

# RELATIONSHIP BETWEEN PROJECT COMPLEXITY AND RISK KINDS IDENTIFIED ON PROJECTS

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**Abstract:**

This paper studies the relationship between Project Complexity and Risk Kinds identified on Projects. Revision of related literature is used as a starting point for further development of author's concept for measuring those dependencies. Author presents the approach used in his research while defining objective Project Complexity Factor measures that reach specific values for specific projects and cannot be changed in the course of project delivery. The Project Complexity Factors are constructed the way that only significant change on the project would cause the change in those values. The aim is to define a system that works with objective rather than often subjective project measures. Project Complexity Factors are then aggregated into Project Complexity that describes the character of the project. For being able to link this project characteristics with specific risk groups author defines eighteen Risk Kind groups that can be inspected on the project. The most significant contribution of this concept is that the Project Complexity can be measured before the project starts and Risk Kind groups on project can be perceived in advance to optimize the decision process and risk management discipline. Based on the results it can be decided whether to proceed with the project, divide the project into smaller manageable parts, or subcontract the project to a contractor with project-specific needs. Introduced concept can be further used for categorization of project managers based on the Project Complexity values of projects they already managed. Project Complexity concept is presented as a technique that can be applied in daily operation by project managers without scientific insight, which was one of the conditions author set as a requirement. In author's research 69 IT projects are analyzed to check the validity of the concept. Partial extract of analyzed data is presented in this paper.

**Keywords:**

Project management, Project Risk Management, Project Complexity Level, Project Complexity Factors, Risk Kind, Altered Project Complexity Level, Project Riskiness, Project Risk Profile

**JEL classification:** M15, O22

## **1 Introduction**

One of the significant milestones in modern Project management can be dated to formalization of basic principles and issuance of consolidated best practices by Project Management Institute (PMBok) and Office of Governmental Commerce (PRINCE2). Through more systematic approach projects are becoming larger in means of: scope, length, costs, number of involved parties, usage of multiple technologies, and project management as a discipline became present in fields where it was not previously present. New terms emerged to project management among which the word complex/complexity is more and more declined. Since there is no strict and widely accepted definition of project complexity new approaches are appearing by scientists to manage those changing demands to project through individual and field specific categorization of project complexity.

## **2 Different approaches to define complexity**

Traditional widely accepted methodologies [1], [2] deal with project complexity as a term that describes the size of the project and its tendency to possible complicated delivery. In some cases [3] the term is used as antonym to simplicity. With aforementioned tendencies for the projects to become more complicated new approaches to define and measure project complexity emerged. Among the most recent studies Senescu et al. [4] describe the complexity in product, organization, and processes. Bosch-Rekvelde et al. [5] describe the complexity measures in technological, organizational, and environment complexity, or Girmscheid and Brockmann [6] describe task, social, cultural, operative, and cognitive complexity. One of the latest study published by Y. Lu et al [7] introduces the TO (Task and Organization) concept model for measuring project complexity that breaks down the project influencing factors in: Task complexity factors and Organization complexity factors. Those are further broken down to three consecutive levels creating complex system how to measure the project complexity.

The goal of my study is to define universal objective measure for project complexity with three main conditions: (1) the project complexity is objectively identifiable using objective Complexity Factors; (2) the project Complexity identification is not taking significant time allowing this concept to be used during standard project operation activities; (3) the project Complexity concept is easy enough to be used by non-scientific team member (Project manager) with common project management knowledge appropriate to his/her role.

Those conditions allow project managers to use this method without going deep into scientific level of understanding and can be aligned with their normal mode of operation defined in their job responsibilities.

Another aim of my study is to find the relation with occurrence of risks on the project. For being able to fulfil those two aims I define objective complexity factors to populate the project complexity and I define the risk kind categories that allows to measure the risk occurrence on inspected projects.

