November-December 2019
ISSN: 0193-4120 Page No. 2262 - 2272

Correlation Analysis of Risk Factors in the big data Projects

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Abstract

These instructions give you guidelines for preparing papers for Big data projects can be performed successfully when they satisfy the two main axes of corporate culture and use of technology. This study conducted correlation analysis of the risk groups and risk sub-groups based on the risk classification table of big data projects and drew a map of correlation using the analysis results. For such a purpose, the correlations among 6 risk groups and 13 risk sub-groups were analyzed. As a result, 12 risk group factors and 15 risk sub-group factors that have a high degree of correlation were discovered. This study will reduce the gap between the corporate culture and the technological culture related to big data projects by drawing the direction and degree of the relationships among risk factors related to big data projects and at the same time will be applied to practical risk management activities in big data projects and provide a theoretical basis that can be used as a parameter at the time of measurement of efficiency for risk management.

Keywords*: big data, big data project, risk management, risk analysis, risk factor*

1. INTRODUCTION

New Vantage Partners are strategic advisors in Big Data and business innovation to Fortune 1000 business and technology executives and industry leaders. According to the 2017 NVP report, Focus areas such as efforts to decrease expenses through operational cost efficiencies have proven to be successful (49.2%) for many firms. But Efforts to establish a data-driven culture remain more aspirational at this stage, with only 27.9% reporting success [1]. It is worth understanding where the greatest benefits and improvements are coming from. In addition, there is much work yet to be done to accelerate business transformation, and the biggest needs seem to be corresponding to people and process issues – not technology.

As shown in Fig. 1 and Fig. 2, the effect of customer service, advanced analytics and expense reduction are successful. But the acceleration of speed-to-market as well as introduce new products and services, while “monetization” pulls up the rear despite showing some increase during the past year. Monetization continues to be the holy grail of Big Data/AI investments – everyone aspires to it, but few achieve it [2].

To summarize such results, companies still have many barriers to the adoption of big data despite the measurable success of big data initiatives. Only 37.1% of companies say that they have succeeded though most companies began to make a corporate culture based on data, which means that though most companies tried to

TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 2262 - 2272

conduct business based on big data, only 37.1% of the companies responded that they have optimized their corporate culture successfully according to big data [1].

Principle Challenge to Becoming Data-Driven	2018	2019
People	48.5%	62.5%
Process	32.4%	30.0%
Technology	19.1%	7.5%

Figure 1: Principle Challenge to becoming Data-Driven [2]

Areas Yielding Measurable Results	2018	2019	Increase
Advanced Analytics	58.0%	79.8%	21.8%
Expense Reduction	40.6%	59.5%	18.9%
Customer Service	34.8%	57.1%	22.3%
Speed to Market	29.0%	32.1%	3.1%
New Services	20.3%	26.2%	5.9%
Monetization	8.7%	19.0%	10.3%

Figure 2: Areas yielding a measurable result [2]

While 85.5% of the companies made efforts to make a data-centered corporate culture, 48.4% of the companies say that they have not made a success, which means that the corporate culture and the use of technology do not match well. According to the 2019 NVP report, on every metric except driving innovation with data, firms ranked themselves as failing to transform their businesses [2]. Big data-based business management is making insufficient effects in the aspects of quick market entry, creation of new services and transformation into a data-based corporate culture [1]. Among the firms that have introduced a data-based decision-making culture, 27.9% answered that big data initiatives were successful [2]. In addition, the success rate of big data projects is about 25%, and 55% of them could not complete the big data projects in time [3].

Basically, big data projects can be considered successful if they satisfy the two main axes of corporate culture and use of technology, and the key to the success of the projects is grasping the main attributes in the aspect of project management which is different from the existing SI project.

In my previous study, I found out the risk factors of big data project. As a follow-up study of the study on drawing the risk factors that hinder the success of big data projects [4], I intend to identify the correlation among the items drawn as risk factors and examine the degree of correlation among the risk factors of big data projects.

2. REARCH BACKGROUND

1.1 Related work

Recently, the main topics of research in the area of risk management are largely the technique of assessment of project risks, evaluation of the effect of risk management, mathematical optimization models for project management and the methodology or framework that can support decision-making at the time of risk planning.

