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MODERATING IMPACT OF COMPLEXITY ON PROCESS MANAGEMENT OF TURNAROUND PROJECT

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Abstract

Maintenance of process plants requires application of good maintenance practice due to a great level of complexity. From a plant maintenance point of view, the most significant activity is turnaround, an activity carried out through project task with long planning process period and very short execution period, which makes it one of the most complex projects of maintenance in general. It is exactly this kind of maintenance that is based on multidisciplinarity which has to be implemented through the system of quality management on all levels of maintenance management. This paper defines the most significant factors determining the process of turnaround projects quality management and its efficiency. Such relation is observed through moderating influence of complexity on process management efficiency in the turnaround project. The empirical research was conducted based on the survey of turnaround project participants in five refineries in Croatia, Italy, Slovakia and Hungary. For exploring the influence of research variables testing of the target relation is carried out by applying logistical regression. Research results confirm the significance of complexity as variable that significantly contributes to the project performance through the moderating influence on success of the project, as well as the influence of an efficient management on a plant turnaround project key results. Beside theoretical indications, practical implications that arise from this research study mainly refers to management process of the industrial plant maintenance project.

Keywords

Maintenance management, turnaround, project quality, process management, complexity, key results.

Introduction

Project management in a plant turnaround is insufficiently explored area and a very complex one because it requires multidisciplinary approach consisted of maintenance area, project quality and management. Turnaround project is significant part of maintenance activity which primary purpose is to renew and improve efficient operation of plant facilities. Turnaround is an important event in plant maintenance which significantly influences the profitability of business, reliability of maintenance systems, compliance with legal regulations, environmental protection, ensuring health and safety of employees.

Turnaround project requires longer preparation period and short implementation period. Also, turnaround project has to last as short as possible due to costs incurred by production halt during turnaround. Turnaround is classified as capital project (capex) and is carried out as project task in order to achieve as efficient as possible cooperation of various organizational units participating in turnaround, which is usually in accordance with maintenance strategy and company internal rules and regulations. Due to high level of complexity, turnaround projects often end up as unsuccessful.

Many researches confirm that complexity influences the relationship between project leadership and its successfulness. Complexity is often unknown, especially in oil refinery projects. Many studies show that complex projects are not fully successful and various authors confirm that early recognition of complexity and managing elements that make the project complex positively influence the successful development of the project itself.

Besides theoretical part, empirical research was conducted on the pattern of chosen refineries. Surveys were carried out among target participants managing turnaround projects and who were at least once included in the project. Two hypotheses will be measured based on a survey questionnaire forming mutually connected claims and variables. The moderating influence of complexity on relation between managing project process and its successfulness will be tested using logistical regression.

Plant turnaround project as a complex project

Project management successfulness is strongly represented topic and the question of performance is the most emphasized at the end of the project. The most usual approach to defining project successfulness is based on goals regarding pre-defined project duration, budgeting, scope of works and desired quality level [1]. According to Baccarini [2], project performance, that is, successfulness, can be observed on two levels. First level corresponds to measuring the success of the project management and the second is measurement of project results performance i.e. project outputs. Successfulness of the project can be best determined by observing it through organizational structure, types of projects, interest groups, priorities and perceptions [3].

Each project, due to its specific demands, has critical factors that make it successful. Often, insufficient quantity of project performance indicators is present, such as project duration, budgeting and scope of works [4]. In order to adequately define and measure project successfulness, it is necessary to determine significant factors contributing to overall project success as well as the direction in which the project is to be heading during project management.

Many authors are pursuing the idea that successful project management directly influence the successfulness of the project. Project management, especially when big project are in question, is emphasizing the importance of factors needed to be taken into account for successful project management, which is finally influencing the success of the project itself i.e. its results [5].

During the project implementation phase, problems are very quickly detected but it is extremely important to define the cause of the problem. Defining and cause detection by all participants is the proper way to solve problems only in cases when decisions are based on facts. The most frequent factors, i.e. causes of turnaround project complexity, according to Fabić et al. [6] are: organizational influence, project leadership, technological influence, technical influence, project duration, cost, scope, uncertainty, interaction, interdependence of professions, interest groups, health, safety, ecology, risk management.

