MASARYK UNIVERSITY
FACULTY OF ECONOMICS AND ADMINISTRATION
MPH_AOPR Operations Research and ERP

Operations Management: seminar work related to

# *Utilization (application) of the Theory of Constraints (TOC), Critical Chain Project Management (CCPM) as a Project Management Methodology based on TOC principles.*

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## 1. Project Description

During this seminar work I will analyze a team project of business process optimization that is a homework assignment for MPH_BUPM Business Process Management course.

The goal of the team project (team consists of 4 students) is to conduct a process analysis in an organization. The structure of team project is presented in table 1.

Table 1 – Structure of team project.

| **Part of the team project** | **Description** |
|---|---|
| Introduction | – the content of the project;<br>– reasons for choosing the organization (enterprise). |
| Description of methodology | – how did you perform the analysis?<br>– retrieved and analyzed data<br>– which software did you used?<br>– how did you spread the work among team members |
| Description of the organization (enterprise) | – location;<br>– size;<br>– business model;<br>– financial condition;<br>– etc. |
| Process architecture | – to create a value chain diagram/ Enterprise Architecture diagram. |
| Model of two core (primary) processes | – to describe in detail two core (primary) processes and model them according to BPMN. |
| Analysis of on core (primary) process and its optimization (possibly with simulation) | – choose one primary process;<br>– analyze it;<br>– re-design;<br>– reason, simulate and justify its optimization. |
| Conclusions | – summary. |

The projects will be assessed according to the following criteria:

- The overall quality of the text and reasoning = 8 points
- The precision of organization description = 4 points
- Quality of process architecture = 8 points
- Model of one core (primary) process and description = 5 points each (you are supposed to make at least two of them)
- Optimization of one process = 8 points
- Quality of the presentation and defense = 12 points
- Quality, clarity and completeness of the presentation = 4 points
- Ability to answer questions = 8 points

## 2. Theory of Constraints Implementation for the Project Planning

How would you apply CCPM and TOC tools (e.g. CRT=Current Reality Tree) for the planning of your project (writing the dissertation is, in fact, a project)? Can you name the main project risks?

30 % of the volume might be a description of the used theories, which will be used as a bridgehead for practical part of the work. You have to mention list of used resources at the end of your work. I expect links (relations) from seminar work body to list of resources, meaning to indicate which texts were taken from which literature (internet resources).

### Theory of Constraints

**Theory of Constraints (TOC)**, invented by Dr. Eliyahu Goldratt, is a «business philosophy which seeks to strive towards the global objective, or goal, of a system through an understanding of the underlying cause and effect dependency and variation of the system in question» (A Guide to Implementing the Theory of Constraints).

The algorithm of TOC implementation is described in table 2.

Table 2 – TOC implementation algorithm.

| Rules of Engagement | Focusing steps |
|---|---|
| (1) Define the system. | |
| (2) Define the goal of the system. | |
| (3) Define the necessary conditions. | |
| (4) Define the fundamental measures. | |
| (5) Define the role of the constraints. | (1) Identify the system's constraint(s). |
| (6) Define the role of non-constraints. | (2) Decide how to Exploit the system's constraint(s). |
| | (3) Subordinate everything else to the above decision. |
| | (4) Elevate the system's constraint(s). |
| | (5) Go back to step 1. Don't stop. |

For most of commercial companies' goal is to make more money now as well as in the future (A Guide to Implementing the Theory of Constraints). Based on the goal we can define measurements that should enable managers to judge whether a local decision has an impact of the global goal (A Guide to Implementing the Theory of Constraints).

The main measurements of TOC are as follows:

- **Throughput** is the rate at which the system generates money through sales.
- **Inventory** is all the money that the system invests in purchasing things which it intends to sell.
- **Operating expense** is all the money the system spends in order to turn inventory into throughput (Goldratt, 2014).

The following measurements can be derived from the basic three ones observed above:

- **Net Profit** is Throughput less Operating Expenses;
- **Return of Investment (ROI)** is Net Profit divided by Inventory;
- **Productivity** is Throughput divided by Operating Expenses (A Guide to Implementing the Theory of Constraints).

Most real systems could be seen in such a way, that there are only a few or better only one element (factor), which is the key point, where and only there all possible managerial methods have to be focused in order to control the whole system. These elements in TOC is called constraints of the system or bottlenecks (A Guide to Implementing the Theory of Constraints). To say it in another words, bottleneck is any resource with capacity that is equal to or less than the demand placed upon it.

A physical constraint, might be a resource, either a person or a machine, or a material of some kind, time or quality, or supply issues. A policy constraint is almost everything else that is non-tangible.

Throughput of the whole system is equal to throughput of its constraint, which means that in order to increase the whole system's throughput efforts should be concentrated on increasing its bottleneck's throughput. Which leads us to the 5 focusing steps, described in table 3.

Table 3 – 5 Focusing Steps of TOC.

| Focusing Step | Description |
|---|---|
| (1) Identify the system's constraint(s). | We can identify the system's constraint (especially physical one) by asking people who do have responsibility for making sure that orders or work are delivered on time (A Guide to Implementing the Theory of Constraints). |
| (2) Decide how to Exploit the system's constraint(s). | Exploit means that once a constraint has been identified, all efforts must be made to properly utilize the capacity of the constraint – to make the very best of the existing situation using the resources that are at hand. Exploitation of a constraint can be seen either as proper utilization of the constraint's capacity or as eliminating waste using Lean approach. |
| (3) Subordinate everything else to the above decision. | It has to be ensured that the subsystems are subordinated to the system.<br>Often the most important part of subordination isn't just ensuring that we do what is supposed to be done; it is ensuring that we don't do what is not supposed to be done. Making sure that we don't find work for non-constraints just to keep them busy is a particularly important example of active restraint. It avoids the waste of stock-on-hand. |
| (4) Elevate the system's constraint(s). | Elevation is the stage at which additional resources are being brought to raise the capacity of the constraint. This action requires some operating expense and/or investment. The intention is to leverage off the constraint so that a small elevation results in a substantial increase in output. |
| (5) Go back to step 1. Don't stop. | Once a constraint has been broken then another one will arise. When managers do break a constraint, they should be careful not to let their satisfaction with the new level of performance stop them from seeking out even higher levels of performance. |

## TOC Thinking Tools

To support first 4 focus steps of TOC various thinking tools can be used. Connection between focus steps and supportive thinking tools is described in table 4.

Table 4 – Connections between 1st 4 focus steps and thinking tools.

| Focus steps | Thinking tools |
|---|---|
| (1) Identify the system's constraint(s) | Current reality tree |
| (2) Decide how to Exploit the system's constraint(s). | Evaporating cloud |
| (3) Subordinate everything else to the above decision. | Future reality tree |
| (4) Elevate the system's constraint(s). | Critical Chain Project Management |

To identify the system's constraint(s) methods that are out of the scope of TOC can be used. For instance, it could be Ishikawa fishbone diagram, Kepner-Tregoe methodology, 5 Whys methodology etc.

### Current Reality Tree

**A Current Reality Tree (CRT)** is a cause-effect logic diagram constructed with "sufficient cause" reasoning that is used to establish a stream of logical relationships that link the core conflict with the UDEs (Ronen, 2005).

