					
19	JCB Bachoe / Loader 3DX	300		300	1473	1571	198	1571	102		100%	66%	630		3			
20	JCB skidsteer loader	300		300	1197	1306	109	1306	191		100%	36%	490	1				
21	Material Hoist(A)	525		525	2289	2542	283	2542	242		100%	53%						
22	Material Hoist(B)	520		520	1804	2045	241	2045	279		100%	46%						
23	Material Hoist(C)	521		521	1069	1458	389	1458	132		100%	74%						
24	Material Hoist(D)	600		600	1470	2035	565	2035	35		100%	94%						
25	Material Hoist(F)	400		400	685	805	200	805	200		100%	50%						
26	Stetter Plant, CP 30	520		520	2644	2844	310	2844	210	3940	100%	60%		5				
27	Stetter Plant, M 1	520		520	631	810	279	810	241	5711	100%	54%						
28	Tower Crane MC-115B(A)	520		520	4561	4842	281	4842	239		100%	54%						
29	Tower Crane MC-115B(B)	520		520	3819	4061	242	4061	278		100%	47%						
30	Tower Crane MC-205B(C)	520		520	2635	3024	389	3024	131		100%	75%						
31	Tower Crane MC-115B(D)	600		600	543	1114	571	1114	29		100%	95%						

33	Tractor Escort Farmtrac 70	300		300	364	393	229	393	71		100%	76%	120					
34	Transit Mixer(A)	520	158	362	8654	8977	323	8977	39	938	70%	89%	720	2				
35	Transit Mixer(B)	520		520	4035	4197	162	4197	358	395	100%	31%	500	3				
36	Transit Mixer(C)	520		520	1251	1552	301	1552	219	784	100%	58%	660	30				
37	Transit Mixer(D)	520		520	6315	6571	256	6571	264	659	100%	49%	505	15				
38	Transit Mixer(E)	520		520	6988	7180	192	7180	328	411	100%	37%	480					
39	Transit Mixer(F)	520		520	4579	4866	287	4866	233	474	100%	55%	520					
40	Transit Mixer(G)	520		520	104	353	249	353	271	436	100%	48%	500					
41	Transit Mixer(H)	520		520	5474	5690	216	5690	304	504	100%	42%	420					
42	Transit Mixer(I)	520		520	5114	5485	371	5485	149	944	100%	71%	760	1				

8.3 B RANK'S of Individual Machine

The output of 10 machines through AHP Method is shown Fig. 4 and 5. Each line explains the utility of each machine. Predicted rank of samples and rank value are also shown. The graph provides the framework of forecasting inputs which can be directly identified with utility of 10 machines. The range of rank value for each machine is between 0.6 and 1.0 and the predicted rank sample is between 2 and 30. It represents current input about future output. The graph provides information about data wise availability of machines. It indicates the quantum of resources required for executing the project.

