Management Concepts Behind in Project Advancement

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ABSTRACT

Although a large number of studies have been made on modelling a multi-project scheduling problem, little is known about proposing a process which calls for the issues of project creation and selection, resource planning and project scheduling. Project advancement (PA) is a new approach involving such concepts. Seven-step rules of engaging the problem with constrained multi-tasking environment are proposed and illustrated to resolve the most challenging part of decision-making problem in PA. The purpose of this paper is not only to explore the properties and rules of applying PA strategies that have been proven useful for the decision-makers at all levels of an organization, but also to examine the management concepts imposed in PA by the case study of polarizer process improvement.
Keywords: *multi-project environment, project advancement, management concepts, polarizer process improvement*

INTRODUCTION

Numerous attempts have been made by Operational Researchers to model a multi-project problem. What seems to be lacking, however, is the process involved both concepts of project creation and resource planning. Chang and Chen (2007) provided a new seven-step decision rule to aid a decision-maker to model a resource constrained multi-project problem. Many viewpoints of PA varied from conventional theories. Except incorporating the concept of project creation and selection into the process of modelling multi-project, PA states the PARAT (Project-Based Resource Allocation and/or Transfer) policy. On the other hand, most traditional studies adopted the Activity-Based Resource Allocation and/or Transfer (ABRAT) policy to model a resource constrained multi-project problem (e.g., Blazewicz et al. (1983); Kurtulus et al.(1985); Kwan et al.(2005); De Reyck et al.(1998); Sprecher et al. (2001); Herroelen et al. (1997; Williams(1999); and Steyn (2001), etc).

ABRAT policy refers to (1) use activity as the basic resource allocation unit, (2) allow to transfer a certain type of shared resource to another project at any time-point even if the shared resource has not complete its whole tasks in the executing project yet, and (3) while the shared resource has left a project, it still has the duty to redo the activities which were not done while the period of the prior working in that project. Nevertheless, the adoption of PBRAT policy implies that (1) the shared resource allocation policy uses a whole project as its basic allocation unit, (2) all activities of the executing project must be either completed or performed in a certain time period, before being allowed to transfer this shared resource to other projects, and (3) no duty to redo the remaindering tasks which were not done while the periods of the shared resource staying in that project According to the definition of PBRAT, four types of project advancement strategies have been suggested by PA.

In addition to the concepts of PBART policy and project advancement strategy, PA also suggested the concepts of fundamental objective, value-perspective objective, and value-based time limit, to predicate what one should do before scheduling multi-project. In short, PA uses such concepts to examine the issue of project selection. According to the critical concepts mentioned above, PA suggests a seven-step decision rule to aid decision-makers at all level in an organization to decide:(1) what things they have to do, (2) what objectives and what modes of time constraints they have to consider when scheduling the multiple projects, and (3) what type of resource allocation and transfer policy and what type of project advancement strategy they should select when modeling a resource-constrained multi-project problem. Few scholars have applied partial results of PA to different fields of researches (e.g., Chang and Chen (2009); Jeng and Chiu (2010). To our knowledge, PA is a new approach and no other scholar has performed a case study to explore its management concepts. This is the reason for putting this article together. In short, this paper aims to demonstrate the management concepts imposed in PA by employing a case on polarizer process improvement.

PROJECT ADVANCEMENT

According to some managerial postulations and technical assumptions, PA suggested that an organization could encourage its decision-makers at all levels follow the seven-step decision rule to do problem-solving when they faced a resource constrained multi-tasking environment. The detailed contents and processes of seven-step decision rule are illustrated as below.

Step 1: Confirm the fundamental objective (FO) which is the result that a decision-maker or his/her supervisor wants from the perspective of benefit-maximization of whole organization when an organization faces a specific problem-setting.

Step 2: Manage the necessary management actions, which are treated as projects, and their specific quality requirements or standards required to achieve the fundamental objective.

Step 3: Identify the value-perspective objectives (VPO) which are the significant factors that lead to a decision-maker's disappointment and frustration if such an objective is lost while conducting those necessary management projects decided in Step 1.

Step 4: Differentiate the time-horizon and mode of value-based time limit (VBTL) of a project with regard to contributing to a specific VPO, if such a VBTL has to be considered in this context.

