Evaluating the Life Cycle Cost and Effort of Project Management for Complex Systems Development Projects

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Self Introduction

- Professional Experience
  - IBM
  - Accenture
  - KPMG
- Academic Background
  - PhD Candidate – Stevens Institute of Technology
  - MS – George Washington University
  - BS – Purdue University
- Research Areas
  - Cost Estimating
  - Project Management and Agile Project Management
  - Systems Engineering and Systems Integration

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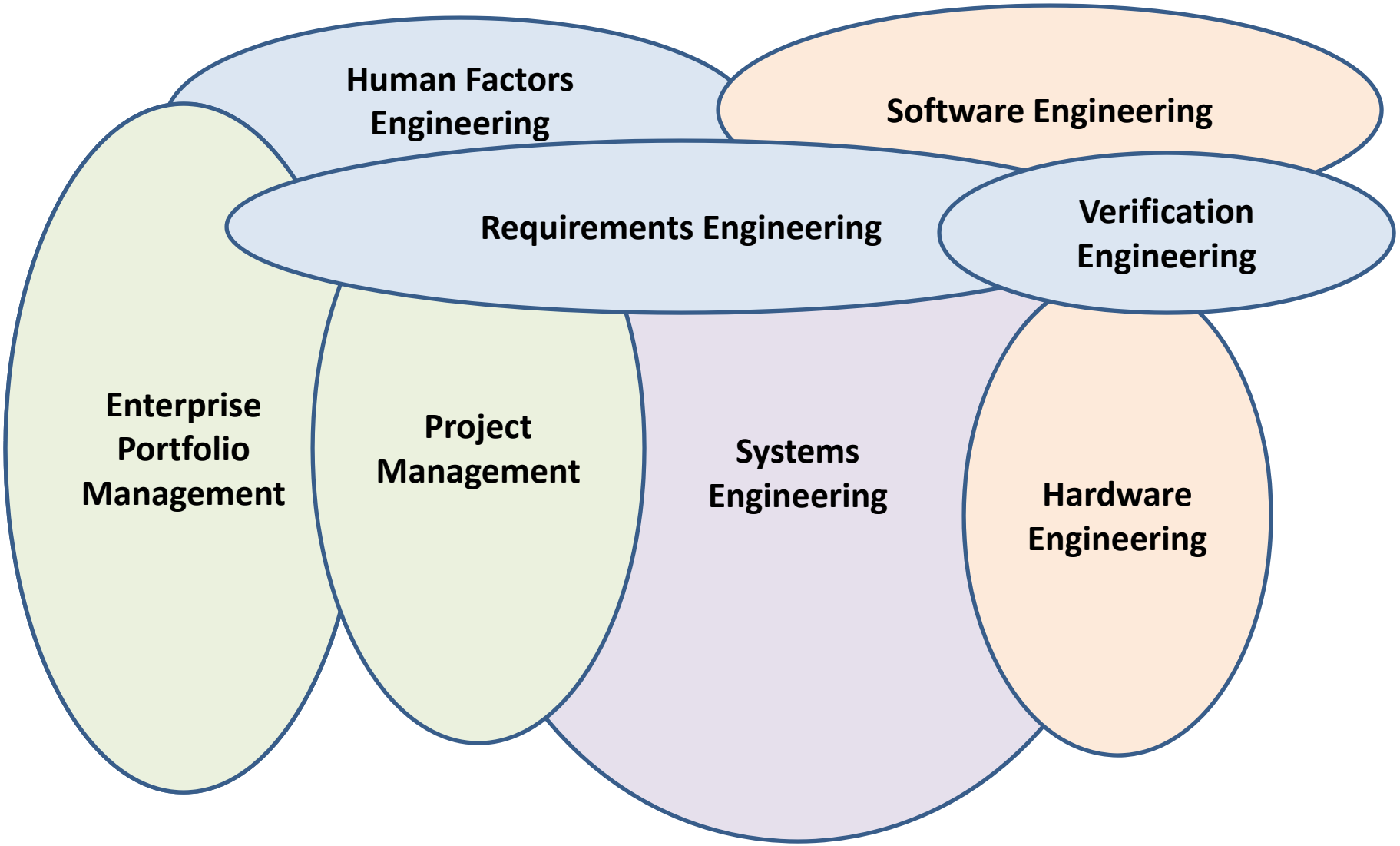
Agenda

- **Introduction**
  - General View of Costing
  - The Cost of Management: Systems Engineering (SE) & Project Management (PM)
- Project Management
  - The Cost of PM
- Life Cycle Perspective
- Research Effort: PM Cost Estimating Model
  - Survey Results
- Summary

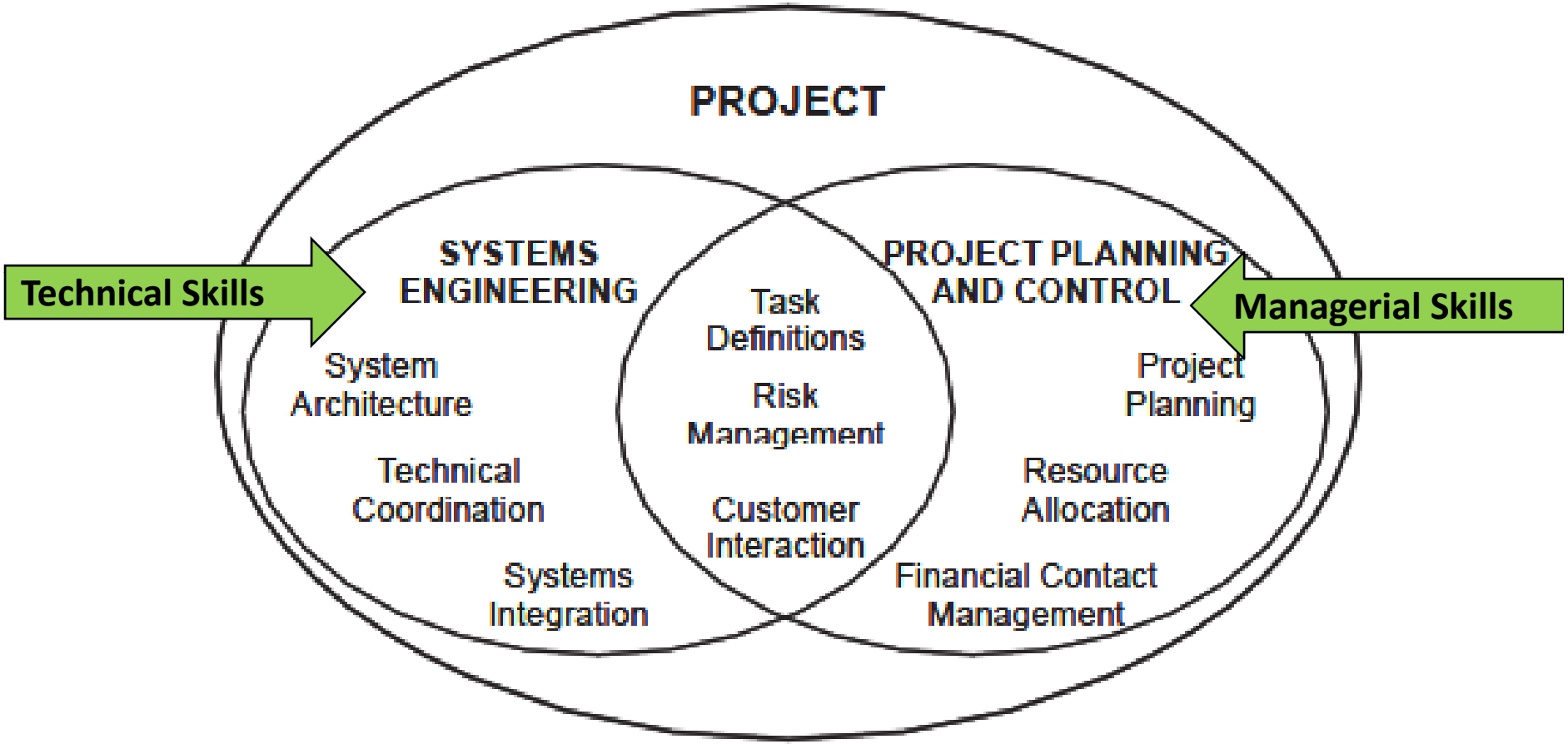
General View of Systems Costs



General View of Systems Costs

- Simplest Form & Subcategories
  - 4 Major Systemic Elements
    - Hardware, Software
      - Mature, e.g. the Constructive Cost Model (COCOMO suite)
    - Integration
      - Emerging area – difficult to estimate, e.g. the Constructive System of Systems Integration Cost Model (COSOSIMO)
    - Management
      - Development Management = Systems Engineering (SE) & Project Management (PM)
      - e.g. Defense Industry, USAF Programs (Stem et al., 2006)
        - » Development Management (100/%) = SE (50%) + PM (50%)
        - » SE/PM costs doubled since 1960s