## **3 Definition of Project Complexity Factors**

Complexity of the project must be invariable during the course of the project. This condition assures that only the factors that define the general aspects of the project are incorporated. This condition also implies that the project complexity factors can be measured anytime during the run of the project including the very initial stages. Values of the proposed complexity factors are set in the beginning of the project

and cannot be changed during the delivery without significantly impacting the character of the project. The concept that I propose in my study consists of 11 Project Complexity Factors:

- PCF\_1. Number of locations in which the project will be created
- PCF\_2. Number of countries that will be involved in the project
- PCF\_3. Number of locations where the project will be delivered
- PCF\_4. Number of subcontractors involved in project
- PCF\_5. Nature of the delivery
- PCF\_6. Size of the delivery team
- PCF\_7. Assignment of appropriate number of people to the project roles in Customer
- PCF\_8. Length of project in months
- PCF\_9. Acquaintance of the delivering company with the customer
- PCF\_10. Acquaintance of the project teams with Project Management methodologies
- PCF\_11. Volume of delivery effort given in MD

Values that are assigned to individual PCFs are either numerical (directly answering the PCF question) or predefined set of answers are listed that indicate the value for each possible answer. Among the first group belong PCF\_1, PCF\_2, PCF\_3, PCF\_4 where the numeric value sets the complexity factor value. Example of the other is represented by PCF\_5 where Nature of the delivery is one of following: a) Analytical project, b) Delivery of "ready-to-sell" solution, c) Delivery and customization of the solution, d) Partial development of the solution (brand new solution that must be created specifically for the customer - new approaches or technology used), e) Pure development of the solution (whole output of the project is brand new solution that must be created specifically for the customer - new approaches or technology used).

Values measured for each PCFs are used for further calculations of the Project Complexity and Adjusted Project Complexity Level.

#### **4 Calculation of Project Complexity and Altered Project Complexity Level**

Each Project Complexity Factor (PCF) is an integer assigned in closed interval  $\langle 1, 10 \rangle$ . The model is constructed the way that allows for aggregation by multiplication of individual PCFs. Multiplicative character of the product correspond to the base assumption that complex character is not only defined as a set of multiple parts of the project but in addition to multi-facet character those parts are interconnected and interact with one another [8].

The Complexity of every project reaches values in interval  $\langle 1; 10^n \rangle$  where  $n$  is the number of Project Complexity Factors (PCFs). For practical reasons the value can be interpreted in logarithmic measure known as Adjusted Project Complexity Level and calculated as logarithm with base of 10 of Project Complexity value. Adjusted Project Complexity Level (APCL) expressed by formula:

$$\log_{10} \prod_{i=1}^n f_i$$

where  $f$  represents the factor of complexity and  $n$  in this case is equal to 11. Adjusted Project Complexity Level is used for creation of Project Complexity Intervals aggregating measured projects falling into Complexity Intervals (CI) for further work.

## **5 Definition of Risk Kinds**

### **5.1 Different definitions of risk kinds**

According to Project Management Institute PMBoK methodology [2] project risks should be grouped into the Risk Categorization group. The powerful tool of Risk Breakdown Structure is presented that uses the analogical approach to logical itemization as WBS (Work Breakdown Structure). OCG too, in its PRINCE2 methodology [3] mentions the Risk Breakdown Structure to illustrate potential sources of risks and groups the risks into logical sets by types. PRINCE2 further refers to use of in-house lists or Risk prompt lists that categorize risks into types or areas and are normally relevant to a wide range of projects. Working with risk libraries with predefined project risks is discussed also by Kendrick [9]. He is describing the usage of Project Experience Risk Information Library (PERIL).

There are two main approaches presented for working with project risks. One is grouping risks by logical connectors either by grouping them by subject or area where they appear or there is predefined risk library. Both means of grouping risks are closely connected to the method that is used for risk identification. Logical grouping brings the advantage of identifying risks specific to the analyzed project whereas libraries psychologically tend to tear the project members to identify the risks roughly delimited by the risk library in use.