The CRT is used to pinpoint the core driver – a common cause for many effects. The most common use is to identify a core problem, which can be thought of as the invisible constraint responsible for many of the system's current problems. ... Constructing the tree is a process that leads to the recognition of the behavioral patterns of the conditions existing in the reality of the system. It is a tool that allows to see order even in the midst of chaos" (Scheinkopf, 1999). Before creating the diagrams, any and all possible information is collected; what issues the inspected company deals with, what its pains are, and what the corporate goals are. These topics can be described with the as-is model, and the information is therefore transcribed into the CRT. The diagram does not represent any reality, but as is the case with the other diagrams, shows relationships based on the cause-consequence paradigm, where undesirable effects in unison create the final problem being addressed by the diagram. Backtracking these consequences to their cause, the single core problem, or the bottleneck, is determined. The CRT construction process contains the following steps: 1. Determine the scope of the analysis 2. List between 5 to 10 pertinent entities 3. Diagram the effect-cause-effect relationships that exist among the entities. 4. Review and revise for clarity and completeness 5. Apply the "so what" test. 6. Identify the core cause(s) (Scheinkopf, 1999).

The CRT construction process contains the following steps (Scheinkopf, 1999):

1. Determine the scope of the analysis;
2. List between 5 to 10 pertinent entities;

3. Diagram the effect-cause-effect relationships that exist among the entities. 4. Review and revise for clarity and completeness;
4. Apply the "so what" test;
5. Identify the core cause(s).

## Evaporating Cloud

**The Evaporating Cloud (EC)** is “by far the most often used of the thinking processes. This may be due to the fact that it is the easiest of the tools to learn. The cloud only has five entities, and it takes just a few minutes from start to finish. The tool is used for conflict resolution, and one thing we humans are not short on is conflict" (Scheinkopf, 1999). The EC is responsible for a majority of the identified UDEs (Ronen, 2005). The second diagram, the EC, shows different approaches to solving a problem. Each approach eliminates the other, while both attempt to reach the same goal. The first diagram, CRT, shows the current state, while the EC requires commitment to the path that management chooses and based on which consequences justifies its success.

The process of EC creation is (Scheinkopf, 1999):

1. Articulate the problem and diagram the cloud;
2. For each arrow, uncover assumptions and identify potential solutions, using the necessary condition thinking process;
3. Choose an injection to implement.

## Future Reality Tree

**The Future Reality Tree (FRT)** is a tool for logically visualizing the future through systematic transformation of the CRT. It presents the results from the planned implementation of healing injections that will eliminate the core conflict (Ronen, 2005). The third diagram shows the future state and how it can be achieved. Based on the chosen strategy in EC, "healing injections" are used to enable processes causing the shift towards the desired state, achieved at the top of the FRT. The diagram also heavily relies on the logical relationships of individual elements as well as their causality. The approach is purely theoretical, on higher levels of abstraction and assumes an ideal context. As a model, it however perfectly translates the situation, needs, and progress to the stakeholders. Every single decision we make, every single action we take, will change something in the future. The FRT is a tool for visualizing and predicting the future.

The FRT contains four parts:

1. Injections are always entry points to the tree. They are entities that do not exist in the system's current reality, and are distinguished from other entities by their squared corners.
2. Entities that do currently exist in the system’s reality. In FRT, this type of entity will usually be entry points and is typically not found in the body of the tree.
3. Entities that do not yet exist in the system. When entities that currently exist (2.) are combined with injections (1.), the (3.) entities will exist in the future.
4. Reinforcing loops are often placed in future reality trees, as a means to create patterns of sustained and continuous improvement (Scheinkopf, 1999).

The steps to making the FRT are:

1. Define the basis for the tree.
   a) Identify an injection (idea).
   b) List the objectives (pro's) of the injection.
   c) List potential undesirable consequences (con's) of the injection.
2. Describe the effect-cause-effect relationships.
   a) Using sufficient cause thinking, connect the injection to the objectives.
   b) Seek and block potential undesirable consequences of the injection.
3. Enhance the solution.
   a) Predict additional effects.
   b) Add reinforcing loops (Scheinkopf, 1999).

## Critical Chain Project Management

In TOC the Critical chain is defined as the longest way (meaning time) from the starting point of the project graph (Gantt) to the ending point which takes into account technological dependencies as well as time of the tasks and moreover, capacities of assigned resources.

Critical Chain Project Management is the Theory of Constraints logistical application for project operations. It is named after the essential element; the longest chain of dependent resourced tasks in the project. The aim of the solution is to protect the duration of the project, and therefore completion date, against the effects of individual task structural and resource dependency, variation, and uncertainty (A Guide to Implementing the Theory of Constraints).

As well as in Theory of Constraint itself, 5 focusing steps for determining the process of change are suitable for describing CCPM methodology (Table 6).

Table 6 – 5 Focusing Steps of Critical Chain Project Management.

| Focusing Step | Description |
|---|---|
| (1) Identify the system's constraint(s). | The critical chain, which is the longest chain of dependent events, must be identified on this step. |
| (2) Decide how to Exploit the system's constraint(s). | The goal of theses 2 steps is to figure out how to achieve the same project's outcome in less time. Buffer management should be used to achieve it. The description of buffer management methodology will be provided later in the seminar work. |
| (3) Subordinate everything else to the above decision. | |
| (4) Elevate the system's constraint(s). | See table 2. |
| (5) Go back to step 1. Don't stop. | |

## 3. Project Risks and Undesirable Effects

Do you know how to diminish (to reduce) these risk factors (to avoid obstacles)? Name at least ten obstacles! If dissertation work is not chosen by you, see my comment below.

Can you specify by use of Thinking Process Tools Your bottleneck as far as studying processes or writing work or working on assigned school tasks (by other tutors) is concerned? Create CRT (see full meaning above) and create a list of Undesirable Effects (named by You as it was mentioned already in clause 1)

Create with use of already existing set of UDE´s Ishikawa fishbone diagram and put some weights meaning numbers specifying the importance of assign reasons. It was clearly shown in Ishikawa FBD power-point presentation. Based on the set of assigned score, create Pareto Lorenz curve (use Excel please). The principle is also shown in just mentioned presentation. Specify most important reasons. Compare with root problem found by use of Current Reality Tree.

According to PRINCE2 methodology, a **risk** is "an uncertain event or set of events that, should it occur, will have an effect on the achievement of objectives" (AXELOS, 2009). In frames of seminar work we will perceive risk only as threats. **Threat** is used to describe "an uncertain event that could have a negative impact on objectives" (AXELOS, 2009).

In the context of a project, it is the project's objectives that are at risk. These will include completing the project to a number of targets, typically covering time, cost, quality, scope, benefits and risk (AXELOS, 2009).

There are 5 **aspects of project performance** (except risk) to be measured:

1. **Costs** – The project has to be affordable and, though we may start out with a particular budget in mind, there will be many factors which can lead to overspending and, perhaps, some opportunities to cut costs.
2. **Timescales** – Allied to this, and probably the next most-frequent question asked of a Project Manager, is: 'When will it be finished?'
3. **Quality** – Finishing on time and within budget is not much consolation if the result of the project doesn't work. In PRINCE2 terms, the project's products must be fit for purpose.
4. **Scope** – Exactly what will the project deliver? Without knowing it, the various parties involved in a project can very often be talking at cross-purposes about this. The customer may assume that, for instance, a fitted kitchen and/or bathroom is included in the price of the house, whereas the supplier views these as 'extras'. On large-scale projects, scope definition is much more subtle and complex. There must be agreement on the project's scope and the Project Manager needs to have a detailed understanding of what is and what is not within the scope. The Project Manager should take care not to deliver beyond the scope as this is a common source of delays, overspends and uncontrolled change ('scope creep')
5. **Benefits** – Perhaps most often overlooked is the question, 'Why are we doing this?' It's not enough to build the house successfully on time, within budget and to quality specifications if, in the end, we can't sell or rent it at a profit or live in it happily. The Project Manager has to have a clear understanding of the purpose of the project as an investment and make sure that what the project delivers is consistent with achieving the desired return (AXELOS, 2009).