Systems Engineering (SE) & Project Management (PM)



The Overlapping Areas of SE & PM in a Project

(Kossiakoff and Sweet, 2003)

Systems Engineering (SE) & Project Management (PM)

- SE Costs – significant amount of research has been conducted
  - –The International Council on Systems Engineering (INCOSE) surveyed (Honour, 2004):
    - 52% of systems projects spent 5% or less of total systems development cost on SE tasks
  - –The Constructive Systems Engineering Cost Model (COSYSMO)
    - As a SE cost estimating tool used by systems engineering, systems cost estimators, etc (Valerdi, 2006)
- PM Costs – Formal Estimating Methodologies and Tools?

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What is Project Management?

- Project Management Institute (PMI) - Project Management Body of Knowledge (PMBOK) guidebook defines PM as "*the application of knowledge, skills, tools and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project*" (PMI, 2004)

- NASA defines PM as "*the function of planning, overseeing, and directing the numerous activities required to achieve the requirements, goals, and objectives of the customer and other stakeholders within specified cost, quality, and schedule constraints*" (NASA, 2007, 2010)

What Does Project Management Include?

Technical Management Processes (PM)
Decision Analysis
Technical Planning
Technical Assessment
Requirement Management
Risk Management
Configuration Management
Technical Data Management
Interface Management

The Roles of Program/Project Manager and Systems Engineer in the Defense Systems Project Life Cycle Processes (DOD, 2010)

How Much Does PM Cost?

- Literature – limited information on PM related expenditures or costs
- Organizations often ***do not*** identify or measure PM costs, and a survey led by UC Berkley (Ibbs and Kwak, 2000a, 2000b) shows:
  - 80% of companies surveyed spend less than 10% of total project cost (TPC) for PM services
  - Average = 6% of TPC, Range = 0.3% ~ 15% of TPC
  - Another survey indicated the average = 10% of TPC (Ibbs and Reginato, 2002)
- Evidently, PM costs varies among organizations
  - Influential PM Cost Factors: project type, size, # of projects, PM maturity level (Archibald, 2003)

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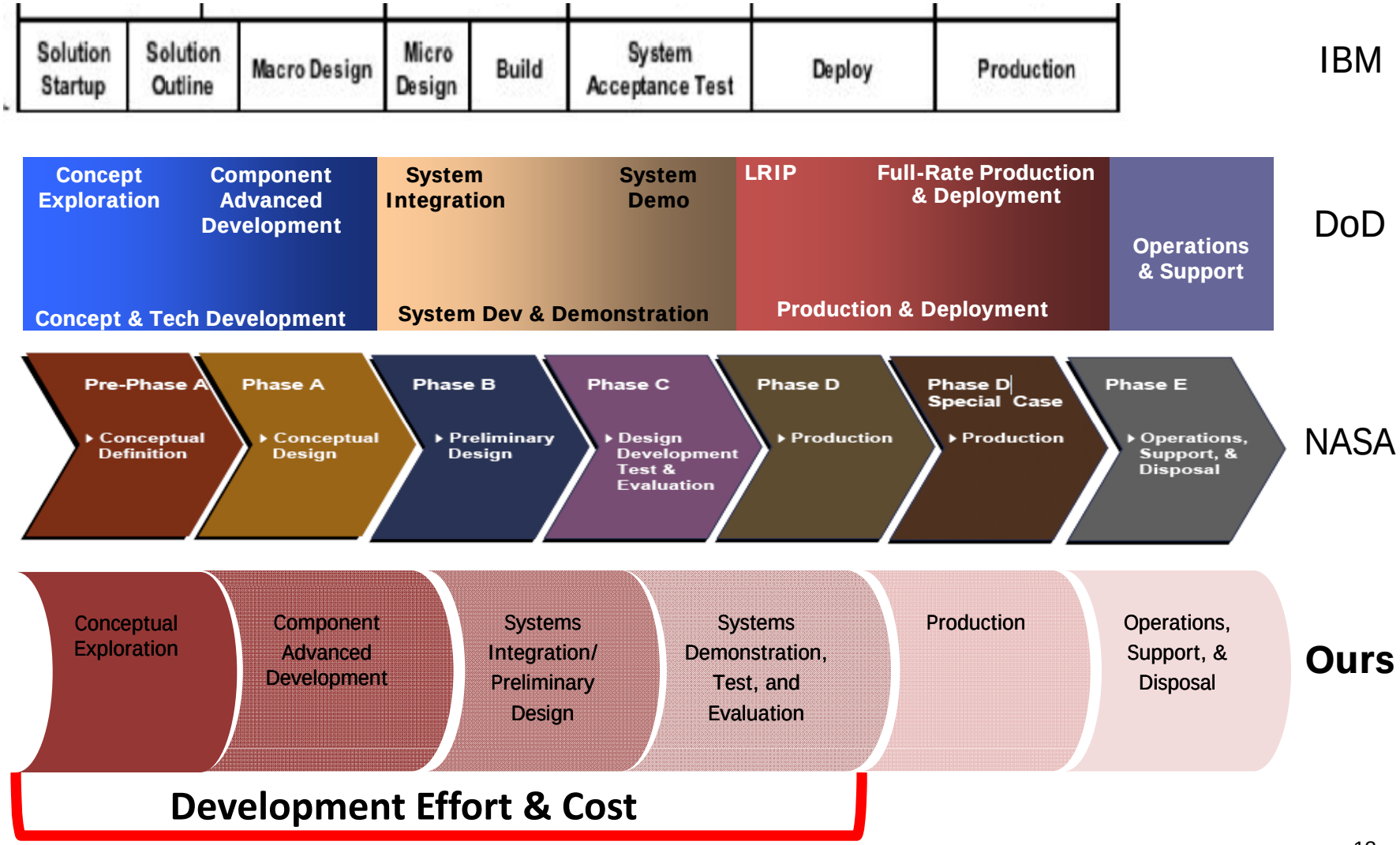
LCC Models



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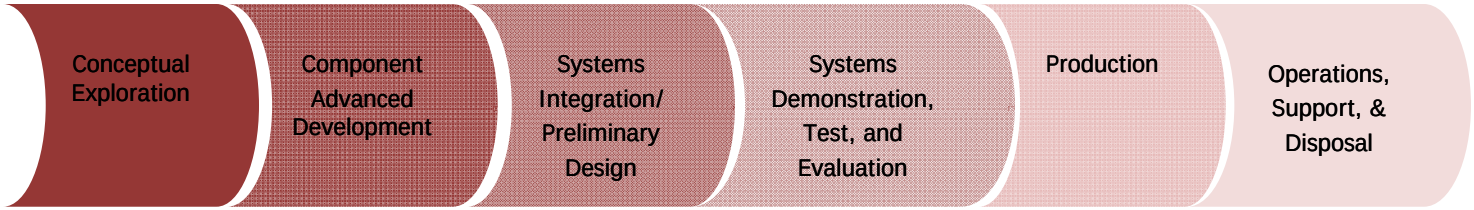
Systems vs. Other Processes



