AN EASY USER INTERFACE FOR MATERIAL HANDLING EQUIPMENT SELECTION

Mudar Dayoub[1*], Saleh Zamzam[2]

[1]*Transportation Services Manager, Shipping department, Syrian railways, Syria*

[2]*Information Technology Engineer ,Syrian Virtual University ,Syria*

ABSTRACT

To select suitable Material handling equipment require a good experience and technical knowledge in the industrial field in all aspect. Engineers often rely on the check list or the few tools that assist them in the selection of appropriate, cost effective material handling equipment. This work reports the details the development a Graphical User interface for the selection of MHE and considers many practical factors in the determination of feasible MHE under typical conditions and handling environment. It includes two stages: (1) inference chain for creating knowledge-base to identify the most appropriate equipment for all combination of attributes; and (2) implementation of the knowledge-base by using EUSMHE tool which we developed in C# Language and NET framework..

Keywords: C#; Material Handling Equipment, NET Framework

I INTRODUCTION

Selection of proper material handling equipment (MHE) is a crucial step for facilities planning. However, due to the availability of wide range of material handling equipment, the determination of the best equipment alternative for a given production scenario is a difficult task. Fifty percent of the total production cost is usually incurred on materials handling. In some industries, like mining, this cost increases to Ninety percent of the operation cost [1-2]., when designers rely on their personal experience to select a proper MHE they usually tend to select the equipment which they are most familiar with. MHE selection Have been studies by several researchers, Malmborg [6] developed an expert system, considering 47 types of industrial trucks with 17 relevant equipment attributes.. Swaminathan et.al [7] developed EXCITE considering a total of 35 equipment types, with 28 materials move and attributes relevant to these equipments. The form of knowledge was presented as production rules, written in terms of attributes and the values were identified by the authors. Park [5] developed MHESA which contains a total of 61 possible choices and 36 attributes classified into four categories. Fonseca, et al [8] developed a knowledge-based system for selecting of conveyor. Bharitkar [9] represent a four-step approach to the problem, consisting of task infusion, filtering tasks and sharing them with resources, task collection, and selection of the system. The knowledgebase has been compiled from extensive review of literature given in Ref 6-12. In this work, a graphical user interface for selection of MHE has been designed by using C# Language and net framework [3], considering many practical factors for the determination of the most feasible MHE. The methodology has been developed with EUMHES Tool, and has extended the scope of work of Chan et.al [4] & Park [5] by adding more MHE and more relevant attributes into the knowledge-base and implemented by a new designed tool named UIMHES.

II THE DEVELOPMENT OF KNOWLEDGEBASE

In this work the knowledgebase includes knowledge to select the material handling equipment; this knowledge consists of the equipment facts and set of rules that have been compiled from the published literature. The advantage of this work is that it overcomes the limitations of other applications in the domain of materials handling equipment selection by considering more MHE with more relevant attributes.

2.1 Types of equipment

In this work a total of 78 types of material handling equipments have been identified from the survey of literature. Table 1 shows the type of equipments included in the knowledge base. These equipments were initially classified into two groups based on their functions: equipments used for the movement of the materials, and the others used for storage/retrieval systems. Move equipments consist of 25 types of conveyors, 6 types of cranes, 5 types of manual industrial trucks, 15 types of powered industrial trucks, 6 types of AGVs, 4 types of industrial robots, and 2 types of manipulators. Equipments used for storage and retrieval consist of 2 block-stacking types, mezzanines, shelf storage system, 9 types of rack systems, 3 types of automated storage and retrieval system.

2.2 Equipment's attributes

In this work a total of 55 relevant attributes pertaining to the different types of equipments have been identified, and included in the knowledgebase to select an appropriate type of material handling equipment. Table 1 shows the equipment attributes included in the knowledgebase and their values. These attributes were selected from available resources, and they are classified into five groups: a) the move attribute, b) the characteristic of the material to be handled, c) the operation requirement, d) the area constraint on available space, and e) technical attributes and other consideration. For the problem here, this approach would have meant thousands of combinations, as there are 55 attributes, each having two or more values. A large number of these combinations are unrealistic or impractical.

