Decision Support System for risk management in Robust Fast Tracking Projects

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Abstract: - Modern management strategies aim for the maximum reduction of projects duration. Two schedule compression techniques are usually used, applied to activities on the critical path of course. The Crashing consists in allocating more resources on a certain activity to make it end before; in this case we obtain an increase of total project cost. The Fast Tracking (FT) reduces the project duration by anticipating the beginning of activities originally scheduled to start sequentially. This method changes the relationship of activities. With fast tracking, activities that would normally be done in sequence are allowed to be done in parallel or with some overlap. This technique involves a relevant increase of project risk that is proportional to the achieved time compression. We believe that should be convenient to anticipate the analysis of fast tracking risks to identify effective, preventive and precautionary mitigation measures. So we try to define a decision support system to identify the risk related to Fast Tracking and Robust Fast Tracking and to choose the best policy to reduce time and to mitigate risks.

Key-Words: - Management strategies, decision support system, quality, risk analysis, robust design, fast tracking.

1 Robust Fast Tracking

The increasing pressure to be first in the global market and the need to beat competitors make products delivery-time one of the most important successful factor. Technological projects are increasingly in competition over scientific aims, innovation, performance, time and cost; innovative products become quickly outdated without commercial/scientific value. So the management has to be "project-dedicated" and strategically innovative, matching the current success keys "speed and quality".

The new Fast-Tracking approach described in this paper consists in the application of risk analysis methodologies to develop flexible deliverables according to the robust design requirements. The fast-tracking strategy should be applied not only to the schedule development but especially should be foreseen and taken into account in the design development phases.

The goal of Robust Fast Tracking (RFT) [5], is to realize very flexible products designed to be easily modified and/or adapted, whenever quality failure should be noticed, with the minimum impact on time and cost. Every product is characterized by design specifications that have to be respected. A critical analysis of design about the specifications allows to detect deviations that could happen in case of fast tracking applications; in this way it is possible to analyze the deviations causes and to identify the relative corrective actions.

While fast tracking (FT) involves reduction of time with exiguous cost increase, RFT will bring up the project total cost, both in the design and in the production phase. Despite of this cost increase it will be achieved a project risk reduction. So, in practical application it will be necessary to evaluate the convenience of RFT, considering and balancing higher costs and lower risks.

In this paper we define a decision support system to choose the best strategy to reduce project duration mitigating the impact of the consequent risks. This methodology, of course, must be applied to the critical path of a project to obtain the overall reduction of time. Particularly, in this paper, the useful application to the main project phases is investigated. Anyway the results could be easily extended to any project activity.

1.1 Robust Fast Tracking: the method

In this paper is analyzed a new RFT methodology approach that essentially divides the risk in two different components, considered as the main "dimension" of the problem:

R_c: risk of cost deviation from planned,
R_t: risk of project delay.

The RFT method is composed by the following main activities:

- determination of ΔT that is the time anticipation compared to logical planning;
- critical analysis of the technical specifications and identification of possible risk scenarios, considering both causes and consequences;
- evaluation of the parameters Rc_{iFT} and Rt_{iFT}: cost and time risk factors related to FT application and identified for any specification i;

- identification of corrective and preventive actions, in the "robust" point of view;
- evaluation, for any action, of Rc_{iRFT} and Rt_{iRFT} (possible cost and time residual risks) and of C_{iRFT} (overall cost factor related to RFT application);
- evaluation of the comparative parameters, depending on to the adopted decisional policy, to verify the RFT feasibility;

The Rx_{iFT} and Rx_{iRFT} are risk factors, related to FT and RFT respectively, that will increase the whole project total risk.
Finally we observe that in any case the project total cost or risk cannot be higher than the total allowed cost C_{max} or the total allowed end date T_{max} (depending on firm policies). So, shall be always respected the following conditions:

$$\begin{aligned} T_P + Rt_{FT} &< T_{\max} \\ T_P + Rt_{RFT} &< T_{\max} \\ C_P + Rc_{FT} &< C_{\max} \\ C_P + Rc_{RFT} &< C_{\max} \end{aligned} \qquad (1)$$

Where Rx_{FT} and Rx_{RFT} are the resultant vectors of Rx_{iFT} and Rx_{iRFT} vectors, summed for any specification i.

