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Reducing Negative Impact of Project Changes with Risk and Change Management

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Abstract: Although changes have proven to be one of the crucial causes of project deviations, this topic is relatively poorly discussed in the literature. This paper presents research whose goal was to examine how changes can be prevented, and how to reduce their negative impact. Theoretical research examined risk management and change management. The developed model was verified after conducting empirical research in Slovenian enterprises. The research confirmed that risk management identifies possible changes and reduces their impact; while formal change management ensures the effective implementation of changes. The combined functioning of both areas ensures effective project execution.

Keywords: project, risk management, change management

JEL Classification: L29 , O22, D22, D23, G32

Introduction

Many projects exceed the planned time and costs, and changes have proven to be one of the most important causes of deviations (Harrison & Lock, 2004). It is not unusual for changes to raise project costs by 50% and sometimes even more. Sixty-four percent of the 1,000 project managers included in the »Hussain and Wearne« research on the biggest problems in project management indicated changes are some of the biggest problems (Meredith and Mantel, 2006). Further, they pointed out changes as the problem that annoys them the most. They generally hate changes because they affect plans and reduce the ability to satisfy the interests of project stakeholders (Baker, 2000). However, changes are often necessary and it is therefore necessary to establish the effective management of changes and ensure compliance with the rules in a disciplined manner. McLean found that change management is a key factor of IT project success (Putnam, 2005), while research by Lee, Thomas and Tucker (2005)

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found it is the second most influential project management technique (after project planning).

According to experts changes are a constant in projects (Rosenau, 1998). Since a project is a dynamic process functioning in a changing environment, a team in the planning phase of a long project cannot predict all factors (Wysocki and McGary, 2003; Frame, 2003; Andersen et al., 2004), and even an excellent project plan cannot prevent all unexpected "surprises" (Young, 2000). Even the most sophisticated plans can fail due to changes in customer requirements (Foti, 2004). One other finding is also important: the cost of change (due to a poor plan or customers making changes) rises as the project progresses (Burke, 2003; White, 2006). The later we decide to change (or discover a hidden change), the larger the impact that change will have on the (non)success of the project.

Despite the awareness that changes are an important factor in the efficient execution of projects, an examination of the literature shows that the area of change management is poorly addressed. On average, this subject is covered by just a few pages in books, not even a whole chapter, and we could not find any books dedicated solely to the management of project changes. Moreover, most authors only discuss »formal« changes, namely, changes proposed by one of the project stakeholders and approved (or rejected) in a formal procedure. The suggested processes of managing changes are incontestably relevant, especially when the procedure is set out at the beginning of the project and when all stakeholders consider them. However, many different changes can occur during execution of a project that are more unofficial and they can have a greater negative influence on time and costs. A few authors mention such changes, but we could not find any "one-size-fits-all" change management model to help master all types of changes.

In response to these findings we conducted more extensive research into project management theory and discovered that changes and the management of them are also partly included in risk management. In combination with ideas acquired by executing many projects in practice, we formulated a model which comprehends project risk management and the management of formal changes. Risk management identifies possible changes and prevents or at least reduces their impact, while change management ensures the effective realisation of formally approved changes. We verified the developed construct by empirically researching Slovenian enterprises.

Types of Changes

A detailed theoretical study and in-depth reflection based on practice led us to a systematic division of changes: changes can be direct or indirect or they can be divided according to area and duration of influence, the procedure of approval, time distance, the possibility to decide on change implementation, and cost covering.

Direct changes are "departures from the approved project scope or design as indicated by a change of any contract, drawing or specification after its approval and issue for action" (Lock, 2003). Direct changes may result from **indirect** changes (market changes, competitors' activities, the emergence of new technologies etc.). We used the word "may" here because project stakeholders can decide whether, on the basis of indirect changes, the project plans and scope will change or not (Bonham, 2005).