Step 5: Evaluate a reasonable project implementation strategy and identify the constrained shared resources by this implementation strategy.

Step 6: Decide whether to adopt ABRAT or PBRAT policy. If a PBRAT policy is adopted, then there remains a second question: evaluate a suitable project advancement strategy.

Step 7: Formulate the resource-allocation and/or transfer model with respect to the concerned VPOs. Also, find an effective solution procedure to resolve the model.

Notice that two kinds of the VBTL associated with a specific VPO were suggested by PA, which were referred to as Mode I and II. Indeed, T_j is referred as to Mode I VBTL, if T_j meets the following Features 1 and 2 given project j is implemented starting at time 0. Further, T_j is termed the Mode II VBTL, if T_j meets the following Features 1 and 3, given project j is implemented starting at time 0.

Feature 1: They make, almost, no value difference, if the quality-standard assigned to project j is achieved at any time points within time interval $[0, T_j]$.

Feature 2: The extra efforts outside the time T_j make no value to the considered VPO, when the quality-standard assigned to project j cannot be achieved within time interval $[0, T_j]$.

Feature 3: The value loss from project j contributing to the considered VPO would be much greater and would grow even worse the longer it takes to achieve the target quality-standard for project j, when we cannot achieve the PG within time interval $[0, T_j]$.

According to seven-step decision rule, we will show the application to a case of polarizer process improvement. Yet, the management concept imposed in PA will be discussed after the case application.

THE IMPLEMENTATION OF PROCESS IMPROVEMENT CASE

Background

Taking a Taiwanese polarizer manufacturer as a case to illustrate the application of PA, all the scenario of this case is real except the numerical data. To simplify the address, we name the target company "Company Z" instead of 'the Taiwanese polarizer manufacturer.' Company Z currently has three different types of polarizer manufacturing factories. In this case, we only take the TFT-LCD production line from Factory L as an example to predicate how the head of the factory applied PA to solve his problem: Being asked by CEO to improve the defective rate of TFT-LCD production line within a certainly limited time-period to reduce production cost. Similarly, 'the head of the factory L' is represented by 'Head L.' There are three kinds of inspection jobs of on-line quality control for TFT-LCD production line. The quality control processes include input quality check (IQC), process quality check (PQC), and output quality check (OQC), respectively. The TFT-LCD production line consists of seven work-stations. They are TAC's optical module extension, PSA module coating, roll to sheet (RTS), super cut, sticking, inspection, and packaging. The inspection and packaging stations are responsible for doing OQC in contrast to other stations responsible for doing IQC. Such is shown in Figure 1.

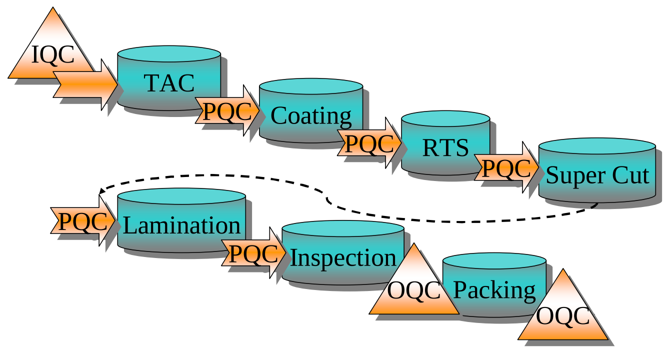

Figure 1: TFT-LCD Polarizer Production Flowchart

In the following subsection, this case will be employed to demonstrate the management concepts behind PA.

Identifying Fundamental Objective, FO

Considering the case that the long-term average rate of defect of the TFT-LCD production line had been maintained around 0.15%, it recently went up to 0.3% all of sudden, which caused a dramatic increase in production cost. Therefore, CEO of Company Z requires Head L to improve the rate of defect within a month and restore it to the level of 0.15%. According to the CEO's instruction, Head L should set the FO as to 'minimize the profit loss caused by low production efficiency of this TFT-LCD production line to original level' according to the definition of FO.

Determining the Necessary Management Projects and Target Quality-standards

Consider the case of Head L having collected and analyzed data through recent quality control of IQC, PQC, and OQC. Five major factors causing defects were identified after careful data analysis. They were abnormal glue ingredient, poor sticking property of coating, optical deviation, improper size of super cut, and low precision of RTS (as shown in Figure 2).

