

# “Bus Driver Scheduling Problem in Public Transportation System”

KUVADIYA UMESH C.<sup>1</sup> DR. P. J. GUNDALIYA<sup>2</sup>

<sup>1</sup>Final Year Student M.E. Transportation Engineering<sup>2</sup>Associate Professor Department of Civil Engineering

<sup>1</sup>L.D. College of Engineering, Ahmedabad, Gujarat, India <sup>2</sup>L.E. Engineering College, Morbi, Gujarat, India

*Abstract*---In planning an active and proficient public transportation system, essentially every transit system in the world must optimize their available resources such that costs are minimized and numerous other criteria are met. This research study involves of bus driver scheduling problem in public transportation system. Primary jobs in planning for transit systems include route design, vehicle scheduling, and driver scheduling. Apart from minimization of costs, the criteria involved in conducting these tasks may include operational time, the number of vehicles and drivers required, and a variety of driver satisfaction aspects, including union rules. As such, the tasks become multi-objective processes. This research work consist formation of scheduling problem. Also graphical representation of scheduling for identify real condition problem. This study give a solution for bus driver scheduling with description in varies steps. This study gives better methodology for bus driver scheduling problem in form of mathematical formulation and software programing.

**Keywords**:- Public Transportation system, bus driver scheduling problem, route design, vehicle scheduling, operational time, driver satisfaction aspects, software programing.

## I. INTRODUCTION

The bus driver scheduling has received much attention in the last decade. The scheduling problem of bus driver consists in finding a set of trips which covers the bus schedule so as to utilize the an power resources effectively and satisfy a set of constraints laid down by the company labour regulations. It can be also stated as finding the minimum cost set of feasible daily duties that cover all trips or vehicle blocks. A vehicle block is the itinerary of a vehicle between its departure from the garage and its returns to the garage. Any vehicle block can be split into pieces of work, such that a split occurs only at a relief point, i.e. a time and a place at which change of drivers is possible. A driver's duty is a set of pieces of work that can be assigned to a driver (Helena Ramalhinho Lourenço, Jose Pinto Paixao & Rita Portugal 2002). Therefore we can say these problems have multiple conflicting objectives and constrain.

It is difficult to decide optimal solution for such problems with the help of predictable approaches. Several formulations and algorithms has been proposed for the crew-scheduling problem. We consider an approach based on the set covering formulation of the problem. One of the advantages of this formulation and algorithms is that it is independent of labour contract and specific company rules. Therefore the generation of all feasible driver duty segments is separated from the selection of the minimal cost or best quality driver duties.

Developers of transit scheduling software have options when it comes to choosing how to perform the scheduling tasks. Many choose to schedule vehicles and drivers simultaneously, building blocks which satisfy the rules for shifts. Some algorithms have been designed to build shifts directly from units of bus work. This task is generally accomplished by first creating an efficient bus schedule, forming a driver schedule to cover all the bus work, and then re-writing the vehicle schedule so that the vehicles follow any restrictions caused by the drivers.

## II. OBJECTIVES OF STUDY

The main objective of this research is to study the problem of bus driver scheduling and identify the problem in form of graphical representation.

- To study of bus driver scheduling methodology.
- To identify problem of bus driver scheduling.
- To give graphical representation of bus driver scheduling problem.
- To developed software base programing code.
- To increase the efficiency of overall transportation system.

## III. LITERATURE REVIEW

The driver and vehicle scheduling processes involve four steps, containing (1) trip structure, (2) blocking, (3) run cutting, and (4) rostering. Trip structure involves determining time tables for scheduling vehicles to arrive at specified locations at specified times, in order to come up with a master schedule. Once the coverage area is known, blocking is performed to create assignments describing the daily activity for a single vehicle. Next, run cutting assigns drivers to vehicles, determining the number of drivers that the transit agency will need in order to operate in compliance with the master schedule. The final step, rostering, involves grouping daily operator runs into a weekly run package and finding individual drivers to fulfil each role (Florida DOT, 2005).