Turnaround project, as well as projects in general, consists of project management process at the planning phase and of project service performance process at the performance phase.

In the process of project management, project managers are the most important ones since they are the most responsible persons for the success of the project, whereas at the service performance phase other project participants are involved as well. Other participants are particular professional team leaders or leaders of directly related organizations within the main organization as well as other members.

Project leaders and other project participants influence the increase of project complexity [6]. Complexity of the project can be defined by observing the extent of certain factors, their duration and their interconnection. It is concluded that turnaround project is a complex project and that above mentioned complexity dimensions are elements of turnaround project. It is necessary to carry out an appropriate statistical analysis that will more precisely indicate which elements are the most significant, i.e. which factors influence increase of complexity the most [7].

Defining process management, project key results and complexity variables

Factors in the relation between turnaround project quality management process and its efficiency have to be defined based on existing models of quality management, especially EFQM (European foundation for quality management) model, and on statements that sufficiently well test i.e. confirm the strength of variables. Many authors have noticed lack of EFQM model of business excellence implementation in the field of project management. For example, Westerveld [5] and Bryde [8] concluded that EFQM model of excellence is inadequate for application in the field of process management, so they developed their own model. Also, Zulu and Brown [9] created a model of business excellence focused on defining construct for measuring quality in project management processes. All described models of business excellence are focused on work environment during project management but they are not sufficiently empirically explored and tested. There is a certain degree of consensus among researchers that EFQM model, which is based on TQM (Total Quality Management) approach, provides for an efficient assessment of model variables performance [10, 11].

Relation between turnaround project factors and their inner relation i.e. their relation in the process of management and process of execution is unknown, especially from the aspect of complexity. Research involving quality management is very complex since there is no unified criterion for quality measurement. Due to the very nature of quality, it is not possible to measure it directly and it is necessary to use adequate factors and adjust those to the project environment so that the impact of quality could be measured. In this paper, factors in turnaround project quality management process and its efficiency will be defined based on a previous research and statements that sufficiently test, i.e. confirm, the variable strength. As most important factors defining the relation between turnaround project quality management process and its efficiency i.e. successfulness, are: process management, project key results and complexity. Explanations of the aforesaid are set forth in continuation of this paper. On the basis of the previous research, the following hypotheses were set:

H1: Efficient management of project business processes will have positive effect on project key results.

H2: Complexity will have moderating influence on relation between efficient management of project business processes and key results of the project.

Efficient management of project business processes and project key results

Organization striving towards business excellence is managing and improving processes in order to fully satisfy and generate greater value for clients and interest groups [12]. Key processes are those having significant influence on critical results for specific organization [13].

Identification of statements that best describe the variable of process management entails risk management, methodology of project management, project supervision and management, process documenting and project management procedure, changes management, tools and techniques of project management, reporting on the progress, project planning and execution, process and procedure implementation, supervision, feedback etc.

Dvir et al. [14] identified statements that describe leadership, but are also important for processes. One of the project management processes is process implementation and project management procedure, which is, as research variable, described using the following indicators: number of variables including system engineering, engineering design, risk management, schedule and resources planning, financial management, contracts management, purchasing management, quality management and reliability, technical control management, final user relations management, configuration management, changes management, team management, decision making and meetings management, reporting, communication and forwarding the same to production.

Available literature, related to statements that describe process variable in project management is rather extensive and is not specified for particular types of projects. Majority of the literature is dealing with organizational processes whereas it rarely explores the field of project management processes.

It is necessary to select statements that best describe process management variable, especially with regard to the specific features of the given project.

Number of statements for this variable is rather extensive in order to include all important turnaround projects management processes. Selected statements describing process management variable are presented in Table 1.

Turnaround project process management is influencing project key results. Therefore, it is necessary to analyze which statements describe i.e. measure the success of turnaround project. According to traditional criteria of project management successfulness, measures such as project duration, cost and quality are not appropriate aspects of successfulness [1, 14–17]. Traditional criteria are not negligible and as such are very significant for successfulness of every project.

