Stochastic simulation of risk factor potential effects for software development risk management

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Contents

Introduction

- Risk management
  - Risks arising from uncertainty
    - Characterize risky scenarios and identify the factors in those scenarios

Type	Definition
In time	When certain events may occur or the ability to react to them
In control	Inadequate authority to influence decisions or inconsistency in processes
In information	Inadequate or inaccurate information on which to base decisions

→ Apply uncertainty of factor to simulation model

Process for managing risks

Identify the risk factors

Model the system to incorporate the risk factors

Quantify risk factor uncertainties

Propagate the uncertainties

Sensitivity analysis

Identify risk factors

- Qualitative survey to use to identify potential effects

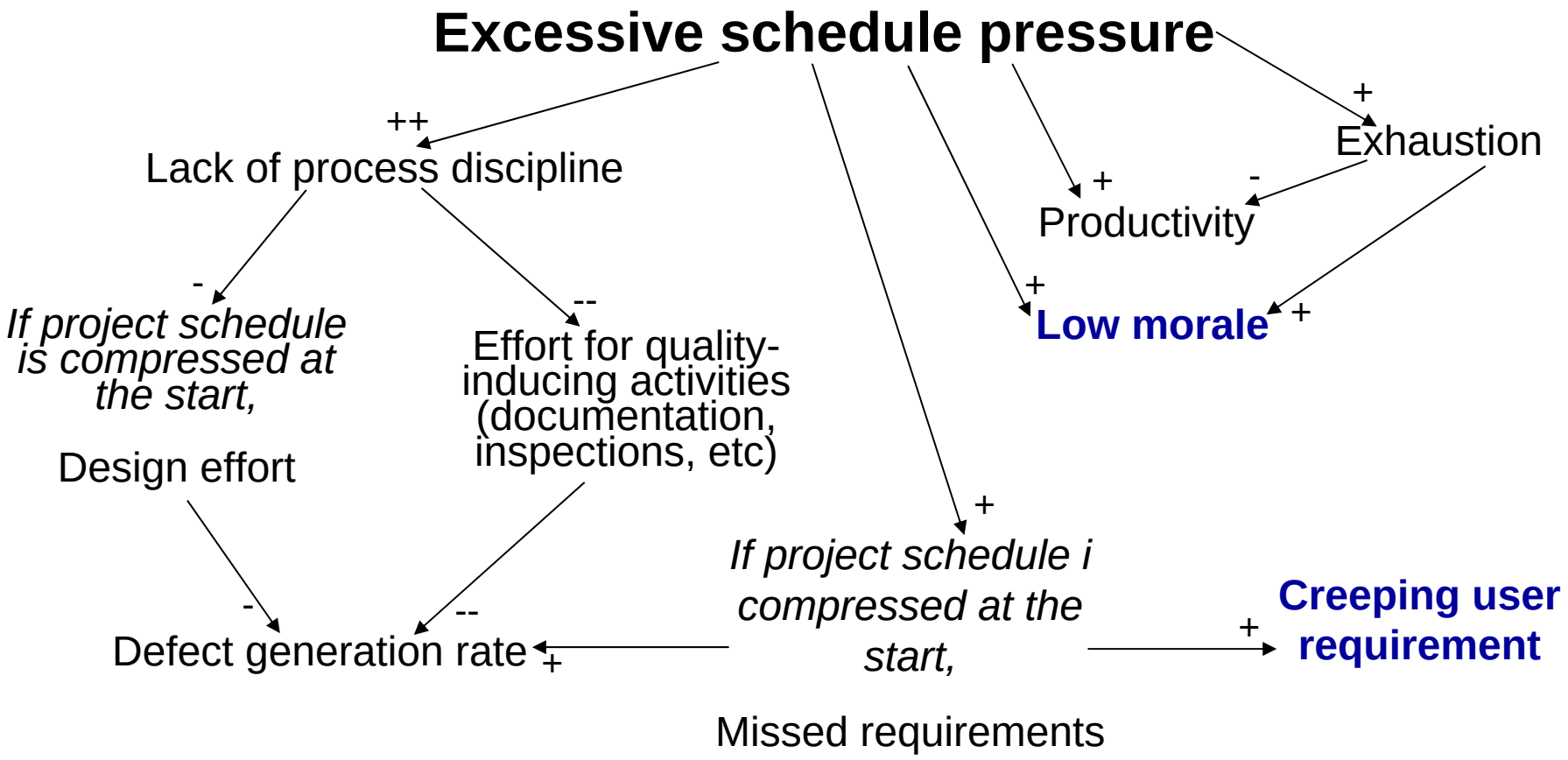
Preliminary effects diagram → Modified effects diagram → Final version effects diagram