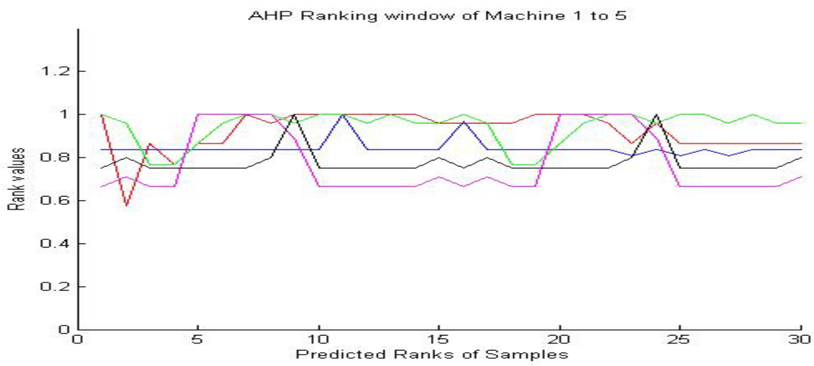


Fig.4 AHP Ranking of Machine 1 to 5

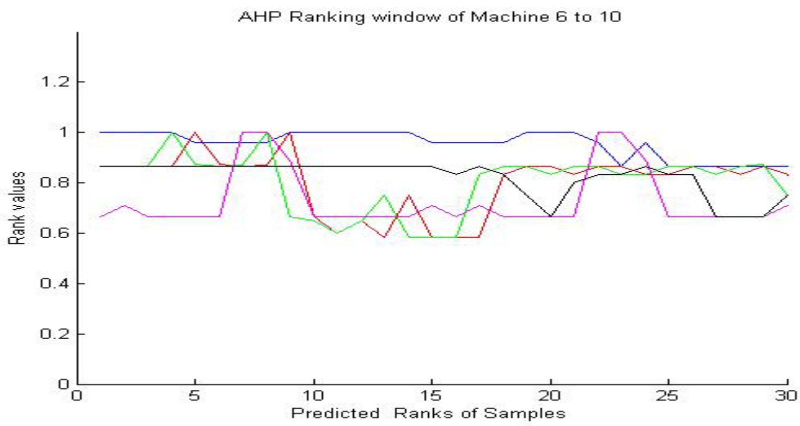


Fig. 5 AHP Ranking of Machine 6 to 10

This selection model offers a comprehensive solution for a systematic evaluation of qualitative decision factors. It will guide the construction industries to handle different complex criteria without losing its practicality. It also incorporates the context and unique conditions of the project, allowing manifestation of user experience and subjective perception. It gives a framework for a structural process and assuring solution consistency.

This study will be of very helpful for the construction industry as it gives better guidelines for the method of equipment selection. Unlike the genetic algorithm, the analytic hierarchy process method is found to be the best as it gives a wide spectrum of planning and personal judgement to take apt decision.

As it gives guideline about the entire site plant and thereby allows the engineer's to make the evaluation of any equipment option.

The systematic consideration of soft and hard factors of this project will make the project engineer's to accommodate owned and rented equipment duly considering cost evaluation. It gives the users in making sound and logical decisions and will guide them to train novice engineers. It gives guideline to solve complex and challenging problem that the modern construction industry spaces.

Above all this study will be of great importance for the future construction industry as it aims at advance decision making in equipment organisation and equipment location covering all phases of equipment use on the project.

The study gives a detailed account about actual assimilation in construction companies and its long term application in construction projects.

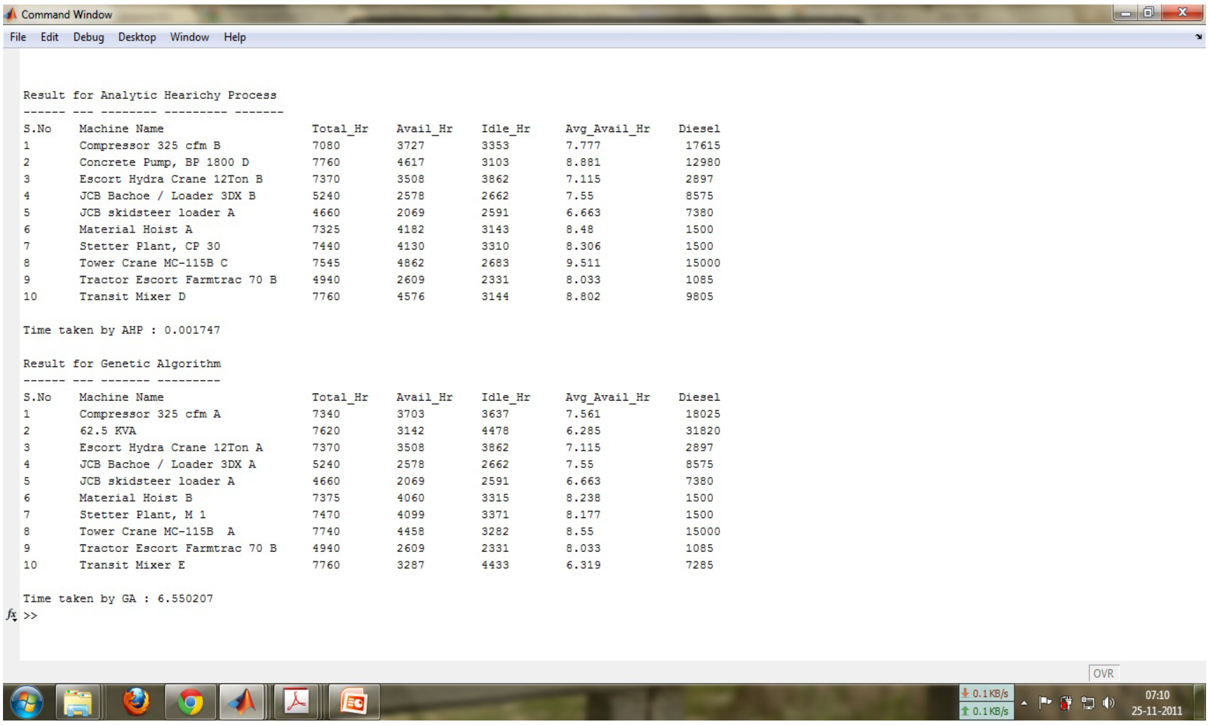
This study offers an efficient and convenient tool that makes the users into methodical thinking, guides them in making logical, consistent decisions and provides a facility for all necessary computation.