First, research on the technique of assessment of project risks involves crowdsourcing-based evaluation of individual risks[5], crowdsourcing-based measurement of risks in development environment[6], risk assessment of dispersed SW projects[7], a study on " human errors or value judgment" that may occur in risk assessment[8], and estimation of influence of risk factors [9].

Second, there are studies related to evaluation of the effect of risk management such as measurement of the potential effect of risk forecasting [10], an analysis of the relationship between risk management performance and project performance [11], a performance evaluation method connecting project risk management and project efficiency management [12].

Third, there are studies on mathematical optimization models for project management. These are a technique which can approach project characteristics, project management and risk management from an integrated viewpoint reflecting the trend of performance[13], Probabilistic descriptions and the theory of fuzzy sets[14], and deterministic quantitative technique)[15]. In addition, there is a study on the methodology or framework that can support decision-making at the time of risk planning [16].

As we examined earlier, there are currently few researches being conducted on the risk factors of big data projects for the establishment or use of big data with a strategic purpose. Many firms have begun to recognize the value of big data, and they are choosing big data projects as strategic projects implemented for the use of big data. Thus, it is urgently needed to conduct in-depth researches about the matter.

1.2 Pearson Correlation Analysis

Correlation analysis is used for analysis of the mutual relationships among the variables composed of continuous data or ranked data. In particular, Pearson Correlation Analysis shows the size of linear relationship with the correlation coefficient(r) when both variables are continuous data. Pearson's correlation coefficient to the population is calculated easily like formula (1) [17].

$$r_{X,Y} = \frac{COV(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$$

$$E[(X-\mu_X)(Y-\mu_Y)] = \frac{\sum_{i=1}^{m}(X_i-\mu_X)(Y_i-\mu_Y)}{m} \quad (1)$$

μ_X: *Mean of X in the population*

μ_Y: *Mean of Y in the population*

σ_X: *Standard deviation of X in the population*

σ_Y: *Standard deviation of Y in the population*

m: *Number of individuals in the population*

Whether the correlation coefficient calculated in this way is zero (0) or not is decided by t-distribution according to statistical verification. The t-score with a standardized correlation coefficient is calculated, and the sum of the areas of the domains which is bigger than the absolute value of t-score becomes p-value. In the case of a two-sided test, p-value is the sum of the areas of the domains smaller than the t-score on the left side and the areas of the domains bigger than the t-score on the right side. The range of Pearson's correlation coefficient is (-1~1), and the degree of correlation between two variables is usually judged as follows.

-0.1≤r≤-0.7: very strong negative (-) correlation

-0.7<r≤-0.3: strong negative (-) correlation

-0.3<r≤-0.1: weak negative (-) correlation

-0.1<r≤0.1: no correlation

0.1<r≤0.3: weak positive (+) correlation

0.3<r≤0.7: strong positive (+) correlation

0.7<r≤1.0: very strong positive (+) correlation

1.3 Overview of Risk Factors Classification of Big Data Projects

In the earlier research [4], More than 520 risk factors were collected from 77 related projects and the risk factors were boiled down to 126 risk factors according to their similarity. Then they were refined and put into groups for finalization of the candidate risk factors. As a result, 6 risk groups were drawn with 13 sub-groups that are composed of 64 risk factors [4]. The risk groups were classified into project-specific risk, the risk associated with the project workforce, project planning risk, the risk related to project execution, the risk related to project organization, and technological risk.

Project-specific risk: The risk which is derived from the unique property of the project which should be carried out in high quality and high efficiency within the scope of budget and by certain time limit.

Project workforce risk: The risk related to the human resources and human resources management such as the superiority of the participating manpower, workmanship and professionalism.

Project planning risk: The risk due to the matters of decision-making in the aspect of management that can affect the project organization in the initial project planning or during execution of the project.

Project execution risk: The risk occurring inside the organization which performs the project such as the owner, the contractor, the inspector or consulting organization from the time of launching of the project to transfer and operation.

Project organization risk: The risk in the operation of the organization which may occur due to the type of the project performing organization or various participating companies.