Scope changes relate to project products (requirements, technical solutions), while **organisational** changes relate to the project execution (tasks, project schedule, deadline, costs). However, scope changes usually cause organisational ones. Scope changes are **permanent**, the organisational ones are **temporary** – permanent changes remain recorded in drawings and specifications, while temporary changes ensure timely execution and are in the domain of the project team (Lock, 2003).

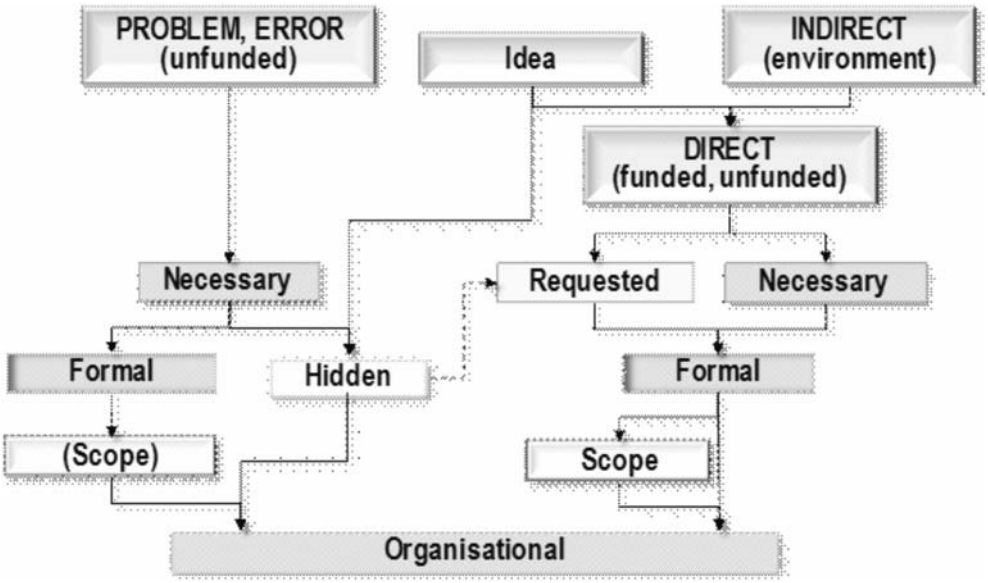
Formal changes are considered and adopted following an agreed procedure and entered in the project documentation. **Hidden** changes occur when a customer, team member or group of stakeholders decide on certain changes to the objectives or a different way of implementing the project without informing the others or without receiving authorisation to carry out the change (Heldman, 2005). Hidden changes cause one or more linked tasks to be reworked, along with delays, increased costs, reduced productivity, and they affect the relationships between those participating in the project (Howes, 2001; Milosevic, 2003).

Unlike formally **requested** changes which are approved or rejected, **necessary** changes must be carried out if the team wants to meet the objectives of the project. Therefore, the team does not decide whether to implement the change or not but has to find out the best way of bringing it to a reality it (Hällgren, 2007). Typically, necessary changes are organisational – they cause schedule changes (the way of task execution, technology). Necessary changes are often caused by errors and problems such as equipment problems, the absence of team members, or contractor delays (Karvonen, 1998; Young, 2000).

Funded (usually scope) changes are requested by the customer, which then also covers the costs of making the change. Funded changes result in schedule, specification and contract changes. On the other hand, **unfunded** changes are those whose sources are problems and errors and/or are proposed by team members. The additional costs of changes are covered by the contractor/project owner (Harrison and Lock, 2004; Charoenngam et al., 2003).

All types of changes and their logical connections are shown in Figure 1. We ranked both sudden and announced changes within expected changes because we presume that the majority of changes can already be expected in the project planning phase.

Figure 1: The sequence and cohesion of various types of changes



Presumably a hidden change already causes some damage to the project (additional work and thus a delay and increased costs), so it is first and foremost an organisational change because we have to change the plan of subsequent activities. However, if a change detected early seems reasonable it can be formally discussed and approved or rejected (as indicated above with a dashed arrow).