Mingming Chena & Huimin Niua (2012) This research paper based on study of bus driver scheduling problem of urban bus crew. They are assuming (1)The type of urban bus line is a ring one,(2) The departure and arrival time of all trips are determined,(3) The number of crew is large enough to meet the demand for bus trips.(4) The type of duty is a single mode. Based on this assumption they give the an optimization formulation. “Tabu search algorithm” is proposed to solve the model. This optimization model base on the minimizing the total idle time for the crew. How to optimize the model with minimum number of crew required and minimum cost and consider the duty factor of crew, are future scope of study.

Valouxis, & Efthymios Housos ( June, 2000) In this paper optimize model for the solution of the combined bus and driver scheduling problem is presented for Greece public transport. This paper presents a quick heuristic scheduling procedure for the solution of the problem. In addition, a column generation procedure named CGQS that uses an LP-solver and the QS process as its integer solution finder is presented. CGQS starts from the solution point of a single QS run and then performs several iterations in which LP problems are solved and new promising shifts are created using the LP dual solution.

Jingpeng Li & Raymond S.K. Kwan(2003) This paper is presents a hybrid genetic algorithm based on the fuzzy set theory for the public transport bus driver scheduling problem. The basic objectives are to minimize the total number of shift & total shift cost. A greedy heuristic(GA) is used, which constructs a schedule by sequentially selecting shifts, from a very large set of pre-generated legal potential shifts, to cover the remaining work. Individual shifts and the schedule as a whole have to be evaluated in the process. Fuzzy set theory is applied on such evaluations.

Asvin Goel and Leendert Kok (November 24, 2009) This paper studies truck driver scheduling problems considering the European Union regulations for team drivers. In this paper “A depth-first-breadth-second search algorithm” is presented. They furthermore show, that the general case in which standard driving time limits may be exceeded, can be solved without increasing the complexity.

Maikol M. Rodrigues , Cid C. de Souza & Arnaldo V. Moura . (2006) are describes a computational tool developed for solve the urban transportation problem in the large metropolitan area of Sao Paulo, Brazil. In this research paper they are use hybrid strategy mathematical programming models and heuristics were combined.

#### IV. METHODOLOGY OF STUDY

For developing objective function and to generate algorithm of bus driver scheduling, the first step is to identify the problem of bus driver scheduling.

A. *Operation Planning Process For Scheduling Used By A.M.T.S.* Transit planning process into four steps: (1) Timetabling, (2) Vehicle Scheduling, (3) Crew Scheduling (4) Duty Rostering, and focused its attentions on the bus driver scheduling problem. The procedure used by Public transportation systems which involve timetables, vehicle schedules, driver duties, and duty rosters for individual driver’s shows in following flowchart:

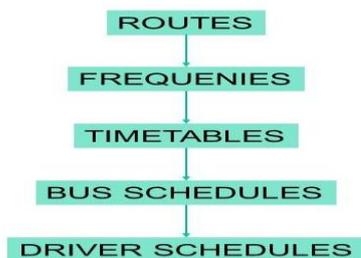


Fig. 1: Flowchart of operation planning process for scheduling

Above flow chart shows the planning process of bus driver scheduling used in public transportation system,

in which the first step is to arrange the route. The further study of the time table of bus driver scheduling used by public transportation system it accomplishes that there are two types of route arrangements:

- Fixed Bus Route in which Bus movement between two Depots
- Initial Trips for Fixed Route between two Depots are completed as that number of trips which was planned, then it changes the movement of Bus which covers more than two Depot Stations.

The next step is to fixed frequencies of bus for each route, which is based on the travel demand of that route. After fixing the frequencies, time table is prepared for the bus trip which is based on the time demand of traveling. In the last step, bus driver schedule is prepared based on the Bus Time Table.

#### V. PROBLEM DEFINITION IN GRAPHICAL FORM

The bus driver scheduling problem of urban bus crew in this study is to arrange the work plan for the bus crew in a bus routes. The work plan for each crew includes a set of trips which cover the break duration, layover time and travel time for peak and off peak hour trip. After study the time table of existing bus driver scheduling used by Public Transportation System .it conclude that there two types of rout arrangement (1) Fixed Bus Route in which Bus movement between two Depots, (2) Initial Trips for Fixed Route between two Depots are completed as that number of trips which was planned, then it changes the movement of Bus which covers more than two Depot Stations.