According to PRINCE2 methodology, a risk is "an uncertain event or set of events that, should it occur, will have an effect on the achievement of objectives" (AXELOS, 2009). In frames of seminar work we will perceive risk only as threats. Threat is used to describe "an uncertain event that could have a negative impact on objectives" (AXELOS, 2009).

Table 7 – Project performance measures for business process optimization team project.

| Project performance measure | Description for team project |
|---|---|
| Costs | - |
| Timescales | To deliver until 12.12.19 |
| Quality | Consistency, usage of recommended methods. |
| Scope | From "Identification" to "Redesign" (see Table 1 and Fig. 1). |
| Benefits | To get BPM competencies. |

From the table 1 and assessment criteria stated in Chapter 1 of the seminar work, we can conclude that the objective of the BPO project is to deliver required documents (thesis and PowerPoint presentation) it in time, at the right scope and quality. Thus, main risks for team project are not to deliver project (a) in time, (b) at proper quality and (c) within scope. And from the student's point of view, the main risk (that can be caused by main project risks) is to get a low grade at the course.

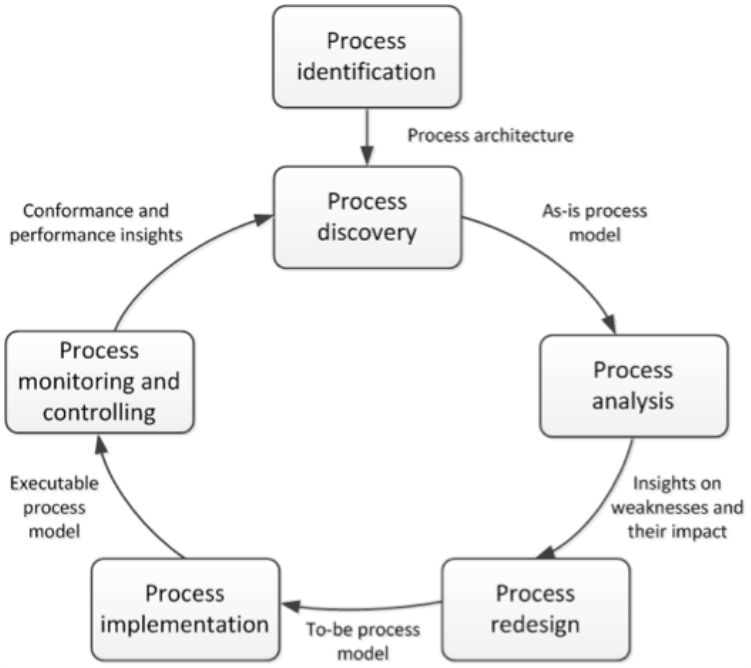



Fig. 1 – Business Process Management Lifecycle (Dumas, 2013)

List of Undesirable Effects (UDEs) can be created as soon as we know main risks of the project. UDEs of the project are as follows:

1. To get a low grade;
2. Low quality of project – stated quality conditions haven't been fulfilled or have been fulfilled partly;

3. Missing deadline – project's products has been delivered later than 12.12.19;
4. Not enough time to deliver project within scope;
5. To deliver project beyond the scope;
6. Poor project planning;
7. Poor project execution;
8. High amount of rework;
9. People involved in project are unavailable;
10. To do work that is out of project's scope;
11. Issues with project's products' safety – documents to be developed and up-to-date versions of them could be deleted either by incaution or due to problems with PC;
12. Bad communication;
13. Not enough competencies to do work properly (i.e., within stated timescales and quality requirements).

Based on list of UDEs Current Reality Tree has been developed. See Appendix 1.

Following UDEs have been identified in the process of CRT development:

1. Personal issues of team members;
2. Bad multitasking;
3. Not enough preparation;
4. Not enough information.

From the CRT, we can conclude that the project has two bottlenecks:

1. Poor project planning;
2. Issues with project's products' safety.

These UDEs influence the result the most and must be eliminated at first.

UDEs identified during the CRT development could also be presented in Ishikawa Fishbone Diagram (Fig. 2).

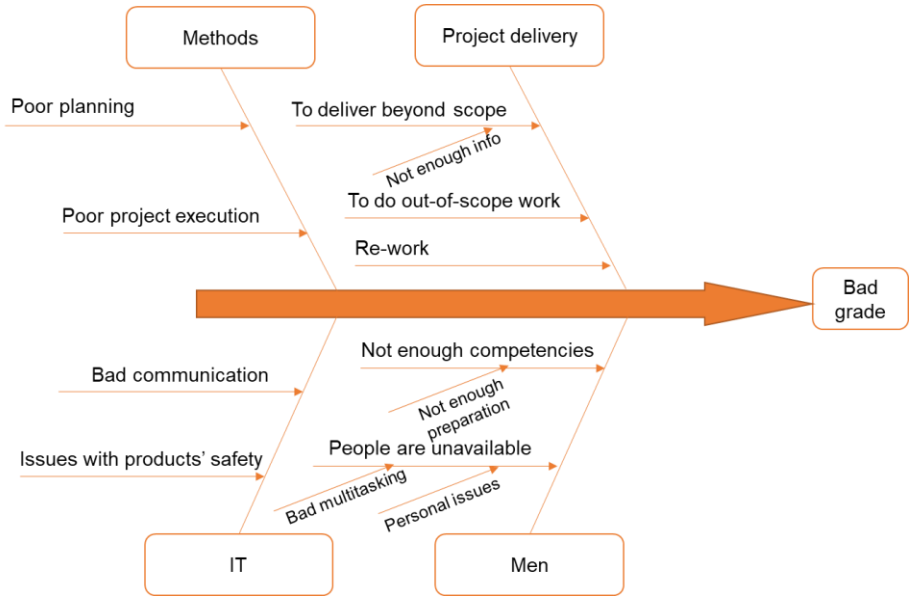



Fig. 2 – Ishikawa Fishbone Diagram

Then, to create Pareto Lorenz Curve (Fig. 3) all the UDEs should be assessed. The assessment is represented in table 8.

