THE INFLUENCE ANALYSIS OF OPENING PROJECTS ON PROJECT PERFORMANCE

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Abstract: Critical chain project management (CCPM), proposed by Goldratt (1997), has been proved to be very prominent in overcoming the weaknesses of human nature in order to achieve a more effective project management. Goldratt suggested that, in order to reduce the impact of bad multi-tasking on project delivery in the multi-project environment, the density of open projects (BN Closeness) should be reduced at least to 75% and below the generally recognized load (Goldratt, 2006). On the other hand, to get better use of resources in practice, the resource loading assignment tends to higher and evener. The above two viewpoints are all considerably related to the use and allocation of project resources. However, both perspectives have no support of actual data. In this study, we employ the @Risk for project simulation software for evaluation and verification of the appropriate density of open projects. The research findings suggest, in general, the density of open projects should be in the range of 75%~100% of the load in multi-project environments of different risks.

1 RESEARCH BACKGROUND AND MOTIVES

There are many factors of influence relating to project delivery and throughput. For example, number of open projects, resource workload, risk degree of projects and time uncertainty, or the evenness of resource allocation (Castro et al., 2008; Herroelen and Leus, 2005). Dr. Goldratt (2006) suggested that, profit-making goals rely not on the number of projects to start but on how many projects can be finished. When too many projects are open, there will be pressure on resource. Therefore, more tasks will be assigned to same resource, and thus lengthen the delivery time of each project. He proposed that the company has to reduce by at least 25% of open projects to avoid unnecessary delay in project delivery.

On the other hand, Anavi-Isakow and Golany (2003) proposed that, in the multi-project environmental organization, it is very important to allow projects to arrive into the system at predetermined time intervals. The main purpose is to prevent the great sum of waiting time resulting from the concurrent arrival of a number of projects at the system. However, the optimal value cannot be accurately defined, as there is no accurate answer from the simulation experiment. Adler et al. (1995) proposed that an organization should take fewer projects at one time. Dietrich and Lehtonen (2005) investigated methods applied to the management of development projects by 288 organizations, and concluded that the number of projects is not the successful factor for the multi-project management.

In addition, time uncertainty is also one of the factors affecting the delay of project. Cates and Mollaghasemi (2007) indicated that there are many project-related uncertain factors including the estimation of activity time or unexpected accident as well as the use of key resources. Moreover, such impact would cause project delay and reduce the interests of stakeholders.

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However, it is not sure whether reduced number of open projects can shorten project time or not and how the application of resource loading impacts on project throughput. This study is going to make situational simulation analysis of the above topics to discuss the number of open projects on 6 delivery time-related performance indicators as the verification targets in the following sections.

2 DEVELOPMENT OF SIMULATION MODEL

The number of open projects as described in this study refers to the number of projects that have been started at any given time after planned scheduling in a multi-project environment. The “Bottleneck (BN)” refers to the resources of average load and other resources within 10% of the maximum load among all the projects. The rest resources are termed as “Non-Bottleneck (NBN)”. “Bottleneck closeness”, denoting as “BN Closeness”, means the closeness between the bottleneck duration and the bottleneck duration of the last project. Note that, the density of open projects in this study is equivalent to bottleneck closeness.

The resources of the projects are seven shared ones. The project network structure is designed by Anavi-Isakow and Golany (2003) as shown in Figure 1. With the three types of projects as the priorities of the multi-project scheduling, we repeat the scheduling processes for three years. Then, the scheduling time of project opening is planned based on bottleneck closeness at 100% and non-bottleneck workload at 70% as the basis. The average duration of various resources are determined by β distribution with 50% work completion probability, the preliminary scheduling throughput can be obtained as illustrated in Table 1.

This study designs the transformed risk degree of project proposed by Shou et al. (2000) as illustrated in Table 2. The estimated task time used in this study is computed according to different risk degrees and β distribution.

The number of projects can affect the overall operation of the enterprises and will result in bad multi-tasking of resources. Goldratt (2006) proposed that the density of open projects (BN closeness) should be limited below 75% of the original number of projects to reduce bad multi-tasking situations. In this way, the delivery time of all projects can be shortened. Suppose each project has only one task without considering the bottlenecks, the working duration for each bottleneck is 10 days and the total working time is 60 days. Therefore, 100% of BN closeness indicates that the bottlenecks of all the projects in the multi-project scheduling are closely connected. Thus, the number of open projects is 6; if BN closeness is reduced to 50%, the number of open projects will be 3. To find the most appropriate BN closeness, this experiment sets the levels of BN closeness from 50% to 200% to test the impact of number of open projects on the project throughput rate.