Based on this type of route planning there is two different problems explained in following Figure 2 and Figure 3.

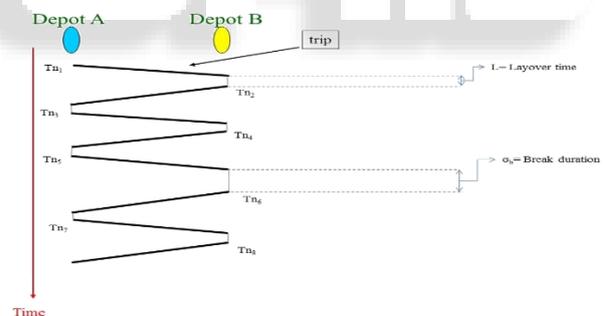


Fig. 2: Graphical representation of Bus Driver Scheduling Problem for Fixed Route Network.

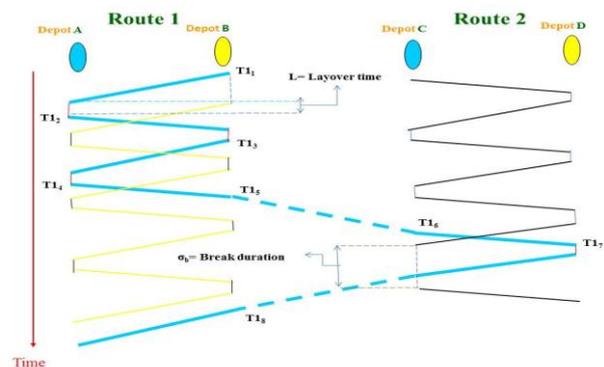


Fig. 3: Graphical representation of Bus Driver Scheduling Problem for Flexible Route Network

## VI. FLOW CHART FOR DEVELOPING PROGRAM CODE OF BUS DRIVER SCHEDULING

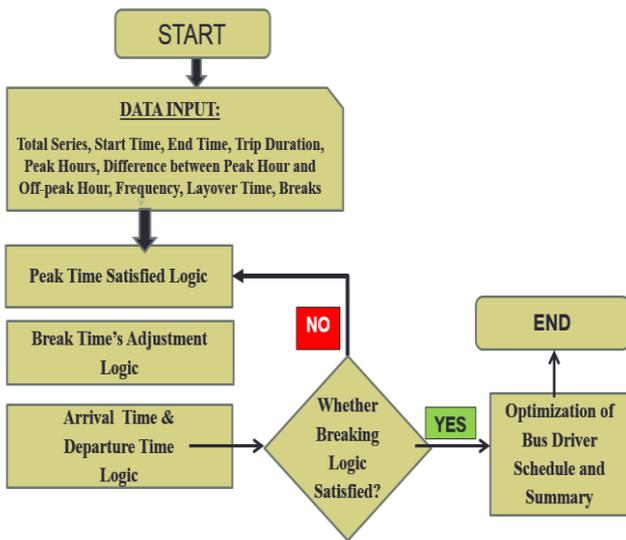


Fig. 4: Flow Chart for Developing Program Code of Bus Driver Scheduling

## VII. ALGORITHM

The initial solution is the starting point of the algorithmic search. In the process of generating solution, this research study considered the peak hour factor, break time, working hours of drivers, trip duration etc.

The procedure of the algorithm as follows:

### A. STEP 1: Initialization, The Trip Set Carried Out By Trip Time Function..

$N$  = Total number of bus,  $n_i$  = Bus Number,  
 Trip Time Function  $T_{n_i}$  = Given Start Time ( $T_{start}$ )  
 (for  $n=1$ )  
 = Given Start Time ( $T_{start}$ ) +  $(n-1) * \text{Given Frequency}$  (for  $n>1$ )

Trip Duration ( $T_{n_i}$ ) is the function of Bus Number and represents Duration of particular trip.