### **5.2 Defined Risk Kinds used in research**

In the research presented I used categorization of risks that correspond to the analyzed projects in IT environment. A preliminary study was conducted followed by analysis of data from 69 IT projects provided from major delivery global companies with legal entity in the Czech Republic. All risks fall into predefined Risk Kind groups that do not limit this categorization approach only to IT domain and are suitable for analysis of dependencies with project Complexity. In my research I describe eighteen Risk Kinds:

- RK\_a. Strategic risks
- RK\_b. Technological risks
- RK\_c. Communication risks
- RK\_d. Political risks
- RK\_e. Risks connected with legislation
- RK\_f. Risks connected with subcontractors
- RK\_g. Risks connected with members of delivery or customer team
- RK\_h. Risks of Project Management methods
- RK\_i. Time bound risks
- RK\_j. Scope bound risks
- RK\_k. Quality bound risks
- RK\_l. Risks of unpredictability of the value of material or other production goods
- RK\_m. Financial risk

- RK\_n. Contractual and legal risk
- RK\_o. Safety and social risk
- RK\_p. Design risk
- RK\_q. Ecological risk
- RK\_r. Force majeure risk

Risk Kinds presented covered all risks that occurred in all analyzed projects. Measured data is eligible for constructing Risk Profiles that allow further aggregate study of relationship with Project Complexity Level.

### 5.3 Project Risk Profiles and Project Risk Configurations

Described Risk Kinds are measured and their values in respective project form the particular set of values that are labeled as Project Risk Profiles. It is assumed that projects on different Project Complexity Levels would evince different Project Risk Profiles. Those typical Project Risk Profiles measured in defined Complexity Intervals ranging in intervals of Altered Project Complexity Levels of <0, 1), <1, 2), <2, 3), <3, 4), <4, 5), <5, 6), <6, 7), <7, 8), <8, 9), <9, 10) are further labeled as CI<0-1>, CI<1-2>, CI<2-3>, CI<3-4>, CI<4-5>, CI<5-6>, CI<6-7>, CI<7-8>, CI<8-9>, CI<9-10>. Connection of typical Project Risk Profile with particular CI<x, x+1> form Project Risk Configuration that is further used on the project for optimization of project risk management. Aim of my research is the study of relationship between CIs and their respective Project Risk Profiles – values of individual Risk Kinds. Knowing the regularities in the dependencies would allow more precise prediction of risks hence optimizing the Risk management. The most significant contribution of this methodology is that the Complexity Factors, hence the value of Project Complexity, are objective measures and from definition they are known before the projects starts. Based on this fact and assumed relationship with Project Risk Profiles it can be predicted what risks are to be identified on the project and how significantly they are to appear. Project team can subsequently be ready for the mitigation risks that are typical for project from specific Complexity Interval. Another usage is that specific project before its commencement can be divided into better manageable parts should delivery company not possess project manager that would qualify for managing the whole project with high value of complexity. Another option for the delivery company can be management decision not to proceed with the project considering the expected riskiness.

## 6 Discussion – Found dependencies

Sixty nine projects were analyzed to observe to trial hypotheses and assumptions. The data was gathered from major IT delivery companies with legal entity in the Czech Republic. The proposed method was applied to measure the Project Complexity and Risk Profiles. Collected data cover Complexity Intervals: CI<0-1>, CI<1-2>, CI<2-3>, CI<3-4>, CI<4-5> and CI<5-6>. Figure 1 depicts the average values of each Complexity Factor grouped by Complexity Intervals (CI). Measured data covered the Complexity Intervals:

