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*Review*

# Critical success factors for technology selection specifically ROBOTS

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**The immense competition in the global market has made it utterly difficult for businesses, especially manufacturers to improve and develop. To cope with this huge competition, manufacturers have no choice but to adopt new technology to develop and be competitors. Their goals and objectives can be satisfied by the application of Advance Manufacturing Technology (AMT). This paper assists managers of the industry in considering all the important criteria for various AMT selections, when purchasing new technology. In addition, it helps those, interested in buying robots, to adopt and apply the necessary criteria.**

**Key Words:** Advanced Manufacturing Technology(AMT); Robot selection; Technology.

## INTRODUCTION

Fierce competition in the global market has forced manufacturing companies to improve their quality and responsiveness in a cost-effective manner. The use of advanced manufacturing technologies (AMTs) offers great potential for improving manufacturing performance to reach these objectives (Sener, 2007). The process of technology selection and transfer is very complicated and requires skills and managerial know-how. The process is also highly delicate and costly and as a result there is a need to put much effort and time into the transfer phase of AMT introduction into an organization (Efstathiades, 2000). Thus, there is a need for the identification of the factors affecting the selection and also thorough understanding of the various issues required for the implementation of AMT (Choudhury, 2006).

Based on previous researches on manufacturing technology Figure 1 was developed, which comprises different areas of activity as explained below.

AMT can be classified into three phases: Pre-implementation, implementation and post implementation. Pre-implementation leads to AMT selection which is categorized into Hard and Soft AMT. The latter leads to integrated systems, branching into: Logistic related technology, Computer integrated manufacturing, and flexible manufacturing technology. Hard AMT has two parts: Intermediate which is Automated Inspecting, and Material handling, where as Stand Alone is divided into: Design and Engineering, and Machining – fabricating and assembly. All the above sub-divisions have their own abbreviations, as indicated in Figure 1. Of the above, the intermediate sub-divisions are: AITS; and ASRS/AMHS, while for stand alone, CAPP and CAD, for Design Engineering, and MWL, NC/CNC and Robot for Machining-fabricating and assembly. Robots are classified into: Small, Low pay load, medium pay load, High pay load and heavy duty, with a ramifying variety of robots 1… (n).

Industrial robots are increasingly used by many manufacturing companies. The number of robot

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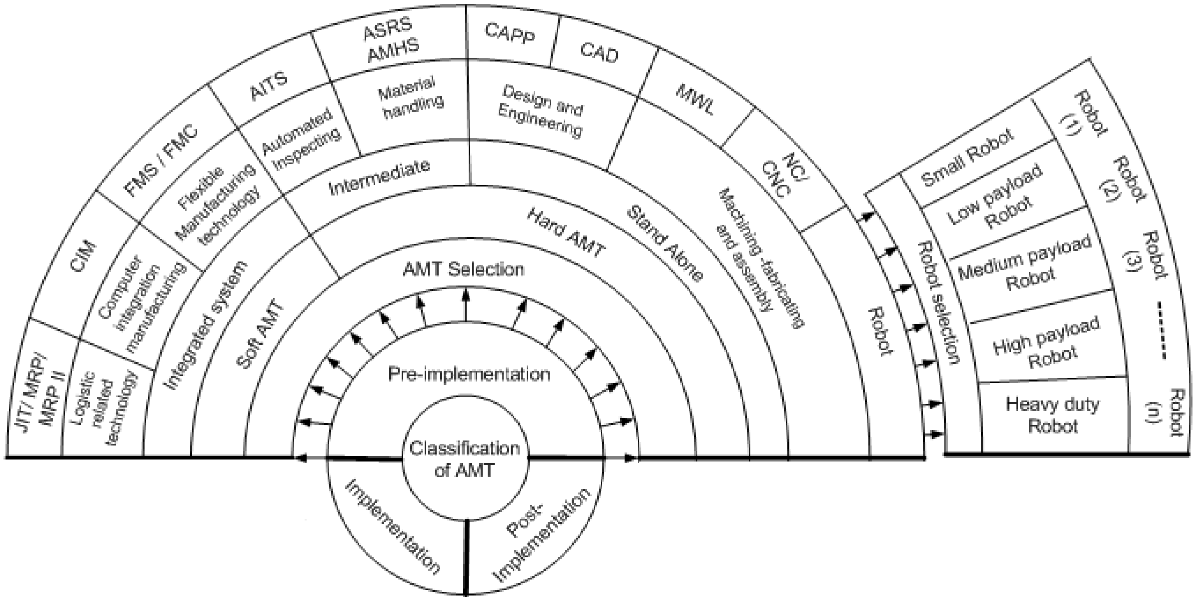


