The Early Warning Signs of IT Project Failure:

The Deadly Dozen & The Four Horsemen of Doom

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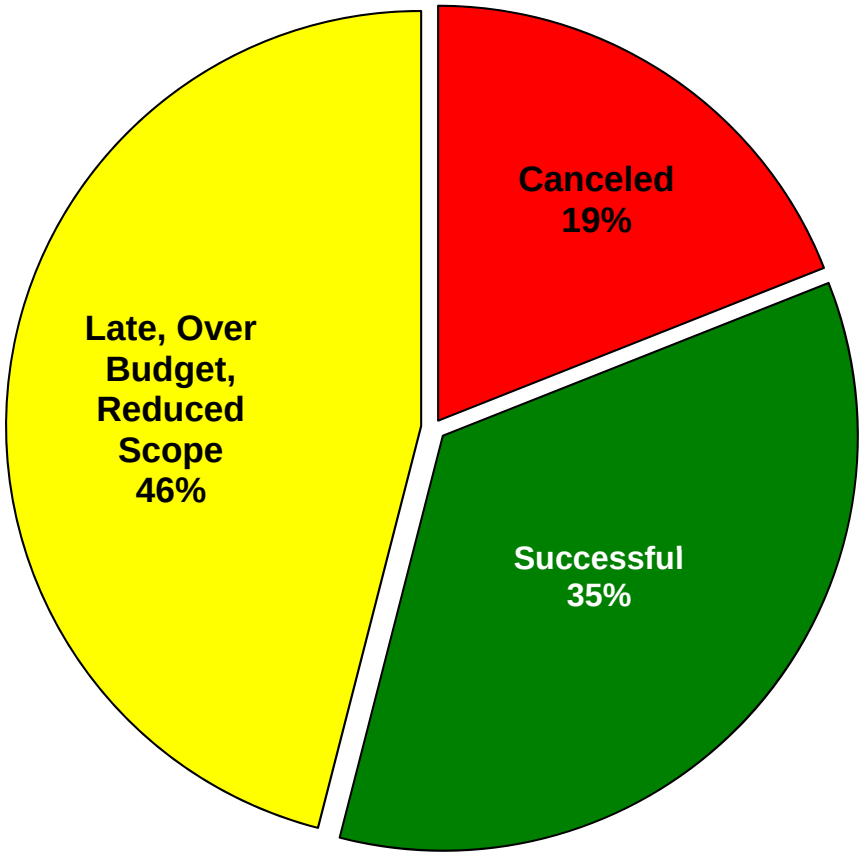
No Shortage of Major IT Project Failures

- **FoxMeyer Drugs ****
- **Denver Airport Baggage**
- **Internal Revenue Service**
- **Dept. of Veterans Affairs**
- **London Stock Exchange**
- **Bank of America**
- **Hershey Foods**
- **American LaFrance ****
- **McDonalds**
- **Shane ****
- **KMart ****
- **Nike**
- **AMR**
- **FAA**
- **FBI**
- **IRS**

FoxMeyer Drugs – a $5 billion annual revenue drug distributor. First billion dollar bankruptcy due to a failed IT project.

***** = IT directly implicated in bankruptcy.***

The Continuing IT Project Challenge



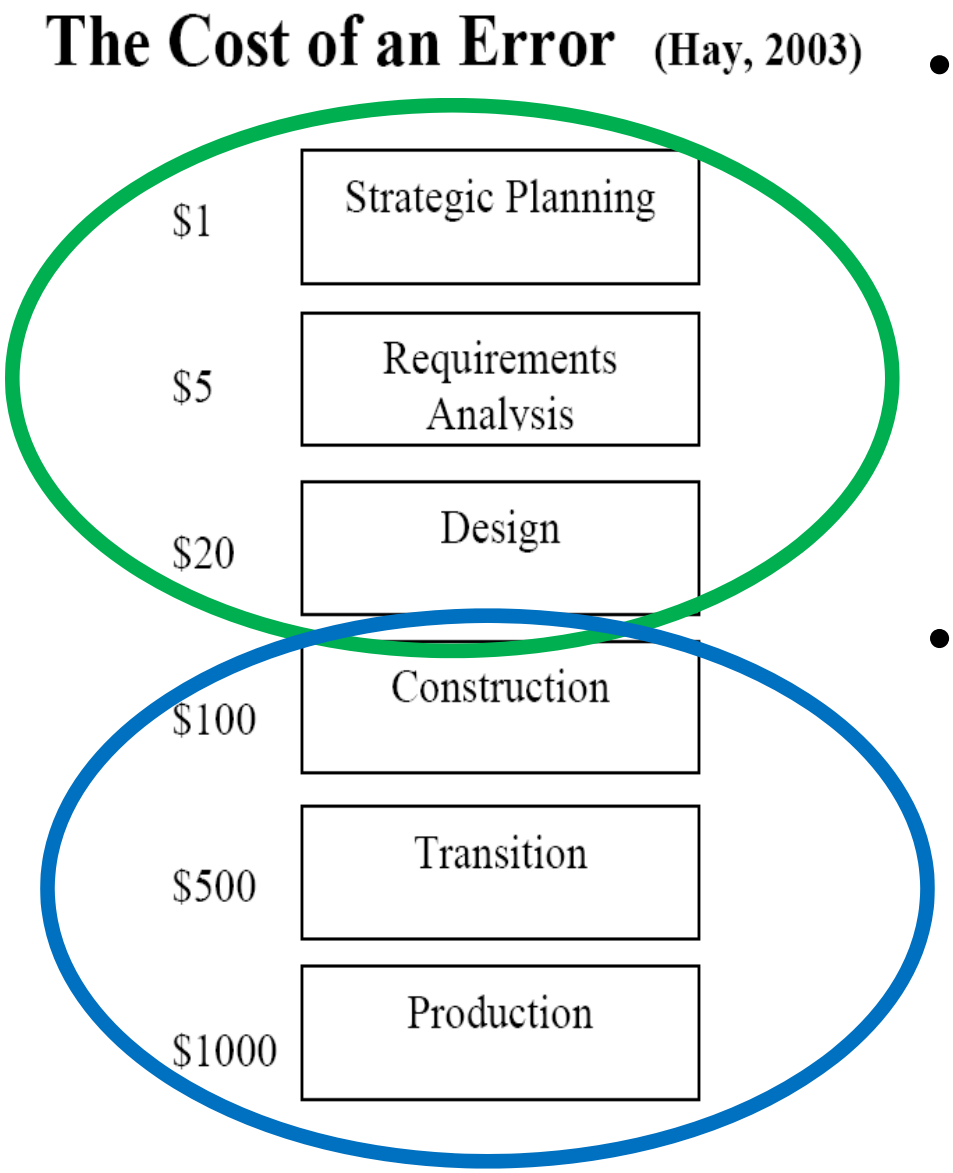
- **19% canceled - "outright failure"**
- **46% "cost or time overruns … didn't fully meet user's needs"**
- **Only 35% completed on time, on budget, with promised functionality**
- **Initial performance & reliability are often less than expected & needed**
- ✓ **Cancellation rate increases w/size:**
  - **32% large projects cancelled (> 10K FPs)**
  - **52% very large (> 100K FPs)**

FPs = Function Points

Capers Jones, 2009

❖*2006 Chaos Report*, The Standish Group, http://www.sdtimes.com/link/30247

Why Focus on Early Warning Signs?