2 Robust Fast Tracking: Risk Factors

Once risk factors related to FT and RFT have been identified, it's necessary to evaluate them in analytic way. The risk parameters, of course, depend on ΔT: the longer is the time interval of anticipation or overlapping of project phases, the higher will be the frequency and severity of deviations. In the following, anyway, we will consider a predetermined ΔT, depending on project constraints, and we will analyze the related risk.
In general terms, for any design specification, it's possible to identify the risk variables Rc_{iFT} and Rt_{iFT} that can be expressed as a function of following parameters:

- f_r : risk frequency, that is the risk likelihood,
- cs_r : cost risk severity, that is a measure of consequences of risk, in terms of project cost increase.
- ts_r : time risk severity, that is a measure of consequences of risk, in terms of project delay.

So we have:

$$\begin{aligned} Rc_{i\,FT} &= \Phi(f_r; cs_r) \\ Rt_{i\,FT} &= \Phi'(f_r; ts_r) \end{aligned} \qquad (2)$$

The evaluated risks (cost or time) are acceptable (see a typical application reported in table 1) if the resultant impact is positioned in a pre-defined zone depending on the project typology and on the socio-economical context.

Severity		Negligible	Marginal	Critical	Catastrophic
Likelihood		**1.1**	**1.3**	**1.5**	**1.7**
Frequent	**0,95**	1,045	1,235	1,425	1,615
Probable	**0,8**	0,88	1,04	1,2	1,36
Occasional	**0,5**	0,55	0,65	0,75	0,85
Remote	**0,2**	0,22	0,26	0,3	0,34
Improbable	**0,05**	0,055	0,065	0,075	0,085

Table 1: Risk Assessment [5]

Considering n specifications, the total risk related to FT, that will be added to the whole project risk, are:

$$\begin{aligned} Rc_{FT} &= \sum_{i=1}^{n} Rc_{i\,FT} \\ Rt_{FT} &= \sum_{i=1}^{n} Rt_{i\,FT} \end{aligned} \qquad (3)$$

The risk related to FT shall be compared to the RFT consequences that are:

➢ residual risks, called Rc_{iRFT} and Rt_{iRFT}, that can be expressed with the (2); it will be always:

$$\begin{aligned} Rc_{i\,RFT} &\le Rc_{i\,FT} \\ Rt_{i\,RFT} &\le Rt_{i\,FT} \end{aligned} \qquad (4)$$

So the total extra risk related to RFT, according with the (3), will be:

$$\begin{aligned} Rc_{RFT} &= \sum_{i=1}^{n} Rc_{i\,RFT} \\ Rt_{RFT} &= \sum_{i=1}^{n} Rt_{i\,RFT} \end{aligned} \qquad (5)$$

All the described parameters, of course, indirectly take into account possible risk of quality failures, that requires dedicated resources and time to be restored.

➢ an overall generalized cost/quality factor C_{iRFT} , that is function of following parameters:
dt_c : design and development phase duration increase
pt_c : manufacturing phase duration increase, related to new design
dc_c : cost increase, due to preventive design activities (robust design)

pc_c : cost increase, due the production costs of new design
p_c : performance factor, that take into account the performance loss related to design redundancy (in this case the "robustness" influences the quality/cost ratio)

$$C_{i\,RFT} = \Psi\left(dt_c; pt_c; dc_c; pc_c; p_c\right) \tag{6}$$

So the total extra cost, in this case, will be:

$$C_{RFT} = \sum_{i=1}^{n} C_{i\,RFT} \tag{7}$$

The (7) allows to evaluate the cost that will be surely paid to apply the RFT, while the risk evaluated with the (5) and (3) express a forecast, that should happen in the worst case.