Life Cycle Perspective According to

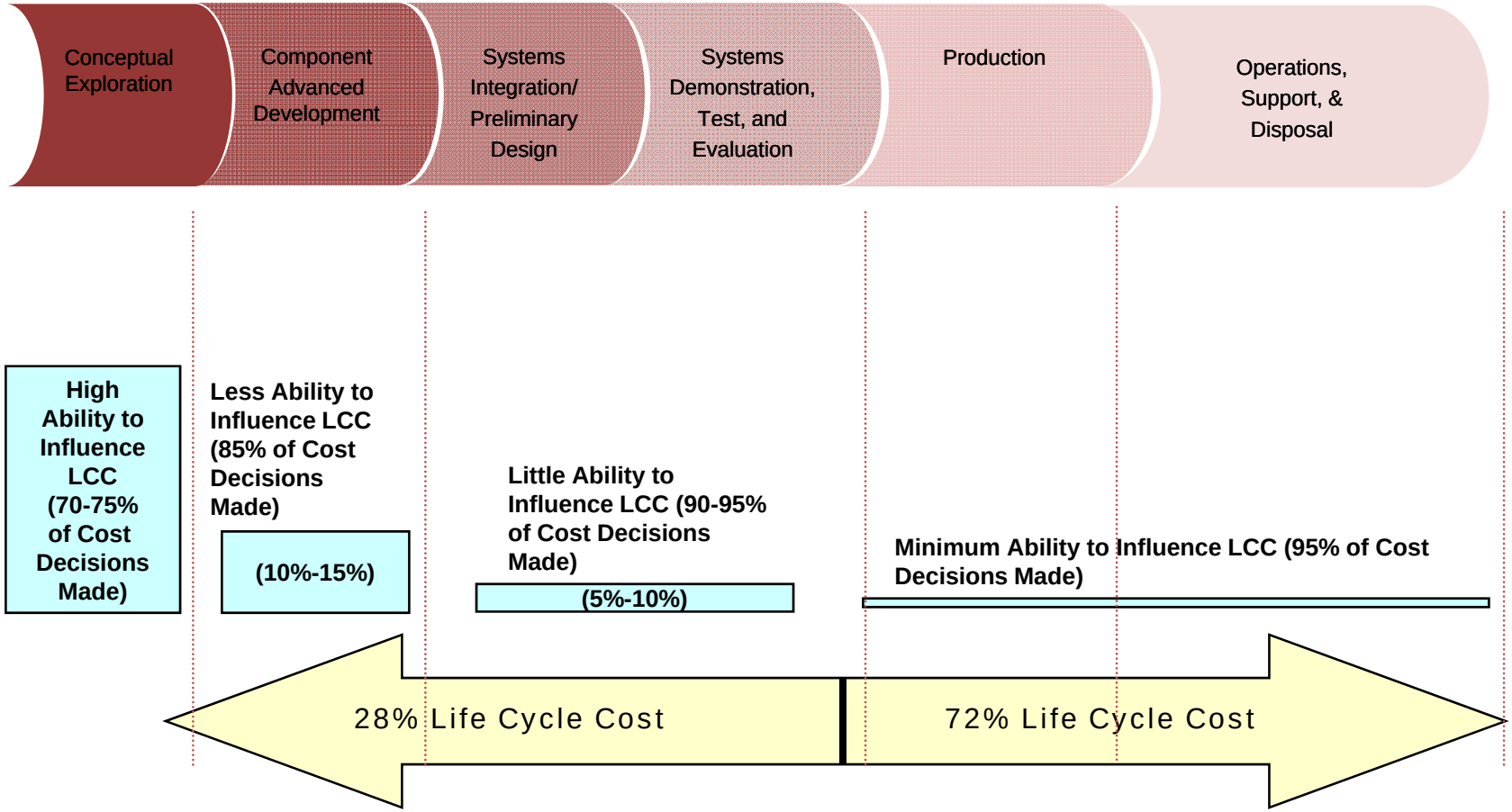
- **Our Model**
- **Customer Perspective**
- **Marketing**

Purchase **Operate / Maintenance** **Disposal**

Introduction **Growth** **Maturity** **Decline**

Systems Engineering ← → Project Management

Cost in the System Development Process



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PM Cost Estimating Model

Synthesized via COSYSMO (Valerdi, 2005)

$$PM_{NS} = A \cdot \left(\sum_{k} \left(w_{e,k} \Phi_{e,k} + w_{n,k} \Phi_{n,k} + w_{d,k} \Phi_{d,k} \right) \right)^{E} \cdot \prod_{j=1}^{5} EM_{j}$$

Where,

PM_{NS} = effort in Person Months (Nominal Schedule)

A = calibration constant derived from historical project data

k = {**REQ, PCR, CST, SCM, DCL**}

w_k = weight for "easy", "nominal", "difficult", or "**low**", "**medium**", "**high**" size driver

Φ_k = quantity of "k" size driver

E = represents diseconomies of scale

EM = **project management efficiency multiplier** for the *j*th cost driver. The geometric product results in an overall effort adjustment factor to the nominal effort.

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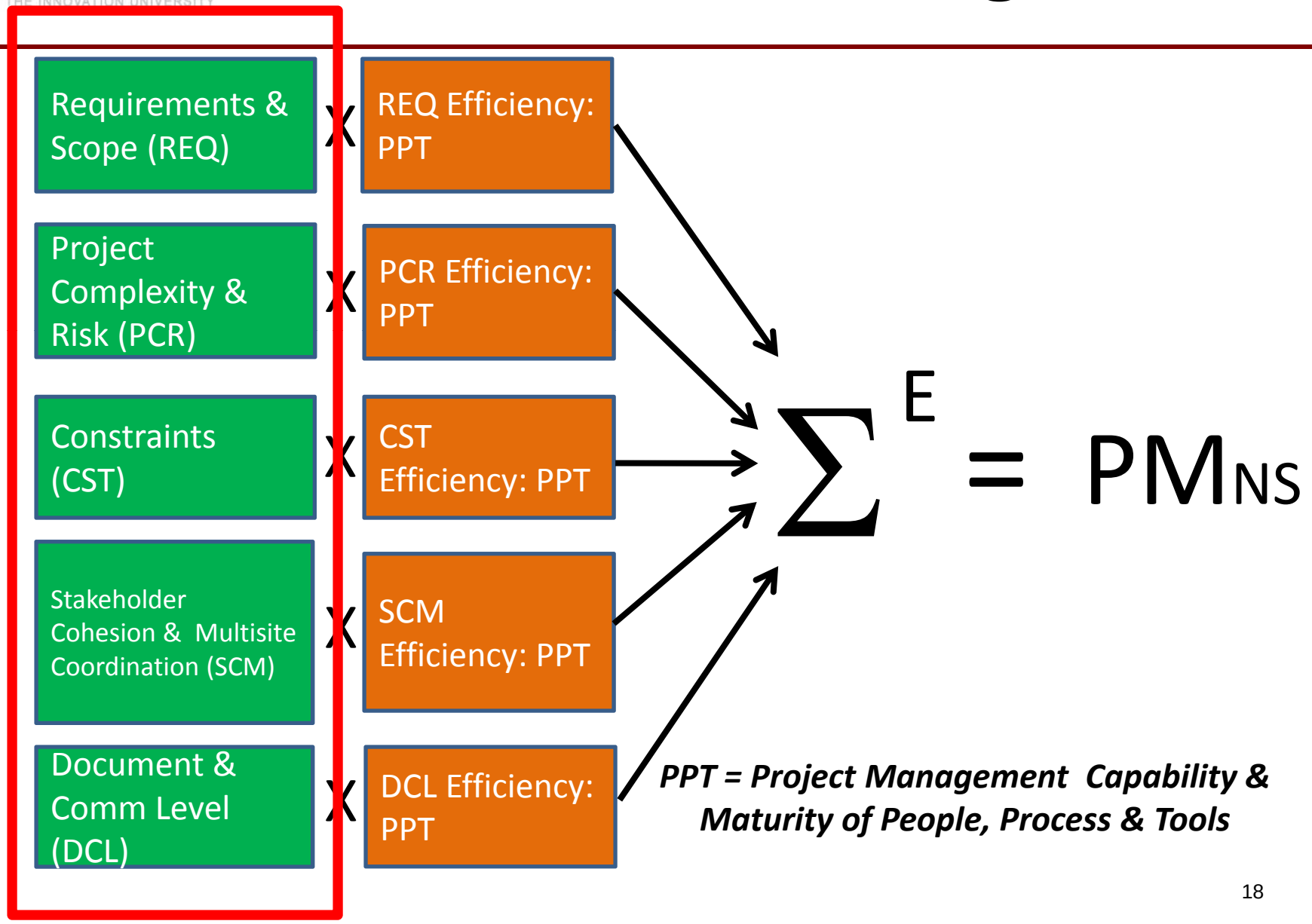
PM Cost Estimating Model