Table 1 Equipment's attributes and their options' values

Move attributes	**Move attributes options**	**Operation attributes**	**Operation attribute options**
Move path	Fixed, Variable.	Function	Move, Storage/Retrieval
Move distance	Vshort to short (20m-), Med -long (20m+).	Accuracy position	High, Low to Medium.
AGV lifting height	Low, High.	Automation	Required, Not required

Move level	In floor, On floor, Overhead.	Robot Work cell up time	Low to Medium, High.
Load accumulation	Accumulate, No accumulate.	Load handled	Uniform, Mixed
Move direction	Vertical upward, Vertical downward, Horizontal Incline, Vertical combination.	Loading\Unloading type	Pick and place, machine loading\unloading.
Truck move distance	Short (less or equal 90m), Long (90m+)	Method of transportation	Tow, Carry.
Truck loading direction	Front loaded, Side loaded.	AGV Loading Unloading operation	Manual, Automatic.
Truck lift speed	Low(up to 0.15m/sec), Med(0.15-0.25m/sec)High(0.25m/s+)	AGV deck design	Roller, Stationary, Lift.
Crane lift height	Low (less or equal 22.5m), High (22.5m+).	Truck stack ability	Stack, No stack.
Crane maximum span speed	Low (less or equal 6m), Long (6m+).	Manual truck handles availability	With handles, without handles.
Crane bridge Speed	Low (less or equal 76.2mpm), High (76.2mpm+)	Control operation	Controllable, Uncontrollable.
Material attributes	**Material attributes options**	Access approach	Man to part, Part to man.
Material frequency	Continuous, Intermittent	Storage/Retrieval order	LIFO, FIFO.
Material volume	Low, Medium, High.	Rider	Standup, Sit-down.
Material weight	Low (less than 1000kg), Med (1000-4500kg), High(4500kg+).	**Area attributes**	**Area attributes options**
Robot load capacity	Light (less than 36kg), Medium (36-110kg), High (110kg+).	Floor space	Available, Not available.
Truck pallet handles ability	Pallet load, Non-load Pallet.	Truss height	Low (less or equal 4m), High (4m+).
Manual truckload capacity	Light (less or equal 450kg), heavy (450kg+).	Robot work envelope	Small, Large.
Powered truck load capacity	Light (less or equal 2700kg), Heavy (2700kg+).	Aisle width	Conventional aisle, Narrow aisle, Very narrow.
Truck outrigger width	Less than load width, Equal load width.	Service area	Indoor, Outdoor.
Conveyor material type	Liquid/Gas, Unit, bulk.	Storage area	Floor, Rack.
Material nature	Fragile, Sturdy	**Technical and other consideration**	**Technical and other attributes options**
Bottom surface	Flat, No flat	Manipulator throughput	Low, Medium, High.
Conveyor material weight	Light (less or equal 100kg), Heavy (100kg+).	Robot flexibility	Low, Medium, High.
Bulk type	Granular, Lumpy	Maintenance	Low, Med to High.
Material type for powered truck	Bar stock, Pallet unit load, individual unit.	Storage throughput	Low, Medium, High
Crane load capacity	Light (up to 10 tons), Med (10-50 tons), Heavy (50 tons+).	Probability of damage	Low, Medium, High.
Storage material type	Small goods, Pallet unit loads, Bulk, Bar stock.		
Storage density	Low, Med, High.		

