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Knowledge Management and Predictive Analytics in IT Project Risks

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ABSTRACT

Knowledge management and predictive analytics are considered to be unusual partners in today's technology. However, they can be very good tools that would solve current problems in valuing data. Predictive analytics has now become one of the forecasting tools that is of huge help in information management. Its application in IT project development risk management is very important, where a lot of raw data is involved with risk analysis and prediction. The use of IT project risk management as supported by knowledge management (KM) will help increase the success rate of IT projects. Knowledge management will bring about additional value to the data needed. This paper presents the usage of KM and predictive analytics to increase the success ratings of projects by predicting the risks that might happen during project development. It explores how KM and predictive analytics can identify risks in IT project development and give recommendations in evaluating the risks that could affect successful completion of IT projects.

Keywords: *Knowledge Management, Predictive Analytics, Big Data Analytics, Software Project, Risk Prediction*

1. INTRODUCTION

The predicament of IT projects today shows that despite the new technologies, new processes, and sophisticated systems today, IT development success is still lower than expected. Still, billions of dollars are being wasted because of project failures.

The year 2013 has shown a stagnation of IT project success [1]. Although that year was also the time the rate of success started increasing, there is still the need for IT projects to improve its success rate. The nature of IT projects is that the entire process entails high risks. Risks in IT projects are many, varied and the probability and impact of these major risks are mostly between low to high.

Risk identification and management are the main concerns in every IT project. KM and predictive analytics partnership will be a big help. The risk can occur in each phase such as risk in understanding the requirement, risk in design of the software, human resource, technical, integration of modules, feasibility, etc. As each project is unique and distinct, the risk varies and measuring the risk is very important. It is said that "if senior managers fail to detect such risks, it is possible that such projects may collapse completely" [2].

The use of IT project risk management requires analysis of a lot of data from the IT project. It analyses the uncertain events of the project, the probability of it happening, its impact to the organization and their causes and effects. Since there are many risks involved in the IT project, specific data is needed to be organized and accessed. Big data predictive analytics could be potential tools for risk management activity [2].

Why KM and risk analysis? Seemingly, there is a vague relationship between risk management and KM. In 2009, a study by Rodriquez and Edward [3]

reasoned that through the use of knowledge management processes, there can be improvement for enterprise-wide implementation of risk management. They claimed that application of KM processes to enterprise risk management (ERM), has a perceived value to ERM especially knowledge sharing and quality of communication. However, the authors concluded that although there exists a relationship between ERM and knowledge sharing, it is significantly low.

From the study above, further studies have opened up to which this paper has taken advantage of. Since the KM community has expressly matured, and new technologies have cropped up since 2009 when Rodriguez and Edward has done the study, the perception of users may have changed. Also, the inclusion of predictive analysis may increase the relationship of KM and risk management.

As such, this paper explores Knowledge Management (KM) combined with big data tools, specifically, predictive analytics, in identifying risk data in IT projects, and predicting which risks are most likely to happen. It will show how these two technologies can be used together to enhance the value of the data that will be extracted and used to predict IT project risks thereby improving the success rates for completing IT projects. The result will be a risk framework that can as a guideline for any IT project.

2. KM and Predictive Analysis Combined

The following are some literature that discuss predictive risk analysis using KM processes in different applications.

Knowledge exists when data and information are applied (Becerra-Fernandez 2004 [4]; Beckett et al 2000[5]; Raisinghani et al 2002[6]). It has been pointed out that big data, information and knowledge are not the same and many researchers use the term casually.

KM is very important in the 1990's because it was supposed to help organizations to have competitive advantage and work effectively through sharing and re-use of knowledge within the organization. In the market place of e-business, KM initiatives are used to systematically leverage information and expertise in improving organizational responsiveness, data delivery, innovation, competency and efficiency (Stromquis and Samoff 2000[7]; Storey and Barnett 2000[8]; Desouza 2003[9]).

Turban and Jay (2001)[10], defined KM as a process that helps organization like retail bank to identify, select, organize, disseminate and transfer important data and expertise information which are part of the organizational memory resides within the organization in an unstructured manner. This enables effective and efficient problem solving, dynamic learning, strategic planning and decision making in big data.