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PM Cost Estimating Model

Cost Factor #1

Requirements & Scope (REQ)

– *How well understood is the project?*

- Scope of requirements
- Number of requirements
- How well they are defined
  - Statement of Work (SOW), Work Breakdown Structure (WBS), etc
- Volatility/Rate at which they are changing
- Expect any new/additional requirements ~ Requirement Creep?

PM Cost Estimating Model

Cost Factor #2

Project Complexity & Risk (PCR)

– *How much risk is there?*

- What is the level of risk for the project?
- What is stakeholders' risk attitude – risk adverse?
- How difficult is it to assess the risk?
- How complex is the project?
  - Project Complexities
    - organizational, technological/product
  - e.g. PM related integration, coordination, etc
- Number of known project complexity and risks

PM Cost Estimating Model

Cost Factor #3

Constraints (CST)

– *How tight are the constraints?*

- Schedule Span
  - Time constraints
  - Deliverable date
  - Amount of slack time allowed
- Budget Constraints
  - Money/Cost constraints
- Resource Constraints
  - Human Resources
- Function/Feature
  - Minimum acceptable features
- Quality
  - Minimum acceptance by customers

PM Cost Estimating Model

Cost Factor #4

Stakeholder Cohesion & Multisite Coordination (SCM)

– *Amount of external PM work to be done*

- Number of stakeholders
- Diversity of stakeholders
  - e.g., have opposing goals/objectives, have different world views
- Communication challenges
  - external clients, internal clients, contractors, languages, time zone difference, etc

PM Cost Estimating Model

Cost Factor #5

Documentation & Communication Level (DCL)

– *Amount of internal PM work to be done*

- Amount and complexity of required documentation
  - e.g., project plan, resource management plan, status reports, etc
- Amount and complexity of required communications
  - Cubical/office noise
    - Solving project issues
  - e. g., number, length and frequency of meetings, etc

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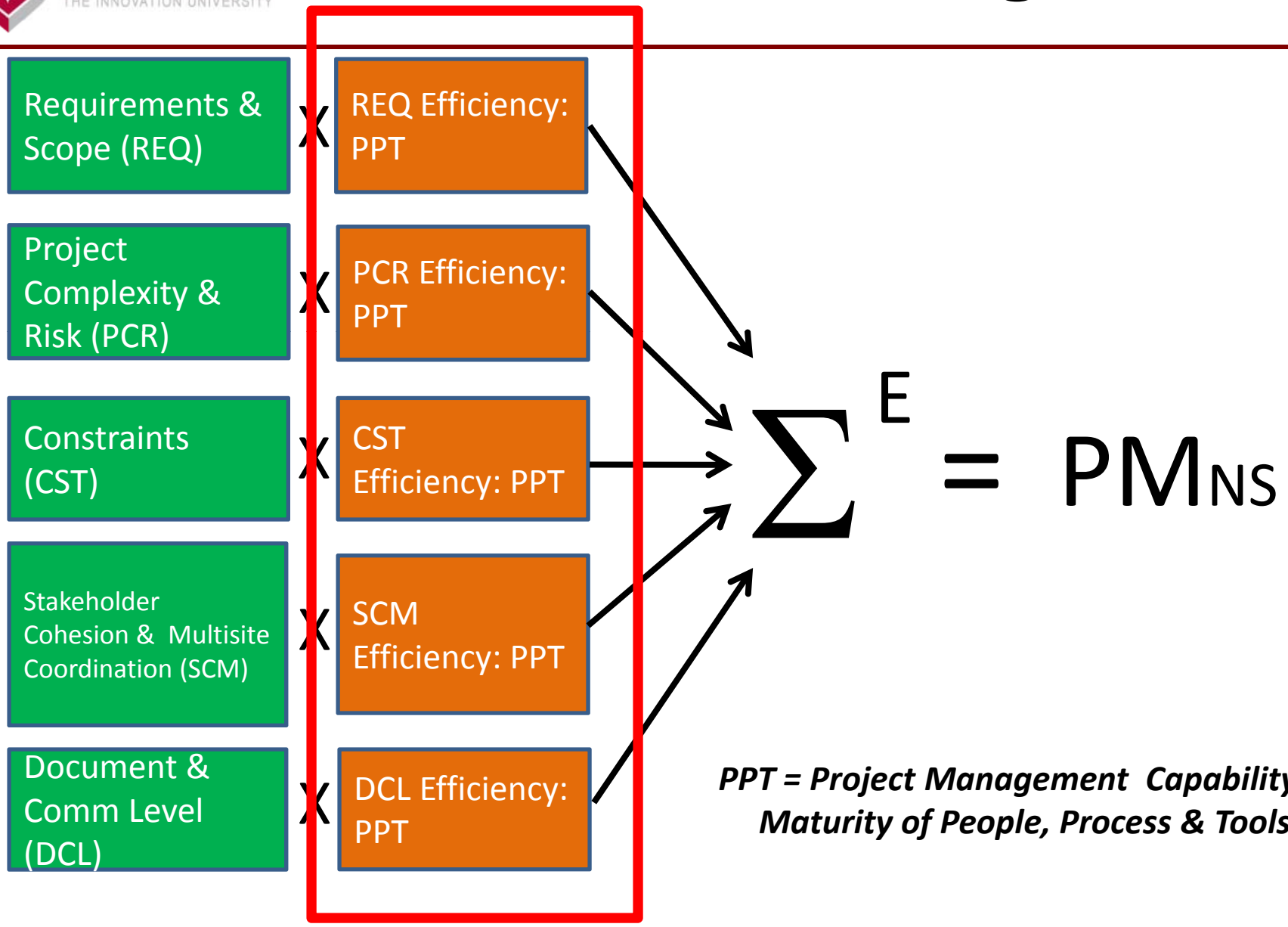
PM Cost Estimating Model



PPT = Project Management Capability & Maturity of People, Process & Tools

PM Cost Estimating Model

PM Efficiency Multipliers: Capability & Maturity of People, Process & Tools (PPT)

*People Capability – PM Attributes**

- Communication skills
- PM experience
- Information sharing willingness
- Delegates appropriately
- Well-organized
- Supports and motivates project team
- Open-minded and flexible
- Provide constructive criticism
- Positive attitude
- Technical competency
- Team builder & player
- Ability to evaluate and select project resources
- Goal oriented
- Courage and conflict solving skills
- Problem solver
- Take initiative
- Creativity
- Integrator (team, PM activities, etc)
- Decision making skills