2.3Inference chain

To create knowledge base one has to identify the most appropriate equipment types for all combination of attributes. This approach has thousands of combinations because there are 55 attributes each having 2 to 4 values. Storing the large number of these combinations in the knowledge base is not only unrealistic, impractical and inefficient; but extremely cumbersome too. A suitable equipment is selected by following sequence of steps with the inference of the attribute at each step being used to guide the search. The decision in this system involves a directed line of reasoning that uses the attributes information to progressively reduce the search space for equipment alternatives. Several problems appeared in the development of the inference chains, they included:

- Determining the attributes that should be considered.
- Determining the equipment options suitable for a set of attributes.
- Determining the sequence in which these attributes should be considered.

The approach used for the development of inference chain is discussed below:

1) Not all attributes are relevant for all equipment categories under consideration. .

2) Even for a particular equipment category such as conveyor, not all attributes may be required to recommend a particular equipment type. A single attribute may sometimes specify the required equipment type without the consideration of any other attributes.

3) A value or set of values can identify the appropriate equipment

4) To narrow the search space and quickly arrive at the solution, the ordering of attributes to be searched were done in a unique way.

6) As each equipment can handle material quantity according to its capability, it is important to determine the material weight range that it can handle

7) Lines of reasoning were identified to determine the sequence in which attributes should be considered for the number of equipment options to be reduced at each stage

8) Only the set of attributes important for the selection of each equipment category or type were included in its search path.

9) The attributes in the inference chain are always pertinent to the equipment category being considered by the system

10) In some cases, consideration of an attribute can be avoided if the attribute is irrelevant for the particular equipment category, or if the recommended equipment type is applicable regardless of the value of the attribute

2.4 An example of an Inference chain

Fig. 1 shows part of the inference chain used in this work as it proceeds to select the type of equipment. A user for example, interested in selecting a MHE for movement of material, will first enter move. As there would be several options eg, all powered and gravity conveyors, manual and powered trucks, AGVs, cranes, industrial robots, and manipulators, the system would trigger a series of windows which the user will interactively answer.

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The questions are related to volume, weight, floor space available, nature of the material to be handled, direction of movement, operation control etc. As the user selects a suitable option for his facility condition in each of the windows, the system helps and guides him to cruise a set path and ultimately reach the final result.