- The cost of fixing an error rises dramatically over time.

  Requirements – "No other part of the work so cripples the system if done wrong. No other part is more difficult to rectify later."

  – Fred Brooks, *No Silver Bullets* (1986)

- Human Nature
  - IT people are optimists
  - Escalation Theory
    - Admitting wrong/don't know
    - Sunk cost
  - Job security
  - Recency bias

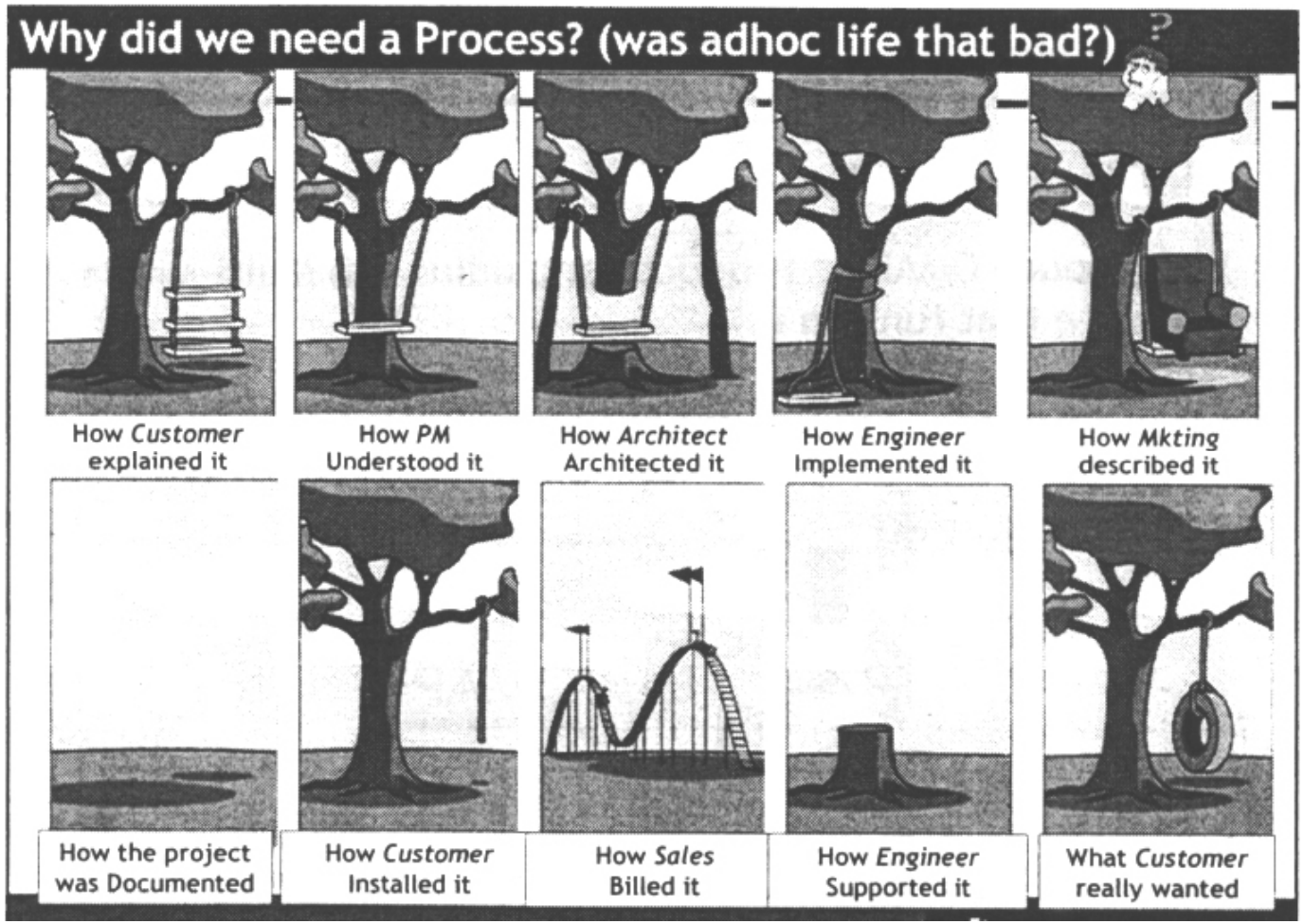
What are the sources of IT project risk?

Three Main Sources of IT Project Risk

- **People**
- **Process**
- **Product**

Requirements Ain't Easy!

Perspectives of People Vary – a lot



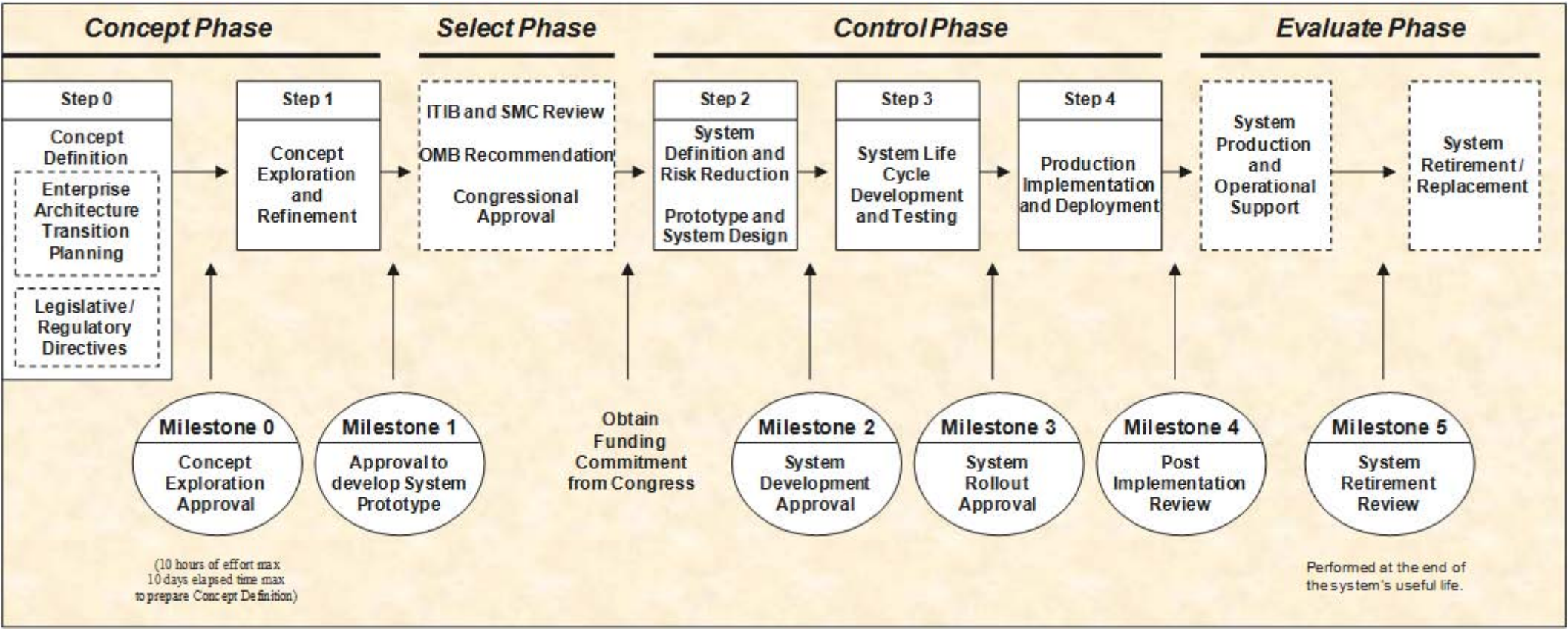
Cook, M. (Speaker). (26 February 2005). *Scorecards and Behavior Checklists as a Method of Measuring Process Deployment Across the Organization* [presentation]. Plano, TX: SEI Software Engineering Process Improvement Workshop, EDS Auditorium.