PM Cost Estimating Model

PM Efficiency Multipliers (cont'd)

Process Maturity**

- PM process maturity (CMMI, The Berkeley PM Process Maturity Model)
- Organization PM maturity (PMI-OPM3)
  - Initial
  - Repeatable
  - Defined
  - Managed
  - Optimized

Tool Support**

- Level of tool automation
  - Very few primitive tools
  - Basic/Micro tools
  - Extensive/Few Integrative tools
  - Moderately integrated environment
  - Fully integrated environment

*Adapted from Software Development Cost Estimating Guidebook (USAF Air Logistics Center, July, 2009) & Essentials of Project and systems Engineering Management (Eisner, 2008)
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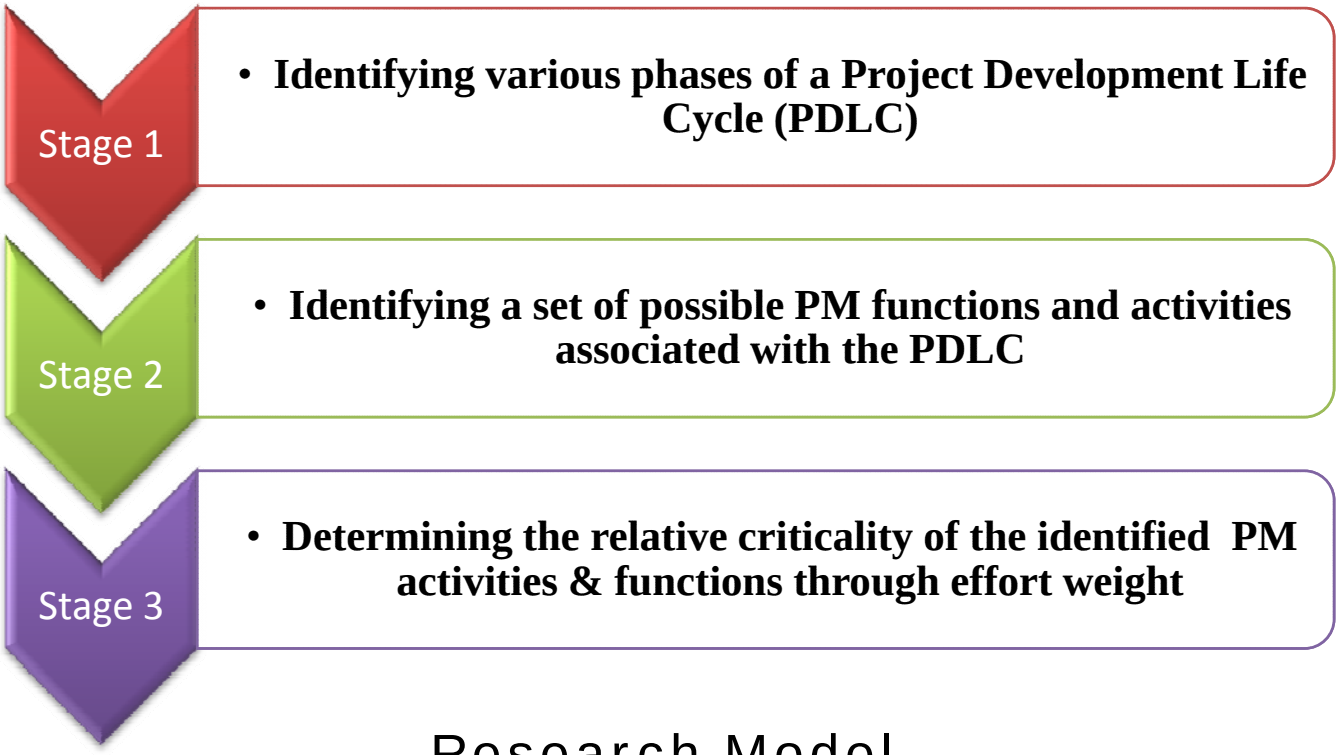
Survey & Interview Results



Research Model

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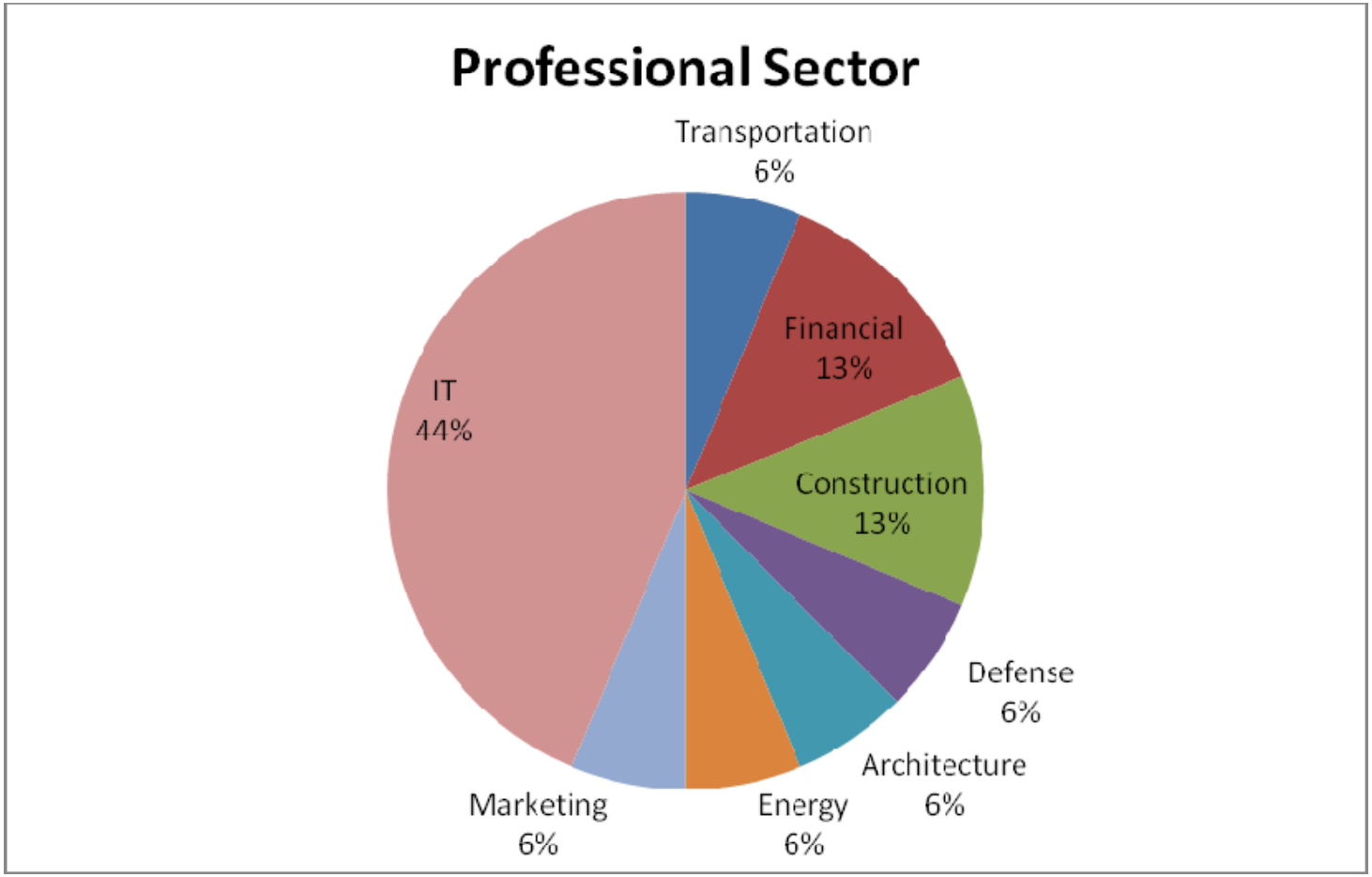