- Selection of risk factors based on importance

Creeping user requirements	Lack of staff commitment, low morale
Inaccurate cost estimation	Instability and lack of continuity in project staffing
Excessive schedule pressure	Lack of senior management commitment

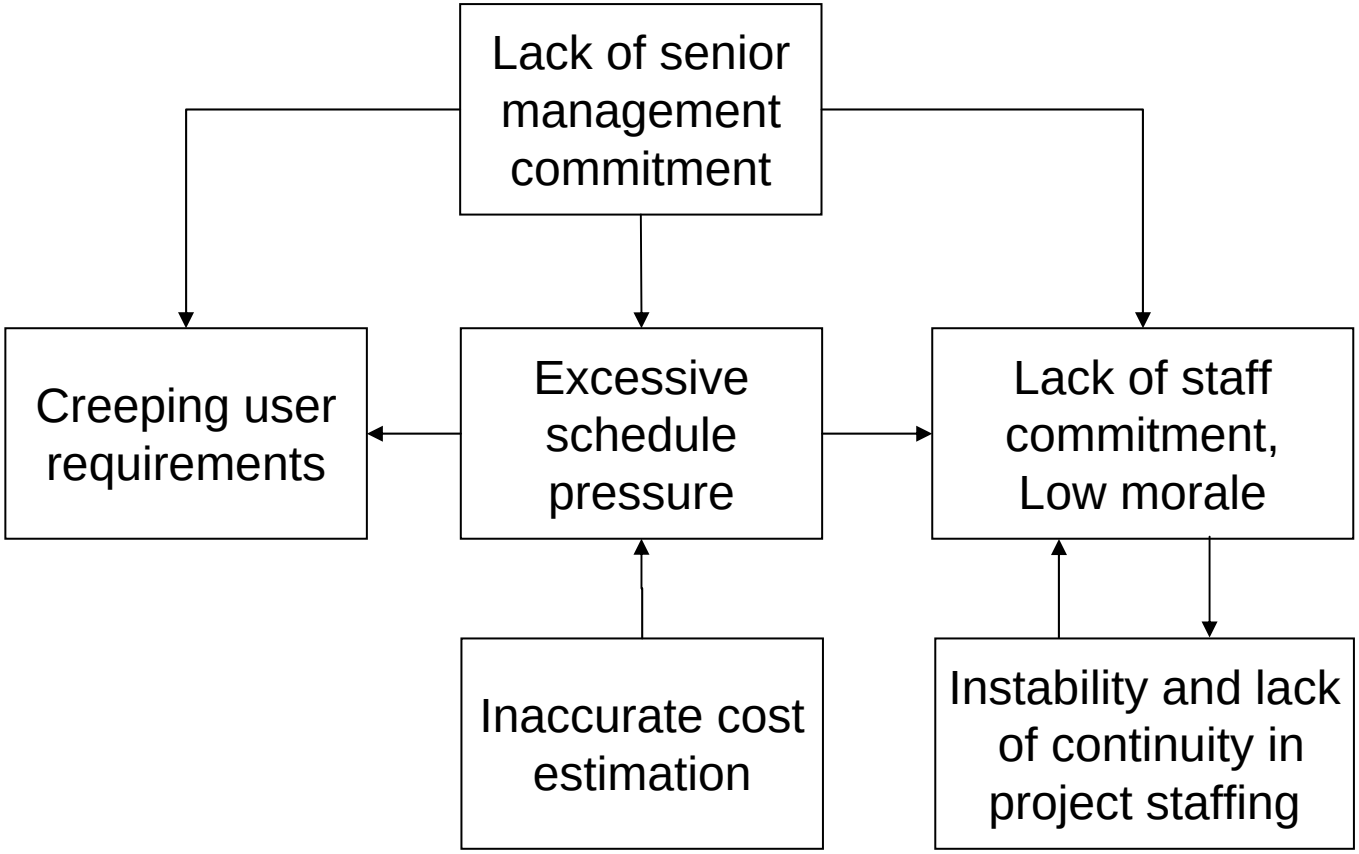
Effects diagram

- ‘Excessive schedule pressure’ factor



Relationship between factors

- Hypothesized influence diagram



Base model

- Reuse model Abdel-Hamid and Tvedt model
  - Focus on Software Development Risk Factors (SDRFs)

