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## Establishment of multi-project scheduling models based on priority rules

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### ABSTRACT

Due to scheduling project problems caused by constrained resources, the essay focuses on a brand-new multi-project scheduling model based on previous research results and specific needs of the project. First, the model analyzes the advantages of critical chain method and technical difficulties in application. Second, the insert of caching techniques in the model will be discussed; including input buffer and project cache, to ensure the model execution will not be effected by the replication environment. The empirical value of this model is practical and has certain reference value to other models' establishment.

### KEYWORDS

rule; Multi-project scheduling models; Resource process.



## INTRODUCTION

Because of the increasingly fierce market competition caused by the economic globalization, projects become more complex, request cycles become shorter, completion rates have higher requirement, and the cost becomes lower. Traditional project plans and scheduling methods cannot meet the actual demands of modern project management. College education is a main way to cultivate high-quality talents, a peak of physical education, and main platform for students to learn theoretical knowledge, skills and to establish scientific thoughts. However, in current situation of college education, college students' physical fitness is declining, mainly for physical weakness, inferior health and emotional instability. Besides some objective factors, the quality evaluation of physical education in college is short of investment, without uniform assessment standards. So it is hard to show the differences on colleges' physical teaching quality.

The main difference between critical chain management and PERT/cPM management is the team. Based on this difference, we can establish a two-dimensional cognition about the satisfaction degree on mass properties and customer satisfaction level. According to service objective performance and recipients' subjective feelings, KANO theory divides the properties of service quality into five categories: 1. Attractive quality (A): when the properties meet, consumers feel satisfied; when the properties cannot be met, consumers can accept it. 2. Expect quality (O): when the properties meet, consumers feel satisfied; when the properties cannot be met, consumers feel unsatisfied. 3. Main Quality (M): when the properties meet, consumers consider it should be like that. When the properties cannot be met, consumers feel unsatisfied. 4. Indifferent quality (I): whether the properties meet or not, consumers show no feeling, satisfied or unsatisfied. 5. Rebellious quality (R): when the properties meet, consumers feel unsatisfied; when the properties cannot be met, consumers feel satisfied.

The essay establishes the multi-project optimization model based on the actual need of resource-constrained project scheduling problems (RCPSp) and finds out scheduling method for critical chain projects with help of previous research results and many simulation experiments, which are compared and contrasted with traditional project scheduling methods.

## PROBLEMS DESCRIPTION

A typical RCPSp can be described as: the total correlation method and T test method will be adopted to analyze a project. The T test reaches the significant level ( $P < 0.05$ ), while the total correlation reaches the significant level ( $P < 0.05$ ). Finally, all tests will be preserved for the later analysis. First, given the reliability of component tables and total scale in tests is Cronbach's Coefficient. The reliability reaches  $x > 0.7$ , which means the reliability is high. It reaches  $0.35 < x < 0.7$ , which means it is average. When the reliability is  $x < 0.35$ , then it is low. In the survey, the five positive-titles  $x$  coefficient include the shape coefficient is 0.85, the reliability coefficient is 0.82, the response coefficient is 0.74, the affordable coefficient is 0.66, the coefficient of empathy is 0.80, and the total scale coefficient is 0.86.

College education is a main way to cultivate high-quality talents, a peak of physical education, and main platform for students to learn theoretical knowledge, skills and to establish scientific thoughts. However, in current situation of college education, college students' physical fitness is declining, mainly for physical weakness, inferior health and emotional instability. Besides some objective factors, the quality evaluation of physical education in college is short of investment, without uniform assessment standards. So it is hard to show the differences on colleges' physical teaching quality. The Mathematical model can be described as followed:

$$\min SFT_j \quad (1)$$

$$\min WIP = \sum_{j=1}^J \left( \frac{1}{|S_j|} \times \sum_{i \in S_j} (SST_i - SFT_j) \right) \quad (2)$$

$$s.t. SST_i - SST_j \geq d_j, i \in S_j \quad (3)$$

$$\sum_{j \in A_k} r_{jk} \leq R_{kt}, k = 1, \dots, K, t = 1, \dots, T \quad (4)$$