According to Cooke-Davies [16], project performance criteria are assessed after the project has ended. Performance criteria are varying from one project to another, due to various factors such as extent of the project, specific features and complexity of the project and it is hard to define universal list of project performance criteria [5]. Turnaround project success can be observed through several dimensions, since it is almost impossible to describe successfulness by one dimension in such a complex project. Different authors define different project success criteria. Most often, as the success indicators of turnaround project, project duration and project cost are compared. Project success elements, as mentioned in traditional projects, are project duration, cost and scope of work and as such they do not present sufficient criteria for measuring success. However, these elements most often present turnaround project measure of successfulness. Anyhow, they are not sufficient and they must be supplemented by other project successfulness aspects, such as risk management and satisfaction of interest groups throughout the project lifetime [4].

Table 1

Statements describing process management variable.

Statements
Preventive activities are carried out in all phases of turnaround project (e.g. preventive activities carried out are documented).
Corrective activities are carried out in all phases of turnaround project (e.g. corrective activities carried out are documented).
Constant implementation of improvements in all turnaround project phases are standardized (e.g. activities improving turnaround project processes are standardized).
Turnaround project risk management is established (measuring methods and risk analysis in all project phases).
Turnaround project documentation in all phases is adequately gathered, distributed and archived.
Risk management related to turnaround project inner processes was established (planning, 1st phase).
Established processes prove turnaround project compliance with beforehand defined quality standards.
Statistical sampling is carried out in turnaround project.
Process of supervision and recording results of conducting quality related activities (for the assessment of efficiency) is established in turnaround project.
Turnaround project quality cost is calculated (e.g. cost of establishing).
Benefits of turnaround project quality are defined.
Tools mostly used for quality control in all phases of turnaround project are control diagrams, histograms, paretto diagrams, linear diagram, dispersion diagrams, causes and consequences diagram...
Turnaround project management procedure is carried out (document which is established and incorporated in the quality management basic manual).
Reports on turnaround project related work done are submitted in the given period, by major contractors and others (no later than 30 days from the completion of 2nd phase – execution).
Process of turnaround project risk management, identification and analysis are established.
Turnaround project risks are measured, evaluated and achived (risk register).
During turnaround project execution weather related risks are taken into account.
During turnaround project execution all environment protection related risks are taken into account.
During turnaround project execution all health and safety related risks are taken into account.
Influence of project task changes risk sources in the ‘still“phase (scope of works) on the turnaround project is observed.
Influence of complex technical solutions risk sources (design solutions, equipment replacement etc.) on turnaround project is observed.
Influence of spare parts and material purchasing risk sources (purchasing) on turnaround project is observed.
Influence of unplanned work risk sources on turnaround project is acknowledged.
Influence of contractors and subcontractors risk sources on turnaround project is observed.
Influence of higher management support risk sources on turnaround project is observed.
Influence of end user (production) additional requests risk sources (after “freezing” work plan) on turnaround project is acknowledged.
Influence of goals such as price and duration in execution phase risk sources on turnaround project is observed (e.g. unrealistic deadlines and price of particular works on the given equipment).
Influence of project leader organizational abilities risk sources on turnaround project is observed.
Influence of foreseen works time and costs planning risk sources on turnaround project is observed.
Influence of quality management risk sources on turnaround project is observed.
Influence of nominated works selection risk sources based on risk matrix on the turnaround project is acknowledged.
Influence of turnaround project budget change risk sources after defining scope of work and other activities on turnaround project is acknowledged (immediately prior to or after the plan freezing).
Health and safety protection plan is established in all turnaround project phases.
Health and safety protection goals are prescribed and quantified wherever possible.
Health and safety risk management is measured as turnaround project results.
Internal audits of health and safety protection management system are carried out in all phases of turnaround project in beforehand planned intervals.
Environmental protection management plan is established in all turnaround project phases.
Measuring system for prescribed measures of environmental protection management and abiding by the same during work execution is established and implemented (2nd project phase).
Goals of environmental protection management are prescribed for turnaround project and quantified wherever possible.
Environmental protection risk management is measured as turnaround project results.
Internal audits of environmental protection management system are carried out in all phases of turnaround project in beforehand planned intervals.

According to Atkins, project success is divided on three levels: 1) process, involving cost, project duration, quality and efficiency, 2) system, involving criteria of project managers, top managers, client-buyer and team members and 3) benefits, involving influence on the client and business success. For example, the Diamond approach to success assessment consists of four elements. The first element is novelty, second technology, third complexity and fourth pace [18].