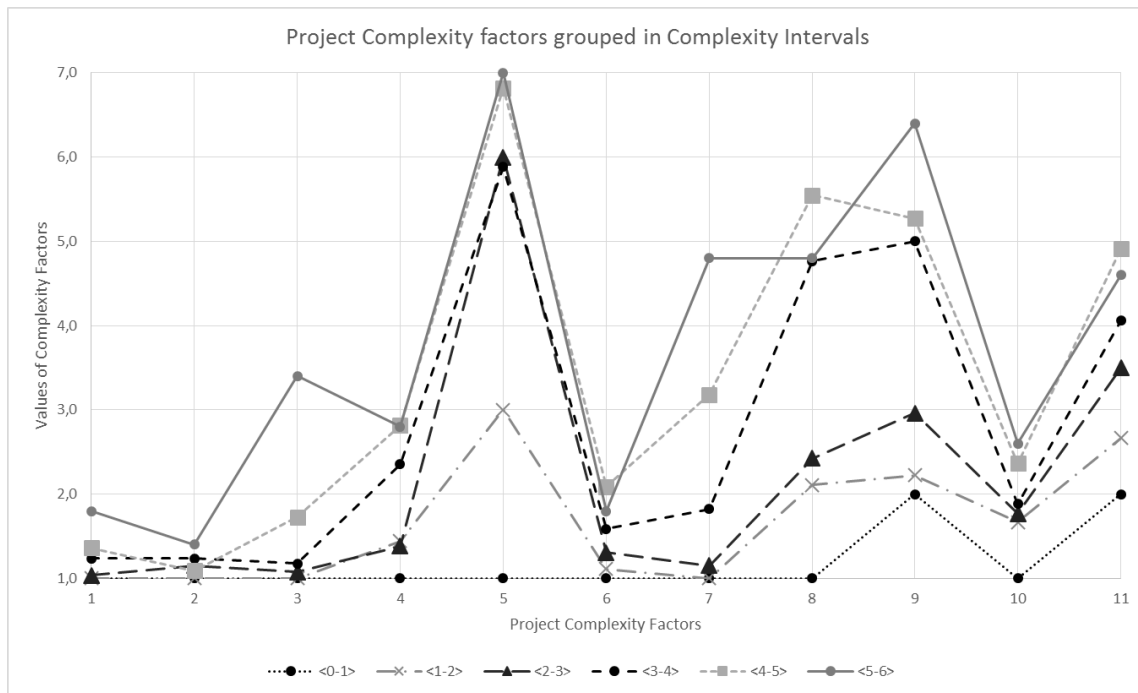


Figure 1 – Project Complexity Factors grouped in Complexity Intervals

The data shown are indicating that in measured sample the least influencing Complexity Factors are PCF\_1, PCF\_2, PCF\_6. Others are gradually growing with growing Complexity.

Figure 2 presents the average data depicting the Risk Profiles for the same projects analyzed above for individual Complexity Intervals CI<0-1>, CI<1-2>, CI<2-3>, CI<3-4>, CI<4-5>, CI<5-6> forming Risk Configurations.

