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SYSTEMIC APPROACH TO PROJECT AND PORTOFOLIO MANAGEMENT

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Abstract: *The paper presents the systemic model of an organization analyzed from the perspective of the theory of constraint, a theory that aims to improve efficiency to a maximum. One of the major approaches is the use of the project management methodology. The scheduling processes are presented using both the Critical Path methodology and the Critical Chain methodology. The main characteristics, as well as the advantages and the disadvantages of each methodology, are presented in a structured way. The portfolio management is presented in a similar way. Finally, the specific situations in which every methodology is useful are underlined.*

Key words: *project management, portfolio management, theory of constraint.*

1. INTRODUCTION

Organizations aim to develop more efficient and flexible organizational models in order to face the high pressure of the market. The Project Management methodology has had a spectacular trend. At the beginning, the focus was on single projects. Now, a major approach is the portfolio management methodology that allows the scheduling and tracking of multiple projects. The theory of constraint modifies the project and portfolio management methodology with a view to improving organization efficiency. This paper will present these new methodologies and the specific situations in which they are useful.

2. ORGANISATION AS A SYSTEM FROM THE POINT OF VIEW OF THE THEORY OF CONSTRAINTS

The theory of constraints (TOC) is a management philosophy based on the idea that every organization can be viewed as a system, and every system has a weakest link. Typically, just one aspect of the system, the constraint, limits the organization's ability to archive its full potential.

The manner in which the constraint is managed determines the throughput of the organization. Dr. Eliyahu M. Goldratt first described the theory in his novel, *The Goal*. In many organizations, TOC logic is the basis for the continuous improvement philosophy [4].

For a manufacturing organization, aiming at making money, TOC defines three operational measurements that determine whether operations are working toward that goal. They are:

- **Throughput:** The rate at which the system generates money through sales. This is considered to be the same as the Contribution Margin (selling price – cost of raw materials). Labor costs are considered to be part of Operating Expenses rather than throughput.
- **Inventory:** All the money the system invests in things it intends to (or could) sell. This is the total system investment, which includes conventional

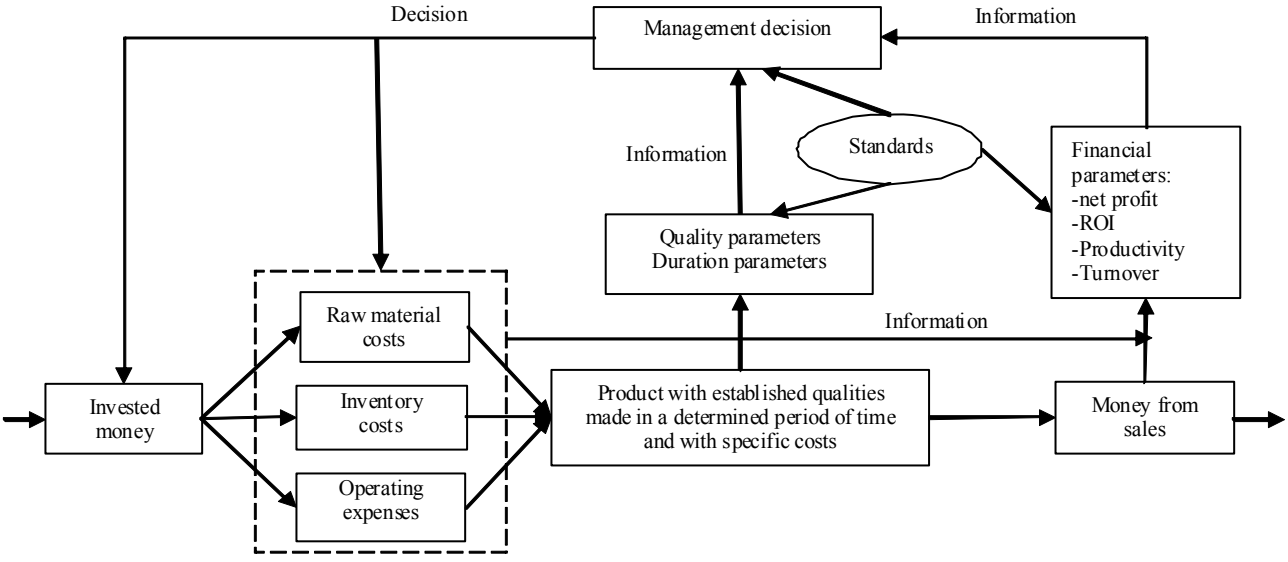

Fig. 1. Systemic approach to money and information flow in an organization (from the TOC perspective).

inventory, but also buildings, land, vehicles, plant, and equipment. It does not include the value of labor added to the Work-In-Process inventory.