$$P(AFT_j \leq (SFT_j + PB)) \geq p_0 \quad (5)$$

Although it can be seen from the two-dimensional mass properties from the attribution table, it is hard to know students' satisfaction degree when the properties meet and their dissatisfaction degree when the properties cannot be met. Therefore, KANO two-dimensional survey is applied to propose the mass index formula, by which students' satisfaction and dissatisfaction under certain properties can be calculated and will be an important standard to improve the mass property. For example, if the coefficient is closer to 0, which means the influence of mass property is less on students. When the coefficient is closer to 1, which means the influence is more obvious on students. The mass index formula is: increasing satisfaction

index=(A+O)/(A+O+M+I) ; decreasing dissatisfaction index =(O+M)/(A+O+M+I); the stability of project should be ensured during the implementation process.

**MULTI-PROJECT SCHEDULING ALGORITHM ON RESOURCES PUSH-PULL TECHNOLOGY**

**Resource conflict detection**

The conflict detection is a key technology for product development. To detect conflicts in a timely and effective manner is the prerequisite for resource conflict resolution. According to the project network chart and time constraint, we can get the start time of every activities under non resource-constrained conditions.

$$TB_{ij} = \max_{All \in AP_{ij}} (TC_{ij} + TB_{il} + TD_{il}) \tag{6}$$

There are 23 quality properties, among which there are 9 basic qualities, accounting for 39.1%; 5 attractive qualities, for 21.7%; the 18<sup>th</sup> quality is abandoned because of contradictions and disputes. There are no rebellious quality and indifferent quality among these 23 quality properties, which provides more justification on the reliability of this survey, and demonstrates that college students give a positive answer to the teaching quality evaluation of physical education in colleges. In theory, Metzler believes that basic quality is the most important property, followed by expect quality, next to attractive quality, last for indifferent quality. So here comes the formula: M>O>OA>I, which has been mutually authenticated with the results of this survey.

Based on the analysis of quality satisfaction, the dissatisfaction coefficients of “class sites”, “quality and quantity of facilities for physical education” and “activities space” are the highest. The short on quality and quantity of facilities for physical education has become the main factor dissatisfying college students. Therefore, colleges should attach more importance on the improvement of sports ground and the supplement of facilities. Based on that, various resources should be applied to meet the requirements of physical education, in order to increase students’ satisfaction of physical education in college.

$$CM_{ijk} = \left\{ A_{hm} \mid \begin{matrix} TRB_{ijk} \leq TRB_{hmk} < \\ RTB_{ijk} + TRD_{ijk}, A_{hm} \in AS_{ij} \end{matrix} \right\} \tag{7}$$

$$Ci_{jk} = \left\{ A_{hm} \mid \sum_{A_{hm} \in CM_{ijk}} R_{hmk} > R_k \right\} \tag{8}$$

$$CM_{hm} = C_{hm1} \cup C_{hm2} \cup \dots \cup C_{hmK} \tag{9}$$

**Priority rules based on resource push-pull technology**

Although the scheduling method based on priority rules is the oldest method in the RCPSP, its index properties can reflex the degree of students’ opinions. Above all, the basic quality should be improved first, including teachers should introduce the course outline to students at the beginning of the semester; teachers should use different teaching approaches to help students; teachers demonstrate right sports skills to students. Students will take these properties as granted. When the properties meet, the satisfaction of teaching will not be increased. But if the properties cannot be met, the satisfaction degree will decline.

Second, the expect quality should be improved, such as class site, maintenance of sports ground and the quality and quantity of physical education facilities. In the meantime, teachers should put more attention on students’ physical strength and adjust teaching contents and teaching approaches. And teacher should deal with the problems with students in time. Students think all these properties should be met. If the properties cannot be met, students will feel unsatisfied. The reliability coefficient is 0.82, the response coefficient is 0.74, the affordable coefficient is 0.66, the coefficient of empathy is 0.80, and the total scale coefficient is 0.86. To increase the expect quality, besides sports facilities and skill teaching during the class, teachers should pay more attention on students, and conduct targeted instructions to students. According to the customer feelings researches and verification results, attractive quality, expect quality and basic quality declines in turn as time passes. That is, the attractive quality turns into the expect quality after a period, and finally become the basic quality. Therefore, the improvement of expect properties begins from sports facilities and skilling teaching during the class, teachers should pay more attention on students, and conduct targeted instructions to students.

