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Review on Monte Carlo Simulation Applications for Project Management

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Abstract: Monte Carlo simulation may be a helpful technique for modeling and analyzing real-world systems and things. This paper may be a abstract paper that explores the applications of town simulation for managing project risks and uncertainties. the advantages of town simulation area unit victimization quantified information, permitting project managers to higher justify and communicate their arguments once senior management is pushing for unreasonable project expectations. correct risk management education, training, and advancements in computing technology combined with town simulation computer code permit project managers to implement the strategy simply. within the field of project management, town simulation will quantify the consequences of risk and uncertainty in project schedules and budgets, giving the project manager a applied mathematics indicator of project performance like target project completion date and budget.
Keywords: Monte Carlo simulation, project management, risk analysis and management, exploratory study.

I. INTRODUCTION

The area of risk management has received vital recognition within the field of project management in recent years (Kwak and Stoddard, 2004). Project managers and their superiors discovered that the method of identification, analysis, and assessment of potential project risks edges them greatly in developing risk mitigation and contingency plans for complicated project (Charette, 1996). This coming up with, in turn, helps the project manager higher handle the troublesome things that invariably occur throughout comes, and thus permits for a lot of winning project completion. One methodology utilized by some project managers throughout the danger analysis method is Monte Carlo simulation applications. This activity has been wide used for many years to simulate numerous mathematical and scientific things, and it's mentioned usually in project management curricula and standards, like A Guide to the Project Management Body of information (Project Management Institute, 2004). Monte Carlo simulation has not nevertheless, however, found a robust footing within the actual apply of project management within the "real world". This paper reviews the applications of Monte Carlo simulation and its connectedness to risk management and analysis in project management. It conjointly outlines the uses of Monte Carlo simulation in different disciplines and within the field of project management. Finally, it discusses the execs and cons of Monte Carlo simulation applications in project management setting, some samples of projected enhancements or alternatives to Monte Carlo simulation, and concludes with a recommendation that a lot of project managers ought to benefit of this straightforward and useful gizmo in managing project risks and uncertainties.

A. Brief History of Monte Carlo Simulation

The Monte Carlo simulation encompasses "any technique of applied math sampling used to approximate solutions to quantitative problems" (Monte Carlo methodology, 2005). A model or a real-life system or state of affairs is developed, and this model contains bound variables. These variables have completely different potential values, delineated by a chance distribution perform of the values for every variable. The Monte Carlo methodology simulates the complete system repeatedly (hundreds or maybe thousands of times), when haphazardly selecting a worth for every variable from its chance distribution. the result could be a chance distribution of the worth of the system calculated through the iterations of the model.

B. Application of Monte Carlo Simulation in Project Management

Monte Carlo simulation is also applied to project schedules to quantify the arrogance the project manager ought to have within the target project completion date or total project length. Project manager and subject material consultants' assigns a likelihood distribution operate of length to every task or cluster of tasks within the project network to induce higher estimates. A three-point estimate is usually accustomed change this apply, wherever the professional provides the most-likely, worst-case, and best-case durations for every task or cluster of tasks. The project manager will then match these 3 estimates to a length likelihood distribution,

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like a traditional, Beta, or triangular distribution, for the task. Once the simulation is complete, the project manager is in a position to report the likelihood of finishing the project on any explicit date, that permits him/her to line a schedule reserve for the project. The higher than will be simply completed victimization normal project management software package, like Microsoft Project or Primavera, in conjunction with town simulation add-ins, like @Risk or Risk+. town simulation has been utilized in construction comes to raised perceive bound risks to the project. for instance, noise and its harmful effects on the encompassing community may be a risk in several urban construction comes. Gilchrist et al. (2003) have developed a town simulation model that permits construction contractors to predict and mitigate the prevalence and impact of construction noise on their comes. Williams (2003) gave an intensive clarification of the benefits of town simulation over alternative strategies of project analysis that attempt to incorporate uncertainty. He explained that though there ar several analytical approaches to project planning, the matter with these analytical approaches was "the restrictive assumptions that all of them need, creating them unusable in any sensible situations". These analytical strategies usually solely provided bound moments of the project length, rather than project length distributions, that were rather more helpful in responsive questions about the arrogance level of project completion dates. Program analysis and Review Technique (PERT) was the previous methodology of selection for evaluating project schedule networks, however this methodology doesn't statistically account for path convergence and thus ordinarily tends to underestimate project length. town simulation, by truly running through a whole lot or thousands of project cycles handles these path convergence things.