**Figure 1:** Classification of a different kind of AMT specific Robot

manufacturers has also increased, with many now offering a wide range of robots (Khouja and Booth, 1995). Robots are now used in many industrial applications, such as assembly, finishing, machine loading, material handling, spray painting, and welding (Khouja and Booth, 1995).

The word ROBOT was coined in 1920 by the Czech author K. Capek in his play Rossum's Universal Robots; it is derived from the Czech word robota, meaning "worker". An industrial robot is commonly defined as a reprogrammable multifunctional manipulator, designed to move materials, parts, tools, or other devices by means of variable programmed motions, and to perform a variety of other tasks. In a broader context, the term robot also includes manipulators that are activated directly by an operator (Raoa, 2006). As Robots are expensive, an investment in robot system and the selection process is an important function for many advanced manufacturing company. Improper selection of robots will adversely affect a company's competitiveness in terms of productivity of its facilities and quality of its products (Goh, 1997). Thus for the sake of improving efficiency and quality and at the same time for performing repetitive, difficult and hazardous tasks with total precision, many manufacturers use robots extensively (Parkan, 1999). Robots are fairly new in industries, and most manufacturers are using them without having thorough knowledge of their selection. It is not unusual for an industry to be a first time robot purchaser (Raoa, 2006) and the number of Robot user's inverses, ramifying in all the tasks. There are more than 90 robot manufacturers and some 200 different robot styles have been reported in U.S.A. (Wang, 1991). Robotic selection, being an important, as well as, ambiguous and crucial task in today's highly competitive environment, robot technology ranking tool is very important to the success of any company. The decision to select which robot is made more complex because robot performance is specified by as many parameters as there are robots as yet there is no industry-wide standards. Ranking robot technology, have varied strengths and weaknesses, requiring careful scrutinizing in their assessment. However it helps decision makers to select the ideal one among a vast source of evolving robot technologies (Farzipoor Saen, 2006). Although there exists a variety of models for choosing AMT, the focus of this paper is on robots selection.

## AMT selection criteria

Numerous issues are addressed by researchers in studies involving the selection and justifications of AMT. Different names are used but the concepts behind the terminology are the same. From the literature, 12 criteria are used for AMT selection by most researchers. From Table 1, it is clear that almost all researchers have unanimously applied the "Flexibility" criteria where as "Maintainability" was used by Choudhury et al. (2006). The rest of the factors are used by the other researchers randomly, which is "Strategic" by all except (Sener, et al. 2007; Mohanty, 1993 and Chan et al. 2006), financial and market positions by Sambasivarao et al., (1995); Mohanty and Deshmukh, (1998); Godwin et al., (1996); Richard et al. (1997); Amrik et al. (2001); Abdelkader and Dugdale (2001); Bruce and Roger (2003);

**Table 1:** Critical success factors for AMT selection

| | | Intangible factors (Subjective) | | | | | | | | | | Tangible factors (Objective) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Sambasivarao and Deshmukh | 1995 | x | x | x | x | x | x | x | x | x | | x | x |
| Mohanty and Deshmukh | 1998 | x | x | x | | x | x | | | | | | x |
| Mohanty | 1993 | x | | | | | | x | | | | x | x |
| Godwin et al. | 1996 | x | | | x | | | x | | | | x | x |
| Richard et al. | 1997 | x | | | x | | | x | | | | x | x |
| Amrik et al. | 2001 | x | | | x | | | x | | | | x | x |
| Abdelkader and Dugdale | 2001 | x | | | x | | | | | | | x | x |
| Bruce and Roger | 2003 | x | | | x | | | x | | | | x | x |
| Rosna et al. | 2005 | x | | | x | | | x | | | | | |
| Punniyamoorthy et. al. | 2003 | x | | | | x | | | | x | | | |
| Chan et. al. | 2006 | | | | | x | x | | | | | x | |
| Choudhury et. al. | 2006 | x | x | x | x | x | | x | x | | x | | |
| Sener et. al. | 2007 | | | | | x | | | | | | | x |