The rate of defect of TFT-LCD production line can be defined as the percentage of defects in process detected by various quality control jobs (IOC, PQC, OQC). So, we use the term "defective rate of factor" to refer to the percentage of defective products in process attributable to a specific factor (for instance, the defective rate of 0.05% in terms of the size of super cut means that for every 10,000 pieces of products, 5 defective products in the manufacturing process are caused by improper size of super cut). The total rate of defect (0.3%) of this production line is the sum of the defective rates of the above five factors. Assume that the existing defective rates of the five factors for Factory L are: 0.06% (RTS), 0.05% (Super Cut), 0.055% (Glue Ingredient), 0.07% (Sticking Property of Coating), and 0.065% (Optical Deviation). In order to reduce the defective rate of the production line to 0.15%, Head L employed the goal of the project on improving factor defective rates as to reduce the current level to 0.03%. In other words, the target quality standards for all projects were assigned value 0.03%.

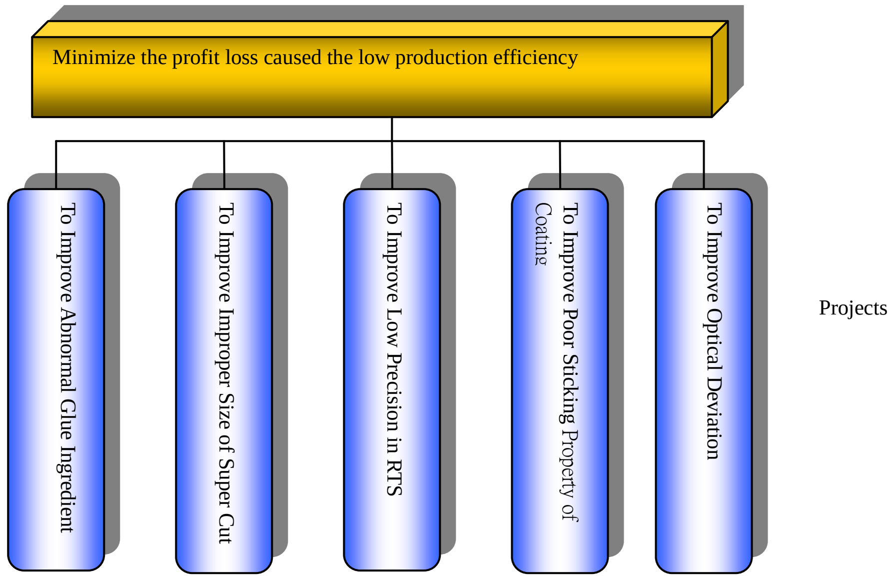

Figure 2: Major Causes of Defects

Confirming VPO and VBTL

In order to obtain the minimal degree of regret, Head L would have to confirm his VPOs before making resource utilization policy. Both personal interest and organizational interest are put into account in Head L's mind for reaching unit's target. The first VPO is 'to minimize the probability of being criticized by CEO or even fired after due date (VPO 1).' The second one is to 'minimize Company Z's loss caused by the lower production quality of his managing factory (VPO 2).' Clearly, VPO 2 is the same as the FO decided by Head L.

Because Head L had to restore the quality of TFT-LCD production line to original level as soon as possible corresponding to VPO 2, the VBTL associated with VPO 2 can be defined as an extremely short time horizon and as a Mode II. On the contrary, the VBTL associated with VPO 2 can be defined as the time horizon of one month and as a Mode I due to the time constraint of one month.

Determining Project Implementation Strategy and Identifying Shared Resource

Project implementation strategy defined in PA is a resource type utilization strategy; in other words, selecting the appropriate project entry strategy is equivalent to selecting the appropriate resource type to realize the fundamental objective effectively. For instance, assuming Head L believed that time-coordination is too difficult and cost is too high to outsource a professional consulting firm or an academic team. A significant increase in defective products at a work station usually indicates the occurrence of structural problems associated with the operational and managerial mechanisms. Therefore, a concrete improvement plan for every station is needed in any attempt to reduce the rate of defect, and therefore experienced engineers would be required. Accordingly, Head L decided to set up a project team consisting of internal experienced technical engineers to take care of these projects.