Planned staffing

Planned manpower

Actual staffing

Reflect experience, overtime, etc

Effort allocation

Calculate effort allocation for each activity

Productivity

Work rate, experience, overtime

Control

Tracking and reporting

Planning

Adjust schedule

Work flow

Flow of work product

Quality manage

Flow of errors and defects

Adjustment of job effort

Effort and defects update due to new work or rework

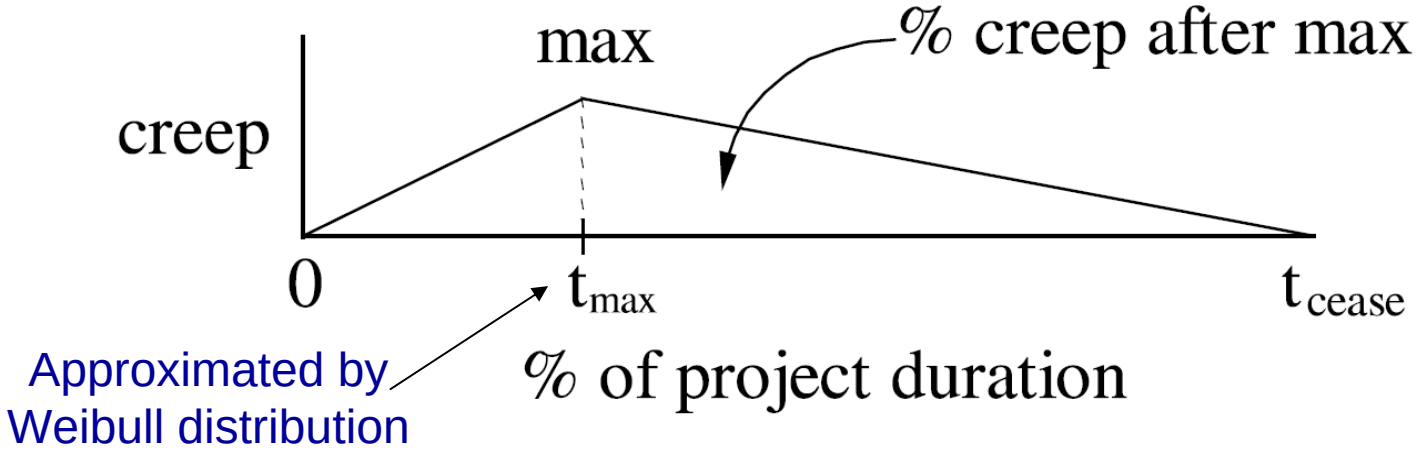
Modeling SDRFs

- Potential effects modeled for each risk factor

Requirement creep	Increased job size Rework	Time at max, % of work, % of creep % of rework, rework productivity
Inaccurate cost estimation	Actual job effort more or less than effort provided by staffing and schedule	Size estimation inaccuracy
Excessive schedule pressure	Morale change Fluctuating productivity, exhaustion, and higher error generation and weaker reviews	Change to morale for schedule pressure
Low morale, lack of staff commitment	Lower productivity Increase in error generation Attrition	Multiplier to productivity Multiplier to error generation Multiplier to attrition
Instability and lack of continuity in staffing	Attrition Morale change Lower productivity due to loss of expertise	Attrition, replacement delay Change to morale for attrition