### B. STEP-2: Calculate The Current Trip And Verify The Trip Time, Break Period, Peak Hour & Trip Duration:

- Step-2.1: If Current Trip within Peak Hours.  
 Then Trip Duration ( $T_{n_i}$ ) = Given Trip Duration +  $\sigma_p$ . Here  $\sigma_p$  additional factor for peak hour trip duration.
- Step-2.2: If Current Trips falls within Break Time and Particular Crew did not have Break then:  
 $Trip\ Time\ (T_{n_i}) = T_{n_i} + \sigma_b$ .
- Step-2.3: If this Trip is 1<sup>st</sup> Trip of  $N$  from given Start Time then:  
 $Trip\ Time\ (T_{n_i}) = Trip\ Time\ (N) + 2 * \text{Given Layover}\ (L)$
- Step-2.4: Go to Sub Step-1 until End Trip is reached.

### C. STEP-3: If All Constraint Are Verified, Then Output The Results; Otherwise Go To Step 2. This Process Is Running From Start Time To End Time Of Bus Route.:

## VIII. DEVELOPMENT OF CODE IN VISUAL BASIC

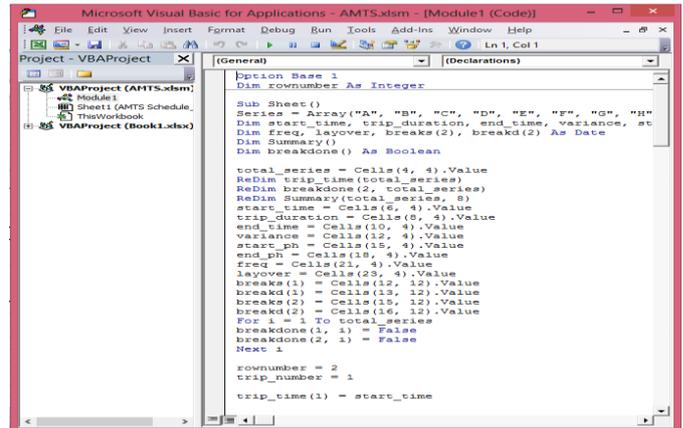


Fig. 5: Development of Code in Visual Basic

Figure 5 shows the preparation process of programming code. This figure shows window of Visual Basic for Applications.

## IX. INPUT DATA SHEET

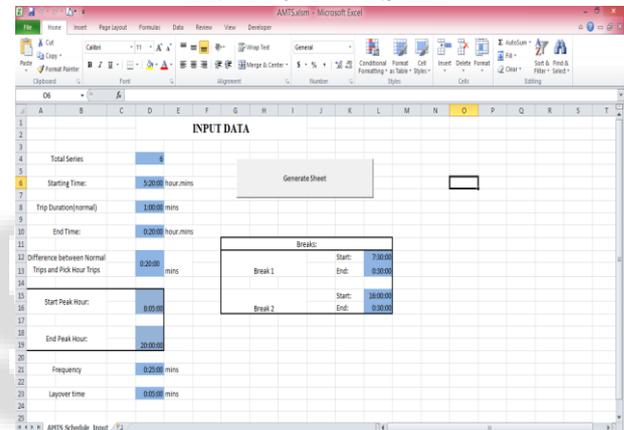


Fig. 6: Input Data Sheet in MS-Excel Form for Analysis of Bus Driver Scheduling Problem.

This figure shows window of Excel sheet. This sheet Display the input data Windows for analysis of bus driver scheduling problem.

## X. CONCLUSIONS

This research consist the study of methodology for bus driver scheduling in public transportation system. Identify the problem from study of method used for bus driver scheduling. Identified problem represented in graphical format for developing algorithm and objective function. Also in this study software base programme is generated for bus driver scheduling. Based on these results of proposed Bus Driver Scheduling method following conclusions drawn out:

- The model developed in this study is a useful tool for effective public transit management and an efficient assistant decision support system.
- It shows that software base solution is the best for planning of bus driver scheduling.

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