Traditional approach of generic projects in measurement of turnaround project success is not adequate. In accordance with the aforesaid, authors included different dimensions of the project success. For example, the closest assessment of turnaround project success elements is precisely assessment of success elements in TAM (turnaround maintenance) projects. TAM project is very similar to refinery turnaround (TAR) project, the difference being that TAM involves other process industries, such as, for example, petrochemical industry, whereas TAR is closely related to oil refineries. According to Obiajunwa [19], project success consists of six elements: 1) project duration, 2) cost, 3) quality, 4) equipment functionality, 5) safety and 6. environmental performances. According to Ben Daya et al. [20] safety is one of key measures for determining TAM project successfulness. Safety measures are constituting elements of successfulness in turnaround projects, therefore safety presents key factor for turnaround project results.

One of most significant turnaround project specific features is unplanned works on relevant equipment, whereas unplanned works are insignificantly present in generic projects [21, 22]. Turnaround projects contain such specific project performances that significantly influence the project successfulness. They have many unique characteristics different from generic projects so, accordingly, they have to be differently viewed with regard to assessment of successfulness.

Approaching turnaround projects using methodology of generic projects management produces unfavorable results of project successfulness, thus unfavorably influencing the project quality and in the end the success of the project itself as well. Turnaround is very important for total profitability of the company. It is necessary to include all significant key results indicators of the project in order to measure project successfulness.

According to Fabić et al. [6], the most significant factors of projects are: project duration, cost quality, environmental protection, safety and health of employees, scope of work, project team, functionality of equipment, equipment check-up after installation. There are no relevant papers in the existing literature dealing with turnaround project successfulness. The literature on that subject is very scarce and there is an evident lack of adequate research carried out by scientific methods, e.g. in the field of determining factors of successfulness. In order to enable carrying out similar statistical analysis for turnaround projects as well, it is necessary to define variable of successfulness with appertaining factors, which are measuring and defining successfulness of the project. Similar analyses i.e. usage of adequate statistical methods, are significantly contributing to understanding of turnaround projects and, among other things, to determination of important points that can be influenced in order to, for example, increase the successfulness of turnaround project [23].

It is necessary to select statements that best describe project key results variable, especially with regard to specific features of the project being examined. Selected statements describing the variable of the project key results are presented in Table 2.

Table 2
Statements describing project key results variable.

Statements
Unplanned works were within framework of planned scope of work.
Final project amount was within the budget.
Final project period of duration was within work scope.
Turnaround project efficiency: Turnaround projects are finished on time (as per plan) or before deadline.
Turnaround projects are finished with planned budget or below the budget.
Other measures of efficiency are completely accomplished.
Business and organizational success: turnaround projects achieved business success from economic point of view.
Turnaround projects increased organizational profitability and efficiency.
Turnaround projects are contributing to an organization by directly increasing performances.
All turnaround project activities are carried out in the planned period (deadline beforehand planned by turnaround project plan, production schedule, time diagrams...).
Health and safety protection plan is completely carried out in all phases of turnaround project.
Environmental protection management plan is completely carried out in all phases of turnaround project.

Efficient management of project business processes, complexity and project key results

Project management complexity, as well as complexity of projects in general, is basically familiar concept. However, in spite of large body of literature on the subject, it is still not clear enough.

Complexity is hard to unify, as well as other project aspects, and it is necessary to constantly develop perception of complexity in relation to work environment as well as the influence it has on desired project goals, such as for example, the project success. Simon [24] is one of first researchers who described the idea of complex system as a great number of elements that are inter-connected in a non-simple way. Characteristics of project complexity often include the element of uncertainty and element of interdependency [25, 26].

According to Crawford [27], project complexity characteristic feature is indirect communication among elements. Complexity of project often emphasizes the lack of clarity about project goals among all participants [28]. Other researchers try to explain the complexity using the theory of complexity [29, 30]. There are many features describing complexity and it is with regard to their presence in projects that authors try to create their perception of complexity and produce models for trying to unify the model of complexity.