Technological risk: The issues of technology itself related to the server, network, database, software development environment, etc.; the issues caused by evolution of technology; and the environmental and human risk factors that affect the operation of services.

Project-specific risk consists of project properness risk which is caused by the number of processes, complexity of work, and information risk factors for the project and project environmental risk which includes the properness of the collaboration environment between groups, planning and control, information access, information expression, the informatization infrastructure, and the risk factors of management level support. Project workforce risk consists of the risk to the professionalism of the workforce which includes the lack of experience in project implementation, the lack of expertise (data, application of skills, work experience, and understanding of work) of participating personnel, lack of essential skill and experience from project manager or leader, and the similarity between core competence of the participating personnel and their actual work in charge and the size and stress level of the workforce which includes the number of participating personnel, the size of the workforce, and stress factors. Project planning risk consists of project governance risk which includes orientation towards cutting edge ideas, competition-based work environment, lack of timely strategies, inadequate compensation and inadequate information security strategy and project planning risk which includes inadequate execution plans, excessive project size, inadequate budget and scheduling, change of key management personnel, and inadequate risk management and mitigation plans. Project execution risk is composed of Project management risks which consist of lack of knowledge management, inadequate project resource management, lack of risk mitigation, insufficient implementation of standard processes. Procedures and methodologies and inadequate training and education and omission of major activities; Project security risks which includes cultural specificities, damage or destruction by humans, hackers and virus EDI fraud, and Project threats which consist of conflicts of requirements, difficulties in predicting requirements and intended project failure. project organization risk consists of inadequate organizational management risk which includes improper workforce forecasting and lack of communication, inadequate workforce management, improper project teaming and cooperation and communication between technical teams and operational teams and complexity of stakeholder risk factors which include requirements for reengineering procedures, hidden conflicts among stakeholders, the number of hardware/software suppliers, and newcomers. Technological risk consists of fundamental technology threats which include equipment failures, incompatibilities with other complementary technologies, transition risks, severe bugs in hardware or software and mix or contamination risks and evolution of technology risks which include constant assessment of new technologies, cutting edge technological ideas,

November-December 2019
ISSN: 0193-4120 Page No. 2262 - 2272

excessive requirements for computer system performance and network data communication, new technologies and software and system interdependence (lack of technical specifications).

These risks occur in an organic relationship, and it is necessary to consider the correlations among the risk factors when we decide strategies and countermeasures for forecasted positive or negative risks. So, this study aims to analyze the relationships among the aforementioned risk category groups (6 groups in the major classification and 13 groups in the medium classification) of big data projects and propose a model of strategy establishment using them.

3. Correlation Analysis among Risk Factors

3.1 Research Process

This study conducts a correlation analysis in order to grasp the relationships among the aforementioned risk groups (6 groups in the major classification and 13 groups in the medium classification). For such a purpose, this research was conducted in the order of the follow steps.

Step 1: Survey overview of big data experts

Step 2: Correlation analysis of the relationship among the risk groups

Step 3: Correlation analysis of the relationship among the risk sub-groups

Step 4: Drawing a map of correlation between the risk groups and the risk sub-groups

3.2 Survey overview of big data experts

This research used the basic survey for the preparation of the risk factor classification table of big data projects drawn in the first research of Kim [4]. To look at the process of drawing this data; 50 experts and workers in big data projects were survey for the identification of risk factors in big data projects and discovery of researches on importance. Demographically, 66% of the survey respondents were men and 34% were women. People of ages from 45 to 50 participated in the survey the most. In educational background, bachelors and masters took 90% of the respondents. Most were deputy department head and department head level. About 40.3% of the survey respondents, the biggest share, were working in ICT area. Regarding the size of the projects, about 68% of the workers who have performed projects answered that they have participated in big data projects whose size is between KRW 500 million and KRW 2 billion. To the question about the number of performance of big data projects, more than 40% of total respondents said that they have performed big data projects 8 times or more.