Requirements change at an average rate of 1.6% per month (1K to 10K FPs), or about 34% over the life of a 10,000 FP project (Capers Jones, 2008)

PROCESS IS CRITICAL

MILESTONES & INSPECTIONS MATTER!

When you've completed a step and are ready to progress into your next step, you must hold a Project Decision Meeting and get the MDA's approval to continue.



Project Size Matters!

Probability of Selected IT Project Outcomes

Table 1 uses six size ranges each an order of magnitude apart. Table 1 is taken from the author's book, Patterns of Software Systems Failure and Success (International Thomson Press, 1996).

Table 1: Software Project Outcomes By Size of Project

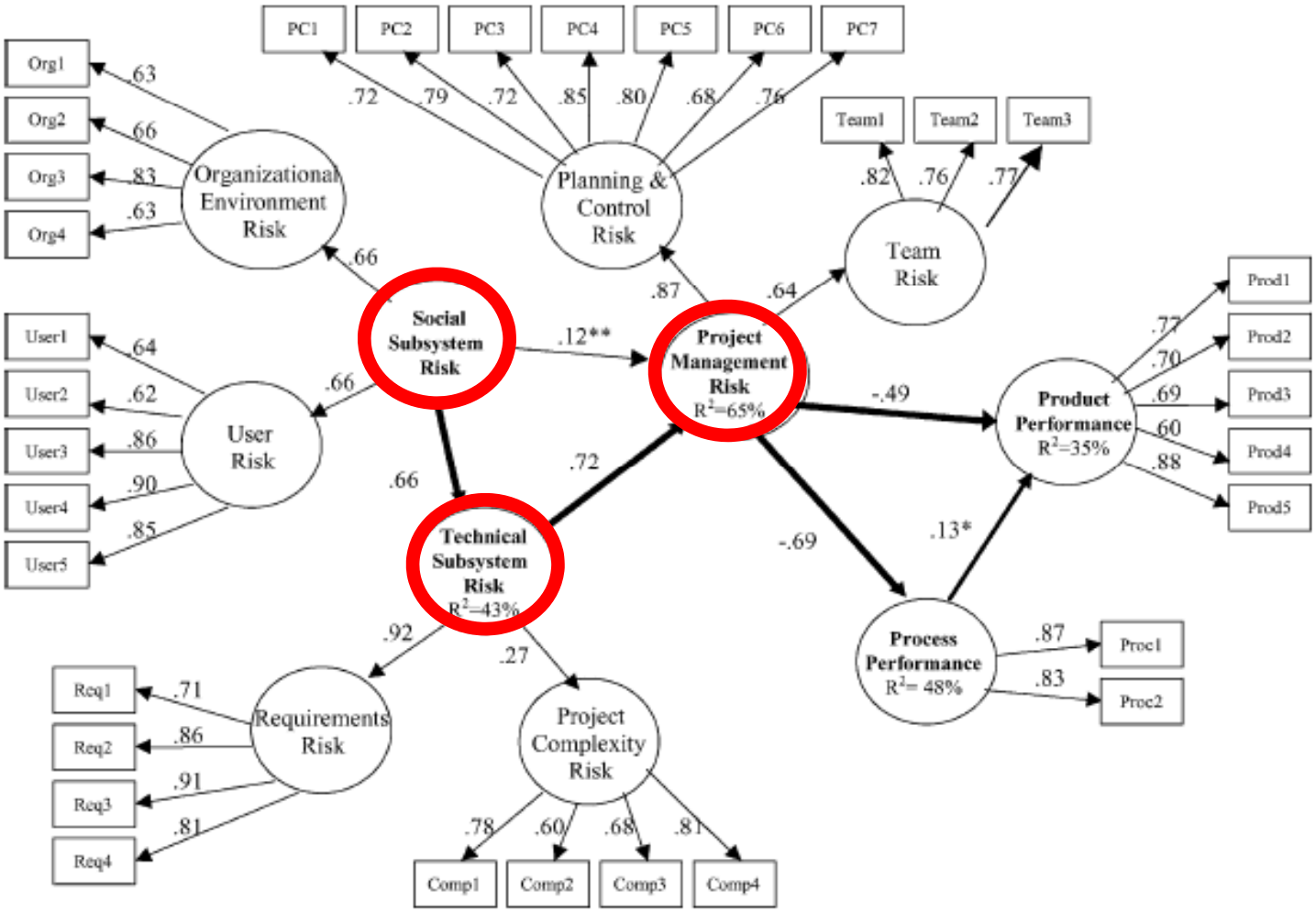
PROBABILITY OF SELECTED OUTCOMES

	Early	On-Time	Delayed	Canceled	Sum
1 FP	14.68%	83.16%	1.92%	0.25%	100.00%
10 FP	11.08%	81.25%	5.67%	2.00%	100.00%
100 FP	6.00%	74.77%	1.83%	7.33%	100.00%
1000 FP	1.24%	60.76%	7.67%	20.33%	100.00%
10000 FP	0.13%	28.03%	23.83%	48.00%	100.00%
100000 FP	0.00%	13.67%	21.33%	65.00%	100.00%
Average	5.53%	56.94%	13.71%	23.82%	100.00%

As can easily be seen from table 1, small software projects are successful in the majority of instances. The risks and hazards of cancellation or major delays rise quite rapidly as the overall application size goes up. Indeed, the development of large applications in excess of 10,000 function points is one of the most hazardous and risky business undertakings of the modern world.