C. Limitations of Monte Carlo Simulation Applications in Project Management

The primary drawbacks of Monte Carlo simulation within the past are high use of computing power and also the quantity of your time and resources spent to complete the simulation activity (Williams, 2003). an absence of easy-to-use software system tools to run complicated simulation against project schedules was conjointly a haul. Dramatic enhancements in computing power and also the introduction of Monte Carlo simulation software system add-ins to the popular project management programming tools have created these considerations nearly obsolete.

	Simulation Method	
	Analytical	Monte- Carlo
Cons	Gives exact results (given the assumptions of the model).	Very flexible. There is virtually no limit to the analysis. Empirical distributions can be handled.
	Once the model is developed, output will generally be rapidly obtained.	Can generally be easily extended and developed as required.
	It need not always be implemented on a computer – paper analyses may suffice.	Easily understood by non- mathematicians.
Pros	Generally requires restrictive assumptions to make the problem tractable.	Usually requires a computer.
	Because of a. it is less flexible than Monte-Carlo. In particular, the scope for extending or developing a model may be limited.	Calculations can take much longer than analytical models.
	The model might only be understood by mathematicians. This may cause credibility problems if output conflicts with preconceived ideas of designers or management.	Solutions are not exact, but depend on the number of repeated runs used to produce the output statistics. That is, all outputs are estimates.

Table 1: Main Advantages and Disadvantages of Analytical and Monte-Carlo Simulation Models

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II. RESEARCH METHODOLOGY

For this research, a questionnaire survey method has been adopted to find the impact of critical factors that leads to delay on resource related in the Indian construction sector drawing from various international researchers mentioned above in particular (Sambasivan and Soon 2007). A questionnaire survey was conducted of construction professionals representing various stakeholders involved in construction projects in India.

A. Questionnaire Design

The questionnaire was designed based on critical factors were identified that contributed to the causes of delays. A questionnaire survey was developed to assess the perceptions of various construction professional of the relative importance of causes and the effects of construction delays.

The questionnaire was designed into two sections: Section A; section B. Section A is to obtain the requested background information about the respondents. Section B is to obtain the information on factors that contribute to the causes of delays in construction projects from the perspective of construction professionals.

A total twenty eight resource related factors were identified under three broad categories namely manpower related, material related and equipment related issues. The critical factors are listed in Table 1. A five point Likert scale (1 very low, 2 low, 3 moderate, 4 high, 5 very high) was adopted where respondents were asked to rank the importance and impact of a particular factors on delay in one of their selected projects.

B. Data Analysis

The data analysis will be done by relative importance index technique used to determine the relative importance of the various cause of factors. The same method is going to be adopted in this study. The five-point scale ranged from 1(very low important) to 5 (very high important) will be adopted and will be transformed to relative importance indices (RII) for each factors as follows:

$$RII= \sum W/A*N$$

Where, W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (i.e. 5 in this case), and N is the total number of respondents. The RII value had a range from 0 to 4 (0 not inclusive), higher the value of the RII, more important was the causes of delays.

The RII was used to rank the different uncertainty factors that cause delay. These ranking made it possible to cross-compare the relative importance of the uncertainty factors as perceived by the respondents. After obtaining index score for each factor, standard deviation and coefficient of variation of each factor is also determined. Subsequently, ranking of factors is done based on Index score.

Applicability of Test Results to Building Construction Projects

Monte Carlo simulation produces distributions of possible outcome values. Monte Carlo simulation provides a number of advantages over deterministic, or “single-point estimate” analysis: Probabilistic Results.

III. CONCLUSION

This analysis examines the town simulation methodology and its uses in varied fields, focusing totally on its use within the field of project management. samples of sensible use of the simulation methodology are listed and mentioned, also as its benefits and limitations. With relevancy the utilization of town simulation in project management, researchers made public however simulation is employed in each project value (budget) management and time (schedule) management and the way these processes area unit integrated with risk management to provide cheap project budget and schedule reserves. the utilization of town simulation within the space of investment risk analysis has additionally been mentioned. town simulation will actually be the project manager’s best weapon for analyzing project risks. it's a very powerful tool that permits project managers to include uncertainty and risk in their project plans and set cheap expectations on their comes, with relevancy each schedule and budget. The results of simulation area unit quantitative, permitting project managers to higher communicate their arguments once management is pushing for chimerical project expectations. Recent advancements in computing capability and town simulation code enable project managers to implement the tactic with relative ease and excitement.