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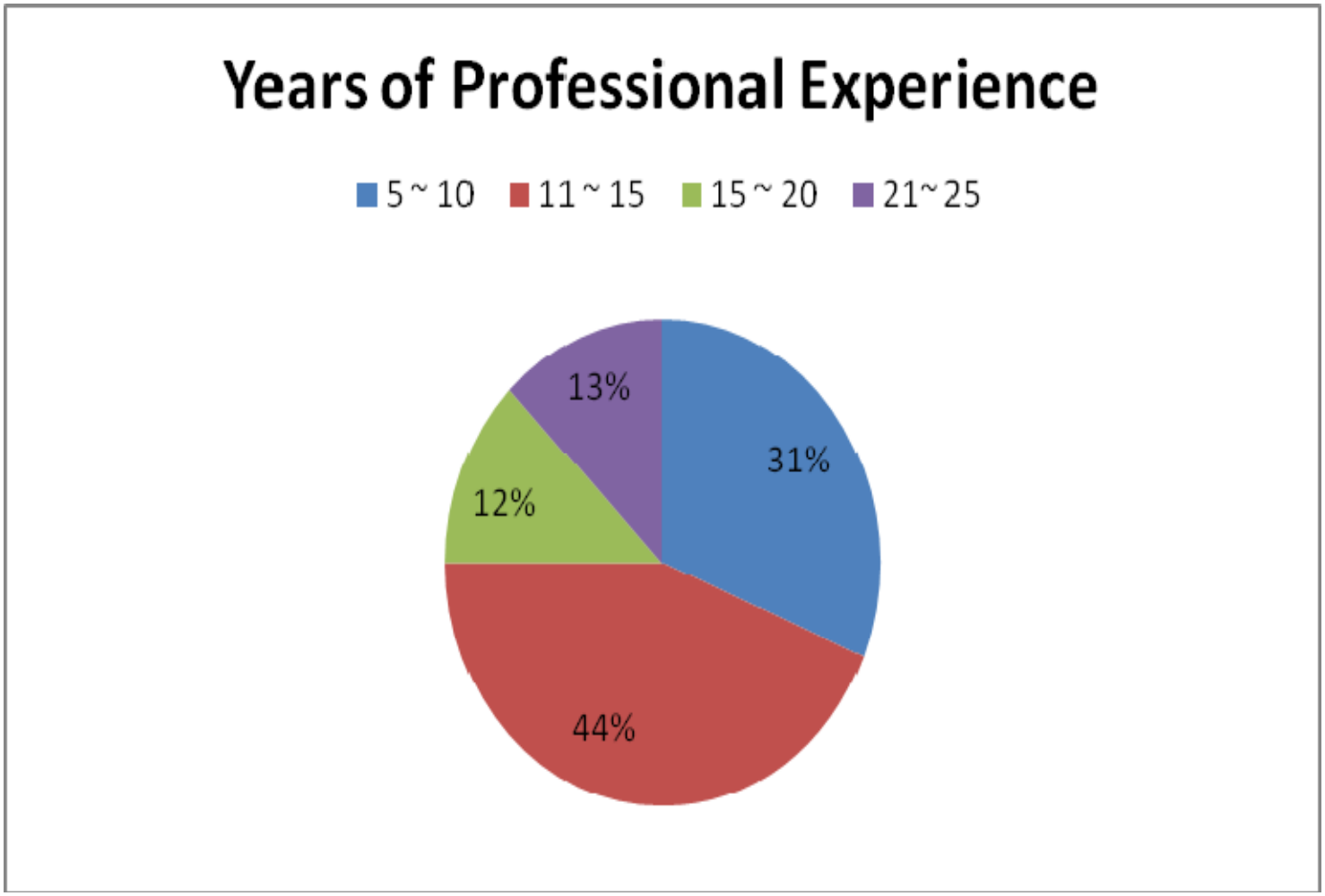

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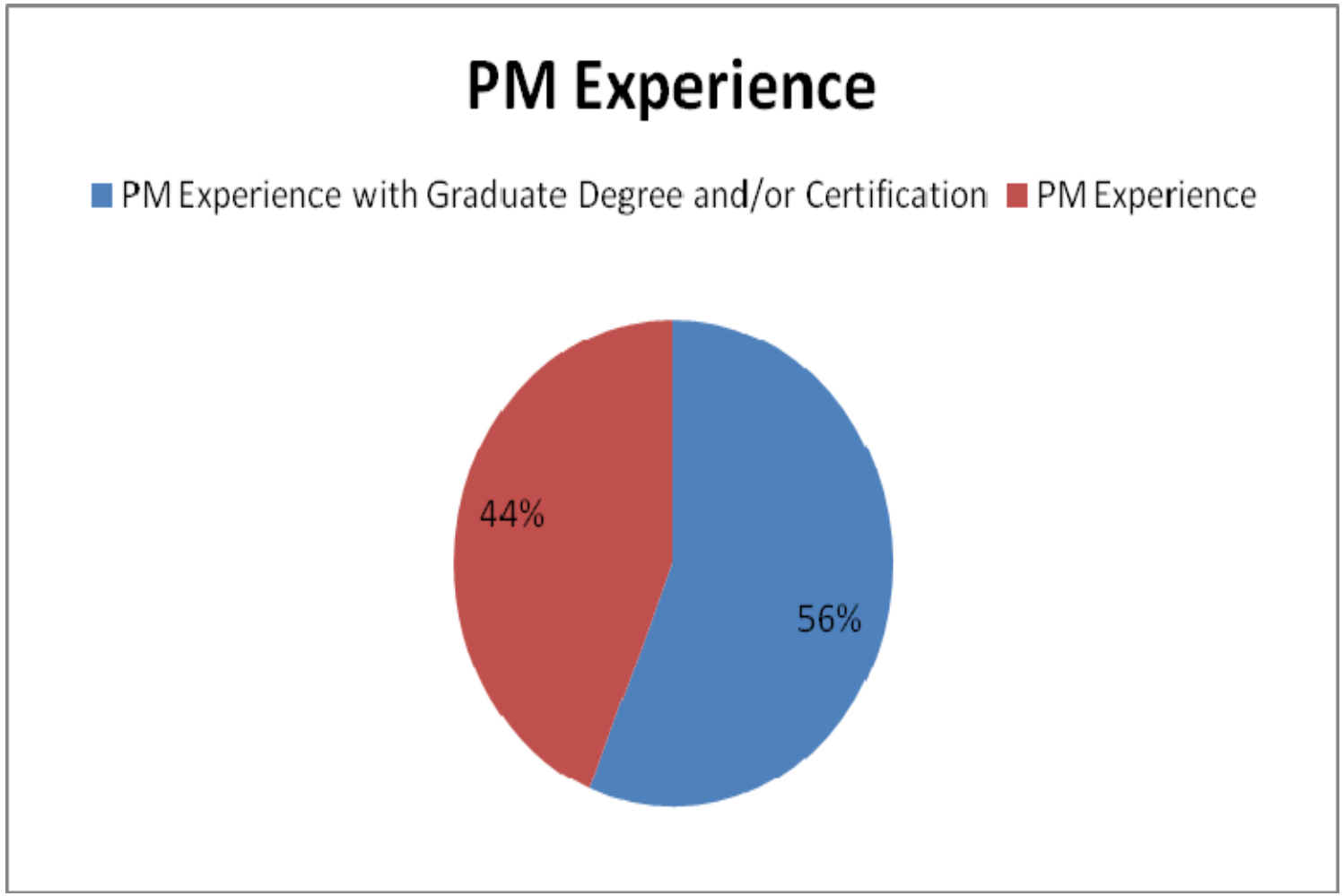