Table 8 – UDEs assessments.

| № | UDEs | Measurements | | | | | | | | Total score weight | **Share** | **Lorenz cumu-lative curve %** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Impact to the goal | | | level in CRT | **Level score** | Trig-gers | **Triggers score** | Level of control | | | |
| | | Time | Quality | **Total** | | | | | | | | |
| | | 1 - yes; 0 - no | | | | (6)/5 | | ABS[(8)-3]/3 | 1 - yes; 0 - no | | | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| 1 | Poor project planning | 1 | 1 | **4** | 5 | **4** | 0 | **3** | 1 | 12,0 | 12,7% | 12,7% |
| 2 | Issues with project's products' safety | 1 | 0 | **2,64** | 4 | **3** | 0 | **3** | 1 | 9,6 | 10,2% | 22,9% |
| 3 | Bad multitasking | 1 | 0 | **2,64** | 4 | **3** | 0 | **3** | 0,5 | 9,1 | 9,7% | 32,5% |
| 4 | To do work that is out of project's scope | 1 | 0 | **2,64** | 3 | **2** | 0 | **3** | 1 | 8,6 | 9,1% | 41,6% |
| 5 | Personal issues of team members | 1 | 0 | **2,64** | 4 | **3** | 0 | **3** | 0 | 8,6 | 9,1% | 50,8% |
| 6 | Poor project execution | 1 | 0 | **2,64** | 4 | **3** | 1 | **2** | 0,8 | 8,4 | 8,9% | 59,7% |
| 7 | Bad communicat ion | 1 | 0 | **2,64** | 4 | **3** | 1 | **2** | 0,8 | 8,4 | 8,9% | 68,6% |
| 8 | Not enough preparation | 0 | 1 | **1,36** | 3 | **2** | 1 | **2** | 0,5 | 5,9 | 6,2% | 74,8% |
| 9 | People are unavailable | 1 | 0 | **2,64** | 3 | **2** | 3 | **0** | 0,5 | 5,1 | 5,4% | 80,2% |
| 10 | Re-work | 1 | 0 | **2,64** | 3 | **2** | 3 | **0** | 0,5 | 5,1 | 5,4% | 85,7% |
| 11 | Not enough competencie s | 0 | 1 | **1,36** | 2 | **1** | 1 | **2** | 0,5 | 4,9 | 5,1% | 90,8% |
| 12 | Not enough information | 0 | 1 | **1,36** | 3 | **2** | 2 | **1** | 0,5 | 4,9 | 5,1% | 95,9% |
| 13 | To deliver the project beyond scope | 0 | 1 | **1,36** | 2 | **1** | 2 | **1** | 0,5 | 3,9 | 4,1% | 100,0 % |
| **TOTAL** | | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | 94,66 | 94,7 | X |

Based on data from table 8, Pareto Lorenz Curve has been created (Fig. 3).

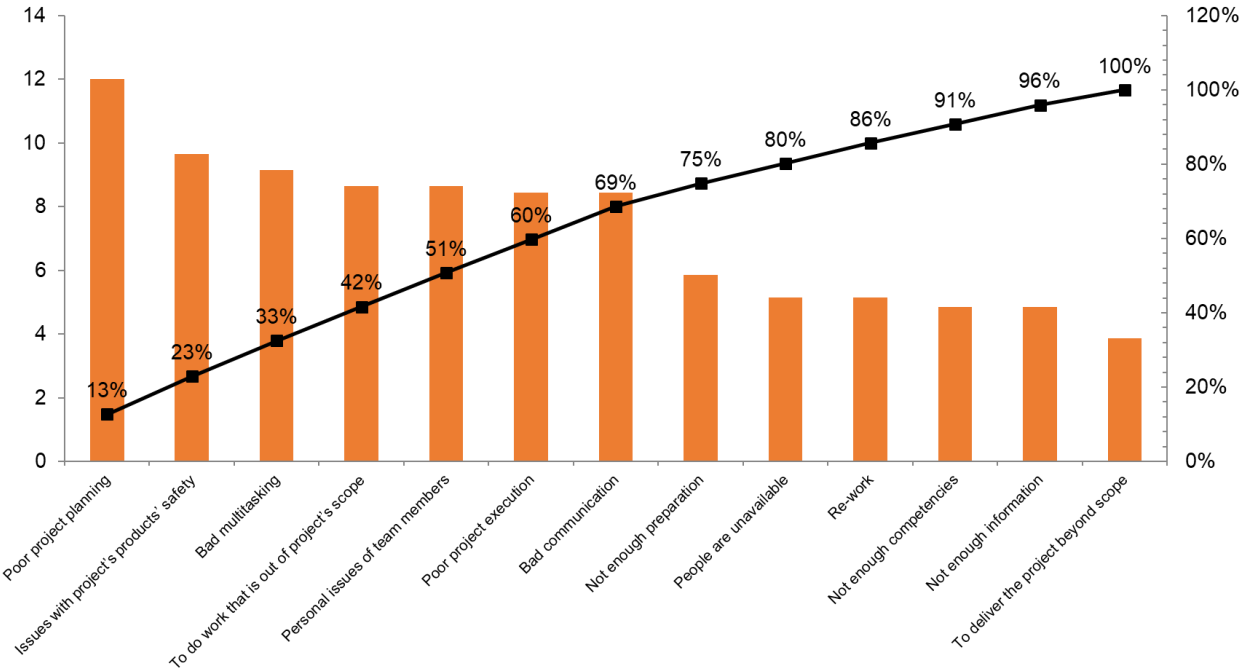



Fig. 3 – Pareto Lorenz Curve

From the Pareto Lorenz Curve it is visible, that 9 of 13 assessed UDEs do 80% of impact on project goals. And as soon as 5 out of mentioned 9 are caused by the rest 4, managerial efforts should be concentrated on these 4: poor project planning, Issues with project's products' safety, bad multitasking and personal issues of team members. Last one is out of control, which means that to improve the project delivery process we should figure out how to manage with poor project planning, issues with project's products' safety and bad multitasking.

## 4. Critical Chain Project Management

What kind of effects do you expect by possible using buffers (time buffers) during the working out of your thesis (dissertation or other chosen project)? Can you explain what the time buffer is? What is project buffers its penetration? How you can measure reached results (used metrics such as time, resource capacity, costs, good-will and so on).

Buffer management consists of four main functions (Buffer management: Determine whether expediting is necessary):

1. Prioritize tasks/orders based on buffer penetration/consumption.
2. Signal when to expedite individual tasks/orders that are at risk (normally identified by penetrating the red zone of the buffer).
3. Provide feedback to the planning process to consider changing certain parameters, like buffer sizes or even take more drastic actions like adding capacity.
4. Identify prime causes of delay to focus ongoing improvement activity.

Buffer is the accepted level of variance that is set for task completion time.

Let's determine buffer management implementation algorithm using first 3 out of 5 TOC focusing steps for determining the process of change.

### Step 1. Identify

Work on project starts 01.10.19. The required date to finish is 12.12.19. So, the maximum project duration is 72 days. There are 4 people involved in project development. Those people would be project "resources". There is no need in other resources, because all the product delivered are information. It is also important to add, that since all the resources we get are people – it means that they are always capable. The natural and inevitable restriction is that quantity of people in the team must be up to 4.

Project schedule with allocated resources is presented in table 9 and Figure 4.