Davenport et al. (2015)[11] has outlined a number of potential benefits that organizations can achieve by means of using big data relating to knowledge management. Organizations focus on data flows as opposed to stocks. It is also reported to have increasing reliance on data scientists and product developers rather than data analysts. Finally, they are gradually detaching analytics away from IT tasks and bringing into core businesses and operational functions. In this manner, organizations can create precious knowledge and exploit it for improved knowledge management and competitive market advantage. Thus, it can be inferred that big data and analytics contributes towards real time knowledge management. Big data is also deemed as a knowledge asset and as such state-of-the-art knowledge management has gained substantial impetus due to the use of big data analytics for knowledge creation and management.

McAfee et al (2012)[12] argue that one of the objectives of knowledge management is to assimilate data from different perspectives and analyze them to extract value for effective decision making. This is now a lot simpler to accumulate data from different big data sources and apply big data analytics to generate value from it so that organizations can use it in decision making. For example, expedia.com which is one of the foremost travel websites has invested a large amount of money to use big data analytics to generate valuable insights from the huge amount of data that is generated from everyday use of the site.

On the other side, they analyze the market strategies that attract the customers who visit their website and establish a contributory relationship between their adopted strategies and customers' response. In this manner, the company generates useful insights by analyzing the big data and decides on how to use this valuable information in improving business strategy.

This serves as an unambiguous instance of how big data is related to knowledge management. One of the big challenge faced by industries today is that to come up with this type of strategic information which help them to make prompt, accurate, and effective tactical decisions.

Credit card companies through big data analytics of huge web monitoring and call center activities data can make better decision regarding personalized customer offers and improved business strategies. In this manner, they are exploiting the concept of real time knowledge generation from big data analytics (Davenport et al. 2013) [11].

Research results obtained by Hair Jr.(2007)[13] demonstrate that predictive analytics and big data provide impressive support for emerging business including product development and distribution (Hair Jr et al 2007) [13]. The examples given above evidently offer an indication of how big data and knowledge management are interlinked and industries are reaping benefits of big data by generating valuable knowledge. Thus, it can be called as big data based on knowledge management that takes full advantage of big data analytics to enhance revenue generation and sales and to reduce risk associated with incurred cost.

According to Fearnley (2013)[14], the reason why big data's predictive analytics is the focus today is because in the recent financial crisis, many market participants and regulators discovered that their data architecture and IT systems could not support monitoring and managing a broad spectrum of risks. Regulators want more frequent reporting of a wide variety of risks and expect firms to be able to respond quickly to ad hoc requests. So to meet more timely and detailed management and regulatory requirements, firms are increasingly investing in open source software solutions (such as Hadoop and Map Reduce).

A most related study is by Rekha and Parvathi (2015)[2], who made a survey of on Big Data Analytics and its application to Software Project Risks. The authors have concluded that big data analytics' tools can be used to predict the risk encountered in software project and provide recommendation for it. This paper further instigated in practical way on how a big data tool – predictive analytics - could be employed for project risk.

3. IT. Project Risks

There are so many risks involved with IT project development. Risk identification and management is a crucial part of IT project management. Florentine [1] stated in her article that the trend for IT projects has finally turned around. Accordingly, from 2013 the failures in IT projects have increased up to 2016. However, in 2017, there were indications that failures in IT projects have decreased. This was corroborated by Ebad [15], who said that in 2016, IT projects in developing countries still suffer from high failure rates. The paper made a thorough study of IT projects in Saudi Arabia to discuss and identify what are the causes of IT project failures of organizations in Saudi Arabia.

Yazdanifard and Ratsiepe [16] claimed that "Poor risk management as a whole is one of the major aspects causing projects to collapse, and this has become an obstacle to each and every project tht is being developed nowadays." Accordingly, poor risk management in itself brings about new risks into the project. This being said, there is an urgent need to find a system that could more efficiently identify IT project risks and mitigate so as to continuously increase success rate in IT project development.

It is not a secret that even the simplest IT project can get very complicated due to external factors but this is hardly a comfort. A typical IT project has many inter-dependent components and modifications and delays in one component can easily affect everything else. In many tech areas it is the same, so no matter how good a project manager is, there are factors nobody can predict or expect. Still, when one is experienced and is aware of the common IT project risks, it is easy to spot early the project risk symptoms and react adequately before everything collapses [17].

Risk Management is the process of identifying, assessing, responding to, monitoring, and reporting risks. Risk identification will involve the project team, appropriate stakeholders, and will include an evaluation of environmental factors, organizational culture and the project management plan including the project scope. Careful attention will be given to the project deliverables, assumptions, constraints, WBS, cost/effort estimates, resource plan, and other key project documents.

