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Creative educational methods in implementation of investment projects in renewable energy

Andra Badea [a]* , Gabriela Prostean[a], Cristian Vasar[b], Octavian Prostean[b]

[a] "Politehnica" University of Timisoara, Faculty of Management in Production and Transportation, 14 Remus str., Timisoara 300191, Romania
[b] "Politehnica" University of Timisoara, Faculty of Automatics and Computer Science, Vasile Pârvan bld., no. 2 Timisoara, RO 300223, Romania

Abstract

Implementation of renewable energy projects (RES) involves very complex processes which are based on the latest creative techniques to give adequate solutions teaching practitioners of this multidisciplinary field. The need for a complex transfer of knowledge at the administrative level, technical level and technological level of RES projects, constitute prerequisites for success in projects implementation of this type. The present paper proposes using creative educational methods for implementing investment projects in renewable energy using a combination of methods of Goldratt. To exemplify bottleneck situations in the management of certain flows within the supply chain of the RES implementation projects, the paper proposes Drum-Buffer-Rope philosophy. In order to underline the effectiveness in fast obtaining and implementing the right solutions along the lifecycle of RES projects, the paper illustrates the steps of Theory of Constraints Thinking Process (TOCTP) integration by problem diagnosing, designing the solutions plan and integrating the solutions plan through the conceptualization of adequate diagrams communication within these types of projects.

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1. Introduction

In the current context, the development of renewable energy sector has already proven to be a very good solution to the actual problem of global energy (energy production from fossil fuels). As the push for alternative energy gains

* Andra Badea. Tel.: +40.744.987.917.
E-mail address: andra@publicist.com

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strength around the world, companies are taking advantage of wind resources to develop and produce wind energy. (Prostean & Badea, 2014) Whereas development projects that support renewable energy production are more complex the attention of researchers in the field is heading also to the need for latest creative techniques to give adequate solutions teaching practitioners in research, development and implementation of such projects. New technological developments impact the ways that project workers organize and apply their skills, including time management and interpersonal relationships (Hardcastle et al, 2009).

Projects developed in renewable energy (RE) have a significant potential which contributes to a sustainable development in green energy and aims to improve and implement new methods which streamline the implementing process of RE projects. (Zamfir, 2011). Currently a strong tendency of Romania's green energy policy, adapting to all evolutionary processes for implementing renewable energy projects has to face the complexity of multidisciplinary design needing also a complex transfer of knowledge at the administrative level, technical level and technological level of RES projects (Prostean, Vasar & Badea, 2014).

The development of renewable energy projects require complex knowledge and particularly much more experience in many fields: mechanical components, electric machines, power electronics, automatic controlling strategies and management.

Another fact when implementing renewable energy projects need to take into account of all aspects of projects life cycles including higher complexity and greater demand on the capabilities of project teams that need to possess appropriate experience to understand the implementation process for every activity in the project. The specific project analyzed in this paper has required a total of 5 specialized teams: mechanical structures and wind turbines (MSWT), electrical machines (EM), power electronics (PE), automatic controlling strategies (ACS), and project management and publicity (PM) (Prostean & Badea, 2014). More specifically it was considered a research and development project in order to design some generators in isolated regime, configured for different geographical areas (hill and mountain locations in Romania), namely the research team exemplify bottleneck situations in the management of certain flows within the supply chain using the Drum-Buffer-Rope philosophy (Fig.1).