Table 9 – Project schedule on the "identify" step.

| № | Task | Resource | Duration | Deadline |
|---|---|---|---|---|
| 1 | Describe strategy and strategic goals | Elena Mikhail | 8 | 08.10.2019 |
| 2 | Finish process landscape model | Elena Mikhail | 8 | 15.10.2019 |
| 3 | Finish as-is models of 2 chosen processes | Mikhail Jana | 8 | 22.10.2019 |
| 4 | Analyze processes | Michaela Elena | 16 | 06.11.2019 |
| 5 | Optimize chosen process | Mikhail Jana | 8 | 13.11.2019 |
| 6 | Finish "team project.doc" | ALL | 8 | 20.11.2019 |
| 7 | Finish draft presentation | ALL | 8 | 20.11.2019 |
| Duration of critical chain | | | 56 | X |

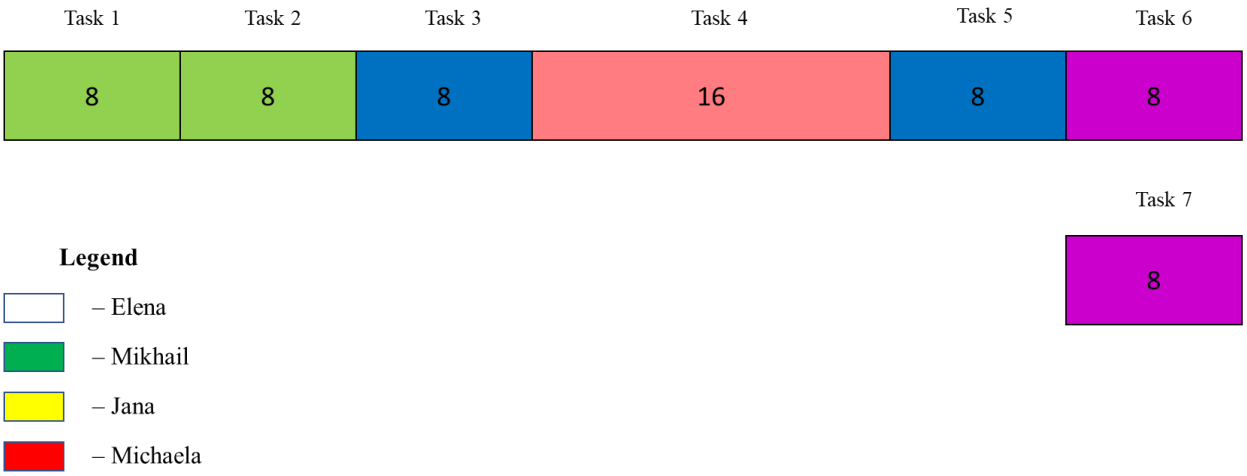



Fig. 4 – Project schedule on the "identify" step

During the "Identify" step plan has been leveled according to the resources. We have identified the critical chain, the longest chain of dependent variables; both resource and structural, and hence the shortest duration in which we can safely hope to complete the project.

## Step 2. Exploit

The only way the timeline of project can be exploited is to achieve the same outcome in less time.

According to generic configuration for Critical Chain Project Management, we can safely reduce the total project duration, the total touch time, to 75% of the initial estimate.

The updated schedule is presented in table 10 and Figure 5.

Table 10 – Project schedule on the "Exploit" step.

| № | Task | Resource | Duration | Deadline |
|---|---|---|---|---|
| 1 | Describe strategy and strategic goals | Elena<br>Mikhail | 6 | 06.10.2019 |
| 2 | Finish process landscape model | Elena<br>Mikhail | 6 | 11.10.2019 |
| 3 | Finish as-is models of 2 chosen processes | Mikhail<br>Jana | 6 | 16.10.2019 |
| 4 | Analyze processes | Michaela<br>Elena | 12 | 27.10.2019 |
| 5 | Optimize chosen process | Mikhail<br>Jana | 6 | 01.11.2019 |
| 6 | Finish "team project.doc" | ALL | 6 | 06.11.2019 |
| 7 | Finish draft presentation | ALL | 6 | 06.11.2019 |
| Duration of critical chain | | | 42 | X |

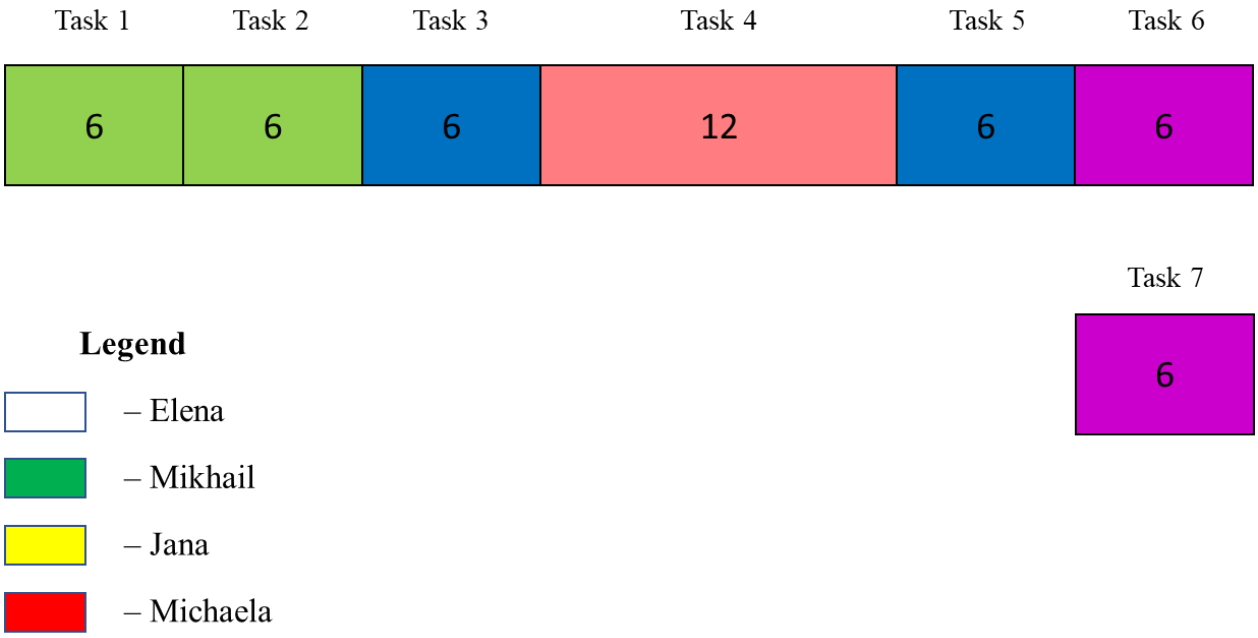



Fig. 5 – Project plan on the "Exploit" stage

## Step 3. Subordinate

The remaining safety is one third of the reduced task time that should be replaced to buffer. The new changes to schedule are represented in table 11 and Figure 6.

Table 11 - Project schedule on the "Subordinate" stage – 1.

| № | Task | Resource | Duration |
|---|---|---|---|
| 1 | Describe strategy and strategic goals | Elena | 4 |
| Project buffer 1 | | Mikhail | 2 |
| 2 | Finish process landscape model | Elena | 4 |
| Project buffer 2 | | Mikhail | 2 |
| 3 | Finish as-is models of 2 chosen processes | Mikhail | 4 |
| Project buffer 3 | | Jana | 2 |
| 4 | Analyze processes | Michaela | 8 |
| Project buffer 4 | | Elena | 4 |
| 5 | Optimize chosen process | Mikhail | 4 |
| Project buffer 5 | | Jana | 2 |
| 6 | Finish "team project.doc" | ALL | 4 |
| Project buffer 6 | | | 2 |
| 7 | Finish draft presentation | ALL | 4 |
| Feeding buffer 1 | | | 2 |
| Duration of critical chain | | | 28 |
| Total project buffer time | | | 14 |
| Total feeding buffer time | | | 2 |
| Total buffer time | | | 16 |

