



Simulating Worst Case Scenarios and Analyzing their Combined Effect in Operational Release Planning

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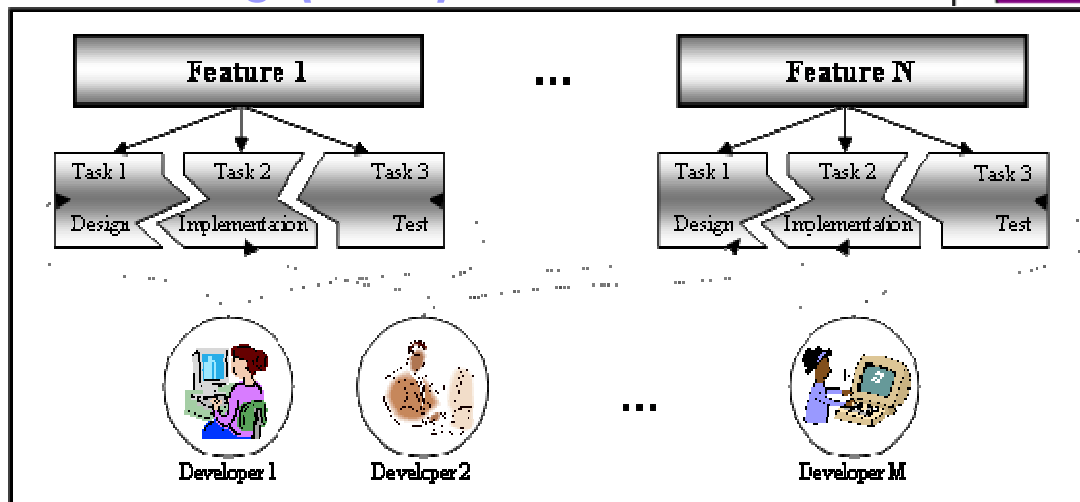
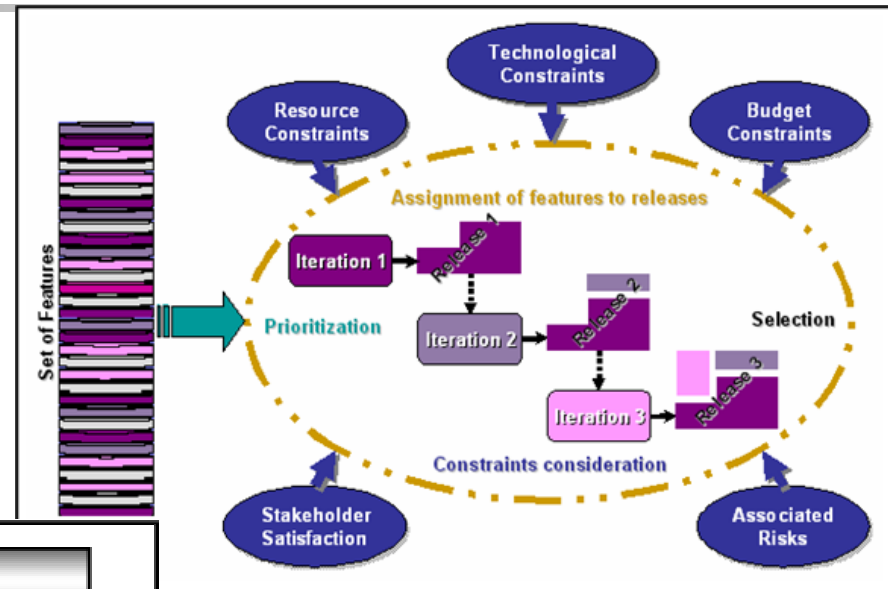
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Introduction

Strategic Release Planning (SRP)

Operational Release Planning (ORP)





Motivation

- “Uncertainty is inherent and inevitable in software development processes and products” [1]
- Managers want to know how worse a situation could be?
- Murphy's Law: “Whatever can go wrong will go wrong, and at the worst possible time, in the worst possible way” [2]



Related Work

- EVOLVE* [3]
- Task allocation optimizer by Duggan *et al.* [4]
- OPTIMIZE_{RASORP} [5]
- A stochastic Markov decision model by Padberg [6]