Lack of senior management commitment	Initial schedule compression Understaffing Lower morale after excessive schedule pressure and attrition Willingness to extend schedule	Multiplier to schedule Multiplier to staffing Change to morale for schedule pressure or attrition Maximum schedule extension

Stochastic modeling construct(1/2)

- Requirement creep
  - Sample once at the beginning of each run
  - Modeled as characteristic of an entire project
  - Parameterize construct for new work due to requirements creep
    - Percentage of the estimated job size



Stochastic modeling construct(2/2)

- Effect of low morale on productivity
  - Sample continuously during each run
  - Modeled as a risk that may vary throughout a project

Logic for modeling the effect of low morale on productivity

```
IF(Morale<= 1 AND U(0,1) <=0.95)
        OR (Morale <=2 AND U(0,1) <= 0.85)
    THEN lognormal_distribution
ELSE IF (Morale<= 3 AND U(0,1) <=0.77)
        OR (Morale <=4 AND U(0,1) <= 0.67)
        OR (Morale <=5 AND U(0,1) <= 0.46)
    THEN Weibull_distribution
ELSE 1)
```

Morale scale

Probability of effect on productivity

Multiplier to productivity

Model verification and validation

- Model's structure
  - Reviewed by experts
- Model's behavior
  - Value of risk factor

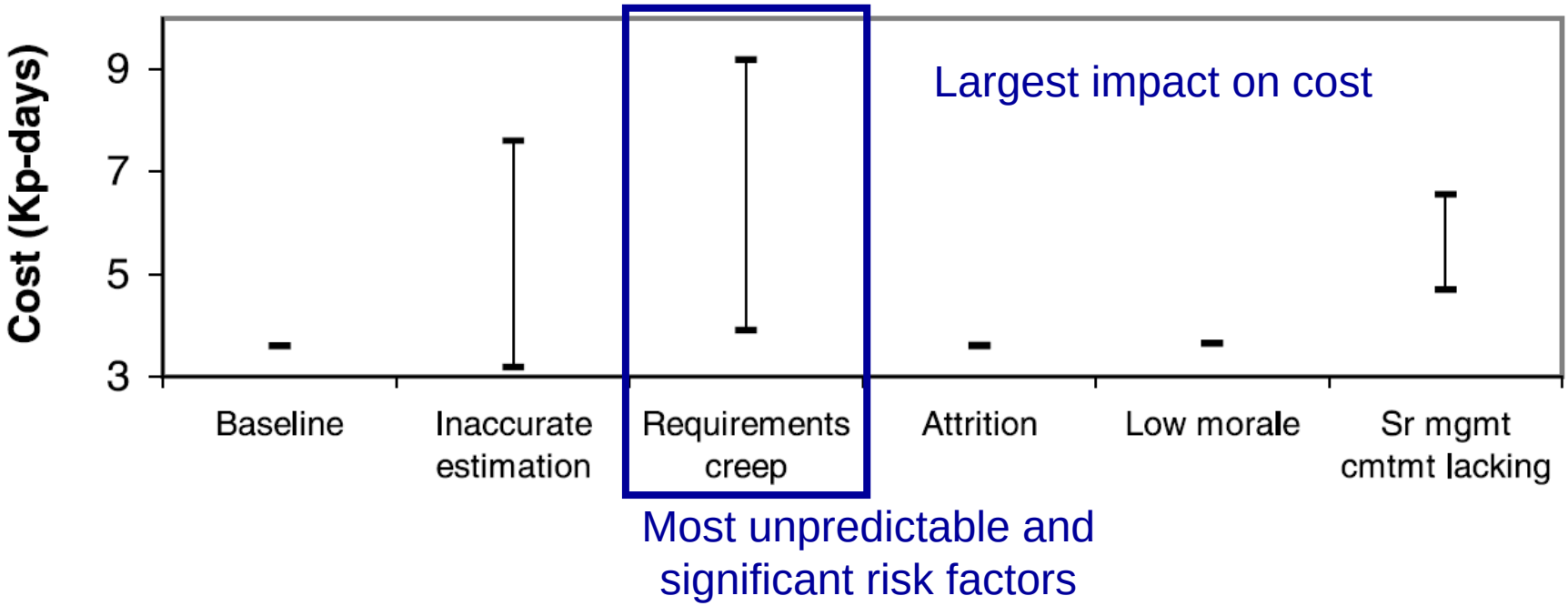
Req. creep	5%	underestimation	18%
Morale	Very high	Schedule pressure	Very high
Staffing	4 people for 10 month	Sr. mgmt	Very high