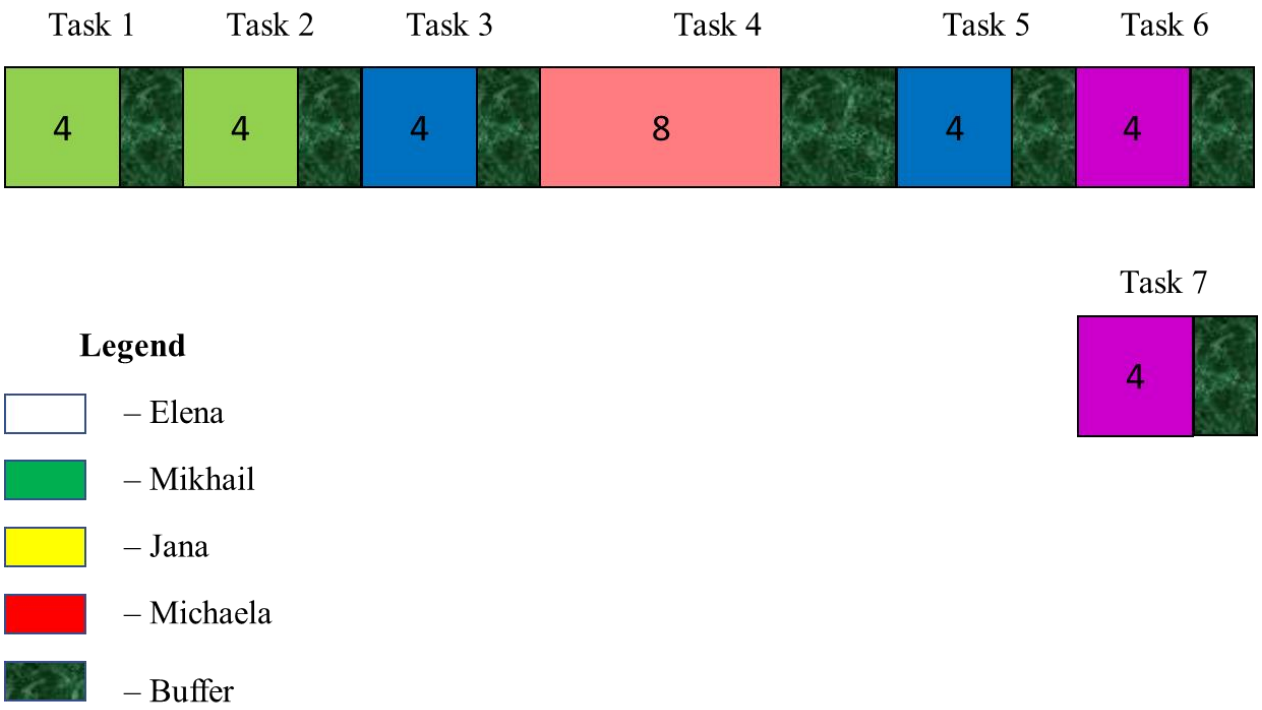



Fig. 6 – Project schedule on the "Subordinate" stage - 1

Then the critical chain safety must be aggregated into a completion buffer at the end of the critical chain and a feeding buffer at the end of feeding chain. The updated schedule is presented in table 12 and Figure 7.

Table 12 – Project schedule on the "Subordinate" stage – 2.

| № | Task | Resource | Duration |
|---|---|---|---|
| 1 | Describe strategy and strategic goals | Elena<br>Mikhail | 4 |
| 2 | Finish process landscape model | Elena<br>Mikhail | 4 |
| 3 | Finish as-is models of 2 chosen processes | Mikhail<br>Jana | 4 |
| 4 | Analyze processes | Michaela<br>Elena | 8 |
| 5 | Optimize chosen process | Mikhail<br>Jana | 4 |
| 6 | Finish "team project.doc" | ALL | 4 |
| 7 | Finish draft presentation | ALL | 4 |
| 8 | Project buffer | X | 14 |
| 9 | Feeding buffer | X | 2 |
| Duration of critical chain | | | 28 |
| Total buffer duration | | | 16 |

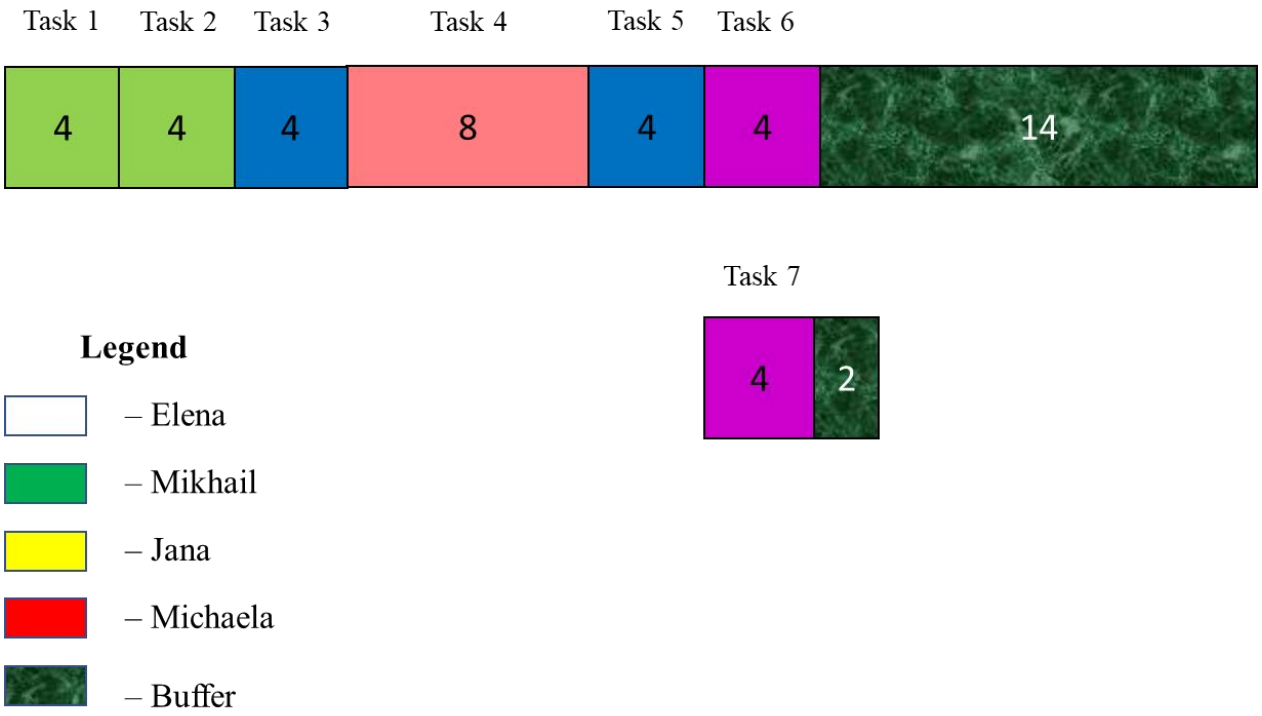



Fig. 7 – Project schedule on the "Subordinate" stage – 2

The whole project can be completed in 75% of the initial project estimate because when we share the safety, we need less overall than if it was locally distributed. The buffer in each case represents 50% of the preceding reduced tasks.

The buffers subordinate the tasks to the total project completion time and ensure that we are able to fully exploit the 25% reduction in completion time.

## How to Control Project Execution with CCPM Methodology

There are 3 measures to control project execution with buffer management implementation.