- **Operating Expenses:** All the money the system spends in turning Inventory into Throughput. This includes all the money constantly poured into a system to keep it operating, such as heat, light, scrap materials, depreciation, etc.

The following four measurements are used to identify results for the overall organization:

- **Net Profit** = Throughput – Operating Expenses
- **Return on Investment (ROI)**= (Throughput – Operating Expenses) / Inventory
- **Productivity** = Throughput / Operating Expenses
- **Turnover** = Throughput / Inventory

A decision that results in increasing overall Throughput, decreasing the overall Inventory, or decreasing the overall Operating Expense for the firm will generally be a good decision for the business (Fig. 1).

A constraint is anything in an organization that prevents it from moving towards or achieving its goal. There are two basic types of constraints: physical constraints and non-physical constraints. A physical constraint is something like the physical capacity of a machine. A non-physical constraint might be something like demand for a product, a corporate procedure, an individual's paradigm for looking at the world or even inertia.

The steps in applying TOC are as follows:

- Identify the system's constraints. After their analyzing and prioritizing, establish only those that really limit system progress towards the goal.
- Decide how to exploit the system's constraints.
- Subordinate everything (all the resources) to the above decision (step 2). Practically, constraint impact can be reduced or eliminated.
- Elevate the system's constraints. If we continue to work towards breaking a constraint (also called elevating a constraint) at some point the constraint will no longer be a constraint: it will be broken.
- If the constraint is broken, return to Step 1. When that happens, there will be another constraint somewhere else in the system that is limiting progress to the goal.

The process must be reapplied, perhaps several times. It is very important not to let inertia become a constraint. Most constraints in organizations today are policy constraints rather than physical constraints.

3. PROJECT MANAGEMENT METHODOLOGY

Project management is a methodology that aims at improving the managerial process of non-routine, one-time effort limited by time, resources and performance specifications named projects. The methodology consists of four phases: definition, planning, execution and delivery. The planning phase is based on the Critical Path method (also named PERT) introduced in 1958. The next major step was made in 1997 with the Critical Chain method, with the major role of shortening project duration and resource leveling.

3.1. Project Management Scheduling Using the Critical Path Methodology

The first step is making the ***Work breakdown structure***, which establishes the principals' deliverables, the partial list of deliverables and the sub-deliverables [1].

Each sub-deliverable requires the defining of work packages that are completed by an assigned organizational unit. They are short duration tasks that have a definite duration, consume resources and involve costs. A manager is responsible for seeing that the package is completed on time, within budget and according to the technical specifications.

Some observations can be made. On the estimation of activity durations, managers tend to establish long duration (safe estimation) in order to finish the activity with a high level of certainty (Fig. 2). Even for activities with longer duration than actually necessary, work expands to fill the time given for execution (Parkinson 1957). On the other hand, it is not a sign of quality if an activity finishes before the time is up (the 3 minute egg rule). Moreover, people are waiting to start a task due to more important work at hand (the student syndrome). These realities determine long duration of the projects.

A ***Network Plan*** is a graphic flowchart of the project job plan. It presents the logical sequences and the interdependencies of the activities, their as soon as possible start and finish (Fig. 3 a). Furthermore, the network presents the slack or float of every activity. Those activities with null slack form the critical path(s) through the network. A delay in one of these activities will delay the entire project.

3.2. Project Management Scheduling Using Critical Chain Methodology

The TOC methodology applied to project management scheduling and control is known as the Critical Chain (CC) methodology (Goldratt, 1997). It gives a heuristic framework to project managers on how to plan, schedule the projects in order to minimize the duration of the projects and eliminate the over-allocation of the resources. The steps of the CC methodology start with a single project environment and continue with a multi-project environment [3].

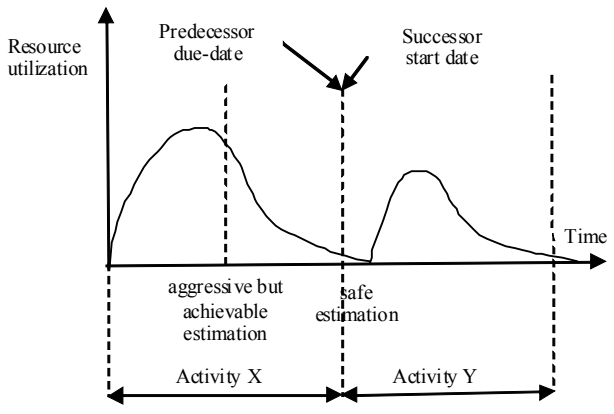

Fig. 2. Level of resource usage in critical path scheduling.