After carefully considering the factory's overall tasks, Head L selected five engineers out of existing experienced engineers to deal with these projects. Where two engineers are persons capable of doing projects 1 (poor precision of RTS) and 2 (improper size of super cut), two engineers are persons capable of conducting projects 3 (abnormal glue ingredient), 4 (inferior sticking property of coating), and 5 (optical deviation). The final one is a well-senior engineer capable of any project.

Deciding to Adopt ABRAT or PBRAT Policy

Assumed that the each engineer could provide eight working hours a day, the total working hours would be forty hours a day if there are five engineers in an organization. Whether to possess continuity of experience for these engineers becomes the most professional issues to such situation. Using "working hour" as the smallest unit for resource allocation tends to cause high risk. Indeed, if an employee quits after undertaking a project through half way, whoever replaces him would encounter the situation of discontinued experience, which will lead to the high variation of performance while conducting a project. Thus, to avoid such occurrence, Head L decided to use "individual" as the smallest unit for resource investment. Consequently, the adoption of PBRAT policy is better than the one of ABRAT with regard to the view-point of experience-continued. Whenever the PBRAT policy is adopted, PA suggested selecting one of project advancement strategies before scheduling the projects, which may take some immeasurable factors into account and thus benefit the reduction of risk while conducting those projects, like the control capability of project leader. Four project advancement strategies were defined in PA as below:

Centralized sequential advancement strategy (CSAS): It refers to centralizing the total amount of a type of shared-resource into a project, and transferring the shared-resource onto another project once the target quality-standard of this project or a desired implementation time interval has been achieved, by the same token, until all projects achieve their target quality-standard or the total time limit is fulfilled.

Decentralized synchronized advancement strategy (DSAS): It refers to decentralizing the total amount of a type of shared-resources into all projects until the implementation of this project reaching the preset time interval, or until the target quality-standard for this project has been achieved.

Type I mixed advancement strategy (Type I MAS): It represents the mixing strategy consisting of both CSAS and DSAS. Consider the projects A, B, C and D, and divide the four projects into two groups: {A & B} and {C & D}, which are referred to as "X" and "Y" respectively. Type I MAS means that deploy the CSAS within the groups X and Y, while going ahead between group X and Y with the DSAS, as show in Figure 3.

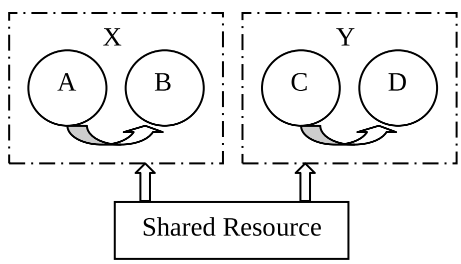

Figure 3: The chart of Type I MAS

Type II mixed advancement strategy (Type II MAS): It refers to deploying the DSAS within the groups X and Y, while going ahead between group X and Y with the CSAS, as show in Figure 4.

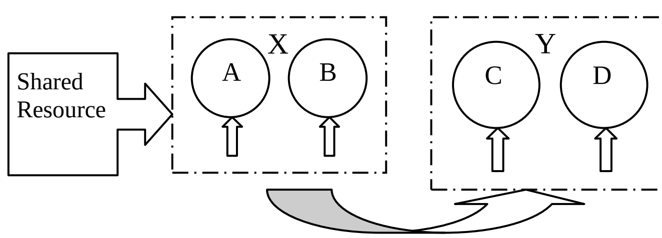

Figure 4：The chart of Type II MAS

Consider the five projects can be differentiated into G 1 and G 2. Different groups imply different needs of special knowledge. G 1 includes poor precision of RTS and improper size of super cut, that is, G 1 includes projects 1 and 2. G2 includes abnormal glue ingredient, inferior sticking property of coating, and optical deviation, that is, G2 includes projects 3, 4, and 5. Owing to the characteristics of shared-resource analyzing in Subsection 3.2.4, the applicable project advancement strategies have boiled down to Type I MAS or DSAS strategies. Additionally, to avoid either insufficient or excessive resource allocation, we have to first find minimum effective scale-size (MIESS) and maximum effective scale size (MAESS) defined in PA for each project. MIESS refers to the lower bound of shared resource allocated enabling to shorten the time required to complete the project goal (target quality-standard). Restated, the expected time to complete the project goal will approximate infinite if the input level is less than the MIESS. In contrast to MIESS, the term of MAESS refers to the upper bound of shared resource allocated enabling to shorten the time required to complete the project goal. In other words, the additional input will make slight contribution to shorten the time required to accomplish the project goal when the input level goes higher than MAESS.

