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# Project Management using Event Chain Methodology

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## Abstract

Any projects are affected by a large number of events (risks), which can significantly change the course of a project. These events may form groups of related events or event chains. The paper discusses a proposed methodology of modeling the software project using event chains. The event chains methodology can contribute to reducing uncertainties in project scheduling through mitigation of psychological biases and significant simplification of process of modeling, tracking, and analysis of project schedule.

## Introduction

You spent a lot of time and effort creating a well-balanced project schedule and thought that you had taken into account almost every possible scenario and risk. However, as soon as you started implementing your project plan, something happened and your schedule became obsolete. This “something” is an unpredictable event. As a result, you have either to significantly update or create a new project schedule and then, another unpredictable event occurs. This repeats again and again, until start to believe that project scheduling is not only futile, but unnecessary. This scenario is very common for projects with multiple risks and uncertainties and especially true in research and development projects such as those found in the software industry. So what should we do in these cases? Should we completely give up scheduling, risk management, and concentrate only on high-level project planning, or is there still a way to provide realistic estimates for project schedules that have multiple uncertainties?

## Estimations in Project Management

To find answers to these questions, let us review some issues related to estimations in project management. There are two types of uncertainties: aleatory and epistemic.

Aleatory (alea is the Latin for die) uncertainties arise from possible variations and random errors in the values of the parameters and their estimates. These uncertainties can be objectively determined. Epistemic uncertainties are subjective and are related to the lack of knowledge of the particular process. For example, the duration of a task may be uncertain because this type of task has not been done before. In most cases, uncertainties related to estimations of durations, costs, and other project parameters are epistemic.

To explain the problem with estimations in project management, let us review the psychological aspects related to judgment and decision-making. In 2002, Daniel Kahneman was awarded the Nobel Prize in economics "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty." According to this theory, fundamental limitations in human mental processes cause people to employ various simplifying strategies or heuristics to ease the burden of mentally processing the information required to make judgments and decisions. In many cases, these heuristics or "rules of thumb" provide a correct judgment. However, under many circumstances, they lead to predictably faulty judgments or cognitive biases. According to the Availability heuristic, decision makers assess the probability of an event by the ease with which instances or occurrences can be brought to mind. For example, project managers sometimes estimate task duration based on similar tasks that have been previously completed. If they make judgments based on the most or least successful tasks they remember, it can cause inaccurate estimations. The Anchoring heuristic refers to the human tendency to remain close to the initial estimate. For example, you started thinking about the duration for an activity that had an original estimate of five days. Anchoring causes your analysis to stay close the original estimate, so that after your analysis the five days will remain the most likely or average duration with a range from three to four days. The Representative heuristic refers to how judgments concerning the probability of a scenario are influenced by the amount and nature of details in the scenario in a way that is unrelated to the actual likelihood of the scenario. Selective perception refers to instances where "you see what you want to see". For example, this occurs when your estimate of a task's cost are influenced by the intention to fit it into the project's budget.

We can perform estimations related to epistemic uncertainties by analyzing historical data and by tracking the current project's performance. The problem is both methods cannot change the subjective nature of epistemic uncertainties. Analysis of historical data is subjective and negatively affected by the aforementioned heuristics. What would happen if you kept accurate records? The answer depends on what type of tasks you are trying to estimate. In some industries, such as construction and manufacturing, these records are available. In these cases, project uncertainties are related to aleatory uncertainties.

However, in many other industries, especially research and development projects, significant number of tasks have never been done before; therefore, historical records may not be available or very useful. Very often a similar, but not exact, task has been done before. Can you use this information about previous tasks as an analog for the estimation? Another problem with historical data is that if there was a problem with the activity before, project managers will avoid making the same mistake again.

Because of these problems with historical data, the tracking of actual project performance remains one of the primary means of keeping projects on track. The goal is that by tracking actual performance, we can somehow reduce uncertainties during the course of an activity and derive better estimates of duration and cost. However, the problem of estimation remains for the remainder of the activity and project.

Therefore, because we recognize that it is difficult to determine a single number associated with task duration and cost, the current practice is to overcome this deficiency by defining a range of numbers or a statistical distribution associated with this range for cost and duration. For example, the range for a task can be from 4 and 7 days. However, if historical records are unavailable, we will still have the same problem. These estimates will be as subjective as if they were defined by a single number (remember we still deal mostly with epistemic uncertainties). If the range estimations are as subjective as a single number estimate, then analysis by using 'classic' Monte Carlo simulation may not provide estimates that are any more accurate than deterministic project schedules.

## Overview of Event Chain Methodology

Therefore, we are drawn to the conclusion that if uncertainties are expressed as events with outcomes, it will significantly simplify our project management estimations. By mitigating some biases in estimation such as availability and anchoring, we can develop numbers that are more accurate for task duration, cost, and other project parameters. Once we have this data, we can perform quantitative analysis and determine how uncertainties in each particular task will affect the main project parameters: project duration, cost, finish time, and success rate. However, real projects are very complex; they have multiple risks that have the potential to trigger other risks. Risks can have different outcomes; in one scenario a risk will delay a task, in another scenario the same risk will cancel it. In addition, some risks are correlated with each other. Therefore, the problem remains how to model these complex processes so that it becomes practical for project management.

