Resource Levelling for a Construction Project

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Abstract: Resources are required to carry out specific tasks in a project, but the availability of resources within a given firm is always limited. While preparing the schedule structure, the Project Manager might schedule certain tasks in parallel. In such cases it might be possible that the same resource is being used in both the parallel tasks, while its availability is limited. This paper emphasises how the Project Manager could resolve such conflicts by using Resource levelling in modern softwares such as Microsoft Project and Oracle Primavera. Resource levelling as defined by PMBOK is a “technique in which start and finish dates are adjusted based on resource constraints with the goal of balancing demand for resources with the available supply.” It basically refers to solving over-allocation of resources for the given project. A resource is over allocated when scheduled to perform more work than possible within the resource’s schedule. Resource levelling may be simple in which the given tasks are delayed until the given resources are available or they can be complex where the given resource might be deployed on multiple projects throughout the company, thus requiring levelling to be done at the company level instead of the individual project. If levelling is done on tasks which are not present on the critical path, the given project will not be delayed, but if the given tasks are critical then the project would be delayed. Hence, Resource levelling is a complex issue which needs to be resolved in order to avoid delays in the project. This paper uses a case study in order to portray how resource levelling could be done using Microsoft Project and what its effects are on the duration of the entire project.

Key Words: Resource, Levelling, Schedule, Over-allocation, Critical

I. Introduction

1.1 Resource Levelling

The network technique focuses on time element and assumes that unlimited resources are available for assigning to the activities to satisfy the time schedule. But when resources are limited, the ‘critical path’ and ‘slack’ lose their significance. Activity may be delayed due to non-availability of resources as well as due to change in the sequence of tasks. The process of distribution of available resources to meet the objectives of various activities constituting a project is called ‘Resource Allocation’ or ‘Resource Loading’. This is done in a way so that the project completion schedule is least affected. The act of taking a project with people assigned to a bunch of tasks and making it so that they don’t have to work overtime is called Resource Levelling.

Step 1: Allocate resources serially in time. That is, start with the first time-period (e.g. 1st day, 1st week etc.) and schedule all activities possible with the available resources. Then move on to the next time-period and repeat the same.

Step 2: When several activities are assigned for the same resources, give preference to the activities with least slack.

Step 3: Reschedule non-critical activities if possible so as to free resources for the critical activities.

In this process, originally non-critical activities may become critical and the completion time of the project may be stretched. Critical path, i.e. a path comprising of activities with zero slack may not remain ‘critical’ in strict sense of the term. After completing resource leveling, resource smoothing may be carried out for further optimization of the problem. Resource smoothing does not change the duration of the project; it only works on the non critical activities.

1.2 Types of Resource leveling

1.2.1 Delaying the task

If a resource is not available for a given task, the given task would be delayed. The software would first perform the activity which is given higher priority in the software. By default the softwares give the same priority to all tasks. The priority for all the tasks may be assigned at the time of preparation of the schedule structure. To control which tasks take precedence over other tasks, user can set project priorities, so that if the user is working with a common pool of resources among multiple projects, the right projects and tasks take precedence.
1.2.2 Splitting
Certain types of work may be interrupted in between execution, instead of listing these tasks as two separate activities; the given task may be split in two or more segments. But it is a well-known fact that when resources have to switch tasks or projects mid-stream, they lose time as they have to re-orient themselves to the work.

1.2.3 Overtime
The given resources may have to work overtime in order to complete the given work. They are paid more wages than that for the standard work hours which is specified by Work Overtime factor. This can level the resources only up to a certain extent and not beyond that.

1.2.4 Levelling
This may be done in two ways, that is automatic levelling or manual levelling. Manual Leveling is always preferred over automatic leveling as it gives much more control in decision making. Automatic leveling gives no control to the user and the software levels all the resources. The only really useful method is the manual resource levelling. It is just impossible for an application to take into account all the possible conditions and restrictions from the real world projects in order to produce good results through an automatic levelling. Just in case the levelling is done automatically, the project manager needs to review the schedule in detail to ensure the automatic schedule makes sense.

1.3 Process of Resource Leveling:
i. Develop Work Breakdown Structure (WBS) to establish work elements constituting the project.
ii. Determine inter-dependency among various work elements or activities/tasks and accordingly define logical sequence of the activities.
iii. Quantify each work element in terms of time/other resources requirements.
iv. Find out constraints, if any, external (e.g. government policies, law and order problem, inadequacies of infrastructure, etc.) and internal (e.g. poor choice of site, inadequacies in agreement with collaborators/consultants, technical incompetence, etc.).
v. Review the work elements, their inter-dependencies and quantification, in the light of the identified constraints.
vi. Develop a flow path of activities, satisfying the logic of interdependency of activities and constraints. Develop a time schedule of activities satisfying the logic of the flow path and time duration of the activities.
vii. Check for any resource over-allocation either in the Resource Graph (Fig 2 to 9) or the Resource Sheet. (Fig 1) Any Over-allocations are indicated in red by the given software.
viii. Level all the given resources to develop a revised schedule by using the leveling tool. The over-allocations indicated in red will no longer be seen on the software once this is done (Fig 10).

II. Case Study
This is a bridge construction project, where the schedule structure is prepared initially without considering any shortage in resources. Once the initial schedule is prepared, over allocations are checked for the resources. Resource over-allocation is resolved by carrying out manual levelling on the softwares. While carrying out resource levelling, some non critical activities turn into critical activities. The critical activities are given higher preference over the non critical activities. The following are the machineries which have been used on the site and are considered for resource levelling in this case study of the bridge project.

Table-1: Machineries used on site

<table>
<thead>
<tr>
<th>Machineries used on site</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit Mixer</td>
<td>16</td>
</tr>
<tr>
<td>R.M.C. Plant</td>
<td>1</td>
</tr>
<tr>
<td>Concrete Pump</td>
<td>2</td>
</tr>
<tr>
<td>Tyre mounted crane</td>
<td>1</td>
</tr>
<tr>
<td>Hydraulic Pile Rig</td>
<td>2</td>
</tr>
<tr>
<td>Equivalent excavator</td>
<td>1</td>
</tr>
<tr>
<td>Hydraulic tipper and dumper</td>
<td>6</td>
</tr>
<tr>
<td>J.C.B.</td>
<td>2</td>
</tr>
<tr>
<td>Prestressing jacks</td>
<td>6</td>
</tr>
</tbody>
</table>
Fig-1: Resource Sheet showing over allocation in red and the activities for which the resource is allocated.

Fig-2: Resource Graph of Transit Mixer showing over allocation
Fig- 3: Resource Graph of Prestressing jack showing over allocation

Fig- 4: Resource Graph of Transit Mixer after levelling

Fig- 5: Resource Graph of Prestressing Jack after levelling.
Fig- 6: Resource Graph of Tyre Mounted Crane showing over allocation

Fig- 7: Resource Graph of Concrete pump showing no over allocation

Fig- 8: Resource Graph of Tyre Mounted Crane after levelling
Fig- 9: Resource Graph of Hydraulic Pile Rig showing no over allocation
III. Conclusion

The initial schedule without resource levelling needs to be revised since there are over-allocations in the resources that have been used on the site. The resource over-allocation is thus rectified by resource levelling on Microsoft Project. The schedule may be further optimised by carrying out resource smoothing. The durations of the activities increase due to Resource Levelling but this step needs to be taken in order to resolve over-allocation of the resources present within a given firm. Certain changes can be made in the softwares such as Microsoft Project and Oracle Primavera wherein, activities consuming the same resource would not be allocated in parallel.

References

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