All risks identified will be assessed to identify the range of possible project outcomes. Qualification will

be used to determine which risks are the top risks to pursue and respond to and which risks can be ignored.

The probability and impact of occurrence for each identified risk will be assessed by the project manager, with input from the project team.

Different authors have categorized IT project risks, one is Stoy [17] who identified five common risks including: mid-project scope change, delay in schedule due to unexpected situation, technical limitations, no problem reported, and key employee quits. Another article [18] also identified five types of risks in software development which are: new and unproven technologies, user and functional requirements, application and system architecture, performance, and organizational. But Mar [19] was more thorough, categorizing risks to 22 groups and identifying specific risks for each category which totals to 130 risks, sample shown in table 1.

Table 1: IT Project Risks 1-27

Risk Category	Specific Risks
Executive Support	1. Executives fail to support project
	2. Executives become disengaged with project
	3. Conflict between executive stakeholders disrupts project
	4. Executive turnover disrupts project
Scope	5. Scope is ill defined
	6. Scope creep inflates scope
	7. Gold plating inflates scope
	8. Estimates are inaccurate
	9. Dependencies are inaccurate
	10. Activities are missing from scope
Cost Management	11. Cost forecasts are inaccurate
	12. Exchange rate variability
Change Management	13. Change management overload
	14. Stakeholder conflict over proposed changes
	15. Perceptions that a project failed because of changes
	16. Lack of a change management system
	17. Lack of a change management process
	18. Lack of a change control board
	19. Inaccurate change priorities
	20. Low quality of change requests
	21. Change request conflicts with requirements
Stakeholders	22. Stakeholders become disengaged
	23. Stakeholders have inaccurate expectations
	24. Stakeholder turnover
	25. Stakeholders fail to support project
	26. Stakeholder conflict
	27. Process inputs are low quality

Table 2: IT Project Risks 28-46

Risk Category	Specific Risks
Communication	28. Project team misunderstand requirements
	29. Communication overhead
	30. Under communication
	31. Users have inaccurate expectations
	32. Impacted individuals aren't kept informed
Resources & Team	33. Resource shortfalls
	34. Learning curves lead to delays and cost overrun
	35. Training isn't available
	36. Training is inadequate
	37. Resources are inexperienced
	38. Resource performance issues
	39. Team members with negative attitudes towards the project
	40. Resource turnover
	41. Low team motivation
	42. Lack of commitment from functional managers
Architecture	43. Architecture fails to pass governance processes
	44. Architecture lacks flexibility
	45. Architecture is not fit for purpose
	46. Architecture is infeasible

Table 3: IT Project Risks 47-130

Risk Category	Specific Risks
Design	47. Design is infeasible
	48. Design lacks flexibility
	49. Design is not fit for purpose
	50. Design fails peer review
Technical	51. Technology components aren't fit for purpose
	52. Technology components aren't scalable
	53. Technology components aren't interoperable
	54. Technology components aren't compliant with standards and best practices
	55. Technology components have security vulnerabilities
	56. Technology components are over-engineered
	57. Technology components lack stability
	58. Technology components aren't extensible
	59. Technology components aren't reliable
	60. Information security incidents
	61. System outages
	62. Legacy components lack documentation
	63. Legacy components are out of support
	64. Components or products aren't maintainable
	65. Components or products can't be operationalized
	66. Project management tool problems & issues
Integration	67. Delays to required infrastructure
	68. Failure to integrate with business processes
	69. Failure to integrate with systems
	70. Integration testing environments aren't available
	71. Failure to integration with the organization
	72. Failure to integrate components
	73. Project disrupts operations
	74. Project disrupts sales
	75. Project disrupts compliance

Table 4: IT Project Risks 51-82

Risk Category	Specific Risks
Requirements	76. Requirements fail to align with strategy
	77. Requirements fail to align with business processes
	78. Requirements fail to align with systems
	79. Requirements have compliance issues
	80. Requirements are ambiguous
	81. Requirements are low quality
	82. Requirements are incomplete
Decisions & Issue Reso	83. Decision delays impact project
	84. Decisions are ambiguous
	85. Decisions are low quality
	86. Decisions are incomplete
Procurement	87. No response to RFP (Request for Proposal)
	88. Low quality responses to RFP
	89. Failure to negotiation a reasonable price for contracts
	90. Unacceptable contract terms
	91. Conflict with vendor leads to project issues
	92. Conflict between vendors leads to project issues
	93. Vendors start late
	94. Vendor components fail to meet requirements
	95. Vendor components are low quality
	96. Infrastructure is low quality
	97. Service quality is low
	98. Vendor components introduce third party liability
	99. Loss of intellectual property
Authority	100. Project team lack authority to complete work
	101. Authority is unclear