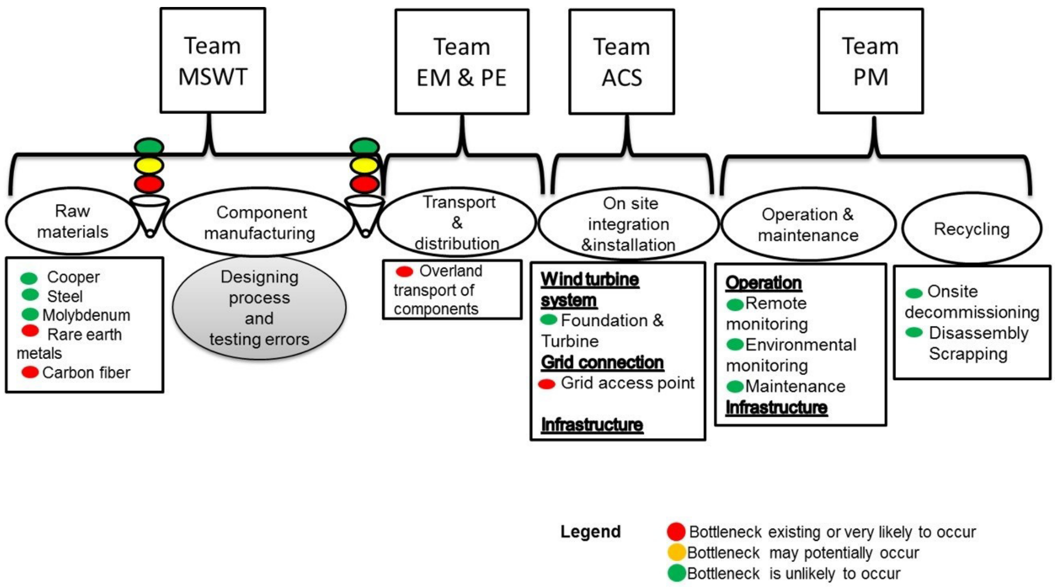

Fig.1. Correlating teams in wind power along the supply chain of a RES project

The present paper proposes using creative educational methods for implementing investment projects in renewable energy using a combination of methods of Goldratt. In this approach the research team after a strong action research in wind power projects implemented and based on the methodology Theory of Constraints (TOC) using Drum-Buffer-Rope (DBR) strategy identified bottlenecks for certain flows within the supply chain of the RES implementation projects, and presents alternative solutions based on Theory of Constraints Thinking Process

(TOCTP), through which feasible alternative solutions have been identified in order to achieve adequate diagrams communication along the lifecycle of RES projects. TOC and DBR are use to eliminate the constraints and to give proper educational solutions when implementing RES projects.

2. Methodology

2.1 Drum-Buffer-Rope philosophy

The DBR method is designed to optimize a flow process, obtaining the full capacity of the most constrained capacity link (CCL) in the supply chain. The rhythm of CCL represents the drum for the rest of the system. The rope represents the mechanism of releasing the raw material into the flow process, protecting the CCL from being swamped with "work in progress". The rope regulates the rate of inserting the raw material into the flow process. The inserting rate is no faster than that impose by the drum. The rope is connected with the drum with the help of the safety buffer that protects the CCL from starving because of the work during the process. The TOC method through DBR helps to move important raw materials (carbon fiber and steel) in supply chain in safety stocks that are placed and dimensioned to protect the rhythm of each individual link in the chain. The purpose of using DBR solution for dimensioning intermediary buffer has the role to protect the links in supply chain against bottlenecks variation occurred within the chain, with the condition to keep the movement rhythm of the project at each link in the supply chain. Dimensioning intermediary buffer through DBR philosophy is done according to the following steps (Prostean & Badea, 2014):

1. Is identified each link rhythm (D-Drum) in the study of this paper is about test medium consumption / link supply chain.
2. Is dimensioned an intermediary stock (B-Buffer) in front of each link in the chain which can create link protection, regardless of orders variation that can occur.
3. Buffer dimensioning is made on three levels (green, yellow and red) in such a way that placing orders decision to refill the buffer must fulfill the following:

- while the consumption rhythm keep the buffer on green is not created another command:
- when the buffer reaches yellow the order is created and validated (it is send to refill the buffer) so that by correlating link consumption rhythm (Drum) with delivery lead time (DLT), the buffer must be refilled during the period when he is at the red level. This is the stage where the replenishment valve rope is pull, also called the rope mechanism (R-Rope) (Fig. 1). DBR helps provide at every time raw materials for a wind power creating safety stocks that are placed and dimensioned in order to ensure fluency tests included in the phase of project cycle development. The levels divided into colors have the result that technical testing of pieces that need to be integrated in component manufacturing must fulfil correctly the specific requirement.

2.2 Steps of Theory of Constraints Thinking Process

In order to underline the effectiveness in fast obtaining and implementing the right solutions along the lifecycle of RES projects, the paper illustrates the steps of Theory of Constraints Thinking Process (TOCTP) integration by problem diagnosing, designing the solutions plan and integrating the solutions plan through the conceptualization of adequate diagrams communication within these types of projects. Considering this avalanche of constraints diagnosed in the project, the most appropriate wind power project practices may lead to the development and implementation of a thorough process of innovation for the project, based on a combination of the best techniques for transposing the constraints into feasible alternative solutions. Consequently, the process for transposing the constraints into feasible alternative solutions must answer the following questions: What to change? What to change to? How to make the change happen? One of the recent concepts of process improvement has been the Theory of Constraints Thinking Process (TOCTP) developed by Goldratt in the 1980s (Goldratt and Cox, 1984). The paper illustrates the steps of TOCTP integration by diagnosing problems, designing the solutions, and integrating the solutions into the conceptual model for transposing the constraints into feasible alternative solutions in renewable energy project (Goldratt and Fox, 1988).

