CHAPTER 8

RESULTS AND CONCLUSIONS

8.1 FINDINGS

Road projects are unique and need to be scheduled with a different approach due to the method of execution and nature of activities. From the above study involving probable production rates of linear activities, the following conclusions are drawn;

i. The parameters controlling critical segments of linear activities in road projects provide the basic information about the behaviour of critical paths in road projects based on various activity relationships. They are also instrumental in identifying the nature of critical segments based on the production rates of activities. From Figure 5.3 and Table 5.4, it is seen that activity bituminous concrete is totally critical between km 101 and km 106 of KTRP for 50 days satisfying equation 4.2. All other ending, start or intermediate linear activities in the LSM comply with the equation relevant to its status. However, when the number of sections and subsections are increased as in large highway projects, interpretation of information and monitoring progress becomes more complex.

ii. A simulation model developed based on the probability distribution helps us to understand the activity durations in a
road project and provides us with a range of probable production rates of linear activities. For instance, the production rates obtained for clearing and grubbing from the model indicates a value of 1.3 days/km to 26.90 days/km. The wide range in production rates shows indefinite delays that occur due to certain factors such as land acquisition, shifting of utilities etc. Likewise the production rates of all the activities from the simulation model exhibit wide variations in production as the probability distribution is based on durations of activities in various types of road projects with no clarity with respect to dimensions, crews and reasons for delay.

In short, simulation model can be used for determining probable production rates only if probability distributions are specific to the type of project in hand.

iii. The Delphi process has led to the benchmarking of the optimistic, most likely and the pessimistic time estimates of linear activities for five major factors influencing project durations based on predictable delays. The simulation results for maximum durations indicate a value of 26.90 days/km for clearing and grubbing whereas Delphi survey indicates a maximum of only 3.00 days/km. Similar comparisons indicate a large difference between the values which is due to the fact that the simulation model caters to all types of factors and a wide range of road projects whereas the Delphi process deals with predictable factors and fixed crew size indicating that specific study is required for the type of project in hand. The results from the Delphi process have been compared with the
productivity guidelines as per standard databook and also the actual production at sites. Although the schedules reflect a slower production when considered section wise, the actual overall production considering the entire project falls within the estimates of the Delphi analysis.

iv. A generalised method of scheduling road projects and estimating durations with the production based LSM has been suggested with a flow chart. The ideal time for completing a continuous stretch of a two-lane carriageway for 5km considering 7 activities for pavement formation with a given set of inputs should take 53 days. If the same project is affected by all factors, it should take 75 days. It is to note here that apart from the probable production rates in activities, the buffer distances play a key role in arriving at these durations. In other words if the buffer distance and the buffer time interval between activities are increased, then the project durations may increase irrespective of high production rates and relatively small time overruns. This has been shown with the sensitivity analysis in Table 7.25.

v. For large highway projects consisting of various developments such as new carriageways, bypasses, service roads etc., the PBSM considering total volume of work against time of activities in the project shall be a practical approach to constructors. Durations of projects can be estimated provided work breaks and progress phases are planned and scheduled adopting probable production rates. This has been illustrated with the production and progress analysis of the KTRP which has taken about 733 calendar
days for completion of all the activities. The model also helps constructors in deciding overtime working hours for ensuring targeted production as planned between two calendar dates. The duration of the project needs to be attributed to the quantity of work involved with little relevance to the length of the project. Therefore based on this study, the model incorporating production rates through Delphi provides for a flexible and improved method of scheduling in road projects based on productivity, site practices and conditions, crews and work quantities.

Distance-time linear scheduling becomes complex for large highway projects as works are carried out in parallel at the same time in various locations. Therefore, production based scheduling based on quantity of work is recommended for such large projects due to its versatility in handling varying production and work breaks. However the use of LSM for different stretches separately can only provide additional information which can help in the effective utilisation of resources and enhance overall production.

From the three time estimates of durations obtained in this work, the project completion can be forecasted for various combinations of factors as done for the hypothetical cases considered. Scheduling road projects considering probable durations due to a particular factor or a combination of factors shall be the best approach. The significance of buffer distance intervals has been discussed by sensitivity analysis which shows that apart from concentrating on the production rates of activities the constructor should also plan based on the buffer distances and time intervals between activities for arriving at a more efficient schedule. This approach not only provides alternative schedules but paves a way for working out costs based on occurrence of various types of risks and time durations.
8.2 LIMITATIONS OF THE STUDY

The production rate approach of scheduling linear construction incorporating time estimate factors provides a basic platform in predicting road project durations. The study deals with a continuous stretch of dual carriageway construction for given dimensions under normal weather and topographic conditions.

The study has been limited to project durations only and does not consider financial factors of production.

8.3 SCOPE FOR FURTHER STUDY

Apart from the study in normal topography and weather conditions, road construction projects are taken up in various locations and scenarios. Therefore, the work may be extended for various categories of road construction with production rates defined for specific types of projects. Also, further study on the effect of variation in production on cost for each category of work shall be useful in balancing work progress with economic aspects of construction in road projects.