Research Context

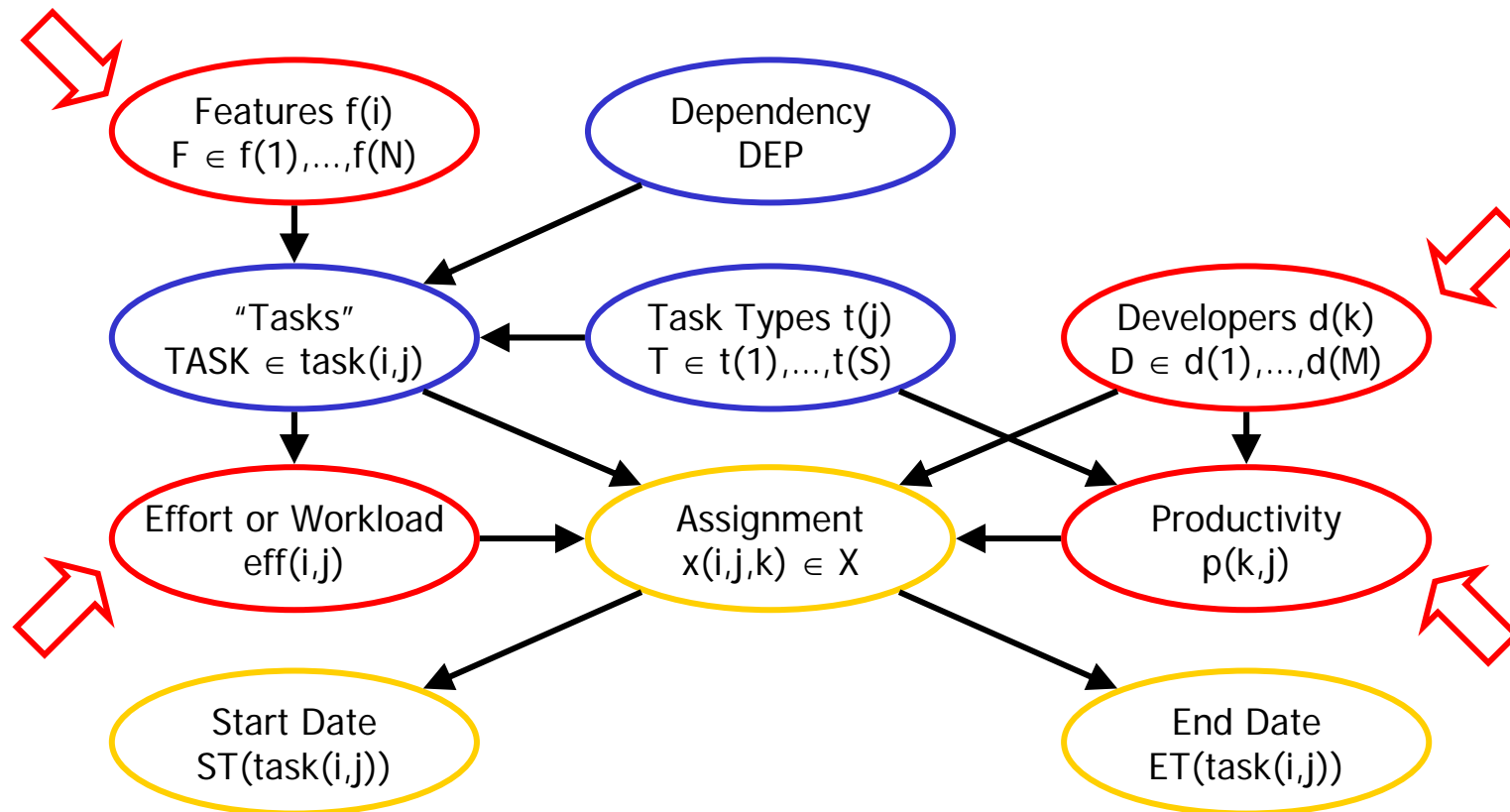
Why Chartwell Technology Inc. was interested?

- Chartwell's project managers were intuitively aware of the uncertainty but lacked the means to quantify or mitigate the associated risks
- In the absence of tool support for management of uncertainty project managers resorted to lengthy planning sessions
- Being principally a manual activity , the process of ORP had numerous shortcomings including lack of repeatability, high labor cost and no provision for easy re-planning



Research Context

What is the ORP Problem?