Change Management

The Traditional Process

Some authors consider change management as part of scope control (Newell, 2002; Burke, 2003; Milosevic, 2003), whereas most of them treat it as an independent process. In so doing, they generally focus on changes that are directly related to the objectives and implementation of the project. As we had expected, our research of the literature revealed that authors mostly discuss changes proposed by individuals and treat within the formal approval process. Partly they also address the detection of hidden changes, but rarely address broader changes. The typical change management process has four steps:

- **change requirement**: identification and documentation of the proposal (Burke, 2003); recording the need for change (Kliem, 2004); a review of the requirements for scope/organisational changes and identification of activities that are affected

by changes (Meredith and Mantel, 2006); and the identification of areas of change (Verzuh, 2005);

- **change evaluation**: assessment of the impact of change on the schedule, scope, budget (Deeprose, 2002); rating changes, the establishment of responsible, planning change (Kliem); evaluation of the benefits and costs of required changes (Meredith and Mantel); and a change activities proposal (Verzuh);
- **change approval**: forwarding the request to the competent people to decide whether to approve or reject the changes; and
- **realisation of change**: the change/update of the plan (Verzuh, Burke) and information share about the change (Deeprose); implementation of the change (Kliem), informing stakeholders about the change and ensuring effective implementation of the change (Meredith and Mantel).

However, many other authors suggest a relatively similar process (Heldman, 2005; Levine, 2002; Lock, 2003; Prince2, 2002; Young, 2000; Thomsett, 2002; Wysocki and McGary, 2003; and Turner and Simister, 2000).

Although the steps that follow a change request are given different names, they refer to similar actions, including an assessment of the change impact on the objectives, approval and implementation of the change. While only a few authors mention the step of developing proposed activities, we think it is appropriate to consider several alternatives of the change realisation and to select that alternative with the minimum negative impact on scope, time, cost and quality.

A dilemma appeared in defining the process steps, in particular with the step "implementation of change." If due to an approved change in the way of realising, or in the solution or objectives, a further schedule is changed then changed project execution follows. "The implementation of change" actually refers to changed objectives and schedule so we cannot talk separately about the extra implementation of change. The implementation of change as an extra step in the process can be discussed in the case of corrective actions we employ to try to continue the project according to the baseline plan as soon as possible (removal of errors, elimination of delays).

Some authors include informing the participants and the documentation of changes as individual steps in the process. We believe that documentation is to be implemented gradually in all steps, while information about the change begins with the change requirement because an expert opinion should be provided by everyone who may be affected by the change. Both the information and documentation should be supported by modern information technology and all information about the changes should be stored or published on the project's portal where project stakeholders can find up-to-date information about the new changes and give their opinions.

Risk Management – The Prevention of Changes

We assume that many changes can be expected due to team members' experience from previous projects. Team can respond to them already in the project planning phase. The literature includes them in the project risk management process.

Most authors similarly link risks and changes – changes to the objectives, scope and execution are the biggest risk factors. If, therefore, the team is aware of potential changes already at the beginning of the project those changes must be included in the risk management process. Several authors also state that the processes of managing change and risk management have to be linked and harmonised (Heldman & Heldman, 2007; Datta & Mukherjee, 2001; Kerzner, 2004; Meredith and Mantel, 2006). Risk can also arise from the inadequate management and documentation of changes (Heldman & Heldman, 2007).

Frame (2003) believes the project team must be ready for change so that changes do not surprise them. He also indicates that ignorance of a project's environmental impacts and a lack of information in the planning phase pose a risk that changes might occur in the project. Charvat (2003) sees the problem similarly, while Kerzner (2006) indicates that the purpose of risk and change management is to reduce the number and range of surprises as much as possible. According to Kerzner, change usually creates new risks, while the occurrence of risk creates changes that are again linked with new risks. Risks and changes therefore appear to be "hand in hand" so enterprises often set up a uniform approach to deal with both. Similar views are expressed by Thomsett (2002) and Young (2000).