Source: Capers Jones (1996)

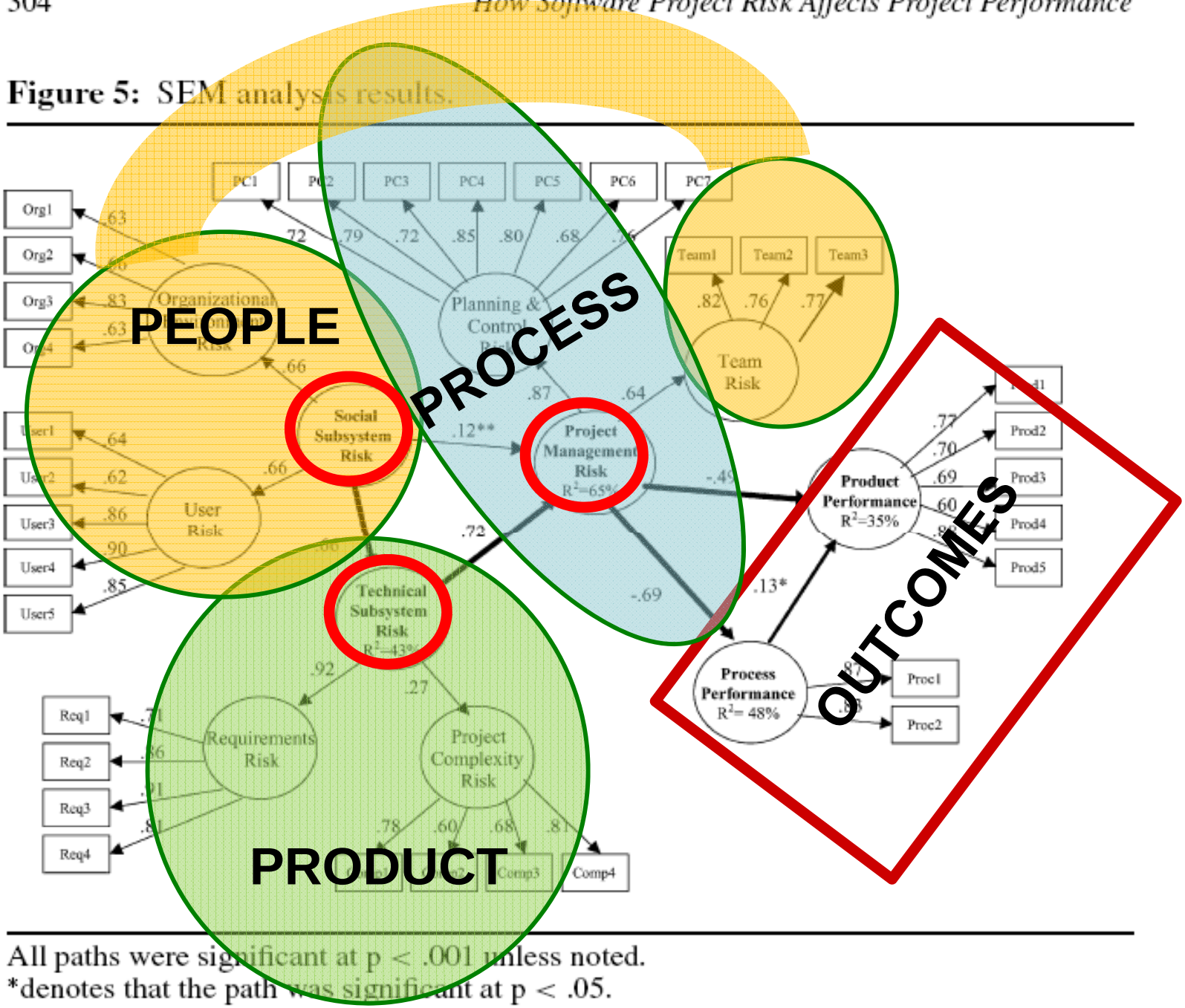
Figure 5: SEM analysis results.



All paths were significant at $p < .001$ unless noted.
*denotes that the path was significant at $p < .05$.
**denotes an insignificant path.

Source: Wallace, Keil, & Rai (2004)

Figure 5: SEM analysis results.