2.1. Stage 1 - What to change?

Within this context, the method supposes the development of the “Evaporating Cloud” (EC) which is used to address the question: What to change?. EC helps to resolve the root causes of a problem by identifying their hypotheses. Treating the alternative hypothesis may lead to unwanted situations which must be changed, specifically it helps to visualize solutions or strategies that can solve the problem. During this stage there are many collaboration obstacles due to hostility and lack of common agreement for defining problems in such kind of RES projects.
The internship is very important, given that only through correct initially definition of the problem may determine necessary technical teams with their components and can correctly estimate the risk sharing between teams.
In addition to EC, “The Current Reality Tree” is configured to help visualize the links between the undesirable effects and the root causes.

2.2. Stage 2 - What to change to?

The next question: What to change to? tries to provide a clear vision of the necessity for an effective collaboration between researchers and wind power specialists. Through the "Future Reality Tree" (FRT) EC is removed. By expressing FRT possible alternative solutions, through the "penetration" of so-called "injection", which is the key solutions. In principle, the injection is the central problem solution and a strategy that will merge and mitigate any undesirable effects (UDE), making them the desired effect (DE). One purpose of FRT is to validate that the solutions or strategies identified will achieve the desired effects (DEs) and, respectively, the desired outcomes (DOs). Configuring FRT is achieved as follows: start by replacing undesirable effects (UDEs) with the desired effects (DEs). DEs are placed in the boxes in the top of the FRT.

In the bottom of the FRT the assumptions are placed together with necessary injections (solution or solving strategies). The idea here is to get a picture of how an injection (a breakthrough) might affect the overall performance of the system. The FRT is the validation that a collection of injections will turn all of the UDEs into DEs.

In this paper we have combined the two approaches described in FRT through 4 injection, to get a complete transfer of knowledge within the persons involved in RES project. To materialize the new vision, in this stage, there will be developed both the “Future Reality Tree” (FRT), and the “Negative Branch Reservation” (NBR), which enables the analysis of all the positive and negative aspects of the change.

2.3. Stage 3 - How to make the change happen?

In the stage of question - How to make the change happen? there is developed the Prerequisite Tree (PRT) based on individual input for turning the obstacles into an implementation plan. PRT it is made upon the experienced that wind power specialists in implementing RES projects have presenting every possible obstacle that they encountered. For each obstacle wind power specialists established ways of overcoming the obstacles.

Each person involved in the process has to understand his or her key role in the implementation of the new solutions to make the change. The Prerequisite Tree (PRT) is listing every possible obstacle which could be met by the team during the process of implementation. For each obstacle, an intermediate objective (IO) is achieved that would surmount the obstacle. These IOs are rather a kind of intermediary states or milestones necessary to pass through to can overcome the obstacles. The IOs need to be sequenced. To find out what actions should be taken to implement each intermediate objective (IO) of the PRT, it is constructed a transition tree (TT) for each IO in hand. This it is configured as follows: On the first level, the bottom, it starts from "Fact condition" that is placed in the box on the left. Is identified the primary problem (conflict) of this level whose solution is needed to achieve the final IO. This conflict is enrolled in "unfulfilled requirement" placed in the middle box. In the right box is formulated one or more injections leading to desired effects, "Specific action". Based on the specific action taken it is moved to the next level. (Goldratt and Fox, 1988). So TT produces a map, a route that lead us to the desired destination.

3. Conclusions

Creative educational methods in implementation of investment projects in renewable energy projects have a major impact in the current economy in such way that can achieve finding alternative solutions that correspond to the responsibilities assumed in such kind of projects. The collaboration between wind power specialist and researchers provides much more ways for the implementation of RES projects can be considered a real success.

All feasible alternative solutions were systematized in project management procedures and stored in a database and considered "good practice lessons" for future renewable energy projects and for new entry students that activate in this domain. This database can support the establishment of a Project Management Office (PMO) in renewable energy. The case study presented provides evidence that TOC might be an effective teaching method for process implementation and value creation offering better solutions through the communication diagrams.

Avoiding bottlenecks in wind power supply chain with the help of DBR philosophy can support the establishment of a Project Management Office (PMO) in renewable energy. The case study presented provides evidence that TOC-DBR might be an effective method for designing, integration, installation and administration of a wind power supply chain and offers educational solutions for those who like to know more about this complex domain.

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