To briefly summarize the process of classifying risks and drawing risk factors in the preceding research; factor analysis was conducted for analysis of the validity and reliability of the variables in the survey results. For drawing of the factors, principal component analysis was conducted and Varimax factor rotation method was selected. Arrangement was done in the order of size on the basis of the eigenvalue value of 1.0 and over and the factor loadings of 0.5 and over. In addition, through KMO and Bartlett verification which can show the appropriateness of the factor analysis, the value that can show the degree of explanation of the correlation among variables by another variable was set 0.7 an over. Reliability analysis is done to check if the concept being measured is measured accurately and consistently from survey respondents. It was interpreted that the internal consistency for reliability analysis is reliable when Cronbach's Alpha was 0.6 or more. Through such an analysis process, the risk classification table of big data projects was completed with 6 risk groups, 13 risk sub-groups and 64 risk factors in total in big data projects.

TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 2262 - 2272

For analysis, the symbols were defined as in below Table-1 for each risk group and the risk sub-groups.

Table 1: The symbols of risk groups of big data projects

Risk Group Name	Risk Symbol
Project-specific risk	R1
Project properness	R11
Project environment properness	R12
Project workforce risk	R2
Professionalism of the workforce	R21
Size of the workforce and stress	R22
Project planning risk	R3
Project governance	R31
Project planning	R32
Project execution risk	R4
Project management risks	R41
Project security risks	R42
Project threats	R43
Project organization risk	R5
Inadequate organizational management	R51
Complexity of stakeholders	R52
Project Technological risk	R6
Fundamental technology threats	R61
Evolution of technology	R62

3.3 Correlation analysis of the relationship among the risk groups

Pearson correlation analysis was conducted for the measurement of the degree and direction of the correlation among the 6 risk groups based on the risk classification table of big data projects. Table 2 shows the results of the correlation of each risk group. The analysis shows that the correlation among risk groups is +0.8 and over in the order of {R3,R4}, {R5, R6}, {R4,R6}, {R3,R6}, {R2, R3}, {R2, R6} and {R4, R5}, and is +0.7 and over in {R3,R5}, {R2,R4}, {R1,R3}, {R2,R5}, {R1,R4} and {R1,R6}. It means that if the risk of the group at one side increases, the degree of risk of the other group increases, too. In this respect, we can see that R2, R3, R4 and R6 are all exposed to risks at a high level of correlation. In particular, R4, project execution risk, and R3, project planning risk, have the greatest 87.7% of correlation with .877 of correlation coefficient between the two variables. R5, project organization risk, and R6, project technological risk, has the second highest 84.4% of correlation with 0.844 of correlation coefficient between the two variables.

Table 2: Pearson's correlation coefficient in risk groups

	R1	R2	R3	R4	R5	R6
R1	1					
R2	.679**	1				
R3	.775**	.825**	1			
R4	.749**	.777**	.877**	1		
R5	.668**	.774**	.796**	.809**	1	
R6	.723**	.812**	.826**	.839**	.844**	1

**p<0.01

3.4 Correlation analysis of the relationship among the risk sub-groups

Secondly, correlation analysis was conducted for the measurement of the degree and direction of the correlation among the 13 risk sub-groups

November-December 2019
ISSN: 0193-4120 Page No. 2262 - 2272

based on the risk classification table of big data projects. As a result, the factors that have much correlation in the risk sub-groups were drawn as shown in Table-3. Usually, it is interpreted that the correlation is high if the correlation coefficient is 0.7 or more [18]. To examine the results in more detail based on such a standard, the correlation coefficients of R32 and R41 with R11 risk sub-group are .739 and .743 respectively showing much correlation of 73.9% and 74.3%. The correlation coefficients of R32 and R51 with R21 risk sub-group are .725 and .790 respectively showing much correlation of 72.5% and 79%. The correlation coefficients of R31 and R43 with R22 risk sub-group are .765 and .729 respectively showing much correlation of 76.5% and 72.9%. The correlation coefficients of R43 and R61 with R31 risk sub-group are .737 and .710 respectively showing much correlation of 73.7% and 71%. The correlation coefficients of R41, R42, R51 and R62 with R32 risk sub-group are .744, .712, .80 and .736 respectively showing much correlation of 74.4%, 71.2%, 80% and 73.6%. The correlation coefficient of R51 with R42 risk sub-group is .739 showing much correlation of 73.9%. The correlation coefficient of R62 with R43 risk sub-group is .724 showing much correlation of 72.4%. Especially, in the case of R51 risk sub-group, its correlation coefficient with R62 is .802 showing the highest correlation among all risk sub-groups.