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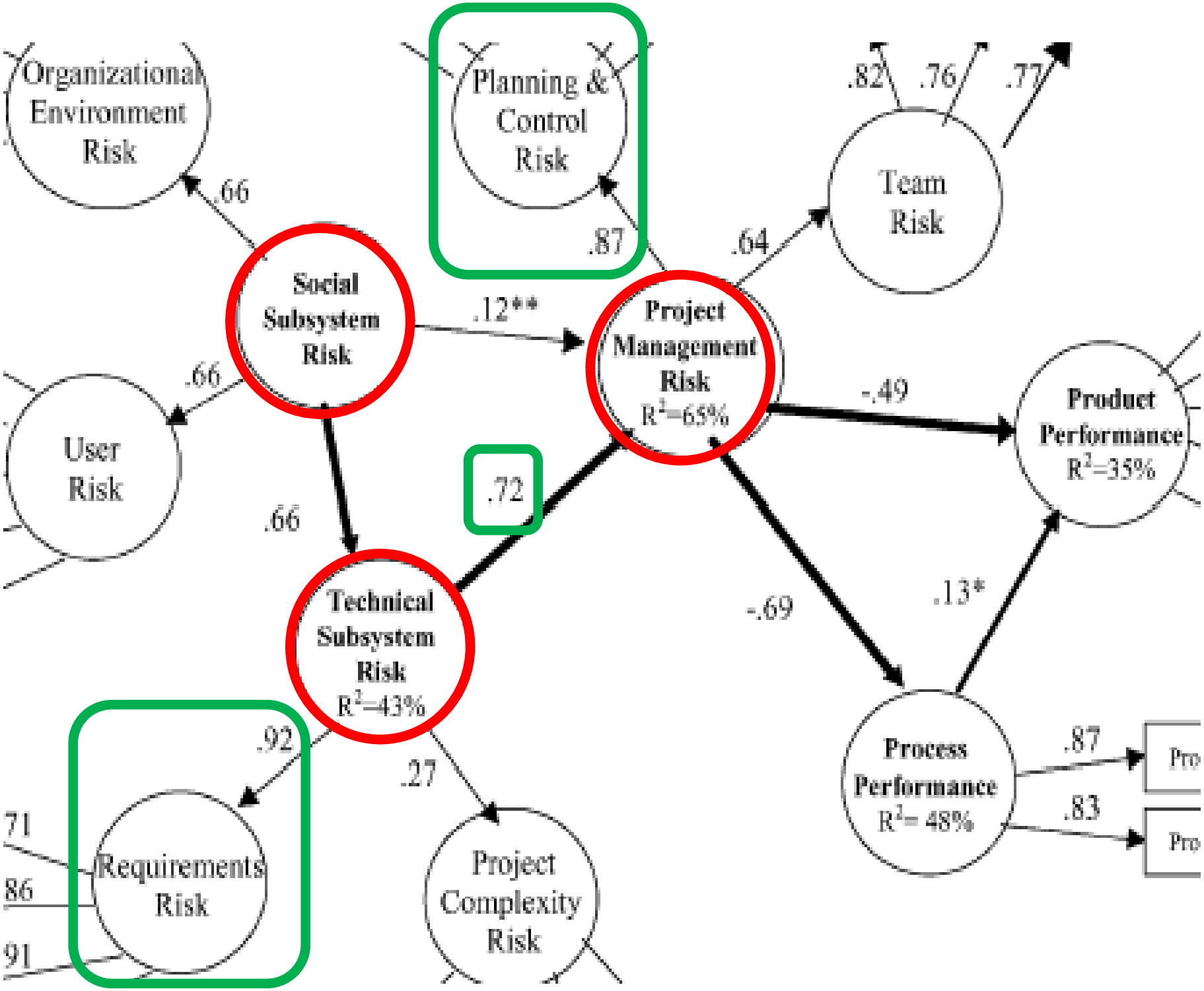
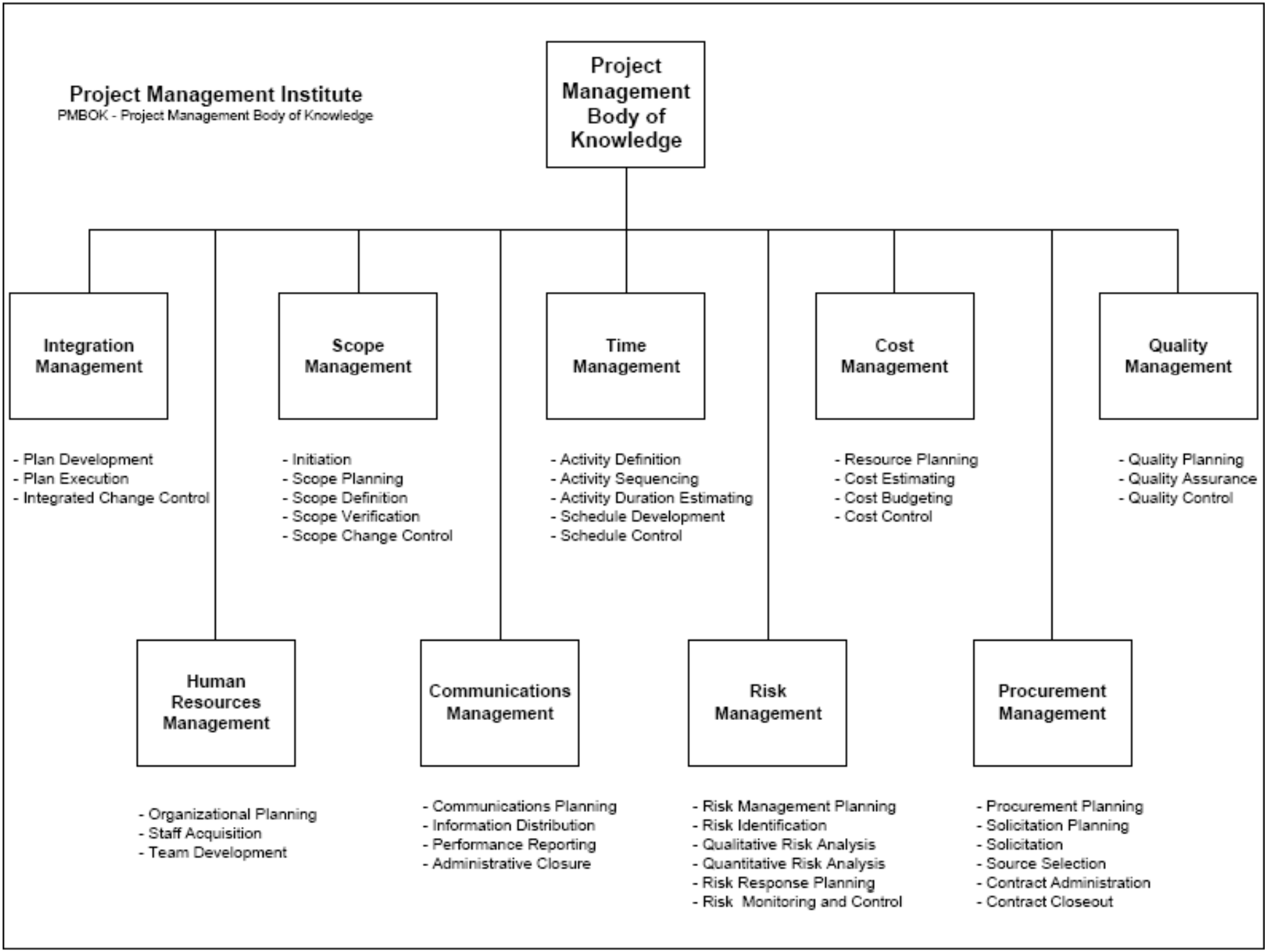

Organizational Environment Risk
Planning & Control Risk
Team Risk
.82
.76
.77
.66
.87
.64
Social Subsystem Risk
.12**
Project Management Risk
R^2=65%
.66
User Risk
-.49
Product Performance
R^2=35%
.72
.66
Technical Subsystem Risk
R^2=43%
-.69
.13*
.92
.27
Process Performance
R^2= 48%
.87
.83
71
86
91
Requirements Risk
Project Complexity Risk



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Best Practices are Known

Figure 3: Classic Mistakes and Best Practices Matrix

	Classic Mistakes \ Best Practices	Agile Development	Communication Plan	Estimate-Convergence Graph	Joint Application Development (JAD)	Comprehensive Project Charter	Project Management Office	Retrospectives	Staged Delivery	Stakeholder Assessment	Work Breakdown Structure
1	Poor estimation and/or scheduling	X		X		X	X	X	X		X
2	Ineffective stakeholder management		X		X	X	X			X	
3	Insufficient risk management			X		X	X	X	X		
4	Insufficient planning			X		X	X	X			X
5	Shortchanged quality assurance	X			X				X		
6	Weak personnel and/or team issues	X	X				X	X	X		
7	Insufficient project sponsorship		X		X	X	X			X	
8	Poor requirements determination	X			X						X
9	Inattention to politics		X			X	X			X	
10	Lack of user involvement	X	X		X				X	X	

Retrospectives conducted in 74 organizations over the prior sever (7) years

Source: R. Ryan Nelson (2007)

Table 1.2 Evaluation of Software Methods, Practices, and Results by Size and Type of Application	11/10/08

	Best Practices		
1	Reusability (> 85% zero-defect materials)	9.65	Reuse
2	Defect potentials < 3.00 per function point	9.35	Quality
3	Defect removal efficiency > 95%	9.32	Quality
4	Personal Software Process (PSP)	9.25	Process Methodology
5	Team Software Process (TSP)	9.18	Process Methodology
6	Automated static analysis	9.17	Quality
7	Inspections (code)	9.15	Quality
8	Measurement of defect removal efficiency	9.08	Quality
9	Hybrid (CMM+TSP/PSP+others)	9.06	Process Methodology
10	Reusable feature certification	9.00	Reuse
11	Reusable feature change controls	9.00	Reuse
12	Reusable feature recall method	9.00	Reuse
13	Reusable feature warranties	9.00	Reuse
14	Reusable source code (zero defect)	9.00	Reuse
	Very Good Practices		
15	Early estimates of defect potentials	8.83	Quality
16	Object-oriented development (OO)	8.83	Process Methodology
17	Automated security testing	8.58	Quality
18	Measurement of bad-fix injections	8.50	Quality
19	Reusable test cases (zero defects)	8.50	Reuse
20	Formal security analysis	8.43	Quality
21	Agile development	8.41	Process Methodology
22	Inspections (requirements)	8.40	Quality
23	Time boxing	8.38	Project Management
24	Activity-based productivity measures	8.33	Project Management
25	Reusable designs (scalable)	8.33	Reuse
26	Formal risk management	8.27	Project Management
27	Automated defect tracking tools	8.17	Quality
28	Measurement of defect origins	8.17	Quality
29	Benchmarks against industry data	8.15	Project Management
30	Function point analysis (high-speed)	8.15	Project Management
31	Formal progress reports (weekly)	8.06	Project Management
32	Formal measurement programs	8.00	Project Management
33	Reusable architecture (scalable)	8.00	Reuse
34	Inspections (design)	7.94	Quality
35	Lean Six-Sigma	7.94	Project Management
36	Six-sigma for software	7.94	Quality
37	Automated cost estimating tools	7.92	Project Management
38	Automated maintenance work benches	7.90	Quality
39	Formal cost tracking reports	7.89	Project Management
40	Formal test plans	7.81	Quality