In this case, Head L has to find the relationship between the expected time required to achieve a project goal and the invested resource (manpower) in order to obtain MIESS and MAESS. Such results were assumed as shown in Table 1.

Table 1: Relationship between time and resource

Project Code Human Resource Input	1	2	3	4	5
1	—	—	—	—	14
2	13	12	12	12	13
3	12	11	11	10	12
4	9	8	9	10	12
5	9	8	9	10	12

With the use of results in Table 3.1, MIESS and MAESS for each project can be found as shown in Table 2.

Table 2: MIESS and MAESS for Projects

Project Code Effective Scale	1	2	3	4	5
MIESS (person)	2	2	2	1	1
MAESS (person)	4	4	4	3	2

According to the results in Table 3.2, it is easy to find that DSAS is not applicable since the manpower is not satisfying the requirement of MIESS for each Project. In other words, Type I MAS is the only feasible project advancement strategy.

Shared-Resource Constrained Allocation and/or Transfer Model

In order to minimize the regret function of decision-makers, if any project associates with Mode I VBTL for contributing a specific VPO, it needs to search for a resource allocation policy under a specific project advancement strategy to maximize the degree of realization of this VPO within its associated VBTL. Otherwise, if any project possesses Mode II VBTL for contributing a specific VPO, it needs to find a resource allocation policy thereby minimizing the value loss of this VPO (resulted from the fact that all project can not be expectedly finished within their associated VBTLs). If any project contributing to a VPO does not possess any mode of VBTL, decision-makers should find the optimal one thereby maximizing the degree of realization of this VPO. Let us consider a J-VPO problem. Letting A_j, L_j denote the achievement-level function and value-loss function for a VPO j, $j = 1, 2, \cdots, J$, and R the regret function. Then the decision problem for this J-VPO problem is to find an optimal resource allocation policy thereby minimizing the following regret function:

$$R\ ((Z_1(P), \cdots, Z_j(P), \cdots, Z_J(P) \mid \text{a specific project advancement strategy}))$$

where P denotes a feasible resource allocation policy, and

$$Z_j = \begin{cases} A_j, & \text{if VPO } j \text{ possesses Mode I VBTL or does not have VBTL,} \\ L_j, & \text{if VPO } j \text{ possesses Mode II VBTL.} \end{cases}$$

The preemptive method is an effective tool to find an optimal resource allocation policy thereby minimizing the regret function R. Central point to use preemptive approach to resolve a PA-based multiple VPOs problem is the determination of priority for each VPO. Having decided the priority of each VPO, it would be necessary to further consider a resource-transfer rule. Goal-based transfer rule (GBTR) and constant-time transfer rule (CTTR) were proposed by PA. GBTR means that the shared resource will be transferred to another project only after the goal of the ongoing project has been completely achieved. CTTR means that the shared resource will be transferred to another project as soon as the predetermined implementation time of the ongoing project runs out.

Taking CTTR into the model will cause the implementation time is a decision variable, whereas taking GBTR it is not one. Just as the illustrative example of process improvement here, the maximum achievement-level model associated with CTTR should be formulated for the VPO 1 (because any project associates with Mode I VBTL in term of contributing to VPO 1). And the minimum value-loss model associated with GBTR should be modeled for the VPO 2 (because any project associates with Mode II VBTL in respective of contributing to VPO 2).