Table 4: IT Project Risks 51-82

Risk Category	Specific Risks
Approvals & Red Tape	102. Delays to stakeholder approvals impact the project
	103. Delays to financial approvals impact the project
	104. Delays to procurement processes impact the project
	105. Delays to recruiting processes impact the project
	106. Delays to training impact the project
Organizational	107. The project fails to match the organization's culture
	108. An organizational restructuring throws the project into chaos
	109. A merger or acquisition disrupts the project
External	110. Legal & regulatory change impacts project
	111. Force Majeure (e.g. act of nature) impacts project
	112. Market forces impact project
	113. Technical change impacts project
	114. Business change impacts project
Project Management	115. Failure to follow methodology
	116. Lack of management or control
	117. Errors in key project management processes
Secondary Risks	118. Counterparty risk
User Acceptance	119. Users reject the prototype
	120. User interface doesn't allow users to complete tasks
	121. User interface is low quality
	122. User interface isn't accessible
	123. Project reduces business productivity
	124. Project reduces innovation
	125. Product disrupts business metrics (measurements of objectives)
	126. Users reject the product
Commercial	127. Product doesn't sell
	128. Product incurs legal liability
	129. Product negatively affects brand
	130. Product negatively affects reputation

4. Methodology

The study explored common practices of IT development risk prediction and how these can be improved with new tools using the predictive analytics and knowledge management. It will use predictive analytics particularly for project development risks. The different variables of IT development risks will likewise be studied and find out what information, how much information and when information are required and how these are treated for predictive purposes.

The fact-finding techniques used in this study are document review, benchmarking and simulation.

The project involved review of the different big data predictive analytics and chose which one is suitable for predicting risks in software development projects. Among those considered were PredictIO and RapidMiner. RapidMiner [20] was chosen because it was easier to use and is also opensource.

The study used benchmarking methodology, particularly the best practices where researchers chose the organizations that are on the leading edge of the industry. The researcher studied existing practices of predictive analytics for software project risks and captured best practices. Simulation, big data predictive analytics tool will be applied to the data from the simulation and measurements will be done using an open source software called RapidMiner. The resulting data will be used to design the risk management.

The data gathered from all these fact finding techniques would be collated, analyzed and evaluated using RapidMiner to predict the risks.

The project used decision trees as the tool to predict the outcome of risks taken from the selected software development projects.

5. Data Analysis and Results

Developers and other stakeholders identify the unique risks of the project. Data from the benchmarking that was conducted were taken, and from these the most probable risks for the specific project was extracted. From the extracted risks, a comparison was made with the identified unique risks and evaluation was done to get further the impact, probability and cost values for the specific risks. This was then simulated using the RapidMiner software. The risk analysis tool that was chosen from RapidMiner is the decision tree analysis because it is used for determining net outcomes from both positive and negative risk events since the probability is 100% or 1.0 in any set of outcomes.

Data that have been extracted from benchmarking and comparison with the current project under study. Data were collated and encoded for further computation. The project used MS Excel data to encode the data and these data is converted it to RapidMiner algorithm.

The following figures are samples of the RapidMiner processes given the data that has been gathered using the decision tree tool.

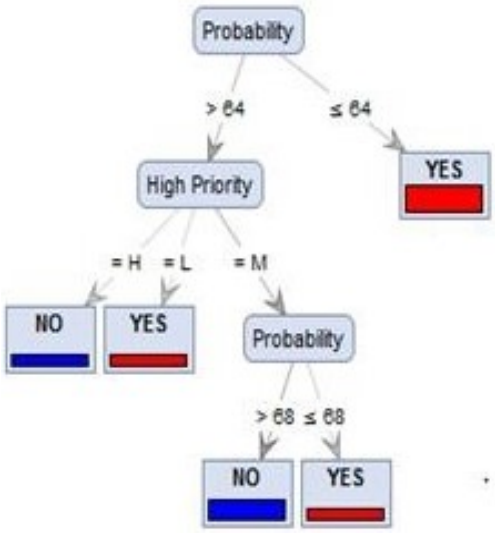

Figure 1: Decision Tree for scope too large Risk

The next process is to set the decision tree. This is connected to the imported Excel file, thus, the connection to the first process which is read excel file.