Keys:
1.Strategic 2. Financial position 3. Market position 4. Human resource 5. Flexibility 6. Quality 7. Social 8. Reliability 9. Capacity 10. Maintainability 11. Direct cost (Porches) 12. Indirect Cost (training,..)

Rosna et al. (2005) and Choudhury et al. (2006). Human resources by Sambasivarao et al., (1995) and Choudhury et al., (2006), subjectively Sambasivarao et al., (1995) applied all the factors along with objective factors except “Maintainability” which is used just by Choudhury et al. (2006) and Sener et al. (2007) is the least applicant of all using “Flexibility” and “Indirect cost”.

## Robot selection criteria

The objective of a robot selection procedure is to identify the robot selection attributes, and obtain the most appropriate combination of the attributes in conjunction with the real requirements. A robot selection attribute is defined as a factor that influences the selection of a robot for a given industrial application.

These attributes, which are objectively and subjectively considered, are presented in Table 2. The objective criteria are: Velocity, Load capacity, Repeatability, Purchases cost, and Manipulator reach, whereas the Subjective ones are: Reliability, programming Flexibility, and man – machine interface.

Table 3 illustrates ten studies, on tangible and intangible critical success factors for robot selection between years 1988 to 2008. The summary of the studies is as follows: A decision making algorithm, using utility theory for the selection and evaluation of robots, for electronics assembly, was developed by Nnaji et.al.(1988) choosing: velocity (m/s), load Capacity (kg), repeatability Error (mm) and reliability (R) as the critical success factors. A decision support system, applying fuzzy set method for robot selection was presented by Wang et. al. (1991). The system uses marginal value functions with objective factors: (load Capacity (kg), repeatability Error (mm) and purchase Cost ($)), and a subjective factor (programming Flexibility).

A two-phase robot selection model, involving data envelopment analysis application (DEA) in the first phase, and a multi attribute decision making model in the second phase was presented by Khouja (1995) with the objective criteria: Velocity (m/s), Load Capacity (kg), Repeatability Error (mm) and Purchase Cost ($). Another research by Khouja and Booth, (1995), use the same criteria with a computerized Fuzzy Clustering Procedure for selecting robots from twenty seven alternatives. Analytic Hierarchy Process (AHP) method was employed for robot selection: Velocity (m/s), Load Capacity (kg), Repeatability Error (mm) and Purchase Cost ($) as objective factors by Goh (1997). A decision making and performance measurement model with applications to robot selection was presented by Parkan (1999). Particular emphasis was placed on a performance measurement procedure called operational competitiveness rating (OCRA) and a multiple attribute decision making method, TOPSIS. The final selection was made on the basis of rankings obtained by averaging the results of OCRA, TOPSIS, and a utility model. For this purpose the criteria weightings factors of Velocity (m/s), Load Capacity (kg), Repeatability Error (mm) and Purchase Cost ($) were applied. Bhangale e.t al. (2004) listed a large number of robot selection attributes, and ranked the robots using TOPSIS and graphical methods, comparing the rankings given by these methods. However, the weights assigned by the authors to the attributes were not consistent. the criteria used are Velocity (m/s), load capacity (LC), Repeatability Error (RE), and Manipulator reach (mm). A decision making model, using FuzzyAHP theory for the selection and evaluation of Robots, was developed by Kapoor (2005)