The Operational Release Planning (ORP) problem:
$$\text{Min } \{ \text{Max } \{ \text{ET}(\text{task}(i,j)) : i = 1, \dots, N, j = 1, \dots, S \}, x \in X \}$$



Research Focus

- Study the impact of uncertainty on release make-span
 - Four planning parameters (Factors)
 - **Static:** "Effort", "Productivity"; **Dynamic:** "Feature", "Developer"
 - Four levels of pessimism
 - **Stochastic:** "Bad", "Worse", "Worst"; **Deterministic:** "Extreme"

- Research Questions
 - RQ1: Factors in isolation:
 - Is there some variation between factors in the degree of impact?
 - RQ2: Factors in conjunction:
 - What is the tendency of impact for combined occurrence of factors?
 - RQ3: Stages of pessimism + Factors in isolation & conjunction:
 - How is the tendency of impact on make-span?



Case Study

- The studied ORP problem in Chartwell Technology Inc. involves the following problem parameters:
 - Thirty five features
 - Three task types
 - Fifteen developers
 - Estimated work volume for feature per task type
 - Estimated productivity of each developer per task type
 - A start-start & end-end dependencies among the tasks of the same features



Research Method

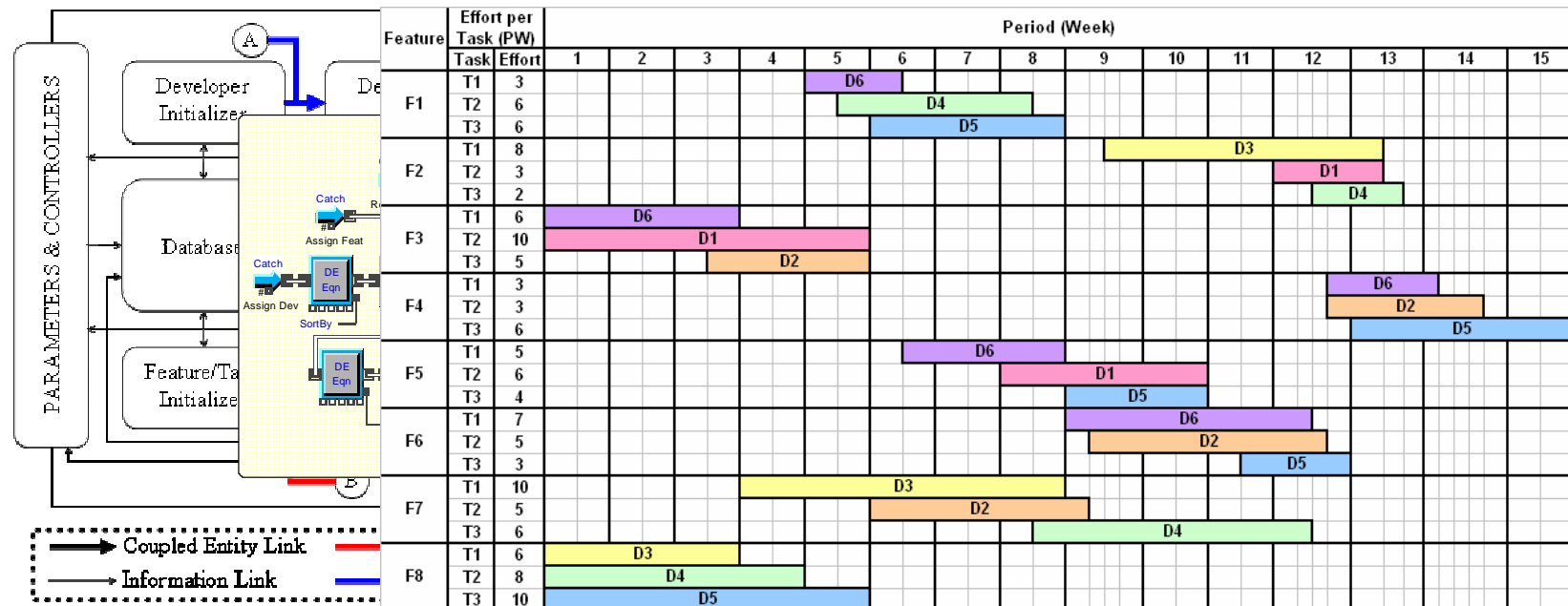
- A risk analysis procedure ProSim/RA [7]
 - STEP 1: Determining the baseline solution
 - STEP 2: Identifying uncertain attributes and defining uncertainty ranges
 - STEP 3: Defining observation variables
 - STEP 4: Conducting Monte-Carlo Process Simulation analyses
 - STEP 5: Interpreting simulation results