Besides, the attractive quality property should be modified. Teachers should use different methods to help students; teachers should respect students’ opinions and communicate with them. Teachers should create a pleasant learning atmosphere to students. The attractive quality property can be listed as a capital for competition. The situation that teachers can adopt different methods in teaching and have a good teacher-student interaction will improve the physical education quality, which is the best strategy to increase students’ satisfactions.

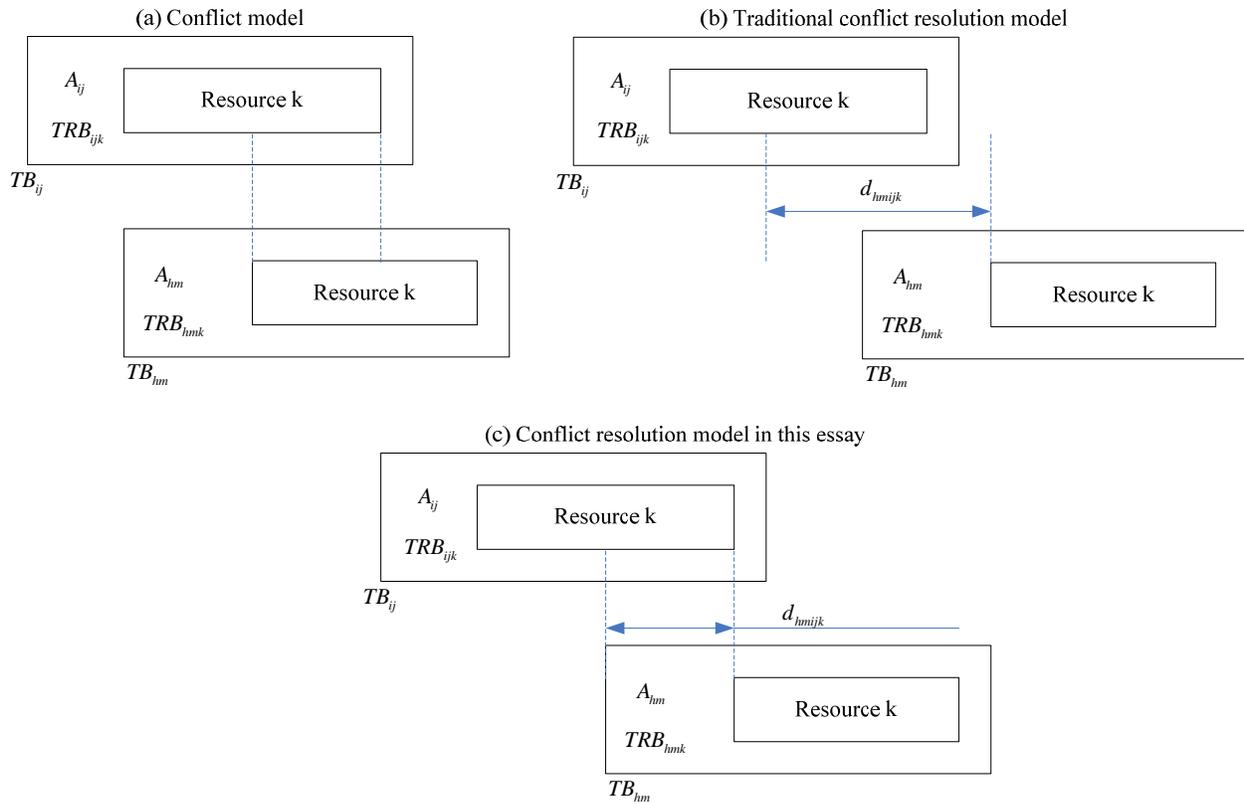


Figure 1 : Resource conflict resolution model

**Resource-constrained multi-project scheduling algorithm**

The heuristic algorithm based on priority rule includes Schedule Generation Scheme (SGS) and project priority rule. The classification method for two-dimensional quality is not always the same. The original basic quality properties can change or turn into indifferent quality properties due to changes of conditions and time. In the survey, the five positive-titles x coefficient include the shape coefficient is 0.85, the reliability coefficient is 0.82, the response coefficient is 0.74, the affordable coefficient is 0.66, the coefficient of empathy is 0.80, and the total scale coefficient is 0.86. To increase the expect quality, besides sports facilities and skill teaching during the class, teachers should pay more attention on students, and conduct targeted instructions to students. According to the customer feelings researches and verification results, attractive quality, expect quality and basic quality declines in turn as time passes. That is, the attractive quality turns into the expect quality after a period, and finally become the basic quality. This change pattern shows the gradual progression of students' demands and difficulties of being satisfied.

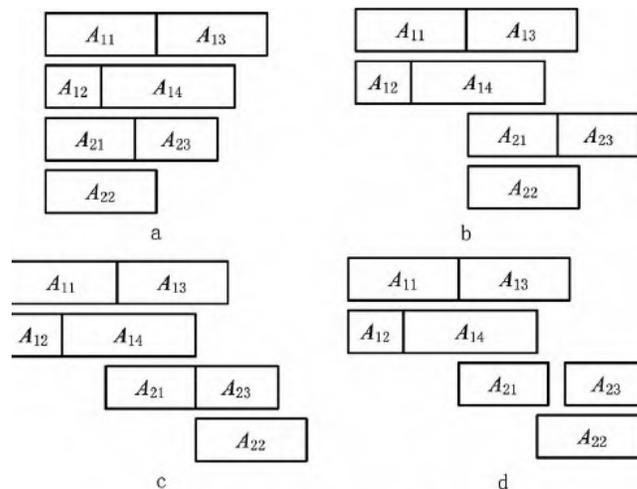


Figure 2 : Algorithm process

**SAMPLE ANALYSIS**

**Data analysis on CIDT**

The physical education teaching evaluation system in this essay is student-oriented, and the index properties show students' opinions about teaching. Above all, the basic quality should be improved first, including teachers should introduce the course outline to students at the beginning of the semester; teachers should use different teaching approaches to help students; teachers demonstrate right sports skills to students. Students will take these properties as granted. When the properties meet, the satisfaction of teaching will not be increased. But if the properties cannot be met, the satisfaction degree will decline.