**Table 2:** Explanation of Robot selection factors

| | Criteria | Criteria Explanation |
|---|---|---|
| **Objective** | Velocity | Which is the maximum speed a robot's arm can achieve.<br>How fast the robot can position the end of its arm. This may be defined in terms of the angular or linear speed of each axis or as a compound speed i.e. the speed of the end of the arm when all axes are moving.<br>This is measured in m/second or inch/second and indicates the quickness of response.<br>• Often enough a Robot is fuzzily described as being _fast' or _slow' on the shop floor. |
| | Load capacity | Which is the maximum weight a robot can lift?<br>This is measured in kg or lbs and is defined as the operating range (or limit) of the Robot payload capacity.<br>• Often enough a Robot is fuzzily described as being capable of handling _heavy' or _light' loads. |
| | Repeatability | Which is a robot's ability to repeatedly return to a fixed position? The mean deviation from that position is a measure of the robot's repeatability.<br>How well the robot will return to a programmed position. This is not the same as accuracy. It may be that when told to go to a certain X-Y-Z position that it gets only to within 1 mm of that position. This would be its accuracy which may be improved by calibration. But if that position is taught into controller memory and each time it is sent there it returns to within 0.1 mm of the taught position then the repeatability will be within 0.1 mm.<br>This is measured in ± mm or ± inch and is defined as the measure of the ability of a Robot to return to the point of reference (or command) repeatedly.<br>• It is common to hear of Robots having comparatively "higher" or "lower" degree of this measure. |
| | Purchase Cost | • The cost of a robot includes its purchase, installation, and training costs. |
| | Manipulator Reach | • An industrial robot is comprised of a robot manipulator, power supply, and controllers. The robot manipulator can be divided into two sections, each with a different function:<br>• Arm and Body - The arm and body of a robot are used to move and position parts or tools within a work envelope. They are formed from three joints connected by large links.<br>• Wrist - The wrist is used to orient the parts or tools at the work location. It consists of two or three compact joints. |
| **Subjective** | Reliability | • This is the probability that a robot will perform its specified mission according to stated conditions for a given time period. |
| | Programming Flexibility | • The setup or programming of motions and sequences for an industrial robot is typically taught by linking the robot controller to a laptop, desktop computer or (internal or Internet) network.<br>• Flexible programming software: The computer is installed with corresponding flexible interface software. The use of a computer greatly simplifies the flexible programming process. Specialized robot programming software is run either in the robot controller or in the computer or both depending on the system design.<br>• Programming flexibility refers to the robot's ability to accept different programming codes. |
| | Man-Machine interface | • User friendliness of the user interfaces to the new system determines the degree of the acceptance of operating staff to related Robot technology.<br>• How user friendly is the user interface of Robot technology? |

**Table 3:** Critical success factors for Robot selection

| | | Tangible factors (Objective) | | | | | Intangible factors (Subjective) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Nnaji et. al. | 1988 | x | x | x | | | x | | |
| Wang et. al. | 1991 | | x | x | x | | | x | |
| Khouja | 1995 | x | x | x | x | | | | |
| Khouja and Booth | 1995 | x | x | x | x | | | | |
| Goh | 1997 | x | x | x | x | | | | |
| Parkan et. al. | 1999 | x | x | x | x | | | | |
| Bhangale et. al. | 2004 | x | x | x | | x | | | |
| Kapoor | 2005 | x | x | x | x | | | | |
| Rao and Padmanabhan | 2006 | x | x | x | x | | | | x |
| Farzipoor Saen | 2006 | x | x | | x | | | | |
| Rao and Venkata | 2007 | | x | x | x | | | x | x |
| Anand et. al. | 2008 | | x | | x | | | | |

keys:
1. Velocity (m/s) =(V) 2. Load Capacity (kg) = (LC) 3. Repeatability Error (mm) = (RE) 4. Purchase Cost ($) =(PC) 5. Manipulator Reach (mm) =(M) 6. Reliability =(R) 7. Programming Flexibility = (PF) 8. Man-machine interface = (MI)

based on Velocity (m/s), Load Capacity (kg), Repeatability Error (mm) and Purches cost (PC).