STEP 1

Determining the baseline solution

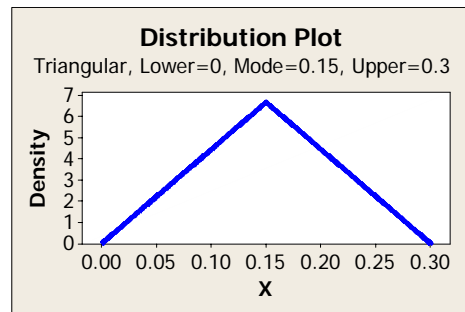
- No parameter variation
- DynaReP (Dynamic Re-Planner) [8] discrete-event process simulation model was applied
- The make-span of the baseline ORP was 15 weeks



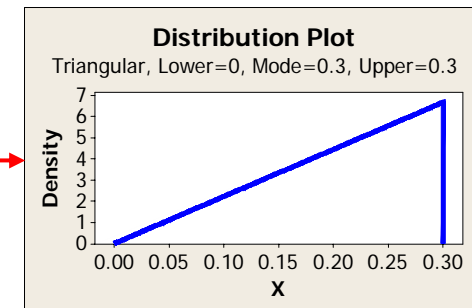
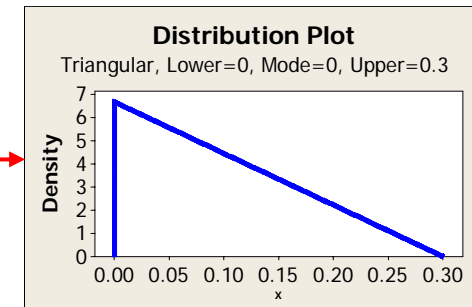


STEP 2

Identifying uncertain attributes and defining uncertainty ranges



Cases	Levels of Pessimism	Input			
		Varied Parameter	Min	Peak	Max
1	Bad	Effort	-20%	0%	30%
2		Productivity	-30%	0%	20%
3		Feature	0%	0%	30%
4		Developer	0%	0%	30%
5	Worse	Effort	-10%	0%	40%
6		Productivity	-40%	0%	10%
7		Feature	0%	15%	30%
8		Developer	0%	15%	30%
9	Worst	Effort	0%	0%	50%
10		Productivity	-50%	0%	0%
11		Feature	0%	30%	30%
12		Developer	0%	30%	30%
A	Extreme	Effort	-	50%	-
B		Productivity	-	-50%	-
C		Feature	-	30%	-
D		Developer	-	30%	-





STEP 3 & 4

- STEP 3: Defining observation variables
 - Make-span
- STEP 4: Conducting Monte-Carlo Process Simulation analyses
 - Enhanced version of DynaReP



STEP 5

Interpreting simulation results

Varied Parameter	Pessimism Level			
	Bad	Worse	Worst	Extreme
Effort (E)	10%	12%	23%	47%
Productivity (P)	16%	22%	30%	93%
Feature (F)	21%	28%	49%	153%
Developer (D)	10%	16%	22%	47%
E + P	21%	35%	53%	173%
E + F	24%	40%	47%	253%
E + D	16%	31%	49%	100%
P + F	31%	44%	58%	340%
P + D	21%	35%	56%	163%
F + D	24%	43%	53%	273%
E + P + F	30%	61%	84%	507%
E + P + D	24%	47%	78%	293%
E + F + D	32%	54%	80%	381%
P + F + D	38%	58%	98%	547%
E + P + F + D	43%	79%	114%	828%