First is **Buffer Penetration** that is equal to Sum Task Estimates less Days Elapsed less Active Task less Remaining Tasks.

Second is **Buffer Status (Buffer Consumption)**. To efficiently use Buffer Penetration managers should know the extent of the buffer. In fact, by knowing the extent of the buffer we can determine the buffer penetration as a proportion rather than an absolute measure. Buffer Status equals to Buffer Penetration divided by Buffer Duration.

Third is **Project Status** that equals to Elapsed Duration divided be Total Project Duration.

On the Figure 8 interdependencies between buffer management and critical chain management are presented.

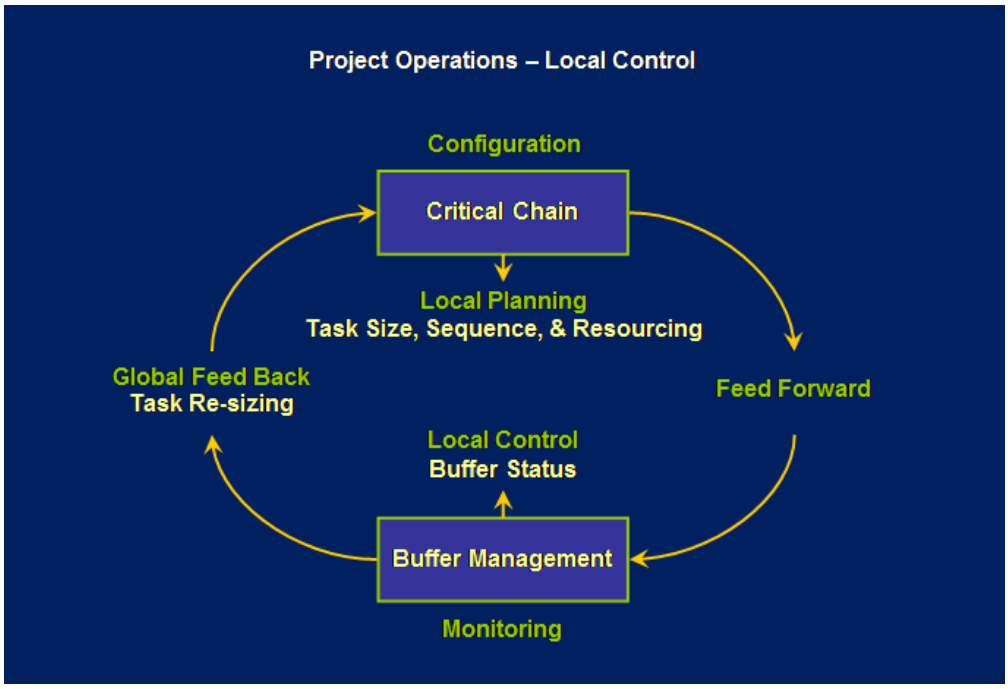



Fig. 8 – Buffer Management and Critical Chain interdependencies

Project execution can be measured by Resource Dollar Days (RDD), that represents both – time and money spent by each resource involved into project execution.

## 5. Ways to Improve Project Delivery

State clearly Your suggestions on how to improve your dissertation writing (or any other chosen project) and related benefits.

In last chapters we have identified 3 main constraints of our project. These constraints are as follows:

1. Poor project planning;
2. Issues with project's products safety;
3. Bad multitasking.

Some injections into system should be made to overcome mentioned restrictions.

### Managing with Poor Project Planning

Firstly, "Poor project planning" should be transformed to "Excellent project planning". In order to do so, we can implement best managerial practices in plan development. One of such practices is PRINCE2 Methodology approach to plan development.

According to PRINCE2, plan is "a document describing how, when and by whom a specific target or set of targets is to be achieved. These targets will include the project's products, timescales, costs, quality and benefits" (AXELOS, 2009).

The plan development algorithm is represented on Figure 9.

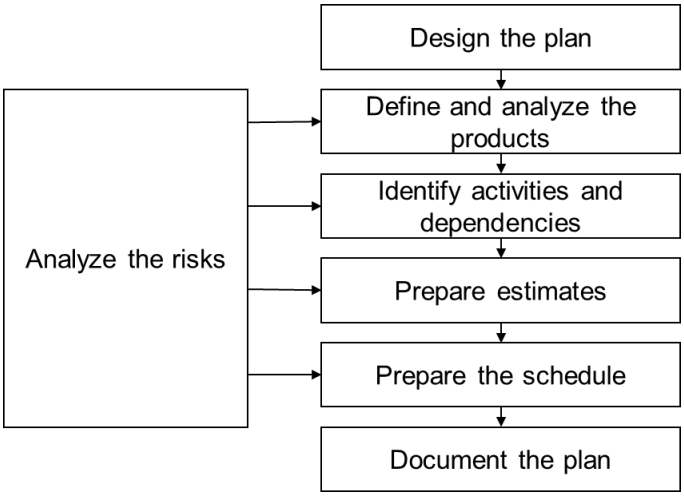



Fig. 9 – PRINCE2 approach to planning (AXELOS, 2009)

The "Prepare the schedule" step can be developed with use of Critical Chain Management.

To design the plan following activities should be accomplished:

1. Write the Project Product Description;
2. Create the Product Breakdown Structure;
3. Write the Product Descriptions;

4. Create the product flow diagram (=Critical Chain).

PRINCE2 approach to planning has its advantages and disadvantages to the project, that has been described in the seminar work, that are presented in table 13.

Table 13 – Advantages and disadvantages of using PRINCE2 approach to planning.

| Advantages (DEs) | Disadvantages (UDEs) |
|---|---|
| Decrease level of rework | Requires more time to complete |
| Decrease level of work out of project scope | |
| Clearly state what to do – increase chances to deliver project within stated scope. | |

Desirable effects (DEs) and undesirable effects (UDEs) of implementing PRINCE2 approach for planning will be inputs for constructing Future Reality Tree.

## Managing with Project's Products' Safety Issues.

By Issues with project's products' safety we meant that documents to be developed and up-to-date versions of them could be deleted either by incaution or due to problems with PC. To overcome stated issues, we can use different approaches, that is presented on Evaporating Cloud (Figure 10).

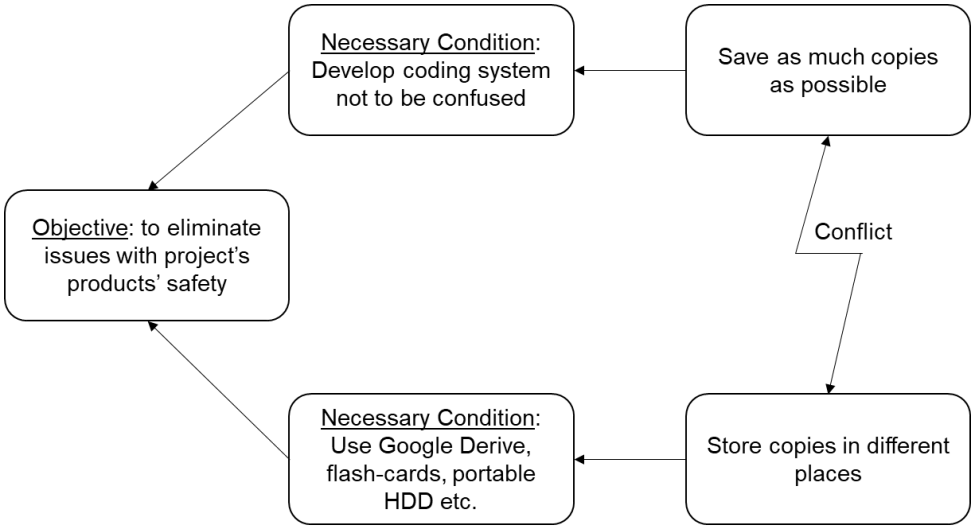



Fig. 10 – Evaporating Cloud for eliminating issues with project's products' safety

As seen from the Evaporating Cloud, two different decisions could be made to overcome issues with products' safety. But both of them require additional efforts and time spending. However, there is better decision. And this decision is to execute project using **MS Teams software**. This decision, considering the fact that Masaryk University students can use it for free, doesn't have considerable disadvantages, but has sufficient advantages such as improving the communication quality between team members and provides safety to documents.