As this selected tool gives a detailed account about availability hours, working hours, idle hours allowing construction industry to decide about the wastage hours. It enables them to decide the apt equipment and gives ideas about reducing the idle equipment and thereby minimizing cost and maximising profit.

9. Comparison of results

The comparison of output result for both genetic algorithm and analytical hierarchy process, the equipment's performance in total hours, available hours, idle hours and average available hours along with diesel consumption are considered in Fig. 6.

10. Result obtained ahp and ga using matlab



Result for Analytic Hearichy Process

S.No	Machine Name	Total_Hr	Avail_Hr	Idle_Hr	Avg_Avail_Hr	Diesel
1	Compressor 325 cfm B	7080	3727	3353	7.777	17615
2	Concrete Pump, BP 1800 D	7760	4617	3103	8.881	12980
3	Escort Hydra Crane 12Ton B	7370	3508	3862	7.115	2897
4	JCB Bachoe / Loader 3DX B	5240	2578	2662	7.55	8575
5	JCB skidsteer loader A	4660	2069	2591	6.663	7380
6	Material Hoist A	7325	4182	3143	8.48	1500
7	Stetter Plant, CP 30	7440	4130	3310	8.306	1500
8	Tower Crane MC-115B C	7545	4862	2683	9.511	15000
9	Tractor Escort Farmtrac 70 B	4940	2609	2331	8.033	1085
10	Transit Mixer D	7760	4576	3144	8.802	9805

Time taken by AHP : 0.001747

Result for Genetic Algorithm

S.No	Machine Name	Total_Hr	Avail_Hr	Idle_Hr	Avg_Avail_Hr	Diesel
1	Compressor 325 cfm A	7340	3703	3637	7.561	18025
2	62.5 KVA	7620	3142	4478	6.285	31820
3	Escort Hydra Crane 12Ton A	7370	3508	3862	7.115	2897
4	JCB Bachoe / Loader 3DX A	5240	2578	2662	7.55	8575
5	JCB skidsteer loader A	4660	2069	2591	6.663	7380
6	Material Hoist B	7375	4060	3315	8.238	1500
7	Stetter Plant, M 1	7470	4099	3371	8.177	1500
8	Tower Crane MC-115B A	7740	4458	3282	8.55	15000
9	Tractor Escort Farmtrac 70 B	4940	2609	2331	8.033	1085
10	Transit Mixer E	7760	3287	4433	6.319	7285

Time taken by GA : 6.550207

Fig.6 Results for AHP and GA

The comparison of the results of output is obtained i.e., the details of 15 month equipment data is analysed.

The comparative results of the working hours of analytic hierarchy process and genetic algorithm method of selection shown in Table. 2 indicates that the analytical hierarchy process is less time consuming and quick process as against genetic algorithm.

Table.2 Process Time Comparison

Analytic Hierarchy Process (Time taken in sec)	Genetic Algorithm (Time taken in sec)
0.001747	6.550207

From below Table, it is concluded that AHP method is best suited for equipment selection as it is less time consuming, best performance, with less cost as compared with the GA method.

Same variables are taken for consideration in both genetic algorithm and analytical hierarchy process method of selection. The data derived from the study shown in Table. 3 and 4 indicates that the best selection method is analytical hierarchy process, as it is less time consuming, profit oriented, solves all complex problems, guides them making logical and consistent decisions and provide all facilities for necessary computations. It offers an effective means for the formalization of knowledge by competent and experienced person.

Table.3 Result for Analytic Hierarchy Process

S.No	Machine Name	Total_Hr	Avail_Hr	Idle_Hr	Avg_Avail_Hr	Diesel
1	Compressor 325 cfm B	7080 *(-1820)*	3727(+168)	3353(-1988)	7.777(+1.52)	17615*(-10856)*
2	Concrete Pump, BP 1800 D	7760	4617	3103	8.881	12980
3	Escort Hydra Crane 12Ton B	7370	3508	3862	7.115	2897
4	JCB Bachoe / Loader 3DX B	5240	2578	2662	7.55	8575
5	JCB skidsteer loader A	4660	2069	2591	6.663	7380
6	Material Hoist A	7325(-400)	4182(+850)	3143(-1204)	8.48(+1.69)	1500
7	Stetter Plant, CP 30	7440(-210)	4130(+217)	3310(-427)	8.306(+0.9)	1500(-4500)
8	Tower Crane MC-115B C	7545(-1365)	4862(+2828)	2683(-4193)	9.511(+6.53)	15000
9	Tractor Escort Farmtrac 70 B	4940	2609	2331	8.033	1085
10	Transit Mixer D	7760(+770)	4576(+4844)	3144(-4354)	8.802(+8.34)	9805(+10788)