  - Actual project replication results

	Cost (days)	Duration	Defect density	Size
Actual	836	220	1.06	32
Simulated	889	231	1.05	32
% difference	6.3	5.0	-0.9	0

Model result(1/3)

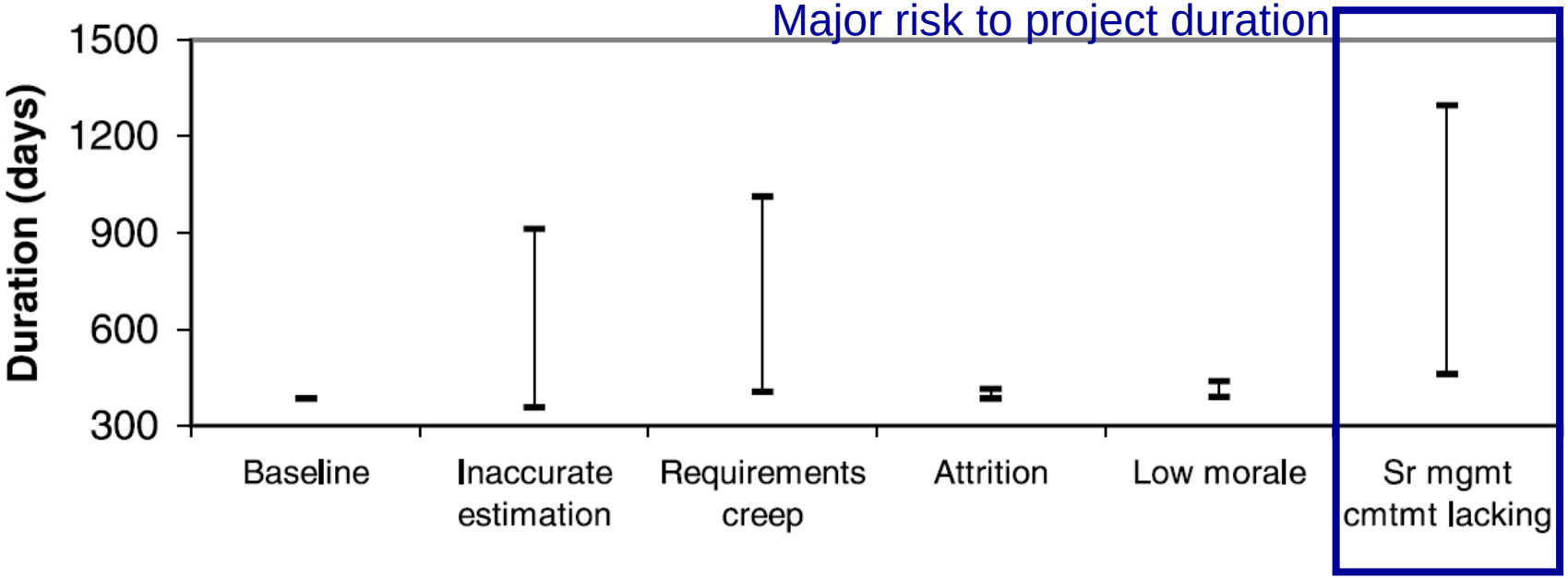
- Parameterized similarly to prototype project for experimentation