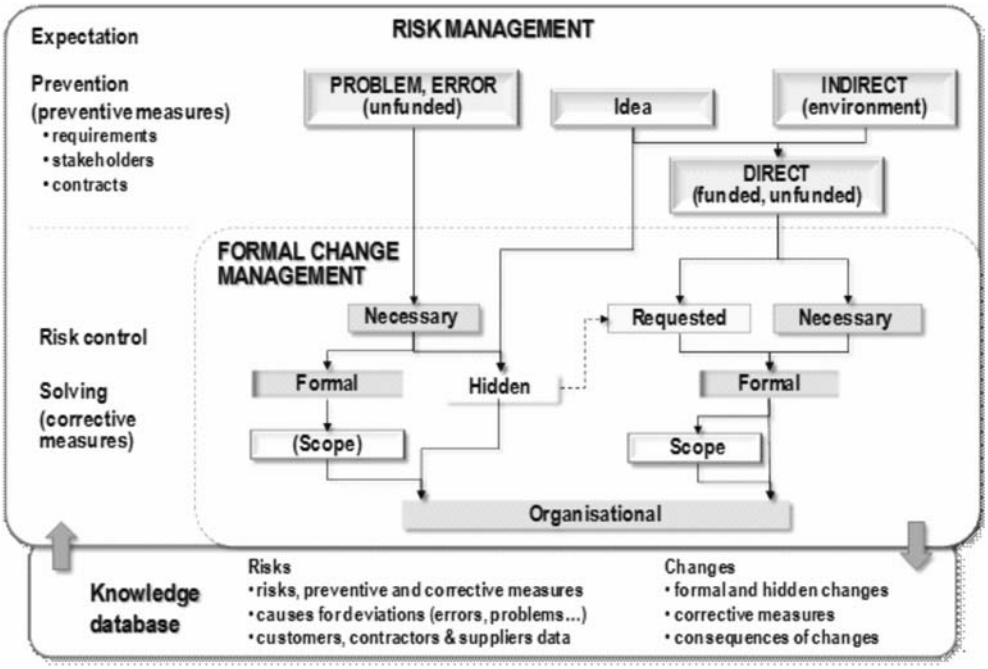
We also found that both processes are integrated by the following authors:

- Chapman & Ward (1997) state that already in the context of risk management it is necessary to assess the consequences of changes to the design and plan;
- Murray-Webster and Thiry (Turner & Simister, 2000) indicate that the methods which contribute to change management are the value management approach which seeks to provide the maximum benefits to all project stakeholders in terms of the costs and benefits of change, and risk management (in terms of assessing the consequences of the change);
- Heldman & Heldman (2007) and Thomsett (2002) consider that it is necessary, when considering requests for change, to examine other potential risks that could arise were the change to be approved; and
- Oni (2008) states that change management includes the establishment of a procedure for identifying and evaluating scope changes which might affect the cost and performance (which in fact deal with risks).

The Developed Model

On the basis of our classification of changes and the study of the literature, we developed a "Project risk & change management model" that is presented in Figure 2. The model is divided into two parts - risk management and formal change management.

Figure 2: Project risk & change management model



Expected changes should be handled by the risk management methods. According to the theoretical research findings, all types of changes can be expected. In addition, a database of risks and changes arising from finished projects may be helpful. Experts in the risk management field recommend various measures to reduce risks. As the most effective approach is the risk (changes) prevention, we presume in the model that risk management can be used for preventing expected changes. If a team cannot find appropriate measures to prevent changes, it plans preventive measures to reduce the probability of the risk being realised. If the risk (change) emerges, the response can be faster using risk management (corrective measures can be planned in advance), while in a normal control process measures can only be defined after the identification and analysis of the problem, which takes more time.

Regular risk control effectively detects sudden direct changes (both scope and organisational) and urgent operative changes as a result of detected errors and problems. When a change is discovered, it can also be considered as requested and treated in the formal change management process (depending on the stage of realisation of the change). Mostly the subjects under discussion are unfunded changes, although sometimes changes arranged between a customer and individual team members (without the consent of the project manager) can be discovered. In the formal process, after a change has been discovered a decision is taken as to who will cover the costs of the change.