The decision tree in Figure 1 is the result of analysis of a file consisting of the risk of the product being too large. The factors of the risk are being considered too large, binomial type, number of team members/employees working on the project, numeric type, priority, multi-choice, and probability, numeric. The consideration that the project is too large is set as the label and the rest are attributes.

The decision tree shows the decision as to whether it is considered too large or not, given the probability and the priority. From the diagram, when the probability is less or equal to 84, it is deemed a large product. Greater than 84 would depend on the priority, if it is high, then it is not large, low priority is yes, it is a large product. As for medium priority, when the probability is greater than 68 then it is no, otherwise, it is yes.

6. KM Framework in Risk Management

As predictive analytics are used in the procedure of risk management, KM processes are utilized as strategies in IT project risk management. Based on Barquin's [21] KM framework, the following matrix, in table 3, was adapted as risk management guidelines for IT projects.

Table 3: KM Process Framework for Risk Management

KM Process	Risk Management
1. Capture tacit knowledge and make it explicit.	Knowledge of risks and other things important for the project shouldn't be exclusively kept by individuals who may not stay with the team. They should be shared so other people within the team may also use them for leverage.
2. Identify and nurture communities of practice.	Everyone must be able to share information of what they do and how they do it so that in their absence someone can still do their job.
3. Find and disseminate best practices.	Benchmark from other organizations to learn practices that can be adapted when applicable to the project.
4. Develop locators of both experts and expertise.	Keep and share a record and locator for experts for people in the project team to contact when they need them for consultation.
5. Feature collaboration tools and resources.	Enhance information sharing specially about risk management by empowering project team members with collaboration tools.
6. Implement enterprise portals as gateways to corporate knowledge.	Create and implement organization-wide portals for easy to reach knowledge on security, emergency response, and compliance to save time from gathering data or searching for information and documents.
7. Have clear taxonomies for major knowledge domains.	Strengthen taxonomies and naming conventions to be able to find and access relevant documents and other contents easily when truly needed. Without such is to bring in more risks into projects and processes.
8. Have a solid enterprise IT architecture.	Systems and processes must be a perfect fit and must have a sturdy IT architecture, preferably as services to be invoked through an architecture that is service-oriented.
9. Build robust data warehousing and business intelligence architectures.	Data warehouses can be extremely powerful platforms for analysis and report generators. When implementing and utilizing risk management systems they are helpful to analyze trends and report unusual patterns of behavior from usage and access data.
10. Focus on knowledge about the customer.	Helps the organization deal with customers and risk management focus stakeholders such as, users of the systems, people who are potential hackers, suppliers, experts, employees, and other. Knowing who they are is essential for

	authentication and verification, but so is knowing their preferences and other attributes in serving the legitimate ones better and preempting the bad guys from doing harm.
11. Use storytelling as a springboard to action.	Nothing captures attention better than a story. Witness the attention to risk management that the VA incident has generated. The power of the narrative should be harnessed to move enterprises to action when and where it is needed in the context of managing risk.
12. Assure culture rewards knowledge sharing.	If good security practices are to be disseminated and shared, if retiring employees need to pass on what they know about emergency response or compliance, there must have a corporate culture that actively rewards such open behavior. Avoid knowledge hoarding as a common practice for job protection.
13. Focus the enterprise on learning.	Learning is the acquisition of knowledge and the organization must focus on this to constantly bring in new knowledge. This is because of emerging new threats and new tools to address them.
14. Provide the leadership to make KM a priority.	Leaders must make KM a priority and use KM techniques to assess and mitigate risks. Support from the top is essential.

6. Conclusion

Even today in the advent of advanced technologies, still a large percentage of IT project developments have failed. This is largely due to lack of management of resources and the large part is not being able to understand and avoid the risks that a ny project would encounter. In every IT project, a lot of risks are encountered. Because of the large amount of data to be analyzed, predictive analytics is a very good tool to use in order to forecast what might happen and the risks may be mitigated or controlled before it will happen. Added to that, the use of KM processes would help in managing the risks.

Predictive analytics combined with KM are helpful tools to predict the occurrence of risks and would be important information to ensure the success of IT projects. The use of software tools such as RapidMiner is an efficient way to use predictive analytics to evaluate and predict the risks in IT projects.

The project has produced an efficient way to predict the risks that are encountered by IT projects and a KM framework is adapted. Future studies in this topic may be done but using different methods where predictive analytics and KM may also be used.

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