3 Decision support system for risk management

Once defined for any specification the five factors (Rc_{iFT}; Rc_{iRFT}; Rt_{iFT}; Rt_{iRFT}; C_{iRFT}), it's possible to decide if the RFT should be applied or not, on the base of a quantitative evaluation of its risk reduction and of its cost.
To better describe the involved parameters, should be useful to draw some qualitative graphs, showing project cost-time diagram including the representation of the related risks.
For an easier look, we suppose there is a project of just two macro-phases: design (including prototyping, test & qualifying) and production. Between these phases we hypothesize a FT application without any consequences on project total cost. In the graphs are shown these parameters:

- T_p: project time: the forecasted completion time, without FT
- C_p: project cost: the forecast about all resources needed to complete the project, without FT
- R_p: project risk: the forecast, made at time zero, on the uncertainty about project deviations compared to initial planning (in terms of quality, cost and time)
- T_{max}: maximum project duration: time limit depending on market conditions, firm policy etc.
- C_{max}: maximum project cost as imposed by firm management

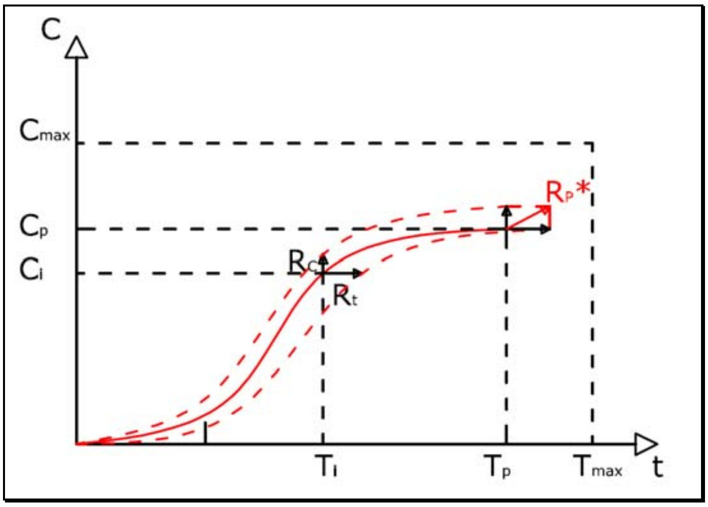

Fig. 1: Project cost trend and risk vectors

In figure 1 the red line shows a typically project time-cost diagram. However for any hypothetic time project status it is possible to evaluate the risk vectors R_C e R_t representing the maximum foreseen deviation, in terms of project cost and time delay, with respect of the initial planned values. The project time-cost diagram so is no longer a single line, but is better represented by the area included by the two dashed lines.

Of course the actual deviations should be an aliquot of the risks evaluated at the project start time, so for any point *i* of the project we have:

$$\begin{aligned} \overline{T}_i &= T_i + \alpha \cdot R_t(i) \\ \overline{C}_i &= C_i + \alpha \cdot R_C(i) \end{aligned} \tag{8}$$

where:
$\overline{T}_i$ is the actual time referred to the project status i
$\overline{C}_i$ is the actual cost referred to the project status i
α is a coefficient, between 0 and 1, representing the risk aliquot actually occurred.

So, taking into account all the previous assumptions, and considering as example the project status specified by the point *i* (*Ti*, *Ci*), we have that, due to the intrinsic risks of the project, the project status should be positioned in any point of the rectangle having *Rc* and *Rt* as bases.
The maximum total risk for the project R_P* is consequently defined as the sum between the two vectors R_C e R_t.
The same diagram is shown in figure 3 for the FT application to the project and in figure 4 for the RFT case.