The formal change management process includes the treatment of all formally requested (direct, scope or organisational) changes and ensures their effective implementation. As mentioned, changes that are discovered early can also be treated in the formal process. However, irrational changes may be rejected.

Empirical Research

Research Method

The model was tested against empirical quantitative research in 137 Slovenian enterprises. The results collected in a Web questionnaire were analysed with multivariate analysis using the SPSS V17.0 software.

Since our basic hypothesis was: »The individual parts of the model and the entire model provide for the more efficient execution of a project«, we first defined three efficiency factors: project delay, cost surplus, and extra work hours. We used the ratio (%) between the baseline and the actual factors (indicated at the end of the project) and these became the dependent variables of the subsequent analysis.

The research showed that in 90% of projects changes are the reason for project delays and higher costs (Table 1). On average projects are prolonged in time by 24.6%, while costs are 14.6% higher. Two-thirds of enterprises stated that the actual work was higher than planned, on average by 17.9%.

Table 1: Project delays, increased costs and extra work as a consequence of changes in Slovenian enterprises

	Time	**Cost**	**Work**
Number of enterprises indicating a surplus	123 (90%)	120 (88%)	90 (66%)
Average surplus	**24.6 %**	**14.6 %**	**17.9 %**
Standard deviation	24.7	12.6	25.8
Number of enterprises with a surplus over 50%	25 (18%)	6 (4%)	4 (3%)
Number of enterprises with a surplus over 20%	58 (42%)	44 (32%)	29 (21%)

The independent variables were derived from the construct. We intended to examine the impact of individual functions on efficient project execution and we therefore determined the presence of those functions in the enterprises (e.g. if certain tasks are performed, whether the enterprise has a policy or a department) and the frequency or scale of the execution of specific tasks. The independent variables we examined were:

- risk management – anticipating changes in the project planning phase, risk identification, evaluation and planning of measures, risk control, risks analysis and database maintenance;
- formal change management – the existence of regulations on change management, the determination of who pays for the change in contracts, a report on changes in the project final report, the existence of a changes database.

To test the developed model we analysed the acquired data with a multivariate analysis, specifically by determining the correlations and regressions.

With a correlation analysis we mostly verified whether the existence of particular variables decreases (or increases) the impact of changes on effective project implementation. By calculating a linear regression of individual variables we found how much they impact on the efficient project implementation. The integrated model and its interacting parts were checked with a multiple linear regression.

Results and Discussion

The multiple linear regression showed that **risk management** reduces the negative impact of changes (the independent variables included: change expecting, and identification, evaluation and planning of measures during the project start-up, risk control, risk analysis and maintenance of a risk database). Risk management mostly contributes to reducing project delays (R 0.413, R_{Sq} 0.171), a less pronounced cost reduction (R 0.281, R_{Sq} 0.079), while the impact on work (spent hours) is negligible. The most influential factors for reducing delays are regular risk control (correlation 0.265) and risk analysis (incorporated into a project final report, 0.289). A minor impact on time and cost was also made by the preparation of measures to reduce risks. Other steps in the risk management process did not prove to be effective in relation to the changes. Otherwise, in most enterprises risk management is still less systematic since only 59% of respondents had knowledge of risk management methodology, half the respondents control project risks, while only 19% of respondents maintain a risk database.

We also analysed the effectiveness of measures for reducing the impact of the expected changes. The analysis showed that pre-planned corrective actions reduce the impact of changes on the project's duration (0.259), while preventing changes provides for the cheaper implementation of projects. However, that impact was found to

be smaller – probably not all the measures are the most appropriate. The regression analysis showed that the passive approach extends the duration by 4.9% and increases the costs by 4.5%, while corrective measures planned in advance reduce the duration by 14.5% and reduce costs by 6.3%.