For example, according to Baccarini [26], the project complexity can be divided in two dimensions: organizational and technological. According to the mentioned author, the mentioned definition of complexity can be applied in various project dimensions, but it is important to define which complexity type the project is oriented towards. Following on the work of Baccarini, researcher Williams [25] defines project complexity in two dimensions: structural complexity and uncertainty. Remington and Pollack [29] are suggesting four dimensions of complexity based on theory of complexity: 1) structural complexity, 2) technical complexity, 3) directed complexity and 4) time complexity. According to Kerzner and Belak [31], project complexity is defined through five dimensions: 1) size and cost, 2) interaction, 3) cultural implication, 4) unreliability, 5) interest group. Extent, i.e. significance of each dimension influences the overall complexity of the project.

According to Shenhar and Dvir [18], project complexity is analysed through three dimensions: 1) assembly, 2) system and 3) array. Each dimension is separately analysed, its extent is determined and together they form the extent of project complexity. Such interpretation of complexity is most frequently used in industry i.e. engineering. Kahane [32] is emphasizing, in the context of complexity, conversation and listening of connected parties in finding solutions to difficult problems. His approach to complexity is deeply rooted in the social environment. He defines complexity through three dimensions: 1) dynamic complexity, 2) generative complexity and 3) social complexity. As per complex project profile model, Hass [33] is dividing complexity in three dimensions: 1) independent, 2) moderately complex and 3) highly complex. Each dimension has size criteria and depending on those sizes the project complexity is assessed. Girmscheid and Brockman [34] identified five dimensions of complexity: 1) task complexity, 2) social complexity, 3) cultural complexity, 4) operative complexity and 5) cognitive complexity.

Many authors emphasize the importance of recognizing complexity elements in projects and they connect them with increased project successfulness. For example, Helm and Remington [35] and Crawford et al. [36] proved that there is a positive correlation between project success and key leadership of project management with emphasis on recognition and management of elements that make the project complex.

According to Shenhar study [37], complexity influences the relation between project leadership and success. Complexity is unknown especially in oil industry projects. For example, in many studies researchers state that complex projects are not entirely successful [4, 38, 39]. Various authors confirm that early recognition of complexity and management of elements that make the project complex, directly influences the success of the project itself.

Existing literature related to statements describing the variable of complexity in project management is considerable but it is also not unified for particular projects. Based on existing literature and contents of this paper [40], it can be concluded that turnaround is a complex project with its specific features adding to its complexity.

Based on the aforesaid, statements that best describe complexity variable were selected, especially in relation to specific features of the given project. Selected statements describing the complexity variable are presented in Table 3.

It is also necessary to determine if and how much exactly the complexity influences the increase of success. Presenting complexity as moderating variable between two variables gives answer to the question about the strength of the subject influence i.e. whether the influence is decreased or increased. Baron and Kenny [41] suggest introduction of moderating variable when the relation between variables in certain conditions or within a certain sub-population is decreased.

Table 3
Statements describing the complexity variable.