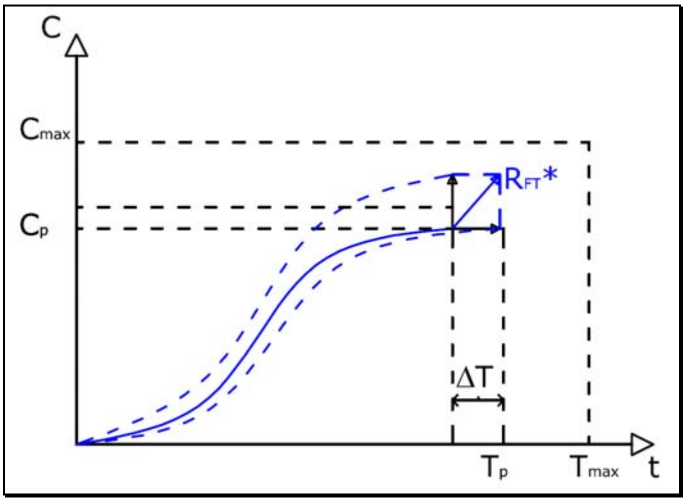

Fig. 2: Risk vectors for FT project

As shown in figure 2, when the FT is applied to the project a shorter time to complete the project is achieved but a higher global risk will affect the forecast, especially in terms of cost.

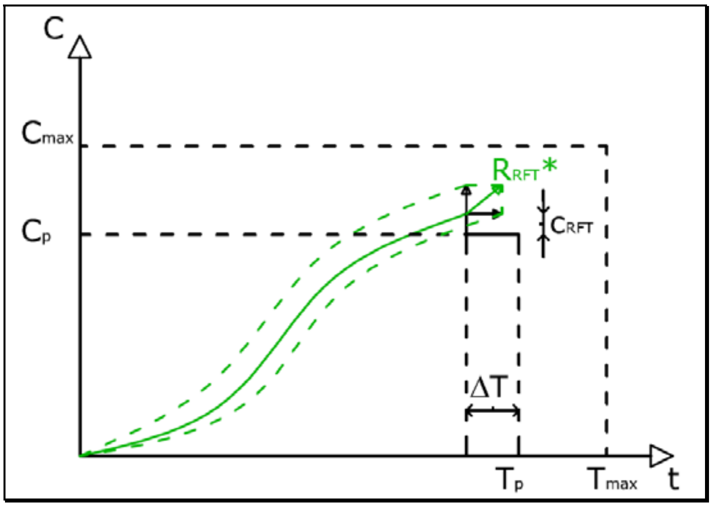

Fig. 3: Risk vectors for RFT project

In case of RFT application the risks are mitigated, as reported in (4), and $R^*_{RFT} < R^*_{FT}$, but the actual project costs should be higher due to the C_{RFT} occurrence (in any case the total cost must be less than C_{max}).

4 Decision policy

The advantage of RFT method so depends on the specific project and on the socio-economical context; in each case it will be necessary to evaluate the time-cost diagrams, see figure 5, and, applying the risk vectors described before, make a choice on the base of a benefit-cost analysis.

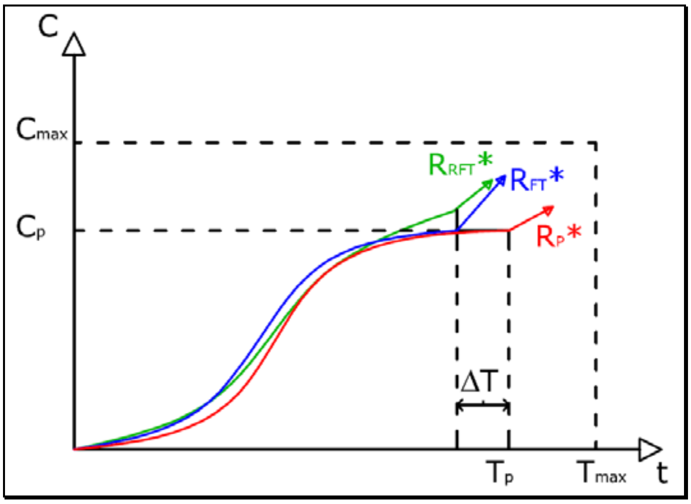

Fig. 4: Comparing risk vectors (Case 1)

Taking into account that the risk vector bring the last point of the graph in a position that individuate the maximum cost and time the project probably will get,
it's possible to identify two cases:

1. R^*_{RFT} vector reach a point that is <u>below</u> the point reached by R^*_{FT} , both in time and in cost (as shown in figure 4; in this case, obviously, the RFT strategy is convenient and shall be applied;
2. the R^*_{RFT} vector reach a point that is <u>below</u> the point reached by R^*_{FT} with respect to time, but <u>above</u> it with respect to cost (as shown in figure 5.