Formal change management was tested with three issues which showed varying levels of the systematic approach. Only a third of the enterprises had defined a systematic approach (including regulations). However, 81% of the respondents indicated that they include information about the changes in the final report, which could be used for knowledge sharing. A database of changes should have a similar function but only a third of the enterprises maintain one. We found that projects in enterprises where changes are systematically managed have 10.2% fewer delays. An even more important factor is information on changes included in the final report – delays caused by changes are 10.1% shorter, while costs are decreased by 6.2%.

So far we have presented an analysis of individual parts of the model. Since our idea was that all both areas together influence the effective management of changes and effective achievement of project objectives, we also examined a multiple linear regression of the model and the performance deviations, as shown in Table 2. Below we summarise the main findings of this analysis.

Table 2: Regression analysis of the model

	Correlation (R)	**Impact level** (R Square)	**Reliability (Sig.)**
Project delay	0.494	0.245	0.001
Higher costs	0.340	0.116	0.188
Additional work	0.285	0.081	0.700

On the basis of calculated reliability (Sig. / ANOVA) we may conclude that the delay of a project depends on at least one of the variables involved. Although the degree of correlation is large (0.49), the variables involved can explain only 24.5% of the project delay. The regression function is shown in Eq. 1.

$$\textbf{Project delay} = 33.98 - 4.68\ ChP + 14.69\ RI + 9.75\ RM - 7.20\ RC - 8.55\ RA - 2.60\ RDB - 11.17\ ChMan - 9.12\ ChAnal + 1.01\ ChDB \quad (1)$$

Legend:

Risk management

ChP – anticipating change in the project planning phase
RI – risk identification
RA – risk analysis
RM – risk mitigation
RDB – risk database
RC – risk control

Formal change management

ChMan – the existence of regulations for change management
ChAnal – analysis of changes in the project report
ChDB – maintenance of a database of changes

By calculating the reliability or probability that each independent variable does not affect the delay in the project (*it should be less than 5%*), the most reliable va-

riables proved to be the identification of risks (0.01) and the existence of change management regulations (0.02).

The reliability of the influence of the integrated model on increased project costs, considering all of the variables, was 0.19 (a 19% possibility that the variables have no impact), while the variables affect just 11.6% of the variability of costs. With limited selection we found variables with a more reliable collective impact on costs (Table 3).

Table 3: Impact of the variables on a smaller cost increase

	Correlation (R)	**Impact level** (R Square)	**Reliability (Sig.)**
Higher costs	0.332	0.110	0.025

We show the variables ranked in equations of regression functions (Eq. 2).

Higher costs = 17.73 + 3.98 RM + 7.33 RM - 4.00 RA – 1.72 ChMan - 5.21 ChAnal *(2)*

Legend:

Risk management	***Formal change management***
RI – risk identification	*ChMan – the existence of regulations for change*
RM – risk mitigation	*management*
RA – risk analysis	*ChAnal – analysis of changes in the project report*

In analysing the developed model's impact on an increased number of work hours, we found that the included variables only explained 8.1% of the variability of the additional hours of work, with a reliability rate of 0.70 (i.e. a 70% chance that the variable does not lead to increased work). Even if we only include variables for which the correlation showed an individual effect, the calculation showed a 56% probability that the variables do not affect spending hours at a rate impact of 3.6%.

The empirical research in Slovenian companies proves that the combined functioning of risk and change management decreases project delays; individual parts of the model mutually reduce costs, although we did not find the model had an impact on work hours spent.

The research also included the Project Management Information System (PMIS) and Project Management Office (PMO). Theoretically, the PMIS should provide the early warning of problems and delays, a quick response, a more exact discussion of changes, and information for stakeholders about changes. PMO can prepare reports on a project's progress and highlight hidden changes, problems, errors, any potential bottlenecks or expected delays. In addition, PMO should set up a formal change management system (process, forms, archives, computer tools). Unfortunately, two-thirds of the Slovenian enterprises included in the research have not yet established

PMO, and half of them do not use any specialised PMIS. A negligible number of them carry out the mentioned functions that should benefit the management of change. Although the analysis partially shows the usefulness of PMO and PMIS, we must wait for reliable conclusions to enable a higher level of development of both functions.