Confidence intervals on mean cost for actualized risk factors

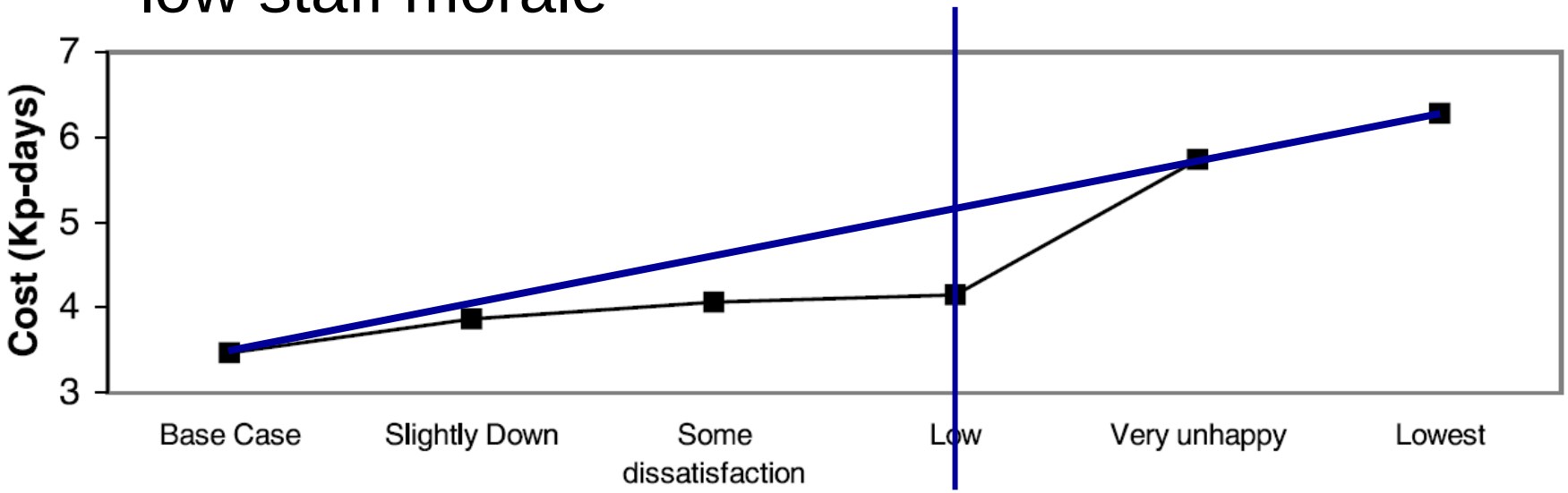
Model result(2/3)

- Confidence intervals on mean duration for actualized risk factors



Model result(3/3)

- Variation in project cost due to starting level of low staff morale



Variation in project cost due to starting level of low staff morale

Conclusion

- Conclusion
  - Use qualitative and quantitative survey on risk factors and their potential effect
  - Support risk management by stochastic simulation
    - Risk analysis, risk management planning

- Future work
  - Development of models for software project risk management
  - Relative influence of various risk factors

Discussion

- Critiques
  - Depend on statistical method
  - Not specific for business area or projects
  - Not sufficient validation of static structure of model
  - Do not sensitivity analysis for project
- Direction
  - Analyze effect pattern of risk factors on cost, duration, size