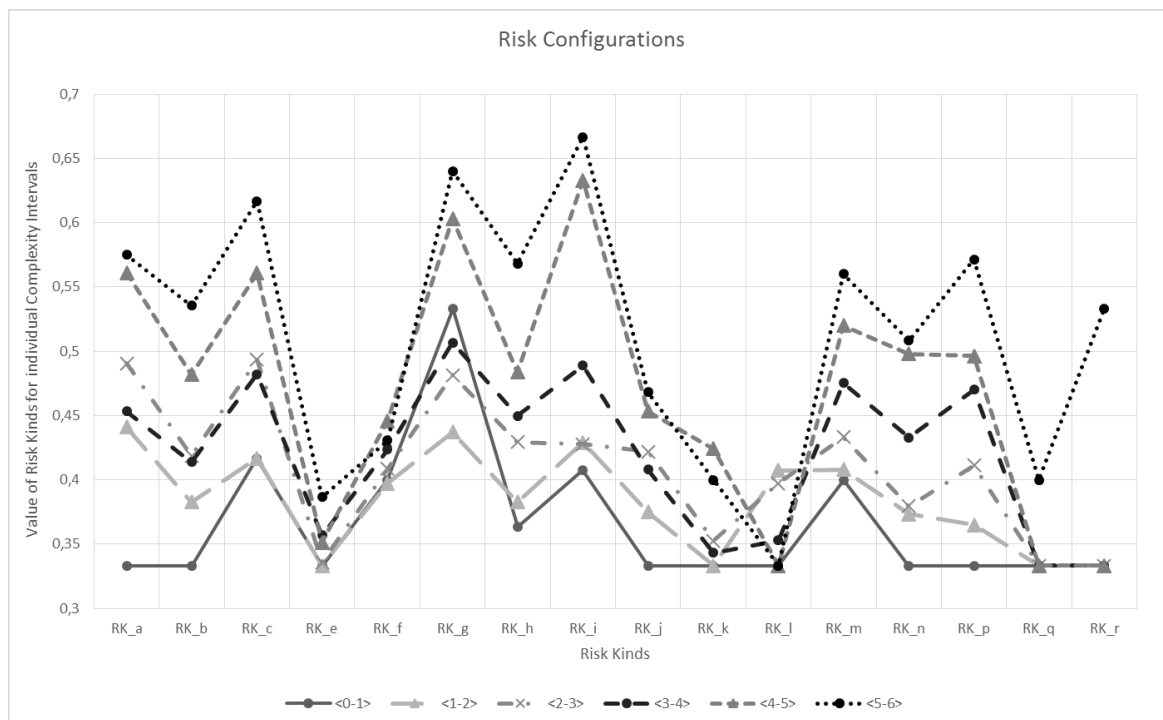


Figure 2 – Risk Configurations

The measured data from 69 test projects are supporting the assumption that higher Complexity Intervals evince higher values in Risk Kinds. Measured data also show that values of Risk Kinds are not distributed evenly, instead they form characteristic peaks in some values. For specific Risk Kinds the values are rather similar and do not provide significant differentiator among different Complexity Intervals. The Risk Kinds that do not show significant variability are: RK\_e, RK\_f, for some CIs: RK\_k, RK\_l, and for most CIs: RK\_q and RK\_r are identical (except CI<5-6>).

RK\_e Risks connected with legislation are reaching similar values and can imply that large IT delivery companies that provided the data for the study have consistently set their contractual policy and regulations and either do not proceed the contractually projects or are able to align the project contract to the level where most significant risks are managed.

Risks RK\_k Quality bound risks form two clusters. The higher one correspond to highest measured Complexity Intervals CI<4-5> and CI<5-6>. The lower Risk Kind value cluster correspond to lower Complexity Intervals CI<0-1>, CI<1-2>, CI<2-3>, CI<3-4>. Measured data are in line with assumption that there is a certain level of project complexity (in between values of CI<3-4> and CI<4-5>) where the values of Risk Kinds change in quantum. This quantum rise can correspond to rise of values of certain Project Complexity Factors – namely: PCF\_3 Number of locations where the project will be delivered, PCF\_7 Assignment of appropriate number of people to the project roles in Customer, PCF\_8 Length of project in months, and PCF\_9 Acquaintance of the delivering company with the customer. Each of these Complexity Factors can be linked in contribution to segmentation of values in RK\_k. PCR\_3 Number of locations where the project will be delivered raises the probability of quality issues. As well higher value in PCF\_7 Assignment of appropriate number of people to the project roles in Customer where not the optimal people in customer are assigned to the project raises the probability of occurring problems with quality in sense of not being able to proceed with project management according to defined standards [1], [2], [3]. Not having the right number of counterparts may delay project significantly and have impact on quality. PCF\_8 Length of project in months can have similar effect on quality taking into consideration increased delivery time to range of average 5 months in the higher cluster CI<4-6> (in contrast with average length of 2 months in CI<0-4>). PCF\_9 Acquaintance of the delivering company with the customer reaches highest values in CI<3-6>. This Complexity Factor implies that the more the customer is known by the delivery company the less quality issues will be perceived. Because the quantum increase in RK\_k are significant in CI<4-6> it supports the assumption that not individual Project Complexity Factors have specific impact on the quality of the project but rather the combination of named four PCFs.