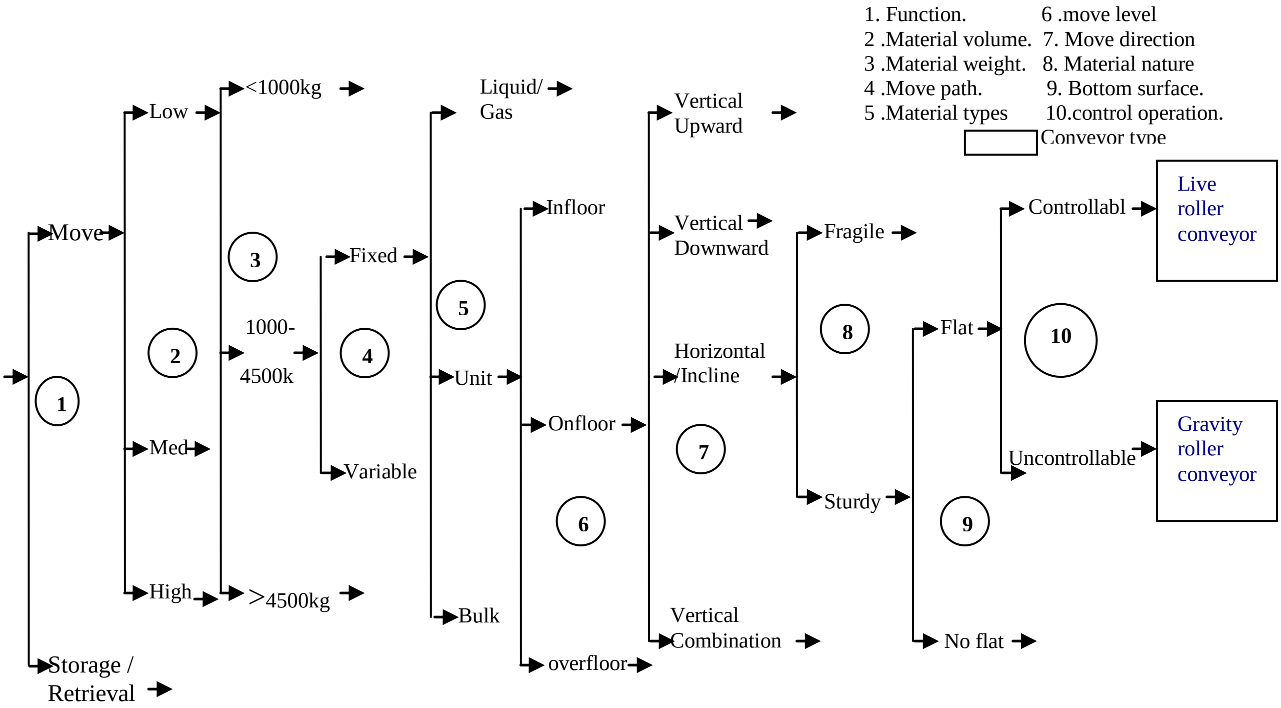

Figure 1. Example of inference chain

III IMPLEMENTATION

As already mentioned knowledgebase was created through C# and NET framework [13] ,This required the development of production rules using the UIMHES tool. Each rule has a basic form of IF<condition> THEN<conclusion> type, .ELSE <condition> THEN <conclusion> type

The knowledge base compiled in this work has 240 rules and considered 78 equipment types and 55 relevant attributes. Inference chain in rule-based system is achieved by using backward chaining. When the user operates EIMHES (User interface for Material Handling Selection), he/she selects the relevant file from a screen menu as shown in Fig. 2, then by selecting New Entry, a new widow will appear asking the user to choose an option suitable for his facility conditions as shown in Fig 3, by clicking NEXT icon a new widow will appear and similarly will ask the user for his desire. By further search when the user is approaching to his desired equipment, by choosing the options that are relevant to his factory condition, a screen appears and tells the user his appropriate equipment for his applied condition. This is shown in Fig. 4.

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Figure 2. EUMHES screen

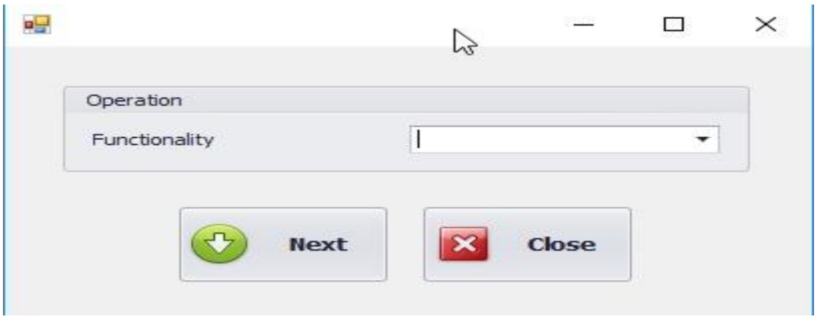

Figure 3. The window under consultation

Figure 4. A screen with desired result.

IV CONCLUSION

In this work an attempt has been made to simplify the selection of MHE. This was accomplished through a comprehensive review of available literature on both move and storage types of material handling equipments used in a manufacturing facility and compilation of the knowledge and recommendation in this source in the form of facts, relationships and rules. A total of 78 MHE with 55 relevant attributes were considered and included in the knowledgebase. This work has the capability and the potential to become a useful design tool for facilities designers in industry. Also the system can be tailored as per the requirements of the specific industry by eliminating: (a) Equipment not of their interest, and (b) Modifying and adding attributes according to the wide view of the system users. Further research can be carried out by adding more material handling equipment to the database to ensure correct solution of material handling equipment. The economic advantage between two competing alternatives also needs to be studied.

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