Note: In table –ve sign indicates how much value lower that the Equipment selected by another technique via +ve sign indicates how much value higher than that the Equipment selected by another technique. Red colour identification indicates un desired and green indicates desired.

Table .4 Result for Genetic Algorithm

S.No	Machine Name	Total_Hr	Avail_Hr	Idle_Hr	Avg_Avail_Hr	Diesel
1	Compressor 325 cfm A	7340*(+1820)*	3703(-168)	3637(+1988)	7.561(-1.52)	18025*(+10856)*
2	Concrete Pump, BP 1800 D	7620	3142	4478	6.285	31820
3	Escort Hydra Crane 12Ton A	7370	3508	3862	7.115	2897
4	JCB Bachoe / Loader 3DX B	5240	2578	2662	7.55	8575
5	JCB skidsteer loader A	4660	2069	2591	6.663	7380
6	Material Hoist B	7375(+400)	4060(-850)	3315(+1204)	8.238(-1.69)	1500
7	Stetter Plant, M 1	7470(+210)	4099(-217)	3371(+427)	8.177(-0.9)	1500(+4500)
8	Tower Crane MC-115B A	7740(+1365)	4458(-2828)	3282(+4193)	8.55(-6.53)	15000
9	Tractor Escort Farmtrac 70 A	4940	2609	2331	8.033	1085
10	Transit Mixer A	7760(-770)	3287(-4844)	4433(+4354)	6.319(-8.34)	7285(-10788)

Note: In table –ve sign indicates how much value lower that the Equipment selected by another technique via +ve sign indicates how much value higher than that the Equipment selected by another technique. Red colour identification indicates un desired and green indicates desired.

11.Conclusions

Based on this study the following are the conclusions:

i) Performance data of 10 equipment is put to test on genetic algorithm and analytical hierarchy process. Analytical hierarchy process at once started analysing and processing and selected quickly the best performance equipment. But genetic algorithm slowly taking process and select secondary performance equipment. So process wise AHP is the best method.

ii) This selected tool gives a detailed account about availability hours, working hours, idle hours allowing construction industry to decide about the wastage hours. It enables them to decide the apt equipment and gives ideas about reducing the idle equipment and thereby minimizing cost and maximising profit.

iii) Analytical hierarchy process is found to be best method as it systematically considers unlimited numbers of equipment.

iv) Analytical hierarchy process is a convenient and efficient method as it evaluates the equipment data at the deep level.

v) The comparative results of the working hours of analytic hierarchy process and genetic algorithm method of selection indicates that the analytical hierarchy process is less time consuming and quick process as against genetic algorithm.

vi) The performance/Superiority of the Analytic Hierarchy Process over Genetic algorithm, omitting the poor time consumption of genetic algorithm it is also proved that, Genetic algorithm is not capable of producing same result and local convergence.

Genetic algorithm results are dependent of the initial random value generated which is also not a desired one.

vii) Analytical hierarchy process method constitutes an effective means of formulation of knowledge as it provides a categorized list of selection criteria and a well tested hierarchy.

viii) Analytical hierarchy process method guides and assists the user in making sound and logical decision.

ix) According to this study analytical hierarchy process method output performance consumes 0.001747 secs and genetic algorithm method of selection consumes 6.550207 secs. So analytical hierarchy process method of selection is time consuming as against genetic algorithm.

x) From the study it is found that analytical hierarchy process method of selecting equipment is best suited as it gives distinct results. It is less time consuming. It minimises cost and maximises profit. As it is analytical it solves all complex problems. It is a novel method as it integrates cost and benefit scores. It provides convenient and efficient evaluation of equipment's performance. This method gives scope for the analysing all the possible solutions. The important academic contribution of the study is to correspond the nature of equipment selection and its utilisation as an effective tool. In genetic algorithm the initial random value and local convergence result may vary, but in analytical hierarchy process both the values remain same. Unlike genetic algorithm programming, analytic hierarchy process is easy.

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