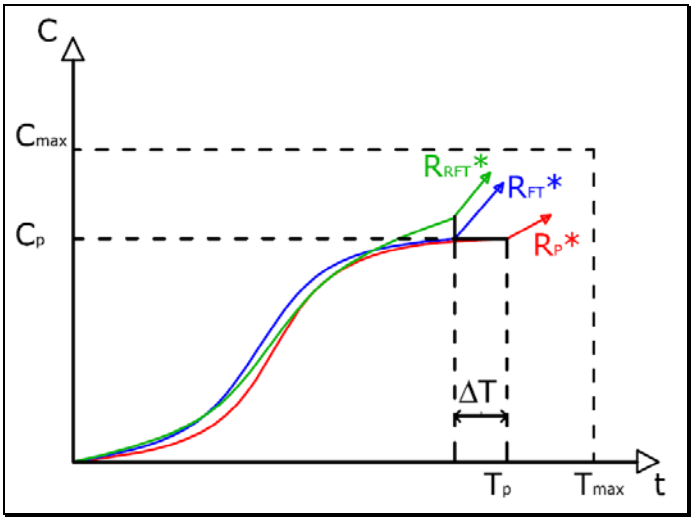

Fig. 5: Comparing risk vectors (Case 2)

While in the first case the decision is obvious, in last case the decision will depend on the relevance that time and cost have for the project purposes.
So, comparison between risk vectors should be leaded not only between resultants R^*, but also with respect to the single time risk and cost risk components; in fact, it could be more important, depending on project typology, to avoid time delays than extra cost, or vice versa.

For instance, if time reduction is much more important than cost, we should accept a higher risk of cost related to RFT application, in any case lower than C_{max}, to achieve a lower risk related to time delay. This is a very common case (that often requires the FT application) in the consumer electronics new products (tv, hifi systems, mobile phones, etc), where the key success is to beat competitors in the time-to-market.
In any case in the risk vectors comparison we didn't consider two possibilities that exclude a priori the application of RFT or FT:

- risk vectors bring to a point above C_{max} or T_{max} (unfeasibility);
- risk vectors bring to a point above R^*_P (RFT or FT application doesn't make sense).

When the decision policy depends on a lot of articulated factors and it is improbable to have effective response directly from the diagram, it is possible to operate in an analytic way.

In this case we propose two new parameters:

- M_C , cost magnification factor, that express the ratio between the cost of the project including RFT and the cost of the project without any fast tracking:

$$M_C = 1 + \frac{C_{RFT}}{C_p} \qquad (8)$$

- F_{TR} , time risk reduction factor, that express the ratio between the project delay risk with FT and the project delay risk with RFT:

$$F_{TR} = \frac{(Tp - \Delta T) + Rt_{FT}}{(Tp - \Delta T) + Rt_{RFT}} \qquad (8)$$

These factors are both higher than 1 and have an upper bound because of the feasibility constraints expressed in (1).
Risk and decision policy are included in the following condition:

$$\frac{F_{TR}}{M_C} \geq X_c \qquad (8)$$

Where X_c, named convenience parameter, shall to be defined for each specific project. It is proportional to the significance of cost and, on the other hand, it's in inverse proportion to planning compliance importance.

5 Future developments

Applying risk analysis to projects makes it possible to evaluate the convenience of FT and RFT. Next studies should be carried on to apply the proposed method to real projects.
In this paper we used to consider a predefined time reduction ΔT. An open issue that has to be deepened is the study of the influence of ΔT on the risk vectors, because, off course, they strictly depend on the interval of time reduction.

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