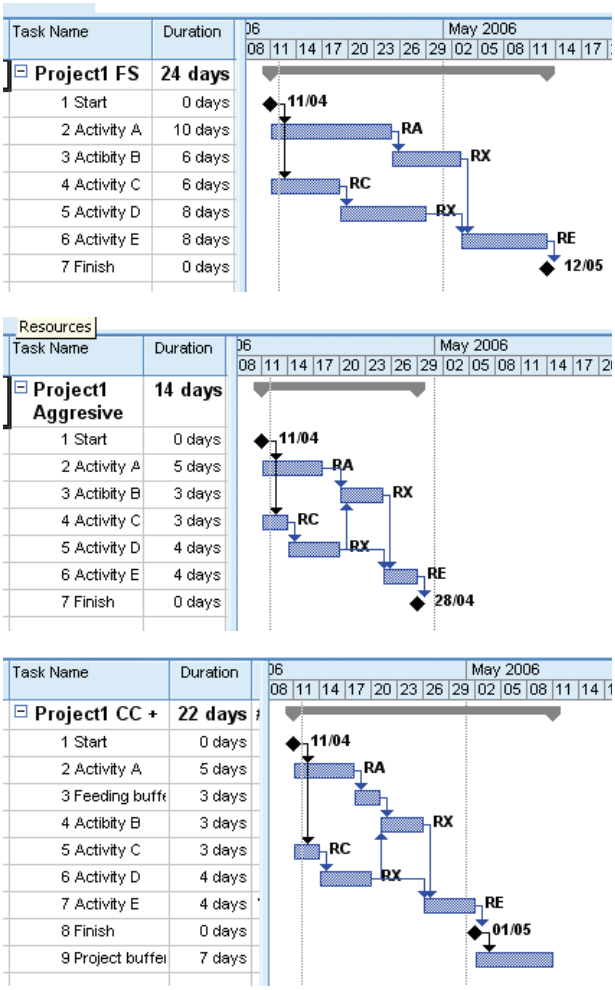

Fig. 3. Scheduling methods a – critical path methodology; safe task duration; resource RX is over-allocated; b – aggressive task durations; c – critical chain methodology with project buffer and feeding buffers; no over-allocations of the resources.

Starting with the project deliverables, the project network is constructed backwards in time with the participation of the project manager and experts. They define the minimum skills required for each task, identify the few tasks that need limited, specialist skills versus the many tasks that can be accomplished by lesser skilled personnel. This aids the reduction of resource dependencies within the project that can reduce project time.

Once the resources and required skills are defined, the network building team estimates the potential variability associated with each task and the potential iteration variability associated with specific sequences of task. Each task is characterized in terms of "highly probable" time to complete and an "aggressive, but possible" time to complete. CC methodology reduces predicted activity times (aggressive times) to their median (which ensures 50% probability of on time completion – Goldratt, 1997) (Fig. 3.b) or to their average duration (Product Development Institute 1999; Herroelen & Leus 2001).

The necessary steps of this methodology are:

- Identify the critical chain. A critical chain is a sequence of activities that determines the project duration, taking into consideration the precedence dependencies, resource constraints and iteration dependencies.
- A Project buffer, located between the end of the Critical Chain and the project's commitment date, protects the project from the effects of execution variability along the Critical Chain. A standard approach is to set the project buffer capacity to 50% of the total duration of the critical chain (Fig. 3.c)
- Feeding Buffers are placed at the end of each non critical activity chain with the aim of protecting the critical chain from variations of non-critical chain that can start early, when possible (Fig. 3.c).
- Control. Buffer monitoring provides a quick understanding of project status, which, in turn enables adaptive control. A consumption of a part of the buffer size determines some preventive managerial actions.

As a result, the duration of the project shrinks considerably, but it needs some supplementary costs for personnel training in CC methodology, which must be known by the entire team.

4. PORTFOLIO MANAGEMENT ANALYSIS

Project management methodology and software tools were originally conceived to be used in large single projects. Over the last few years it has become apparent that the vast majority of users of project management tools are involved in a number of small, similar and interrelated projects. This is known as program management or portfolio management.

There are clear differences between portfolio management and project planning. Some of the key differences are presented below.

Project planning is useful in the following cases: one project at a time; concentration on time and method; project tends to be unique, without similarities with other projects; plans may be complex, the critical path is important; there is a need to minimize demand for resources; there is a finite start and end; there is one single and precise objective; the resources tend to work full time for the project.

On the other hand, portfolio management methodology is used in the following cases: many simultaneous projects; concentration on resources; projects tend to be similar with each other; plans tend to be simple; there is a need to maximize resource usage; there is no finite start and end – there is a continuous workload; there are many different objectives.