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Tools Can Help

RESULTS >10,000 FUNCTION POINT PROJECTS

	Probability of Selected Outcomes			
	Cancel	**Delays**	**On time**	**Early**
Automated estimates **Automated plans** **Formal tracking** **Optimal quality control**	**1%**	**2%**	**78%**	**19%**
Manual estimates **Manual plans** **Informal tracking** **Minimal quality control**	**40%**	**45%**	**15%**	**0%**

Source: Capers Jones (1996)

EWS Research Goal

Identify relative importance of Early Warning Signs (EWS) of impending IT Project Failure within the first 20% of the original project schedule … While there is still time to get back on track to success at a reasonable cost.

IT Project Success is defined as being completed on-time, on-budget, with the originally promised functionality and necessary performance and reliability, all adjusted accordingly for changes in requirements.

Our Research Approach:
Three Phases

1. **Extensive literature search**
2. **Panel of 15 Experts - Delphi Study**
3. **Survey of senior IT project managers**
   - **Average 15 years experience**
   - **Maximum project size of $3 million to $7 billion**

Survey

- 53 possible Early Warning Sign factors
- People, Process, and Technology EWS
- Developed an on-line survey tool
- Rank each EWS factor from 1 to 7
    - 1 – Extremely Unimportant
    - 7 – Extremely Important

TABLE 2 53 Early Warning Signs Ranked by Mean Importance Score
(7 = Extremely Important, 1 = Extremely Unimportant)

Rank	Item Description*	Source	Mean Importance Score
1	Lack of top management support or commitment to the project	Schmidt et al., 2001	6.59
2	Functional, performance, and reliability requirements and scope are not documented	Winters, 2002	6.56
3	Project manager(s) cannot effectively lead the team and communicate with clients	Schmidt et al., 2001	6.39
4	No change control process	Schmidt et al., 2001	6.33
5	Project stakeholders have not been interviewed for project requirements	Ward, 2003	6.32
6	No documented milestone deliverables and due dates		6.30
7	Undefined project success criteria		6.22
8	Project team members have weak commitment to the project scope and schedule	Schmidt et al., 2001	6.17
9	Communication breakdown among project stakeholders	May, 1998	6.17
10	Key project stakeholders do not participate in major review meetings		6.16
11	Project team members do not have required knowledge/skills	Barki et al., 2001	6.16
12	Project resources have been assigned to a higher priority project	Havelka et al., 2004	6.12
13	No business case for the project	Ward, 2003	6.11
14	No project status progress process	Havelka et al., 2004	6.11
15	Schedule deadline not reconciled to the project schedule		6.09
16	Early project delays are ignored — no revision to the overall project schedule	McKeeman, 2001	6.04
17	Subject matter experts are overscheduled: retain all prior duties yet expected to provide substantial participation to the project	McKeeman, 2001	6.04
18	No planning and estimation documentation	Jones, 2004	5.96
19	Project managers have poor training	Schmidt et al., 2001	5.94
20	Key stakeholders do not review and sign off deliverables on a timely basis		5.93
21	Project stakeholder decision delays have caused due dates to be missed		5.90
22	No due diligence on vendor(s) and team members	McKeeman, 2001	5.91
23	No written commitment for the project outside of the project team		5.88
24	Significant goal, scope, or schedule requirements change immediately after project kickoff	Boehm, 1991	5.85
25	Team members have undefined roles and responsibilities	Jiang et al., 2002	5.83
26	No project communications plan or resources devoted to managing and communicating project expectations		5.80
27	Project team members are overscheduled	Schmidt et al., 2001	5.77
28	Users are not willing to cooperate	Schmidt et al., 2001	5.75
29	No team member experience with the chosen technology	Schmidt et al., 2001	5.73
30	No project management methodology	Schmidt et al., 2001	5.67
31	No project charter document at early stage of project		5.65
32	No risk analysis documentation and process	McKeeman, 2001	5.65
33	Failure to gather requirement via joint application design		5.63
34	No documented analysis of business strategy alignment	Winters, 2002	5.61
35	Major new risks are identified after the project kickoff		5.58
36	No performance and reliability requirements metrics tracking process	Jones, 2004	5.57
37	Approved project budget less than budget estimated by the project team		5.56
38	Budget, schedule, scope, and quality all mandated from outside the project team		5.56
39	Project manager(s) have never managed a project of this scale before	McFarlan, 1982	5.55
40	Deliverable due dates missed during the first 10 percent of the project schedule	McKeeman, 2001	5.54
41	IT operations infrastructure and network infrastructure problems have major impact on project team productivity		5.52
42	Difficulty in determining the input and output of the system		5.51
43	Cultural conflict among organizations involved	Winters, 2002	5.50
44	No contingency budget for known risks and rate of changes		5.50
45	Unstable organization environment (such as changes in senior management or restructuring)	Schmidt et al., 2001	5.49
46	Project team member(s) have low morale	McKeeman, 2001	5.48
47	Key team member turnover after project kickoff	Schmidt et al., 2001	5.46
48	Key stakeholders have not signed the project charter		5.38
49	Large number of interfaces to other system required	Barki et al., 2001	5.30
50	Users cannot get involved because of lack of understanding of new system capabilities	McFarlan, 1982	5.29
51	Project involves implementing a custom or beta version of hardware or software	Schmidt et al., 2001	5.10
52	Users or technical support team feel threatened by a project to replace their legacy system	Jiang et al., 2002	4.80
53	Earned value systems not in place or used to control program		4.56

* The items for which no source is listed were not identified from earlier studies; they were added based on the authors' experiences and on feedback from a panel of 15 experts.

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EWS Research Findings

- **17 (out of 53) with a mean score > 6 (out of 7)**
- **These 17 consolidated down to a Top 12 – The "Deadly Dozen" Early Warning Signs**
- **No Technical factors made the top 40**
- **Technical Factors were all in the bottom 20%**

IT projects almost never fail because of technical causes, despite the fact that people and process problems may manifest technically.

The technical ailments of IT projects can be traced to people and process causes that exploit inherent product risks, such as large size, high complexity, or novel technology. Nevertheless, these technical risks can be mitigated with proper people and process practices.

Even risks of large size projects, which are technical (product) risks, can be mitigated by good process and people.