Besides, the attractive quality property should be modified. Teachers should use different methods to help students; teachers should respect students' opinions and communicate with them. Teachers should create a pleasant learning atmosphere to students. The attractive quality property can be listed as a capital for competition. The situation that teachers can adopt different methods in teaching and have a good teacher-student interaction will improve the physical education quality, which is the best strategy to increase students' satisfactions. The schedule after the conflict resolution is shown in Figure 2.

(2) As we can see from the Chart 4b and Chart 4c, the expect quality should be improved, such as class site, maintenance of sports ground and the quality and quantity of physical education facilities. In the meantime, teachers should put more attention on students' physical strength and adjust teaching contents and teaching approaches. And teacher should deal with the problems with students in time. Students think all these properties should be met. If the properties cannot be met, students will feel unsatisfied. After we took back all these questionnaires, we use the total correlation method and T test method to analyze the project. The T test reaches the significant level ( $P < 0.05$ ), while the total correlation reaches the significant level ( $P < 0.05$ ). Finally, all tests will be preserved for the later analysis. First, given the reliability of component tables and total scale in tests is Cronbach's Coefficient. The reliability reaches  $x > 0.7$ , which means the reliability is high. It reaches  $0.35 < x < 0.7$ , which means it is average. When the reliability is  $x < 0.35$ , then it is low. In the survey, the five positive-titles  $x$  coefficient include the shape coefficient is 0.85, the reliability coefficient is 0.82, the response coefficient is 0.74, the affordable coefficient is 0.66, the coefficient of empathy is 0.80, and the total scale coefficient is 0.86. Therefore, to increase the expect quality, besides sports facilities and skill teaching during the class, teachers should pay more attention on students, and conduct targeted instructions to students. TABLE 1 below shows the scheduling results.