MANAGEMENT CONCEPTS OF PROJECTMENT ADVANCEMENT

Some management concepts imposed in PA were predicated as follows:

Allow employing the objective of personal interest maximization as the resource-allocation objective limited to the necessary management actions and the associated target quality-standards that were determined by the objective of organizational benefit maximization. PA believes making such a decision for any decision-maker might not threat the competitive survival of an organization; however, it would benefit the organizational commitment of a decision-maker in the long term. As stated in the process improvement case, such a decision might create the profit loss resulted from the target quality-standard of any project that may be achieved by a longer time due to the discontinued experiences of engineers if the Head L conducted a resource allocation policy to maximize the performance of process improvement within the period of one month to minimize the probability of being criticized by CEO. Therefore, such a profit loss may be predicted as a small value since the necessary management actions and their associated quality-standards were determined by the objective of organizational benefit maximization. Yet, such a management concept proposed in PA has to satisfy the postulation that the decision-makers at all levels would employ the objective of organizational benefit maximization as the resource-allocation objective, if the consideration of a specific VPO could threat the competitive survival of an organization.

Do not always think the efficiency of resource utilization. Indeed, the adoption of ABART policy usually seems to benefit the efficiency of resource utilization since one can find a resource-allocation policy to minimize the expected idle time of any resource. However, the variation of performance of a project on the duration of conducting this project is high and it is hard to evaluate this variation by an objective method whenever adopting ABART policy. As shown in the process improvement case, using “working hour” as the smallest unit for resource allocation may lead to the extremely high variation of performance of process improvement due to the discontinued experiences of engineers. On the contrary, the adoption of PBART seem to result in a longer idle time of any resource than the adoption of ABART, however, it may be actually create the desirable performance for a decision-maker.

The appropriate selection of project advancement strategy may benefit the reduction of risk while conducting multi-project. The case of process improvement fits any one of type I MAS and type II MAS as the resource allocation and transfer strategy if all engineers have the specialty to do any project. In this context, the major advantage of type I MAS is the efficiency of resource utilization and the experience-cumulated in same project group. The major disadvantage is the diversification of control of project-leader, which leads to growth of the variation of progress and quality. In constant to type I MAS, the major advantage of type II is the centralization of control of project-leader, which leads to the reduction of variation of progress and quality. The major disadvantages of this strategy are the less efficiency of resource utilization and the loss of experience-cumulated in same project-group. In practice, the choice of Type I or Type II is in accordance with what has been set up the situation and made actually.

Mode I and mode II VBTL alarm the decision-maker to define the correct resource-allocation objective. It is possible that a specific VPO associated with two kinds of VBTL. In other words, a specific time horizon may be identified as mode I VBTL by a specific decision-maker and may be identified as mode II VBTL by another one corresponding to a certain VPO. For example: if a manufacturer plans to conduct a multi-product R&D program and hopes to render the new products in a market when a specific time horizon has elapsed, since this manufacturer believes that the major competitors will also render their new product when this time horizon has elapsed. Based on this premise, a manufacturer will treat this time horizon as a mode I VBTL and take the constant-time transfer rule to find the resource allocation policy, if this manufacturer believes the loyalty of customers is low. On the other hand, a manufacturer will treat this time horizon as a mode II VBTL and take the goal-based transfer rule to find the resource allocation policy, if this manufacturer believes the loyalty of customers is high.

Mode I VBTL indicates the partial value concept. It is more suitable to illustrate the example of R&D projects mentioned above to explain this view-point. Indeed, if a manufacturer will treat this time horizon as a mode I VBTL, then this manufacturer should create the situation where there are multiple choices of quality-standard for any project, since the resource allocation time has to be treated as decision variable. Restated, if only single quality-standard is assigned (i.e., only the target quality-standard is available), a lower efficiency of resource utilization within VBTL will be predicted.

CONCLUDING REMARK

PA is characterized by the following critical concepts: (1) value-based objective, (2) value-based time limit, (3) project-based resource allocation and/or transfer policy, (4) project advancement strategy, and (5) minimum and maximum effective scales related to the input level of shared resources. PA focuses on aiding the managers of all levels in an organization (a group or community) to: (1) identify the right problem-solving context facing them, and (2) build an effective resource planning model to minimize their regret functions for the problem-solving process in a specific shared-resource constrained multi-tasking environment. In this paper, we have examined the management concepts imposed in PA by employing the case study of polarizer process improvement since the nature of new approach. Because the application of seven-step rules of PA presented in this article already covers most of the management concepts of PA theory, the results of proposed case will undoubtedly enhance decision making in an organization.

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