Early Warning Signs "Deadly Dozen"

People Factors

Center on five not altogether mutually exclusive groups of people: Top Management, Project Management, Project Team Members, Subject Matter Experts (SMEs = users), & Stakeholders in general.

1. **Lack of Top Management Support**
2. **Weak Project Manager**
3. **No Stakeholder involvement and/or participation**
4. **Weak Commitment of Project Team members**
5. **Team Members lack requisite knowledge or skills**
6. **Subject Matter Experts are over-scheduled**

Early Warning Signs "Deadly Dozen"

Process Factors

Center on five project management processes and their associated deliverables that are essential to success: Requirements (including a Business Case), Change Control, Schedule Control, Communications, and Resources.

1. **Lack of Documented Requirements / Success Criteria**
2. **No Change Control Process**
3. **Ineffective Schedule Planning / Management**
4. **Communications Breakdown among Stakeholders**
5. **Resources assigned to a higher priority project**
6. **No Business Case for the Project**

Table 1: The Early Warning Signs of IT Project Failure

The Deadly Dozen EWSs	The Four Horseman of IT Project Doom			
	Stakeholders	Requirements	Processes	Team
People-Related Risks				
1. Lack of top management support.	X			
2. Weak project manager.				X
3. No stakeholder involvement.	X			
4. Weak commitment of project team.				X
5. Team members lack requisite knowledge and/or skills.				X
6. Subject matter experts overscheduled.	X			
Process-Related Risks				
7. Lack of documented requirements and/or success criteria.		X		
8. No change control process or change management.			X	
9. Ineffective schedule planning and/or management.			X	
10. Communication breakdown among stakeholders.			X	
11. Resources assigned to higher priority project.		X		
12. No business case for the project.		X		

"Material Financial Risks of IT Projects: The Early Warning Signs of Failure" by Leon A. Kappelman,
forthcoming in 2010 in ***the Interpreter*** a quarterly publication of the Insurance Accounting & Systems Association

Fred Brooks on the difficulties of software development…

"The hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the detailed technical requirements…. No other part of the work so cripples the system if done wrong. No other part is more difficult to rectify later."

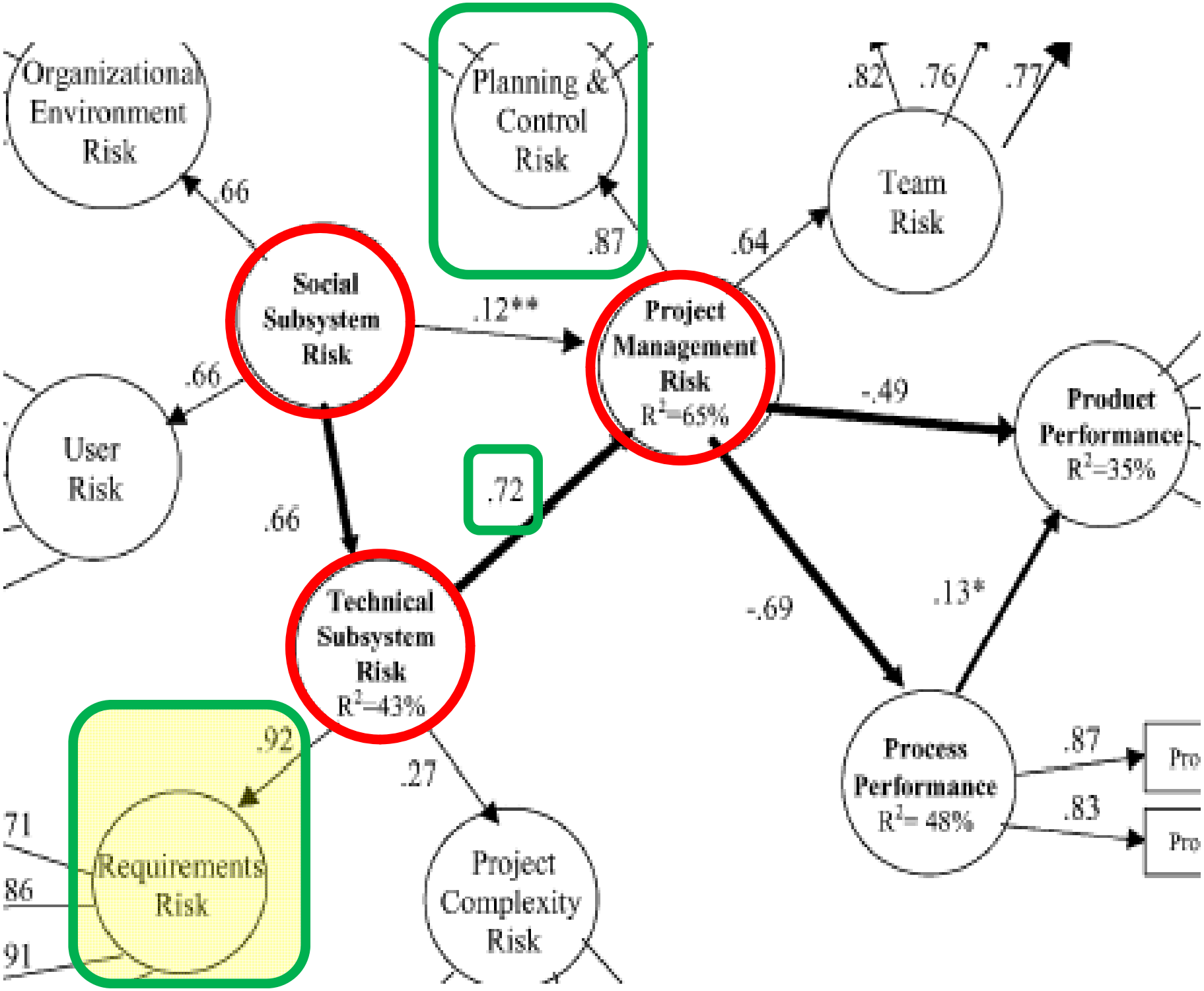
"No Silver Bullet - Essence & Accidents of Software Engineering"
1986 in Information *Processing 86*. H.J. Kugler, ed., Elsevier, 1069-1076. (Invited paper, IFIP Congress '86, Dublin)
Reprinted in *The Mythical Man-Month, 20th Anniversary Edition*, Frederick P. Brooks, Jr., Addison-Wesley, 1995.

Requirements = Architecture
Architecture? What's that?

- **<u>Architecture</u> is "the set of descriptive representations about an object."** [John Zachman]
- **<u>Enterprise Architecture</u> is "the holistic set of descriptions about the enterprise over time."** [SIMEAWG]
- **<u>Enterprise Architecture</u> is modeling the enterprise.** [LAK]

Why do we need architectural models?

Failure to plan is a plan for failure


Organizational Environment Risk
Planning & Control Risk
Team Risk
.82
.76
.77
.66
.87
.64
Social Subsystem Risk
.12**
Project Management Risk
R^2=65%
.66
User Risk
-.49
Product Performance
R^2=35%
.72
.66
Technical Subsystem Risk
R^2=43%
-.69
.13*
.92
.27
Process Performance
R^2= 48%
.87
.83
Pro
Pro
71
86
91
Requirements Risk
Project Complexity Risk

INDUSTRY DATA ON DEFECT ORIGINS

Because defect removal is such a major cost element, studying defect origins is a valuable undertaking.