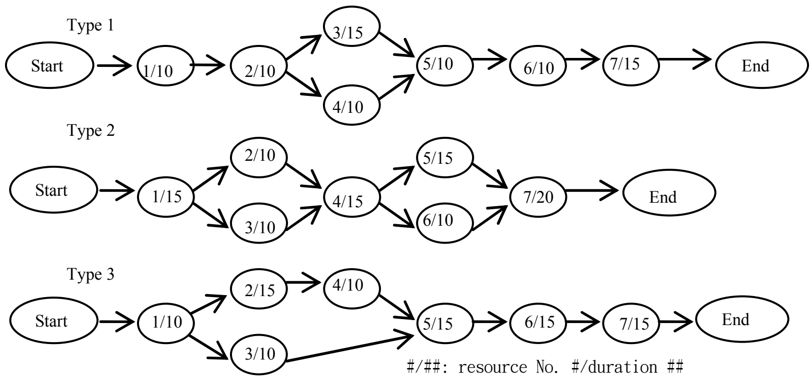

Figure 1: Multi-project network.

Table 1: The Expected Throughputs.

BN closeness(%)	50	60	70	75	80	90	100	125	150	175	200
Expected throughputs	17	19	21	24	25	27	34	41	45	54	61

Table 2: Transformed risk degree of project.

project degree of risk	Probability error range	
	Low bound	High bound
low	-5%	+20%
medium	-12.5%	+35%
high	-20%	+50%

3 ANALYSIS OF THE APPROPRIATE BN CLOSENESS

The performance evaluation of the experimental simulation results are summarized as follows:

- Throughput: representing the total throughput of the all the completed projects during the simulation period. As shown in Figure 2; when the BN closeness rises at 75%, the project throughput starts to rise considerably while it significantly drops when the BN closeness is at 100%. In case of BN closeness at 100% and low risks, the project throughputs (26) are optimal, indicating that the throughputs are not as high as expected (34) to fulfil our original commitments. In general, in case of different risk degrees, the BN closeness should be controlled within 75%~100% to get the most appropriate results.
- Delivery rate: representing the responsiveness to meet the delivery time as designated by customers. According to Figure 3 that the delivery rate in case of different risks is better when the BN closeness is lower than 75%, indicating that the delivery responsiveness is very poor when the BN closeness is higher than 75%.
- Complete rate: representing the percentage of completed projects in a multi-project environment. As shown in Figure 4, in case of different risks, the throughput rate will decrease along with increasing BN closeness. When the BN closeness accounting for more than 75%, the complete rate declines, and the expected number of completed projects will be decreasing.
- Mean tardiness: tardiness refers to the delay between the project completion time and delivery time. The average value of the tardiness of all projects is termed as the mean tardiness. According to Figure 5, the mean tardiness will rise along with increasing BN closeness. In particular, the mean tardiness starts to rise considerably when the BN closeness accounting for more than 100%. This indicates the project completion time cannot satisfy demands on delivery accuracy and become more serious when the BN closeness accounting for more than 100%
- Mean lateness: lateness refers to the period that the project completion time later than the due delivery time. As seen in Figure 6 the mean lateness time in case of different risks will rise along with increasingly higher BN closeness. And it becomes more and more serious when the BN closeness accounting for more than 100% while it has no significant different when the BN closeness accounting for less than 75%.
- Mean time in process: the equivalent of Time in Process (TIP), namely, the time from project opening to completion. As illustrated in Figure 7 mean TIP will rise along with rising BN closeness. Higher BN closeness will result in more serious bad multi-tasking and more delivery delays of projects. However, it has no significant difference when the BN closeness accounting for less than 75%.

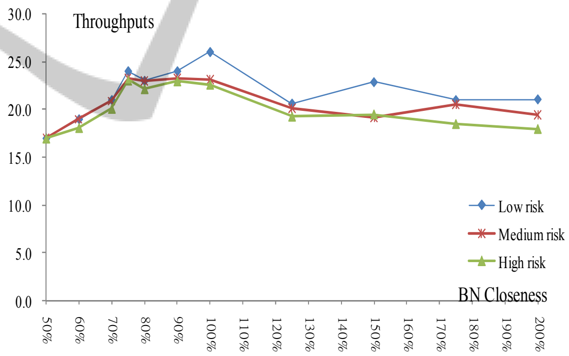

Figure 2: Project throughputs in case of different risk degrees and BN closeness.