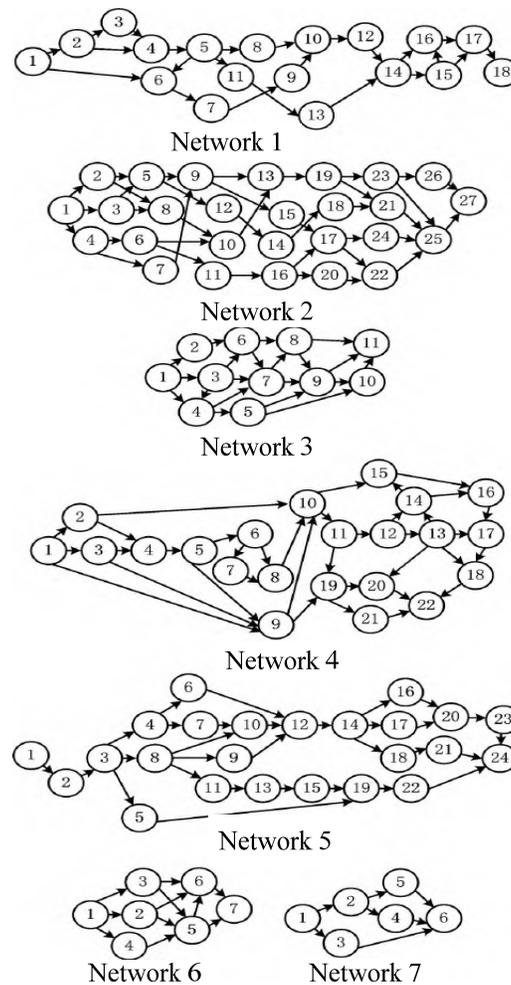
**TABLE 1 : Scheduling results of two online samples**

priority rule	activity time	activity							extension of time
		A <sub>11</sub>	A <sub>12</sub>	A <sub>13</sub>	A <sub>14</sub>	A <sub>21</sub>	A <sub>22</sub>	A <sub>23</sub>	
CIDT	beginning time	0	0	3	1	3	5	6	4
	ending time	3	1	6	5	5	8	8	
CR	beginning time	0	2	6	5	0	3	3	5
	ending time	3	3	9	9	2	6	5	
LSSA	beginning time	0	2	6	5	0	3	3	5
	ending time	3	3	9	9	2	6	5	

According to the TABLE 1, we can see that the expect quality should be improved, such as class site, maintenance of sports ground and the quality and quantity of physical education facilities. In the meantime, teachers should put more attention on students' physical strength and adjust teaching contents and teaching approaches. And teacher should deal with the problems with students in time. Students think all these properties should be met. If the properties cannot be met, students will feel unsatisfied. Therefore, the improvement of expect properties begins from sports facilities and skilling teaching during the class, teachers should pay more attention on students, and conduct targeted instructions to students. According to this, 673 project scheduling test samples have been established. The project network is shown as Figure 3.

**TABLE 2 : Comparison of algorithms**

algorithm	CIDT	CR	LSSA	MINLFT	MINSLK
average extension of time	21.16	25.52	22.21	27.84	27.86



**Figure 3 : The project network**

## CONCLUSION

In order to make a full advantage of limited resource and shorten project time, the essay analyses the resource push-pull process and proposes the resource conflict resolution model based on the resource push-pull technology. Because of project scheduling problems caused by resource constraints, the essay establishes a new multi-project scheduling model on the basis of previous researches and the actual needs of the project. The model analyzes the advantages of critical chain method and application difficulties in the model. Second, the insert of caching techniques in the model will be discussed; including input buffer and project cache, to ensure the model execution will not be effected by the replication environment. Justified by experiments, the model proposed in the essay is practical and can solve the multi-project scheduling problems, which has certain reference value to other models' establishment.

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