A methodology based on digraph and matrix methods for evaluation of alternative industrial robots was proposed by Rao and Padmanabhan (2006), using Velocity (m/s), load capacity (LC), Repeatability Error (RE), and Purchase Cost ($) criteria factors. A robot selection index was proposed that evaluates and ranks robots for a given industrial application. The index was obtained from a robot selection attributes function which was in turn obtained from the robot selection attributes digraph. The digraph was developed based on robot selection attributes and their relative importance for the application considered. Technology ranking based on DEA method, and tested with numerical example was suggested by Farzipoor Saen (2006) using the objective criteria factors of Velocity (m/s), Load capacity (LC), and Purchase Cost ($) with alternative 27 Robots. A review, comparing objective criteria factors of Load capacity (LC), Repeatability Error (RE), and Purchase Cost ($) with subjective factors Programming Flexibility and Man-machine interface was conducted by Rao and Venkata (2007) to analyze a variety of methods. Fuzzy Analytic Hierarchy Process (FAHP) based on the objective criteria factors Load capacity (LC) and Purchase Cost ($) was developed by Anand et al. (2008) to select an ideal robot system.

## Robot selection method

Table 4 illustrates the different kinds of methods that can be applied for robot selection. Their advantages and disadvantages are also shown in the table.

The Analytic Hierarchy process (AHP) method for robot selection was employed by Goh (1997) to deal efficiently with objective and subjective factors. The advantages of the methods include qualitative and quantitative criteria can be included in the decision making and uncertainty of the future and multi-objectivity can be incorporated. The disadvantages are more complex to manipulate and requires data based on experience, knowledge, and judgment.

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method for robot selection which deals with objective factors and ignores subjective types was used by Parkan et al. (1999), Agrawal et al.(1991) and Bhangale et al. (2004). The advantages of the method used the ability of TOPSIS to identify the best alternative quickly, its mathematical simplicity, very large flexibility in the definition of the choice set. The disadvantages are capturing just the objective, and ignoring the subjective criteria.

Operational Competitiveness Rating Analysis (OCRA) method was used for robot selection by Parkan et al. (1999). The advantages of the method was it is a General computational method, applicable to both tangible and intangible data ,and well suited for the measurement and analysis of a company’s performance. The disadvantages are: (1) The premise of the OCRA method is that the cost/revenue ratios are known. In any practical cases, cost and revenue must be measured in dollar values in order to use the OCRA method. 2) When all costs and revenues are measured in dollar values, the results of rating methods are more likely to be misleading. On the other hand, robust statistical methods (such as ANOVA) are more commonly applied for performance analysis in such cases. 3) The assumption made by the OCRA

**Table 4:** classification of different kinds of methods use for Robot selection

| Author | Method | Advantage | Disadvantage |
|---|---|---|---|
| Goh (1997) | Anatitic Hierarchy Process (AHP) | • Uncertainty of the future and multi objectivity can be incorporated<br>• Subjective criteria can be introduced in the modeling phase<br>• Qualitative and quantitative criteria can be included in the decision making<br>• A large quantity of criteria can be considered | • Require more data<br>• Usually more complex<br>• Require data based on experience , knowledge and judgment<br>• Inconsistency on the method<br>• Require enumerations of all issues<br>• Require intense management involvement |
| Parkan et. al. (1999)<br>Agrawal et. al.(1991)<br>Bhangale et. al.(2004) | Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) | • A relative advantage of TOPSIS is the ability to identify the best alternative quickly<br>• The TOPSIS has two main advantages: its mathematical simplicity and very large flexibility in the definition of the choice set. | • Capture just objective criteria<br>• Ignoring subjective criteria |
| Parkan et. al. (1999) | Operational Competitiveness Rating Analysis (OCRA) | • Non parametric method<br>• General computational method is an outranking procedure.<br>• Reduces to simple ratio-type computation.<br>• Applicable to both tangible and intangble data<br>• Well suited for the measurement and analysis of the company's performance. | • The premise of the OCRA method is that the cost/revenue ratios are known. The problem with the OCRA method is that all the costs (inputs) and revenues (outputs) must be measured in a single measurement (dollar value) in order to use the OCRA method.<br>• The OCRA method assumes that the category with a higher cost will receive a higher weight, other things being equal the results from the OCRA method are often misleading |
| Parkan et. al. (1999)<br>Khouja, M. (1995)<br>Bragili and Petroni (1999)<br>Karsak and Ahiska (2005) | Data Envelopment Analysis (DEA) | • Uncertainty of the future and multi objectivity can be incorporated<br>• Subjective criteria can be introduced in the modeling phase<br>• DEA is a linear programming methodology that evaluates the efficiency of a number of units.<br>• The DEA is designed to measure relative efficiency in such situations where there are one or multiple inputs and one or multiple outputs. | • Input and output quantities<br>• Require more data<br>• more difficult to accommodate multiple outputs<br>• usually more complex than the economic analysis<br>• A disadvantage in terms of the method's rationale if the decision maker is unfamiliar with linear programming concepts.<br>• The problem of DEA is the confusion of "ratings" and "performance."<br>• DEA is nonparametric multiple criteria method; no production, cost, or profit fuction is estimated from the data. |