Stated facts should be considering while developing Future Reality Tree.

## Managing with Bad Multitasking.

The decision here is simple. All we should do is to conduct Multitasking training, which will slightly increase time spent during the project execution, but will considerably decrease the negative impact of bad multitasking to team members availability, that in the end will decrease waiting time.

## Conclusions

Having injections developed and knowing its desirable and undesirable effects, we can construct the Future Reality Tree (Appendix 2).

According to Devil's quadrant (Fig. 11), "improving a process along one dimension may very well weaken its performance along another" (Dumas, 2013). In our case change is happening between time and quality. Yet, by spending more time on certain activities such as using PRINCE2 approach for planning and multitasking training, we save more time by reducing amount of rework and work on tasks that are out of the project's scope. In case of MS Teams implementation, all the team members have a status of Masaryk University students which gives them an opportunity not to pay for the software. Without stated opportunity cost to quality and time exchange could took place.

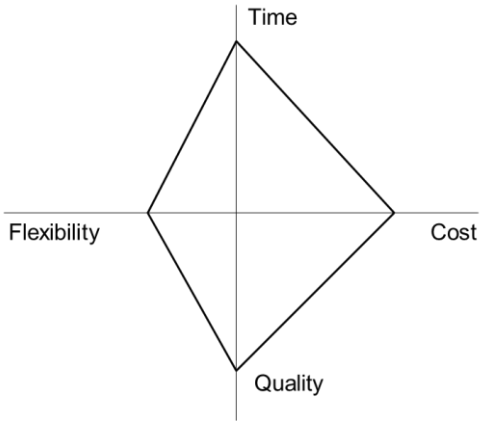



Fig. 11 – Devil's quadrant

## References

2009. Managing successful projects with PRINCE 2, Axelos.

A Guide to Implementing the Theory of Constraints (TOC), viewed 17 November 2019, <http://www.dbrmfg.co.nz>.

Buffer Management: Determine whether is necessary, viewed 17 November 2019, <https://mailchi.mp/toc-goldratt/understanding-toc-concepts-buffer-management-determine-whether-expediting-is-necessary?e=f783cc0ffd>

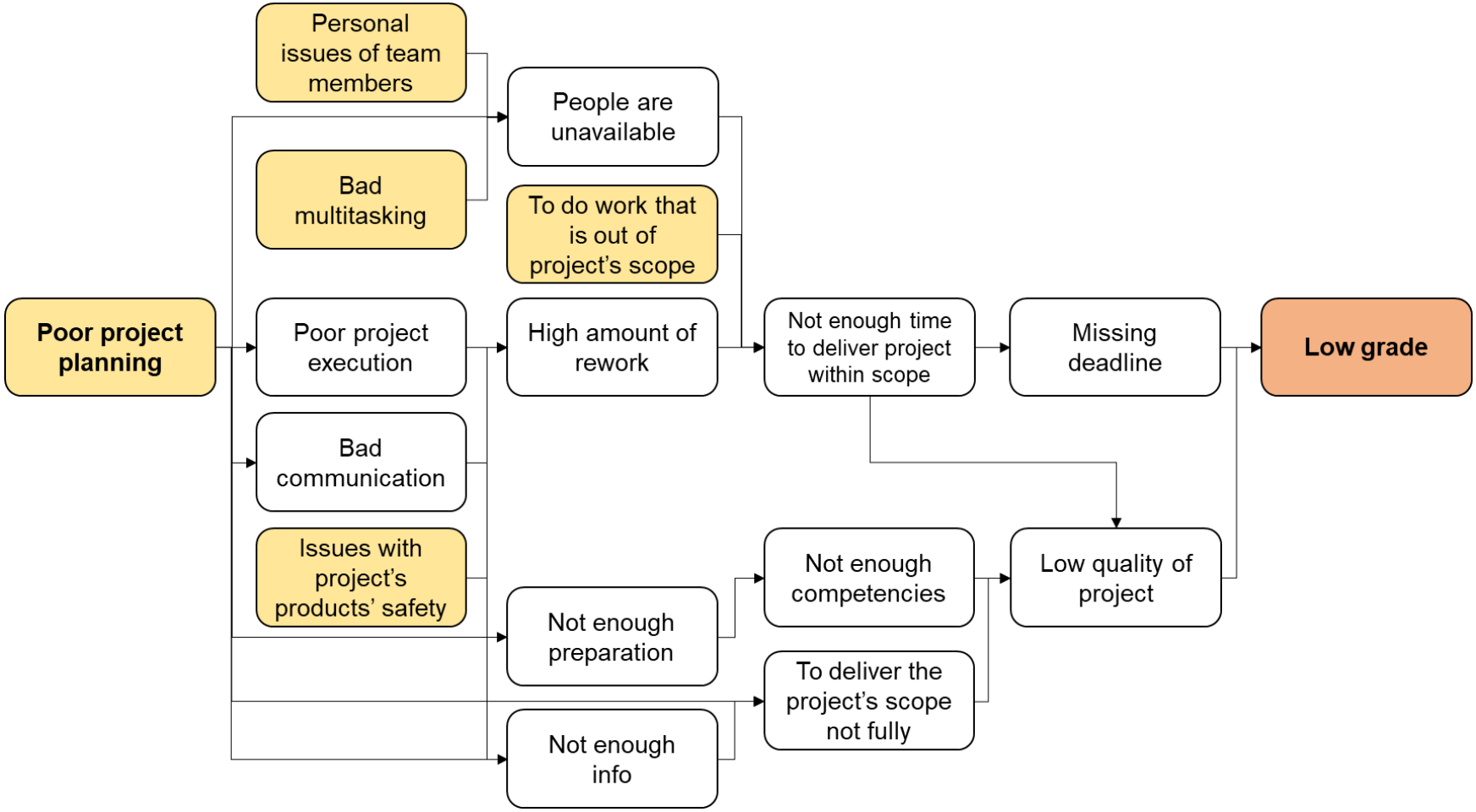
Dumas, M., La Ros, M., Mendling, J., A. Reijers, H. (2013). Fundamentals of Business Process Management. Berlin, Heidelberg: Springer.

Goldratt, E. & Cox, J., (2014) The Goal: A Process of Ongoing Improvement, Great Barrington, MA.: North River Press.

Scheinkopf, L., (1999) Thinking for a change: putting the TOC thinking processes to use. St Lucie Press/APICS series on constraint management

**Appendix 1**

## Current Reality Tree



**Appendix 2**

## Future Reality Tree