Portfolio methodologies were created starting from both critical path projects and critical chain projects. Both of them start with single project planning, but there are some considerable differences [5].

The planning of a portofolio of projects using critical path methodology consists of the folowing stages:

- Treat each project as a single project. Each project is planned in terms of time and resources.
- Transmission of the individual project plans to a central point
- Combining the many individual plans into a portfolio plan
- Determine the inter-project conflicts and identify the problems, especially the resources over-allocation

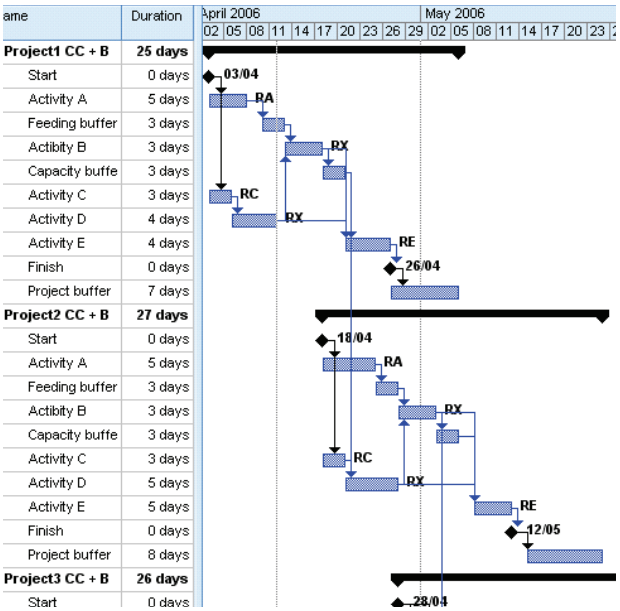

Fig. 4. Multi project scheduling using the critical chain methodology.

- Find optimal schedules for the future workload using different strategies
- The dissemination of decision taken back to the individual project teams with the modification of the individual project plans
- Regular control of the project progress. Achievement measurement through time sheets or other means provides a feedback loop to the single project plans or to the portfolio plan.

The main steps of the scheduling and control process of a portfolio management system using critical chain are the following [2]:

- Treat each project as a single project. Individually schedule each of the multi-projects using the four steps: reduce activity duration by eliminating safety margins, identify the critical chain, create a project buffer, create feeding buffers and control.
- Arrange in an alternative pattern the projects according to the bottleneck resource. First identify the bottleneck, namely the most constraining resource (often by using managerial experience). Arrange the projects sequentially in such a manner that the bottleneck will work continuously and there are no idle time (Fig. 4).
- Create a capacity buffer. A time buffer, called a capacity buffer is associated with the bottleneck and its role is to ensure bottleneck availability. The capacity buffer decouples between bottleneck activities that belong to successive projects, determining project start time.
- **Control.** Scheduling multi-projects is based on buffers (similar with the single projects). Top priority is given to critical chain activities over non-critical chain activities; secondary priority is given to activities of projects with the highest level of project buffer utilization (least slack time). Least priority is given to activities of projects with the highest feeding buffer consumption.

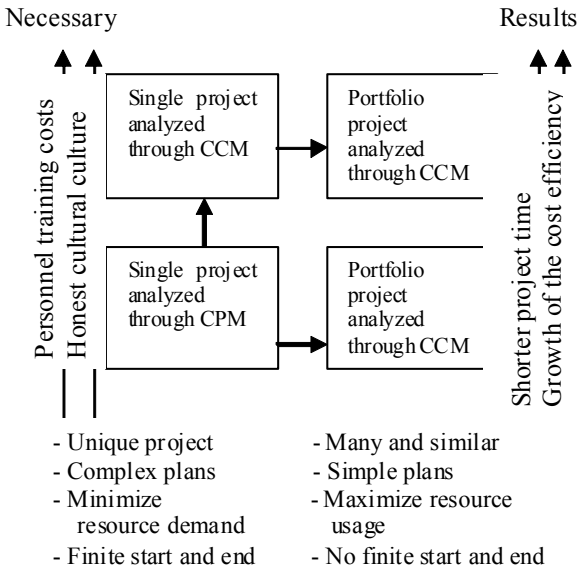

Fig. 5. Project management methodologies and their application areas (CPM – critical path methodology; CCM – Critical chain methodology).

Depending on the production type, on the organizational structure, organizational culture, financial status, the organization will choose one of the methodologies presented before (Fig. 5).

5. CONCLUSION

The paper presents a systemic approach to an organization focused on efficiency and the major trends in project and portfolio management, while underlining the situations when they are useful.

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