Although organisational culture factors were not included in the construct, we did examine them in the empirical research. The analysis shows a high level of importance of organisational culture on the implementation of projects. The degree of correlation is quite large (Time: 0.52, Costs: 0.39), while the included variables explain 27.2% of delays and 15% of cost increases. Important factors of culture are: that projects follow the internal project management regulations (corr.: 0.307 Time, Costs 0.256, 0.247 Work); everyone respects the competencies of the project managers (T 0.309, C 0.231); the projects have clear priorities (T 0.368, C 0.288), top management supports the projects (T 0.329, C 0.228, W 0.254), and team members are motivated (T 0.418, C 0.260). We believe that the motivation of team members reduces the impact of changes in two ways. The first involves the acceptance of change – more motivated teams quickly adopt and effectively implement change without any major resistance. Another aspect may relate to unpaid overtime work – if team members feel strong affinity to the project, problems, errors and changes will be resolved in overtime, without the expectation of payment, simply to ensure execution of the project within the deadlines and budget.

Conclusion

Changes to the objectives and scope, as well as a changed way of implementation, are some of the more important risk factors of a project. In addition, we also discovered that the changes and risk factors could be identical. Since many changes can be expected, they can be managed by using risk management tools. The probability of change can be reduced by taking preventive measures, while the negative impact of changes can be reduced by corrective actions planned to be implemented in the event that a change occurs. The expectation of change at the same time provides intensive and more focused control which ensures the early detection of change and a rapid response. An important prevention measure is having a highly detailed product configuration.

An important part of risk management is the use of experience, based on past projects, especially relating to changes. The project final report contains an analysis of project risks, changes and other causes of time and cost deviations. Based on final reports and analysing them, a database of risks and changes is maintained in which causes of deviations are documented and structured, along with corrective measures and other new experiences.

For the effective realisation of changes, a formal change management system has to be established and implemented in the enterprise. It includes the procedure of change approval, the documents generated in the process, and information system support. The procedure also defines the competencies and responsibilities of the project stakeholders in the process. A proper system operation can provide "a change co-ordinator", who can also be responsible for documenting changes and accelerating their approval. The procedure for managing change should be defined in a contract with the client or the contractors. The change proposal should also include who is expected to pay for the costs of a change.

The sharing of change information begins with the change proposal since an opinion on the advisability of change may affect anyone involved in the project. Information sharing and documentation is part of the change management system and should be supported by the information system. Through IT support the approval process is partly automated and thus faster. Information on changes may be published on the portal, thereby allowing the project stakeholders to receive daily information about new proposals, the status of the proposals and any approved changes.

The combined functioning of risk and change management enables the more efficient management of changes to ensure the better achievement of the project objectives. In the event that each field of activity functions alone, more activities would be duplicated. The changes are significant risk factors, approved changes usually create new risks while risk realisation creates changes that are again associated with new risks.

The most important contribution of this research is the developed model that was validated by empirical research. Through the combined functioning of risk and change management, the model deals with all kinds of changes – it provides the prevention, early detection and effective realisation of approved changes. Another contribution to science is the definition and systematic view of the range of different types of possible project changes. Since we have proven that the model contributes to the effective implementation of projects in practice, and consequently boosts the effectiveness of enterprises, we also highlight its high practical value.

To better understand change management we propose further research in two directions. The first should focus on human components such as resistance to change, and methods of persuading opponents of change. Further studies should also determine how much the management of change depends on the system and how much on the flexibility, ingenuity and systematic work of individuals. The second direction of research should address the problem of managing change in a multi-project environment. This study was oriented to individual projects and considered that project resources are only limited by cost and not quantity. In practice, companies have a limited number of people available so changes in one project may also influence other projects due to the limited availability of people as they are working on several projects at the same time.

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