Table 3: Pearson's correlation coefficient in Sub risk groups

	R11	**R12**	**R21**	**R22**	**R31**	**R32**	**R41**	**R42**	**R43**	**R51**	**R52**	**R61**	**R62**
R11	1												
R12	.348*	1											
R21	.604**	.452**	1										
R22	.617**	.332*	.575**	1									
R31	.692**	.353*	.566**	.765**	1								
R32	.739**	.524**	.725**	.562**	.602**	1							
R41	.743**	.514**	.636**	.575**	.669**	.744**	1						
R42	.584**	.495**	.571**	.499**	.530**	.712**	.612**	1					
R43	.559**	.291*	.466**	.729**	.737**	.579**	.554**	.500**	1				
R51	.663**	.532**	.790**	.644**	.638**	.800**	.636**	.739**	.639**	1			
R52	.558**	0.237	.556**	.472**	.629**	.476**	.638**	.503**	.491**	.565**	1		
R61	.573**	.401**	.544**	.675**	.710**	.537**	.641**	.457**	.579**	.578**	.639**	1	
R62	.644**	.490**	.662**	.661**	.629**	.736**	.618**	.688**	.724**	.802**	.619**	.570**	1

*:p<0.05, **:p<0.01

To sum up, a high level of correlation exists between R1.Project properness risk sub-group and Project planning and Project management risks; between R2. Professionalism of the workforce risk sub-group and Project planning and inadequate organizational management; between R2. Size of the workforce and stress risk sub-group and Project governance and Project threats; between R3. Project governance risk sub-group and Project threats and Fundamental technology threat; between R3. Project planning risk sub-group and Project management risks,

November-December 2019
ISSN: 0193-4120 Page No. 2262 - 2272

Project security risks, inadequate organizational management and Evolution of technology; between R4. Project security risks risk sub-group and Inadequate organizational management; between R4. Project threats and R5. Inadequate organizational management risk sub-groups and Evolution of technology sub-risk.

3.5 Map of correlation among the risk groups and the risk sub-groups

The correlations among the risk groups and the risk sub-groups are drawn from the results of the above analyses. Only the groups which have much correlation with 0.7 and more correlation coefficient were shown in the map of correlation in order to raise the reliability of the research results. Fig. 3 shows the results of analysis of the correlation among risk groups and risk sub-groups and drawing the degree and direction of the relationships. The map of correlation shows the degree and direction of the relationships among risk groups and those among the risk sub-groups comprehensively. The red arrow indicates the correlation among risk groups, and the blue arrow indicates the correlation among risk sub-groups. The direction of the arrow means the direction of the relationship, and the degree of the correlation between the two groups is presented by correlation coefficient.