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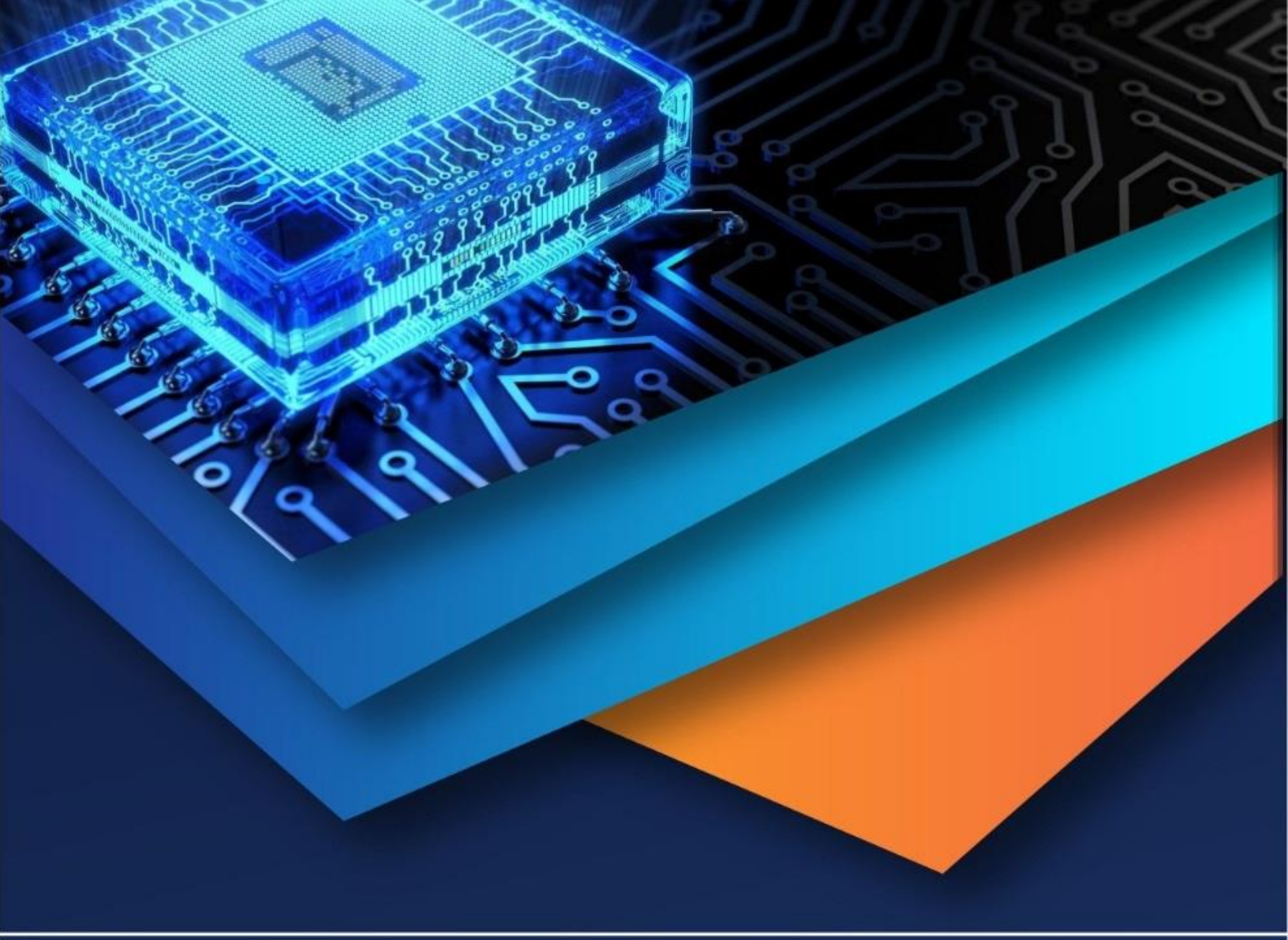

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