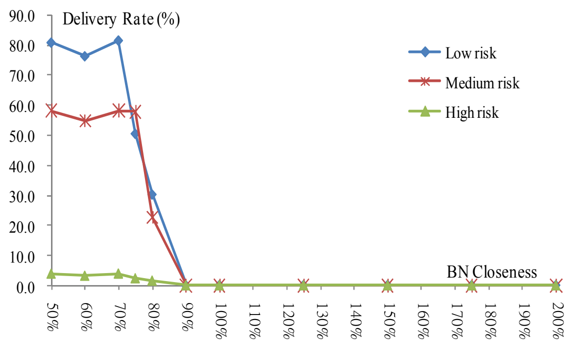

Figure 3: Delivery rate of BN closeness in case of different risk degrees.

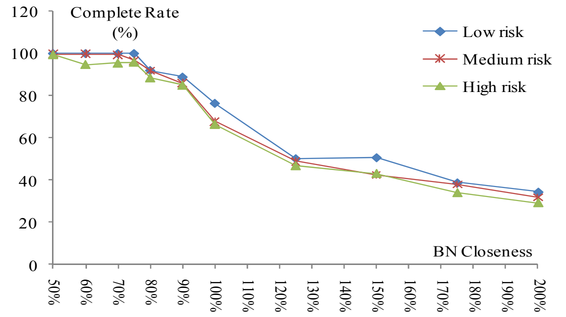

Figure 4: Complete rate of BN closeness in case of different risks.

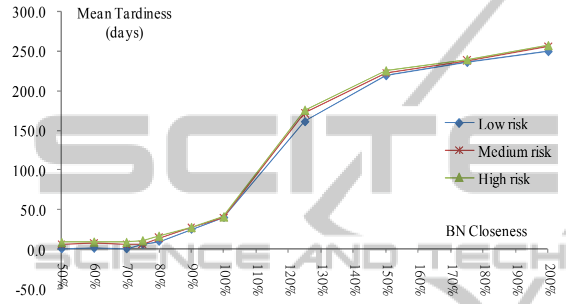

Figure 5: Mean tardiness of BN closeness in case of different risk degrees.

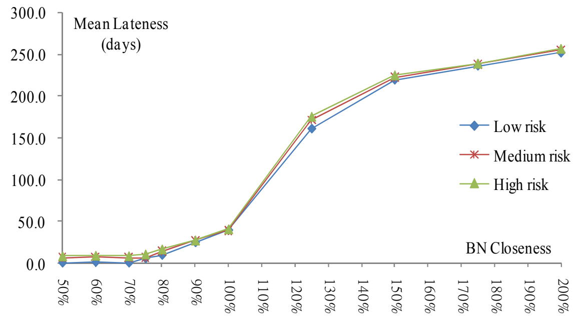

Figure 6: Mean lateness of BN closeness in case of different risk degrees.

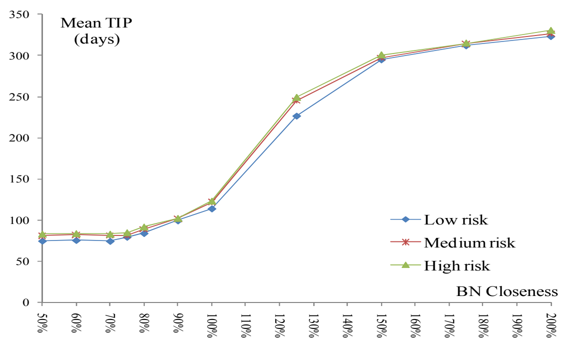

Figure 7: Mean TIP of BN closeness in case of different risk degrees.

4 CONCLUSIONS

The main purpose of this study is to get the most appropriate degrees of BN closeness in uncertain environment and verify the viewpoints of Dr. Goldratt according to the experimental results. In case of various risks, the setting of BN closeness at 75%~100% can result in better performance in terms of the throughput, complete rate, delivery rate, mean tardiness and mean lateness in the multi-project environment. On the contrary, when increasing BN closeness, the mean tardiness, mean lateness and duration will increase.

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