Statements
Complexity (of scope) of works is defined considering the number of activities, multidisciplinarity of professions for a particular work, number of participants, investments, safety, environmental protection.
Technologically-technical level of turnaround project process equipment is defined considering the complexity of equipment conditioning replacement of spare parts with or without significant modifications for the process, equipment modifications, investment works e.g. including more complex equipment etc.
Importance of time on turnaround project is defined in the following way: regularly, fast-competitively, time critically and blitz.
Number of elements causes turnaround project complexity.
Inter-dependence of elements causes turnaround project complexity.
Delays in certain processes ("bottle necks") cause turnaround project complexity.
Technical challenges cause turnaround project complexity.
Unclear goals in the planning and execution phase cause turnaround project complexity.
Disagreements about project goals cause turnaround project complexity.
Change of goals over a certain period of time causes turnaround project complexity.
Unavailability of key resources causes turnaround project complexity.
Unpredicted changes in outside environment bring about forced changes thus causing turnaround project complexity.
Unpredicted changes in internal organization bring about forced changes thus causing turnaround project complexity.
Lack of top management support causes turnaround project complexity.
Role of turnaround project Supervisory Board causes turnaround project complexity.
Unclear processes within turnaround project cause turnaround project complexity.
Insufficient communication between participants in the turnaround project causes turnaround project complexity.
Decision making processes are inefficient thus causing turnaround project complexity.
Unrealistic turnaround project deadlines cause turnaround project complexity.
Key risks are not identified in turnaround project earlier planning phase thus causing turnaround project complexity.
Unproductive risk management is causing turnaround project complexity.
Purchasing system not helping in scope of work management causes turnaround project complexity.
Project interest groups have their schedules in turnaround project causing its complexity.
Non-compliance between planned maintenance scope of work and investments in turnaround project causes its complexity.
Occurrence of greater number of unplanned works in turnaround project causes its complexity.
Complexity (of scope) of works is defined considering the number of activities, multidisciplinarity of professions for a particular work, number of participants, investments, safety, environmental protection.
Technologically-technical level of turnaround project process equipment is defined considering the complexity of equipment conditioning replacement of spare parts with or without significant modifications for the process, equipment modifications, investment works e.g. including more complex equipment etc.
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Unclear goals in the planning and execution phase cause turnaround project complexity.
Disagreements about project goals cause turnaround project complexity.
Change of goals over a certain period of time causes turnaround project complexity.
Unavailability of key resources causes turnaround project complexity.
Unpredicted changes in outside environment bring about forced changes thus causing turnaround project complexity.
Unpredicted changes in internal organization bring about forced changes thus causing turnaround project complexity.
Lack of top management support causes turnaround project complexity.
Role of turnaround project Supervisory Board causes turnaround project complexity.

Complexity – moderator of relation between turnaround project processes and key results

Empirical research was carried out by surveys in 2013 in five refineries in Croatia, Italy, Slovakia and Hungary. Questionnaire was given to project managers in turnaround management offices and to turnaround project interest groups, who are most familiar with research issues. Survey was sent for 250 respondents. The rate of return amounted to 118 respondents, which makes 47, 2%. Questions were measured by Likert scale from 1 to 5 (1 = I totally disagree, 2 = I disagree, 3 = I neither agree/nor disagree, 4 = I agree, 5 = I totally agree). Criterion for participating in the survey was the selection of respondents who were included in at least one turnaround project. This criterion is set so that turnaround project could be observed as realistic as possible. Survey was also carried out based on interviews with turnaround project managers and members of interest groups as well as on author's personal observations when acting as turnaround project main team leader.

Relations between variables are first presented using descriptive statistics. For exploring the influence of variables in given relation, i.e. exploring statistical significance of stated hypotheses, the method of logistic regression is applied. Considering the fact that dependent variable in this research is categorical it is appropriate to apply logistic regression. Also, special feature of the logistic regression is that, in general, it requires smaller sample in order to get sufficiently strong testing. Sometimes the dependent continuous variable turns into a categorical one since it is not possible to form sufficiently big testing sample.

Testing results for H1 are presented hereunder:

Efficient management of project business processes will have positive effect on project key results.

Table 4 shows descriptive statistics for variable of project business process management in relation to project key results variable.

Table 4
Descriptive statistics – process management variable in relation to key project results variable.

Project key results	Process management		
	N	Arithmetic mean	Standard deviation
1	0	0.00	0.00
2	1	1.00	0.00
3	12	3.00	0.74
4	60	3.37	0.74
5	45	4.11	0.75

Table 4 indicates that most respondents in this sample regarded project key results variable as value level 4 and value grade 3.37. Mean grades of process management variable are the highest for the variable of project key results of level 4 and 5. In this case, interdependency between variables cannot be established.

Furthermore, testing of hypothesis H1 by analyzing maximum likelihood, with results presented in Table 5, is following. It is confirmed that at least one independent variable in the model is influencing and describing the dependent variable.

Process management variable coefficient has p-value < 0.05, which means that this variable significantly statistically influences the project key results variable. After proving statistically significant influence of process management on project key results, the nature of the aforesaid influence is presented in the following Table 6.

Table 6
Probability ratio, H1.

Effect	Point estimate	95% wald confidence limits	
Process PM	4.184	2.513	6.967

Probability ratio is defined as the ratio of the probability of success over the probability of failure. The transformation from probability to odds means that the odds increase as the probability increases or vice versa. Probability ratio for process management variable is 4.184. It can be concluded that each increase of process management variable by one grade increases the probability ratio that key project results will be in the higher category (in relation to lower category) by 4.184 times.