STEP 5: RQ1

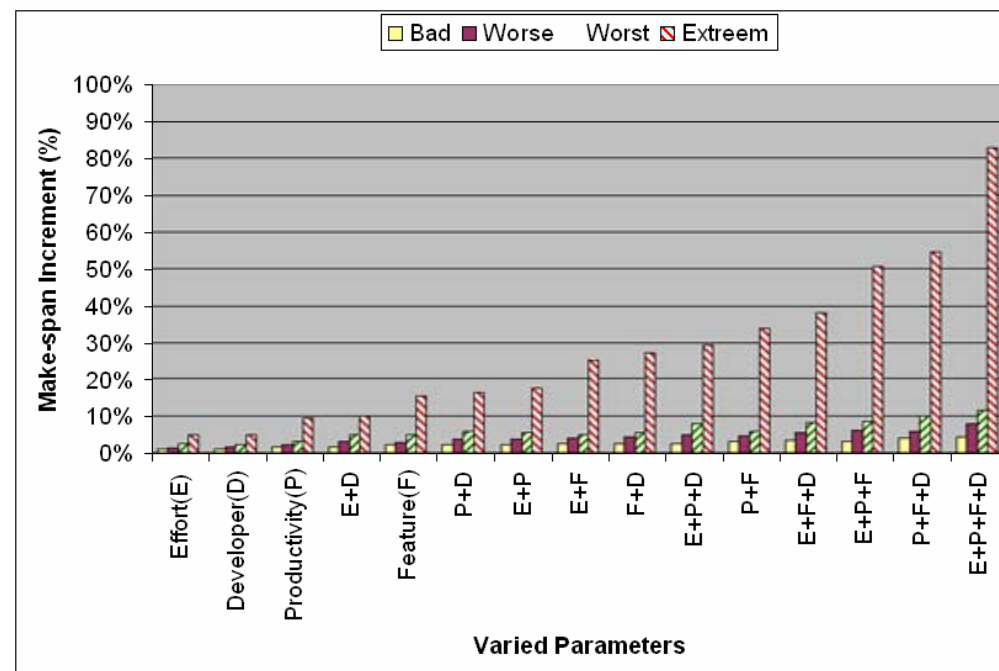
- Considering the impact of each factor in isolation:
 - Is there some variation between factors in the degree of impact?

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STEP 5: RQ2 (1/2)

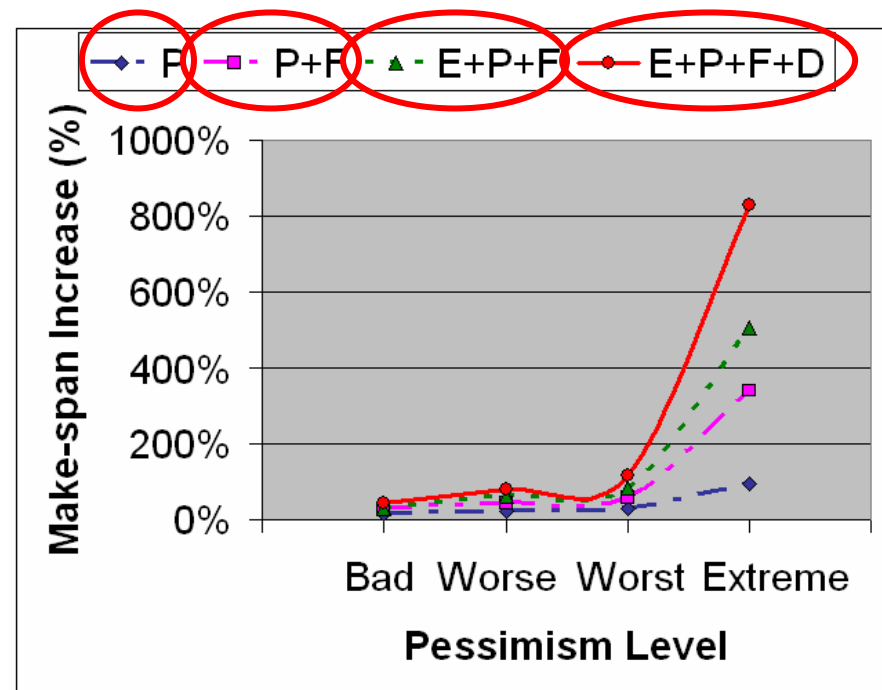
- Considering the impact of the factors in conjunction:
 - What is the tendency of impact for combined occurrence of factors?