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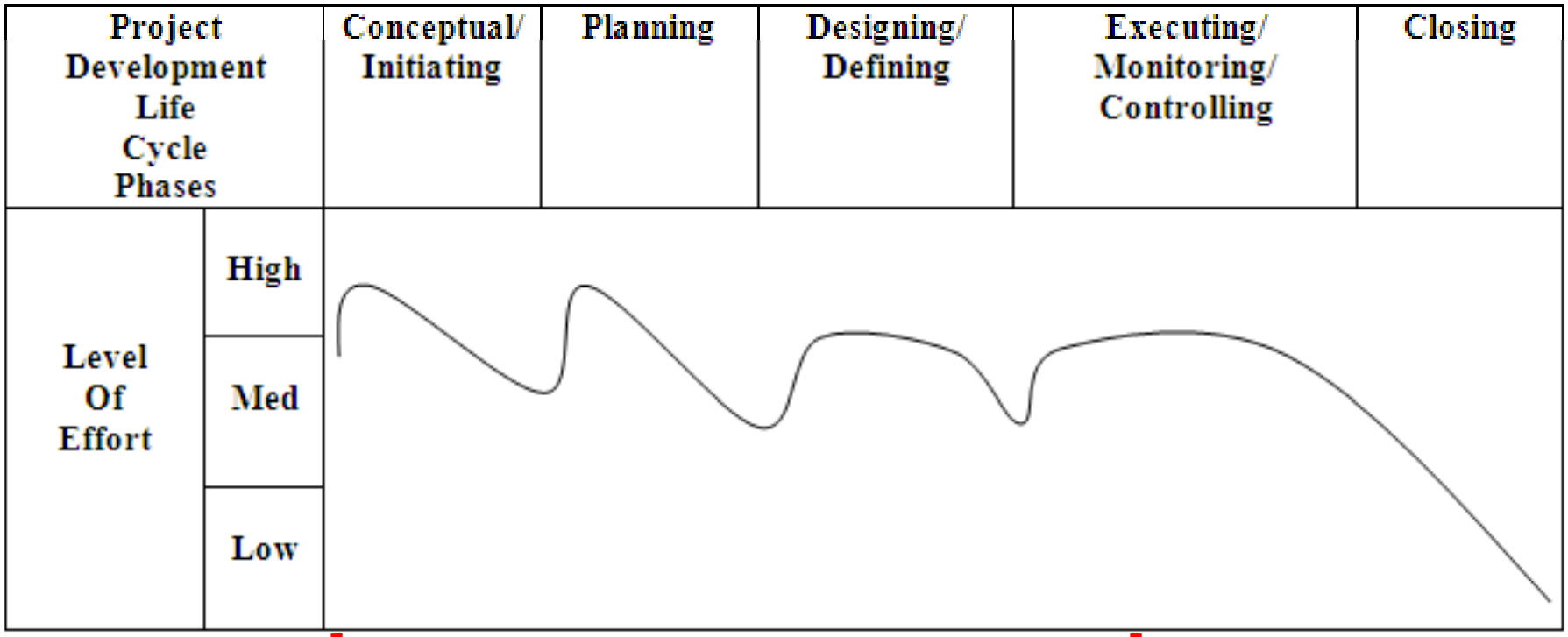

If Planned Well…

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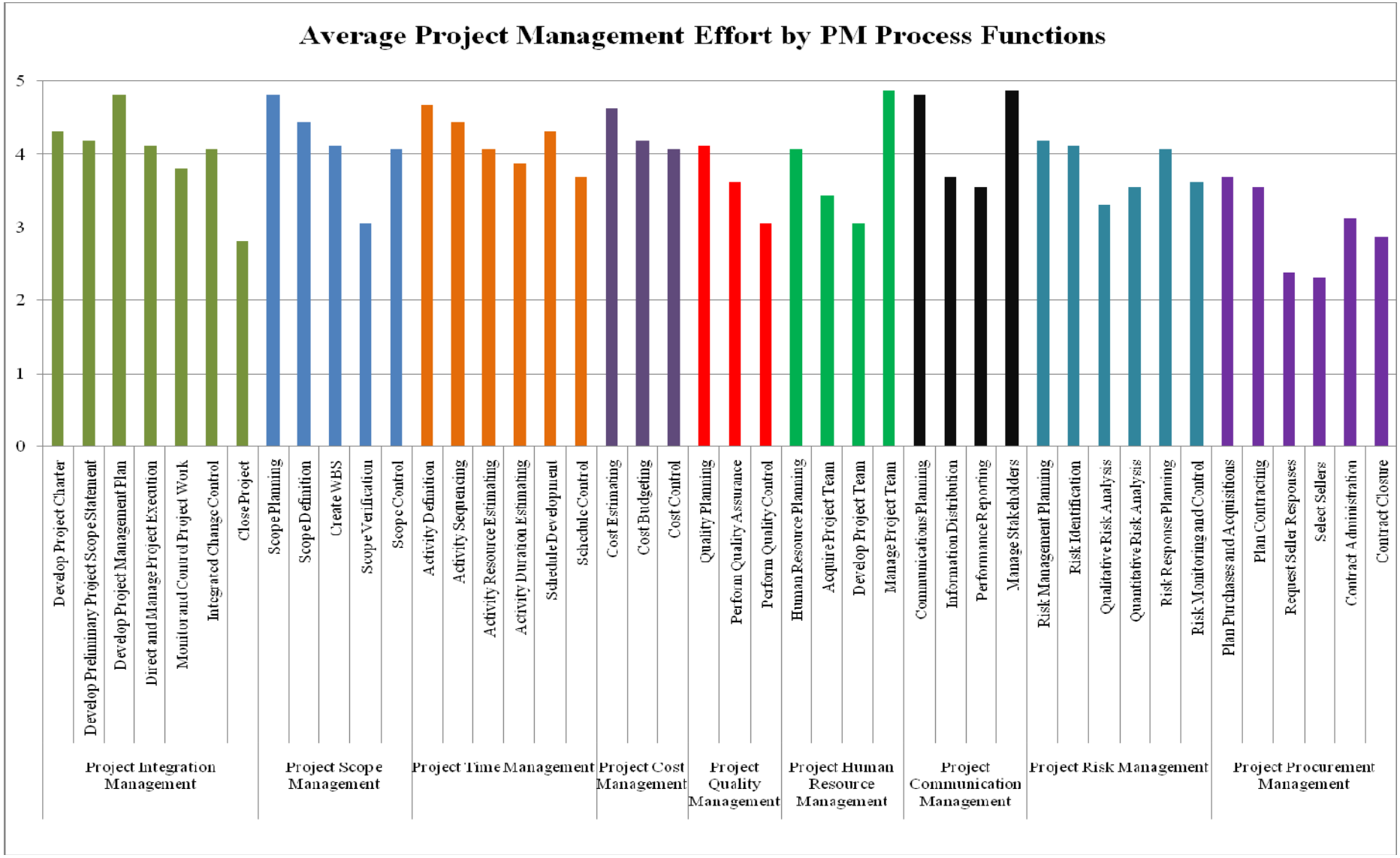

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Conclusion

- Managing Stakeholders
- Managing Project Team
- Project Plan Defined
- Project Scope Management
- Communication, Communication, Communication

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Conclusion

- Help project managers and cost estimators measure and quantify PM effort
- Identify and assess PM activities that need serious attention
- Allocate appropriate and adequate amount of budget for major PM activities
- Product reliable and defensible cost estimates for PM effort
- Allow more robust and accurate project planning and tracking of cost and resources