Table 5
Maximum likelihood analysis, H1.

Parameter	DF	Estimate	Standard deviation	Wald Chi-Square	p < ChiSq
Intercept 5	1	−5.745	0.9835	34.1215	< .0001
INTERCEPT 4	1	−2.5892	0.8621	9.0204	0.0027
INTERCEPT 3	1	0.3446	1.2612	0.0747	0.7847
PROCESS PM	1	1.4313	0.2601	30.2819	< .0001

It can be concluded that with each increase of process management variable level the level of key project results will also be better i.e. increased.

Proving the hypothesis on positive influence of process management variable on project key results variable (H1) shows the importance of process management in the sense of its systematic adjustability for particular types of projects.

By all means processes have to be constantly changed and improved since they significantly influence the efficiency of project key results. This case also leads to an assumption that project management success and the success of the project itself will be increased through influencing project process management.

Test results for H2 are given hereunder:

Complexity will have moderating influence on relation between efficient management of project business processes and key results of the project.

Table 7 presents results of descriptive statistics for project process management variable in relation to project key results variable previously dealt with (H1). In the second part of Table 7 results of complexity variable descriptive statistics in relation to project key results variable are presented.

Value relation of respondents presented by descriptive statistics of process management variable and project key results variable is analyzed in hypothesis H1. It can be concluded that increase of complexity variable level also implies the increase of project key results variable level. The given statement leads to conclusion that there is a possibility of positive connection between complexity variable and project key results variable.

Furthermore, testing of H2 hypothesis by the analysis of maximum likelihood is presented in Table 8. Also, it is confirmed that at least one independent variable in the model influences and describes the dependent variable.

The table shows that coefficient of project process management variable has the p-value < 0.05, which means that this variable is significantly statistically influencing the variable of project key results. Also, it is evident from the above table that project management complexity variable has the p-value < 0.05, which means that this variable is not statistically significant. After proving the statistical significance of the influence that project process management has on project key results, Table 9 presents the nature of the aforesaid influence.

Table 7
Descriptive statistics – complexity variable in relation to process management and project key results variables.

Project key results	Process management			Complexity	
	N	Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation
1	0	0.00	0.00	0.00	0.00
2	1	1.00	0.00	2.00	0.00
3	12	3.00	0.74	1.83	0.39
4	60	3.37	0.74	2.38	0.49
5	45	4.11	0.75	2.69	0.97

Table 8
Maximum likelihood analysis.

Parameter	DF	Estimate	Standard deviation	Wald Chi-Square	p < ChiSq
Intercept 5	1	−6.1566	1.0678	33.2446	< .0001
Intercept 4	1	−2.9628	0.9363	10.0124	0.0016
Intercept 3	1	−0,0272	1,3217	0,0004	0,9836
Process PM	1	1.2965	0.2753	22.1783	< .0001
Complexity PM	1	0.3605	0.3017	1.4276	0.2322

Table 9
Probability ratio, H2.

Effect	Point estimate	95% wald confidence limits	
Process PM	3.656	2.132	6.272
Complexity PM	1.434	0.794	2.591

Probability ratio for process management variable is 3.656. It can be concluded that each increase of process management variable by one grade increases the probability ratio that key project results will be in the higher category (in relation to the lower one) by 3.656 times. Accordingly, it can be concluded that with each increase of process management variable level the level of key project results will also be better i.e. increased.

Probability ratio for complexity variable is 1.434. It can be concluded that each increase of complexity variable by one grade increases the probability ratio that key project results will be in the higher category (in relation to the lower one) by 1.434 times. However, this variable is regarded as insignificant.

For further analysis of hypothesis H2 the existence of moderating influence is also assumed, meaning that complexity will moderate i.e. increase or weaken the positive influence of process management and project key results. Testing of moderating effect is realized through creating a separate new variable of predictor (process management variable) and moderator (complexity variable) product, which is a carrier of possible interaction and is included in regression equation as the last predicting variable.