**Table 4.** CONT.

| | | | |
|---|---|---|---|
| Farzipoor Saen (2006) | | • | • |
| Parkan et. al. (1999)<br>Nnaji and Yannacopoulou (1988) | Multiple Attribute Utility Theory (MAUT) | • Quick, simple<br>• Flexible conditions for obtaining protection | • Require a priori selection of key individual characteristics and attributes and only involve a limited selection of individual specific variables |
| Rao and Padmanabhan (2006) | Diagraph & Matrix | • logical and systematical approach be useful for modeling and analyzing various kinds of systems and problems in numerous fields of science and technology<br>• The matrix approach is useful in analyzing the graph/digraph models expeditiously to derive the system function and index to meet the objectives. | • A disadvantage of this method is that the number of edges might grow considerably. |
| Wang et. al. (1991)<br>Liang and Wang (1993)<br>Khouja andBooth, (1995) | Fuzzy Logic | • Fuzzy logic is conceptually easy to understand<br>• Subjective and objective criteria can be included in the decision making<br>• Fuzzy logic is flexible.<br>• Fuzzy logic is tolerant of imprecise data.<br>• Fuzzy logic can model nonlinear functions of arbitrary complexity.<br>• Fuzzy logic can be built on top of the experience of experts.<br>• Fuzzy logic can be blended with conventional control techniques.<br>• Fuzzy logic is based on natural language.<br>• Very powerful tool for dealing quickly and efficiently with imprecision and nonlinearity. | • Fuzzy logic is a convenient way to map an input space to an output space. If you find it's not convenient, try something else.<br>• Require data based on experience , knowledge and judgment<br>• Require decide for fuzzy controller based on experiment or real data |
| Anand et. al. (2008) | Fuzzy Anatitic Hierarchy Process (FAHP) | • Captures both qualitative and quantitative criteria<br>• Subjective criteria can be introduced in the modeling phase<br>• Rank criteria according to the needs of the user<br>• The pair wise comparisons in the judgment matrix are fuzzy numbers that are modified by the designer's emphasis | • Require more data and enumerations of all issues<br>• High complex of the model<br>• Require management involvement<br>• Require data based on experience , knowledge and judgment |

**Table 4.** CONT.

| | | | |
|---|---|---|---|
| Kapoor (2005) | | • | • |
| Imang and Schlesinger (1989) | linear Goal Programming (GP) | • Allows multiple objectives<br>• Allows slack in the constraint<br>• Uncertainty of the future and multi objectivity can be incorporated<br>• Subjective criteria can be introduced in the modeling phase | • Just objectively set to the criteria requirement<br>• Complexity of the “overall objective”<br>• Often must elicit weights as well<br>• Must elicit goal values from Decision Maker<br>• Require more data<br>• Usually more complex |

method that “the category with a higher cost will receive a higher weight, or the category with the higher cost is more important than one with a lower cost,” is problematic.

Data Envelopment Analysis (DEA) method was evaluated for Robot selection by Parkan et al. (1999), Khouja, M. (1995), Bragili and Petroni (1999), Karsak and Ahiska (2005) and Farzipoor Saen (2006) defending their reasons for their choice, at the same time, accepting the fact that DEA requires more computation. Thus introducing large numbers of factors, and small number of alternative Robots, makes DEA a poor discriminator of poor and good performers. The most disadvantage factors in terms of method rationale are evident when the decision maker is not familiar with linear programming concepts.