Event Chain Methodology proposes to solve this problem. It is important to note that Event Chain Methodology is not a simulation or risk analysis method. It is based on existing analysis methodologies including Monte Carlo simulation, Bayesian Believe Network and others. Event Chain Methodology is a method of modeling of uncertainties for different time-related business and technological processes including project management.

Event Chain Methodology is based on six major principles.

1. An activity (task) in most real life processes is not a continuous uniform procedure. It is affected by external events, which transform an activity from one state to another. It is important to point out that these events occur during the course of an activity. The moment, when an event occurs, in most cases is probabilistic and we can define it using statistical distribution. Events (risks) can have a negative impact on the project. For example, the event "delayed arrival of component" can cause a delay in an activity. However, the opposite is also true, events can positively affect an activity, e.g. reduce costs.

2. Events can cause other events, which will create event chains. These event chains can significantly affect the course of the project. For example, requirement changes can cause a delay of a task. To accelerate the activity, a resource is allocated from another activity; which can lead to a missed deadline. Eventually, this can lead to the failure of the project. Events may instantly trigger other events or transform an activity to another state. The notion of state is very important as states can serve as a precondition for other events. For example, if a change of requirements causes a delay, it transforms the activity to a different state. In this state, the event “reallocate resource” can occur. Alternatively, it is possible, if the task is in certain state, an event cannot occur.
3. Once events and event chains are defined, we can perform quantitative analysis using Monte Carlo simulation to determine uncertainties and quantify the cumulative impact of the events. Sometimes we can supplement information about uncertainties expressed as an event with distributions related to duration for start time, cost, and other parameters, as done in classic Monte Carlo simulations. However, in these cases it is important to discriminate between the factors that are contributing to the distribution and the results of events to avoid a double count of the same factors.
4. The event chains that have the most potential to affect the projects are the “critical chains of events.” By identifying critical chains of events, we can mitigate their negative effects. We can identify these critical chains of events by analyzing the correlations between main the project parameters, such as project duration or cost, and the event chains.
5. Probabilities and impact of the events are obtained from the historical data. Monitoring the activity's progress ensures we use updated information to perform the analysis. In many projects, it is hard to determine which historical data we should use as an analog for future analysis. For example in most cases, in research and development, new projects differ from the previous projects. We can accomplish the proper selection of analogs for the historical data by applying analysis using a Bayesian Belief Networks. In addition, during the course of the project, we can recalculate the probability and time of the events based on actual data.
6. Event Chain Diagrams are visualizations that show the relationships between events and tasks and how the events affect each other. By using Event Chain Diagrams to visualize events and event chains, we can simplify the modeling and analysis of risks and uncertainties.

## **Event Chain Methodology Phenomena**

The application of Event Chain Methodology can lead to some interesting phenomena. Here are some examples:

1. Sometimes events can cause the start of an activity that has already been completed. This is a very common scenario for real life projects; sometimes a previous activity must be repeated based on the results of a succeeding activity. Modeling of these scenarios using event chain methodology is very simple. We do not have to update the original project schedule, we just need to create an event and assign it to an activity that points to the previous activity. In addition, we need to define a limit to the number of times activity can be repeated.
2. Events can generate other activities that are not in the original project schedule. These are activities related to the mitigation plan. They are modeled outside of original project schedule and assigned to the event. The original schedule is augmented with these activities when the event occurs.
3. Event Chain Methodology offers a new way of resource leveling and modeling of resource allocation as when an event is the reassignment of a resource from one activity to another, which can occur based on certain conditions. For example, if an activity requires more resources to complete it within a fixed period of time, this will trigger an event to reallocate the resource from another activity.
4. Events can cause other events to occur either immediately or with a delay. The delay is a property of the event. The delay can be deterministic, but in most cases, it is probabilistic. If we know the time of the original event and the delay, it is possible to determine when the new event can happen and in some cases, the activity that will be associated with it.

## Conclusions

What we have just described sounds very complex. Are we able to use this modeling methodology for the real life schedules? The beauty of this approach is that it includes a very well defined mathematical model that can be easily implemented as a software algorithm. Project managers must define project schedules and risk lists or risk breakdown structures. For each risk, the manager defines the chance the risk will occur, the risk's impact (delay, increase cost, trigger other risks, cancel task, etc.), and when will the risk occur during the course of activity.

The question, which is often raised, does Event Chain Methodology lead to better project management? The answer is the methodology allows us to model projects with uncertainties in a much simpler manner. It also allows us to mitigate psychological biases related estimation and as a result provide better forecasts and project tracking. If risk and uncertainties based on Event Chain Methodology are defined properly, your project schedule should be much more robust. Remember, most project managers actively create and update project schedules and risk lists. Event chain methodology allows you to combine both lists to provide a simple answer to the central question of project management - how long will the project take and how much will it cost if an event occurs.