In Tables 10 and 11 results are given of the global test with hypothesis that all coefficients in the model are equal to null. Since the realized p-value < 0.0001, this hypothesis is dismissed.

The mentioned indicates that at least one independent variable in the model influences and describes the dependent variable, in this case project key results variable.

Analysis of maximum likelihood, results of which are presented in Table 12, also confirms that at least one independent variable in the model influences and describes the dependent variable.

Table 12 shows that moderating complexity variable is also statistically significant. Further, the table indicates that variable is negatively signed, meaning that increase of moderating complexity variable level reduces by one the connection strength of process management variable on project key results variable. If the level of moderating complexity variable is reduced, the influence of process management variable on project key results variable is increased. It can be concluded that moderating complexity variable negatively influences the relation between process management variable and project key results variable, therefore it is statistically significant.

Table 10
Results of global test for moderating variable H2.

Model fit statistics		
Criterion	Intercept only	Intercept and covariates
AIC	238.323	201.676
SC	246.635	218.3
−2 Log L	232.323	189.676

Table 11
Results of global test for moderating variable H2.

Testing global null hypothesis: beta = 0			
Test	Chi-square	DF	p < ChiSq
Probability ratio	42.6472	3	< .0001
Score	34.7218	3	< .0001
Wald	34.4345	3	< .0001

Table 12
Analysis of maximum likelihood for proving moderating variable H2.

Analysis of maximum probability estimates					
Parameter	DF	Estimate	Standard deviation	Wald Chi-Square	p < ChiSq
INTERCEPT 5	1	−12.5058	3.2472	14.8325	0.0001
INTERCEPT 4	1	−9.1743	3.1257	8.615	0.0033
INTERCEPT 3	1	−5.8964	3.0446	3.7507	0.0528
PROCESS PM	1	2.8166	0.7807	13.0172	0.0003
COMPLEXITY PM	1	3.2341	1.3952	5.3737	0.0204
PROCESS PM * COMPLEXITY PM	1	−0.6828	0.3178	4.6178	0.0316

Conclusions

This paper deals with solving issues of turnaround project quality management through implementation of complexity variable and its moderating influence on the efficiency of turnaround process management. The empirical research was carried out on a sample of 118 turnaround project participants in five refineries in Croatia, Italy, Slovakia and Hungary, which makes total response rate of 47.2%. For testing the research variables relation statistical method of logistical regression was used.

Results obtained by research confirmed the set hypotheses, that is, the efficient management of project business processes has positive impact on project key results. Also, the complexity variable achieved moderating influence on relation between efficient management of project business processes and key results of the project. Consequently, research results indicate that increase of complexity reduces the successfulness of TAR project. Furthermore, efficient management of project processes increases the probability of achieving greater project performance, thus implying the realization of a greater degree of availability and reliability of turnaround project. Beside theoretical contribution, this study results has important practical implications, especially in the industrial plant settings, with emphasis on turnaround project management.

The above refers primarily to the requirement that change of management process in turnaround project has to be flexible and in accordance with specific features of the given project. Processes should not have formal features, instead they should be in the function of the significant tool through which all courses of particular turnaround elements are defined, especially in the planning and preparation phase. Complexity is an element that significantly contributes to the project successfulness. As shown in this paper, increase of complexity reduces the successfulness of turnaround project. If complexity is not recognized in the early phase of turnaround project, it is usually further increased during project lifetime and eventually brings about the reduction of the project successfulness.

Furthermore, the most important research but also practical contribution of this paper in the realm of the turnaround project management and quality management, refers to solving issues of turnaround project quality management through implementation of complexity variable and its moderating influence on the efficiency of turnaround process management. Complexity is characteristic for all turnaround projects and is often present in all project phases, however it has not been implemented in models of quality management so far. Complexity variable presents measure of complexity and it is shown in this paper that it is exactly the complexity variable that affects the project successfulness i.e. project key results.

Most common aspects of project successfulness are duration, budget, quality and scope whereas success in turnaround projects also includes environmental protection aspects, safety and health of participants. Relation of variables presented by set hypotheses represents also the success of refinery turnaround project management, which can be measured by observing particular variables. It is proven that greater success in turnaround project process management will have positive impact on the turnaround project key results.

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