Multiple Attribute Utility Theory (MAUT) was used by Parkan, et al. (1999) for Robot selection, Nnaji and Yannacopoulou (1988) also used the same method, developing a decision making algorithm, for the selection and evolution of Robots for the assembly of electronics products, mentioning advantages as: Quick, simple and flexible conditions for obtaining protection, and disadvantages as: Requiring a priority selection of key individual characteristics and attributes which only involve a limited selection of individual specific variables.

Digraph and Matrix methods for evaluation of alternative industrial Robots was proposed by Rao and Padmanabhan (2006), which evaluates and ranks Robots for a given industrial application. The index ranks Robots for a given industrial application. The index was obtained from a Robot selection attribute function which, in turn, is obtained from the Robot selection attribute digraph. The digraph was developed based on Robot selection attributes and their relative importance for the application considered. Advantages and disadvantages of this method is indicated to support his reasoning.

Advantages: 1) logical and systematical approach be useful for modeling and analyzing various kinds of systems and problems in numerous fields of science and technology, 2) The matrix approach is useful in analyzing the graph/digraph models expeditiously to derive the system function and index to meet the objectives. Disadvantages: A disadvantage of this method is that the number of edges might grow considerably.

Combining the concepts of Fuzzy set theory and hierarchical structure analysis, Liang and Wang (1993), proposed a Robot selection algorithm that was used to aggregate maker’s fuzzy assessment about Robot selection attributes weighing and obtain Fuzzy suitability indices. With the support of their advantages and disadvantages of the model, the suitability ratings for ideal Robots were ranked. Khouja and Booth, (1995), use a computerized Fuzzy Clustering Procedure for selecting Robots from twenty seven alternatives over four criteria viz., Cost, Load Capacity, Velocity and Repeatability.

Applying Fuzzy Analytic Hierarchy Process (FAHP), Anand et al. (2008) and Kapoor (2005) proposed a model for selecting the Robot system indicating the advantages as: 1) The possibility of the subjunctive criteria to be introduced in the modeling phase. 2) Modification of fuzzy numbers in the judgment matrix of the pair-wise comparisons by the designer’s emphasis. And the disadvantages: 1) High complexity of the model, requiring more data and enumerations of all issues. 2) Requiring data based on experience, knowledge, and judgment.

Linear goal-programming approach to identify the Robots selection was proposed by Imang and Schlesinger (1989), with the indication of its advantage, which is allowing multiple objectives, and disadvantage which is just objectively setting to the criteria requirement, and usually more complex, requiring more data.

## CONCLUSION

On account of the grave importance of AMT in contemporary industry, finding related criteria and methods are the almost necessity for a technology procurement manager.

In this paper various criteria has been investigated upon for AMT selection, having the importance of AMT in mind. These criteria has been classified into subjective comprising: Strategic, Financial position, Market position, Human Resource, Flexibility, Quality, Social, Reliability and Capacity; and Objective containing: Maintainability, Direct cost and Indirect cost. Out of the above classification, “Flexibility” enhanced the most number of users, while “Maintainability” had the least number of users. Some of the industries applied all the criteria, while some used only a few. Some research has been performed on methods and criteria for Robot selection; however it has not been enough to satisfy our needs. Thus it makes this paper outstanding and applicable for our purpose. As for Robot selection criteria has been grouped into tangible factors (Objective) containing: Velocity (m/s), Load Capacity (kg), Repeatability Error (mm), Purchase Cost ($) and Manipulator Reach (mm) and intangible factors (Subjective): Reliability, Programming Flexibility and Man-machine interface, out of which “ Load Capacity (kg)” has been used unanimously, but “Manipulator Reach (mm)” has been ignored except one user. Considering methods, the following are applied with the indication of advantages and disadvantages: AHP, TOPSIS, OCRA, DEA, Utility, Digraph and Matrix, Fuzzy, Fuzzy-AHP and Linear goal programming.

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