RK\_l Risks of unpredictability of the value of material or other production goods also show division of values into two value clusters. Those clusters are different to clusters in RK\_k. This characteristic evidence can be attributed to values in PCF\_4 Number of subcontractors involved in project. It is assumed that the raise in number of subcontractors involved in the delivery in CI<3-6> can have effect to lower the measure of unpredictability of the material and other production goods due to transferring those risks to the subcontractors. Hence raise of the Project Complexity the RK\_l raises as well to the value where the values of PCF\_4 Number of subcontractors involved in the project raises over 2 and then the RK\_l lowers down. This effect groups the values of RK\_l for CI<3-6> with the lowest Complexity Interval of CI<0-1>.

RK\_q and RK\_r are special group of Risk Kinds with lowest measured values. Both reach the lowest same values in CI<0-5> with different higher values in CI<5-6>. This effect is in accordance with assumption that RK\_q Ecological risk is less perceived in lower complexity projects and can have higher presence in higher complexity projects.

Significant difference in values of RK\_r Force majeure risk correspond to significant difference in value of PCF\_3 Number of locations where the project will be delivered. It was recorded that increased number of locations where the project is to be delivered increase the chance of occurring risks falling into category of force majeure.

Risk Kinds RK\_d, RK\_o were not measured on either of researched projects. For RK\_d Political risks it can be assumed that this fact is due to the sensitivity of the topic. Before the analyses of the researched project data it was assumed that the higher measured Project Complexity would correspond to higher values in RK\_d. This was assumed based on the fact that larger projects in IT field are more involved with public sector and political risks will have direct impact on the delivery of the project. This could not be tested due to absolute lack of data in RK\_d. Discussion of this situation can lead to two explanations: (1) the data is correct and there is no risk involved in any project from any Project Complexity; (2) the data is not recorded in political risks for its sensitive character. The record of the impact cannot be recorded or corporate policy directly prohibits to link the project to specific political situation in the country. This risk is not manageable by the risk manager since management in general is banned from influencing the political representatives of the country by internal corporate anti-corruption policy. This is in line with the fact that no political risk is recorded. Any possible risk would be connected with the change of status quo that would directly change the conditions for the project. In this case it can be assumed that standard change management will be applied to deal with altered circumstances.

Last mentioned Risk Kind is RK\_o Safety and social risk. In this Risk Kind group also no data was measured on analyzed 69 projects. These measures are assumed to be corresponding to reality as the area of analyzed projects in IT do not often raise the social emotion environment to form official social protest groups against the project being delivered. IT projects also do not threaten team members or others in life or health in contrast for example with construction projects where this group can be assumed to evince significantly higher values.

## 7 Conclusion

Project Complexity approach was created and can be used on the project to objectively measure the character of the projects. Project Complexity Factors were selected the way that they stay unchanged during the length of the project. It was proven that Project Complexity has relationship with values of Risk Kinds that were defined in this research. The concept of Project Complexity, Risk Kinds forming the Project Risk Profiles and Project Risk Configuration can be applied and were shown on analyzed 69 project data provided by largest IT delivery companies operating in the Czech Republic. The data analyzed supported assumptions that increased Risk Kind values can be linked to particular Project Complexity Factors. The graphs indicate that some Risk Kinds tend to change more than others and that some stay more uniform or remain unchanged for wide range of Complexity Intervals (CIs). For Risk Kinds RK\_d and RK\_o it was discussed possible cause why no data was measured. All data is in accordance with assumption that Project Complexity and Risk Kind specification is a concept that can be used in project risk management.



Presented concept of Project Complexity and Risk Kind classification brings contribution in simplified categorization of projects with objectively defined Project Complexity Factors. Measured Project Complexity remains the same during the whole length of the project and its connection to Risk Kind values can be used for improved prediction of risks that might appear on the project. Using described method can be used for optimization of project risk management in two ways: (1) it can be decided whether to proceed with the project before the project starts; (2) if the project is already in delivery phase the risks can be managed in optimized way that increase the awareness in project manager and in management in general.

Another contribution of presented concept is ability to classify project managers based on the projects they managed in the past. Being able to measure what is the complexity of planned project together with knowing the complexities of projects managed by individual project managers provides beneficial decision information input for management to decide which project manager to assign to which project in the portfolio.

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