IBM Corporation (MVS)

45%	Design errors
25%	Coding errors
20%	Bad fixes
5%	Documentation errors
5%	Administrative errors
100%	

SPR Corporation (client studies)

20%	Requirements errors
30%	Design errors
35%	Coding errors
10%	Bad fixes
5%	Documentation errors
100%	

TRW Corporation

60%	Design errors
40%	Coding errors
100%	

Mitre Corporation

64%	Design errors
36%	Coding errors
100%	

Nippon Electric Corp.

60%	Design errors
40%	Coding errors
100%	

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U.S. AVERAGES FOR SOFTWARE QUALITY

(Data expressed in terms of defects per function point)

Defect Origins		Defect Potential	Removal Efficiency	Delivered Defects	
Requirements	45%	1.00	77%	0.23	56%
Design		1.25	85%	0.19	
Coding		1.75	95%	0.09	
Documents		0.60	80%	0.12	
Bad Fixes		0.40	70%	0.12	
TOTAL		5.00	85%	0.75	

(Function points show all defect sources - not just coding defects)

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BEST IN CLASS SOFTWARE QUALITY

(Data expressed in terms of defects per function point)

Defect Origins		Defect Potential	Removal Efficiency	Delivered Defects	
Requirements	40%	0.40	85%	0.08	77%
Design		0.60	97%	0.02	
Coding		1.00	99%	0.01	
Documents		0.40	98%	0.01	
Bad Fixes		0.10	95%	0.01	
TOTAL		2.50	96%	0.13	
		50%		17%	

OBSERVATIONS

Most often found in systems software > SEI CMM Level 3

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“No other part of the conceptual work is as difficult as establishing the detailed technical requirements…. No other part of the work so cripples the system if done wrong. No other part is more difficult to rectify later.” – Fred Brooks

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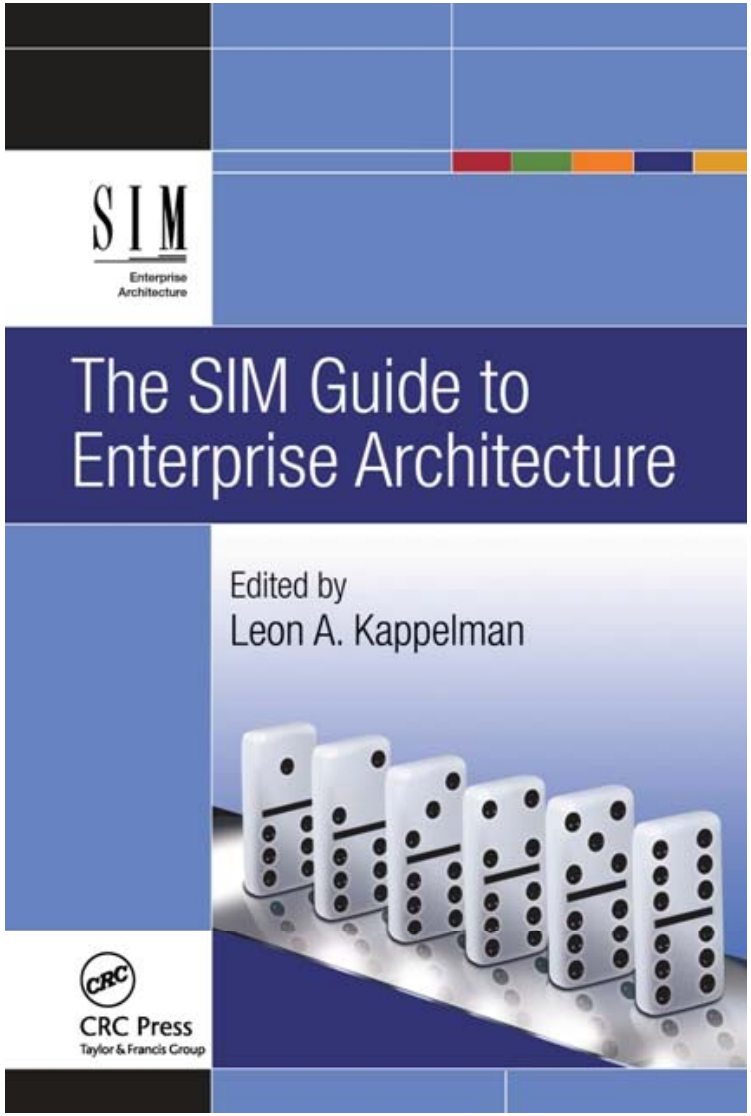

A project of the SIMEAWG

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The act of discovery consists not in finding new lands but in seeing with new eyes.

– Marcel Proust

EWS of IT Project Failure

Four Horseman of Doom

- ***Requirements***
  - Lack of documented requirements and/or success criteria
  - Resources assigned to a higher priority project
  - No business case for the project
- ***Stakeholders***
  - Lack of top management support
  - No stakeholder involvement and/or participation
  - Subject matter experts are overscheduled
- ***Project Team***
  - Weak project manager
  - Weak commitment of project team
  - Team members lack requisite knowledge and/or skills
- ***Project Management Processes***
  - No change control process or change management
  - Communication breakdown among stakeholders
  - Ineffective schedule planning and/or management

There is Still No Silver Bullet

- ✓ **The warning signs are clear -- if you are willing to look. But it is very hard for project stakeholders and participants to be objective.**
- ✓ **Hope is not a strategy, but that is too often the strategy.**
- ✓ **Success requires objectivity, candor, hard work, and hard choices.**

EWS to Lower Personal Career Risk

- **All participants are often damaged.**
- **Project recovery miracles are very rare.**
- **A project “death march” rarely succeeds.**
- **Most CFOs have been burned enough that credibility of project status reports are low.**
- **Big IT projects are very visible (material risk).**
- **Outsourcing more (even all) of IT can result.**
- **Career damage can result.**
- **Use EWSs awareness to be the winner who is credible and delivers!! Improve your career prospects.**

What can you do?

- **Pay attention! – See with "new eyes"**
- **Make all stakeholders aware of EWS risks from the beginning – feasibility, planning, funding.**
- **Outside experts can be helpful & objective**
  - **When it's tough for stakeholders to be objective.**
  - **When knowledge transfer desired.**
- **If EWSs are identified, then ask:**
  - **How can the EWS be fixed, managed, mitigated?**
  - **Is the business case still valid?**
  - **Is stopping the project the best answer?**
    - ***Sunk costs are sunk – throwing good money after bad is foolish.***
    - ***Human behavior is sometimes obtuse – Escalation Theory (and market bubbles) – but <u>you</u> don't have to be "stupid on purpose".***
- **Candor + Courage = Credibility**

“No one has to change. Survival is optional.”

– Dr. W. Edwards Deming

The Early Warning Signs of IT Project Failure:

The Deadly Dozen & The Four Horsemen of Doom

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