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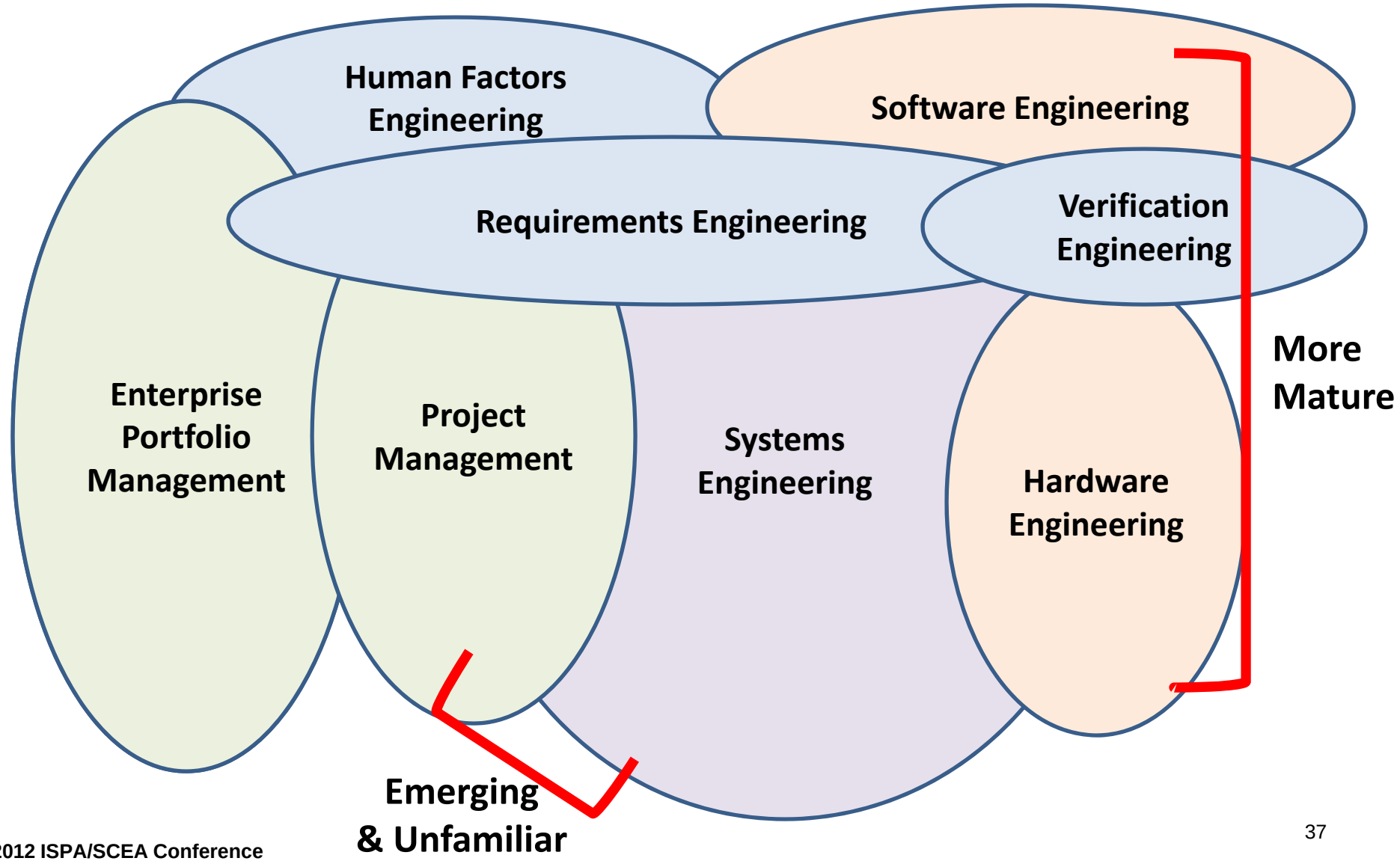
Fields of Cost and Effort Estimation



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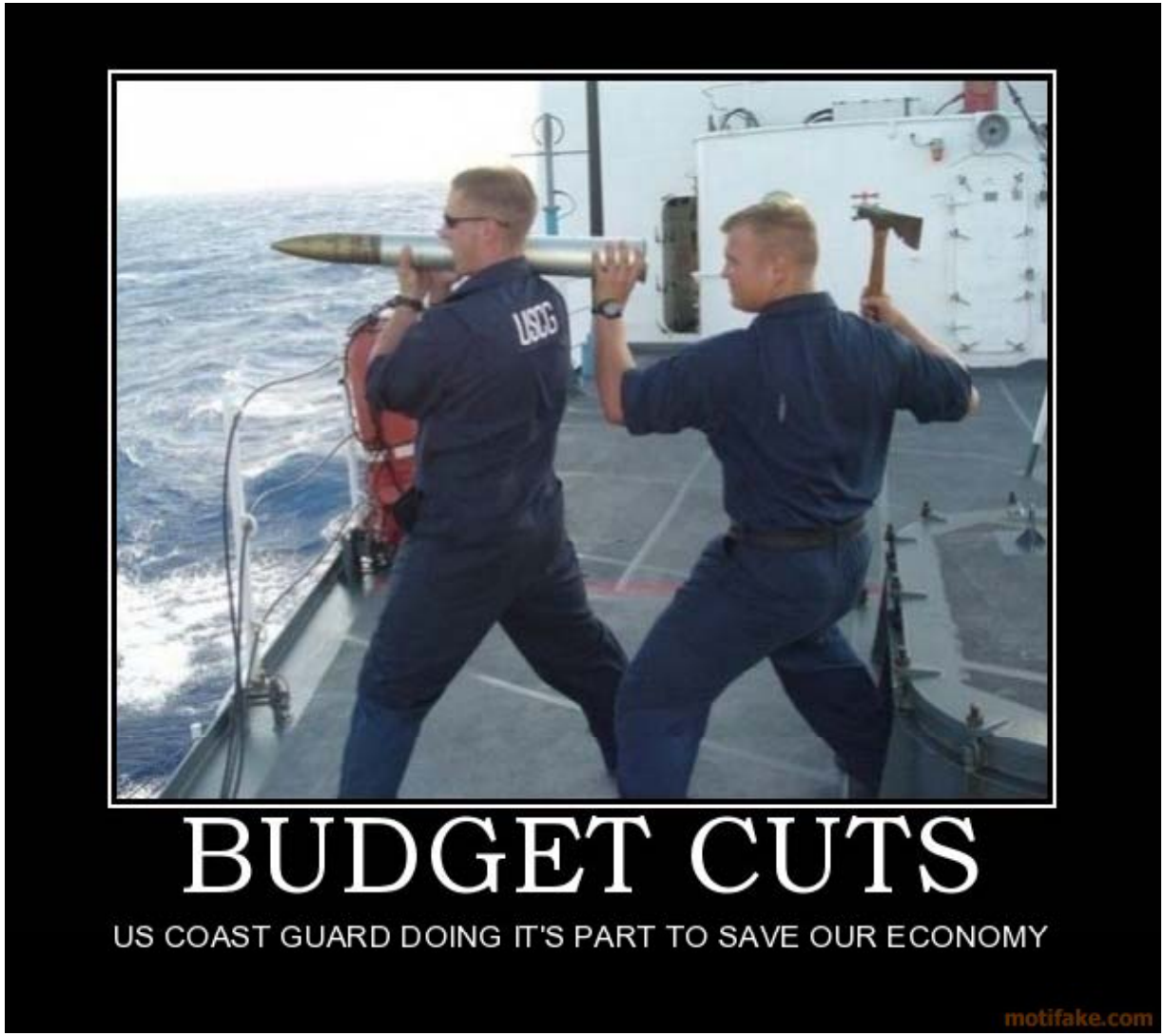
Why Should You Care?



- Manage projects and budgets more efficiently and effectively
  - Bang for the Buck

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Questions?

Discussion Questions

- How do commercial sector and public sector entities estimate PM costs?
- What type of estimating methods do they use to estimate PM effort?
- What PM related cost factors or drivers do they currently use?