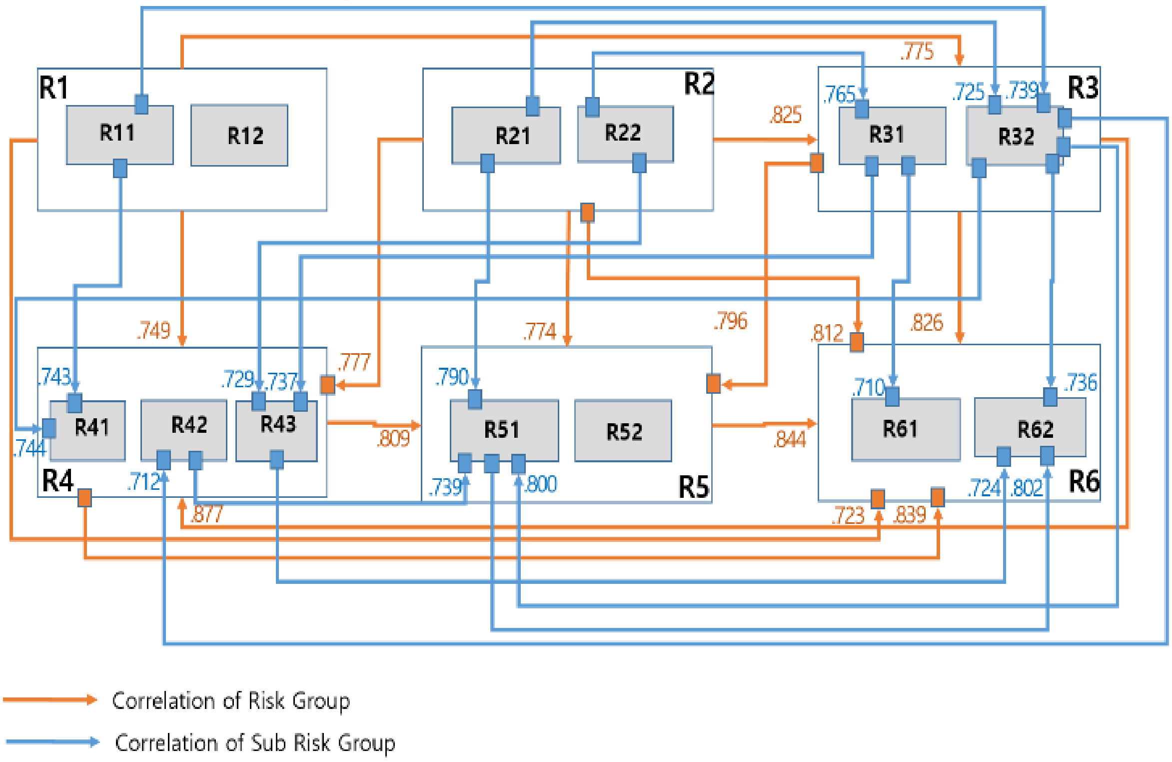

Figure 3: Map of correlation among the risk groups and the risk sub-groups

3.6 Discussion

Especially, the results of this study show that the highest correlation occurs between project planning risk and project execution risk. It was confirmed that Project governance for the use of big data and faithfulness in project planning cause Project management risks, Project security risks and Project threats. In other words, it is clearly shown through the analysis that if high-tech ideas are aimed, competition-based change or strategic timing is lacking, changing competitors are ignored, appropriate compensation is not given, information security strategy or project execution plan is not set up adequately, the size of project is too excessive, the budget is not predicted properly, the schedule is not predicted well, the core management is changed, or the risk management or risk litigation is not taken into consideration sufficiently in the aspect of project governance, it will cause lack of knowledge management, inappropriate resource management, insufficient information on project input and output, lack of application of standard process or methodology, or omission of major activities at the level of project risk management when big data projects are actually executed. At the level of security risks, destruction by human beings or security vulnerability due to cultural peculiarity may occur easily. At the same time, project threats may cause collision of requirements or unpredictable difficult situations [19-21].

4. CONCLUSION

The results of the analyses performed on the basis of the criteria of the risk classification table of big data projects drawn by the preceding research of Kim [4] clearly showed that the risks related to project planning have the highest correlation with all risk groups.

As a result, project-specific risk, project workforce risk, and the project execution risk were highly correlated with the project planning risks, positively correlated by 77.5%, 82.5%, and 87.7% respectively. On the other hand, the risk related to project organization was positively correlated with technological risks by 84.4%. This indicates that risk management related to project planning is the most crucial and influential factor for a successful big data project. It also suggests that effective project organization management can control not only project technology threats but the risks to project technology itself. In addition, the degree of correlation of the factors within the risk sub-groups provides more detailed ground for the correlation among the risk groups. Such specific correlation among the risk groups will have to be considered as the standards for the decision of priority for control of risks and establishment of countermeasures. The results of this study can be used usefully not only for the control of the specific factors included in the drawn risk groups and risk sub-groups but also for the decision of parameters when countermeasures for risks are prepared and the efficiency of execution is measures. Ultimately, this study will provide a theoretical basis that can be used in practical works for the fulfillment of successful big data projects by reducing the gap between the changing corporate culture and the existing technological culture in making decisions based on data.

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