STEP 5: RQ2 (2/2)

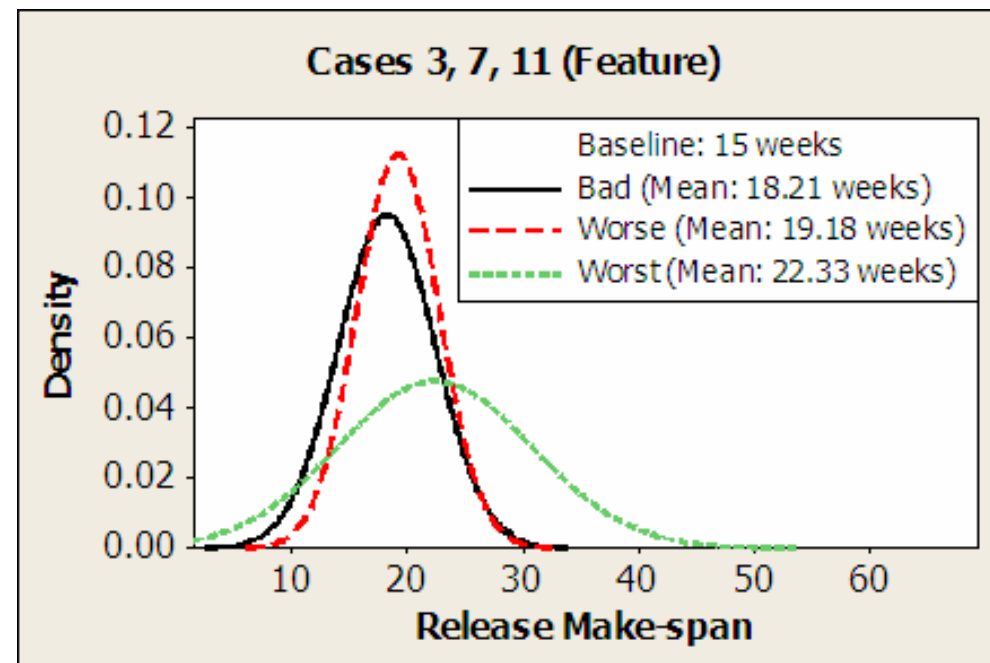
- Considering the impact of the factors in conjunction:
 - What is the tendency of impact for combined occurrence of factors?





STEP 5: RQ3

- Considering the four stages of pessimism for both the factors in isolation and in conjunction:
 - How is the tendency of impact on make-span?





Relevance of Results

At the Chartwell Technology Inc.

- Project Alpha
 - Situation: Case 1 & Case 2 (“Bad Effort” and “Bad Productivity”)
 - Focus: Effort estimated
- Project Beta
 - Situation: Case 5 & Case 6 (“Worse Effort” and “Worse Productivity”)
 - Focus: Developer productivity
- Project Alpha vs. Project Beta – “Bad” vs. “Worse” – “Effort” vs. “Productivity”



Discussion

- Limitations and Threats to Validity
 - Internal validity: Treatment-outcome relationship
 - External validity: Other projects & organizations
 - Heuristic used in DynaReP: ANOVA Statistical Test
 - Triangular distribution for all stochastic variable
 - Productivity may be dynamic and, in addition, might vary also in dependence of specific feature
 - Results for "Feature" and "Developer" could not be validated
- Future Research
 - Examining dynamicity of productivity variation and effect of rework
 - Looking into mix of pessimism levels
 - Observing the impact on variables other than make-span



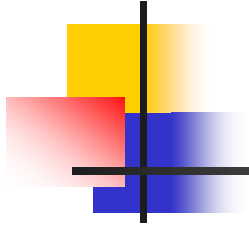
Conclusion

- The importance of our results is based on the following types of analysis of simulation runs:
 - Comparison of the impact of four classes of individual uncertainty factors
 - Analysis of the different kinds of combined impact of uncertainties
 - Consideration of different levels of negative impact of uncertainty factors
 - Comparison between stochastic and deterministic uncertainty
- The usefulness of this approach is that it
 - Provides useful information for early risk detection and development of mitigation strategies
 - Allows managers analyze the effects of multiple areas of uncertainty acting in concrete
 - Offers advice on which areas are the largest contributors to overall plan uncertainty



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- [8] Al-Emran, A., Pfahl, D., Ruhe, G.: DynaReP: A Discrete Event Simulation Model for Re-Planning of Software Releases. In: ICSP 2007. LNCS, vol. 4470, pp. 246-258. Springer-Verlag, Berlin-Heidelberg (2007)



Thank You