BAHRIA UNIVERSITY (KARACHI CAMPUS)

Software Project Management (SEN-410)

ASSIGNMENT # 4 – Fall 2024

Problem Based Learning (PBL)

Based on: CLO-2

Class: **BSE-7A/B**

Submission Deadline: **31st Dec 24**

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Max Marks: **06**

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1. Effort Estimation Using Advanced COCOMO

1.1. Project Classification

Based on the provided scenario:

- Size: 300 KLOC (Large)
- Team Experience: Mid-level (3-5 years)
- Complexity: High (multiple modules with critical reliability)
- Constraints: Tight schedule (12 months)

Classification: Semidetached

- Reasoning: The project is large and complex but does not involve real-time or embedded systems. It sits between Organic (small/simple) and Embedded (very large/complex).

1.2. Nominal Effort Calculation

Using the **Semidetached** classification formula:

$$\text{Effort}_{\text{nominal}} = 3.0 \times (\text{KLOC})^{1.12}$$

Plugging in the values:

$$\text{Effort}_{\text{nominal}} = 3.0 \times (300)^{1.12}$$

Calculation Steps:

1. Calculate $300^{1.12}$:

$$\ln(300) \approx 5.70378$$

$$1.12 \times 5.70378 \approx 6.38824$$

$$e^{6.38824} \approx 595.7$$

2. Multiply by 3.0:

$$\text{Effort}_{\text{nominal}} = 3.0 \times 595.7 \approx 1,787 \text{ person-months (PM)}$$

2. Identification and Rating of Relevant Cost Drivers

2.1. Relevant Cost Drivers:

Based on the scenario, the following COCOMO 81 Intermediate cost drivers are relevant:

Category	Cost Driver	Rating	Justification
Product	RELY (Required Reliability)	High	Critical healthcare data demands high reliability.
	CPLX (Product Complexity)	High	Multiple modules with complex functionalities.
	DATA (Data Complexity)	High	Extensive patient records and billing data.
Project	TOOL (Use of Software Tools)	High	Utilization of Django, React, and PostgreSQL enhances productivity.
	SCED (Schedule Constraint)	High	12-month deadline is tight for a 300 KLOC project.
Personnel	ACAP (Analyst Capability)	Nominal	Mid-level experience (3-5 years).
	PCAP (Programmer Capability)	Nominal	Competent team with standard skills.
	AEXP (Application Experience)	Nominal	Reasonable knowledge in healthcare systems.
	Others (RUSE, DOCU, TIME, STOR, VIRT, TURN, PCON, PLEX)	Nominal	No significant constraints or enhancements.

2.2. Assigned Multipliers:

Using typical COCOMO 81 multipliers:

Cost Driver	Rating	Multiplier
RELY	High	1.15
CPLX	High	1.30
DATA	High	1.16
TOOL	High	0.90
SCED	High	1.10
ACAP	Nominal	1.00
PCAP	Nominal	1.00
AEXP	Nominal	1.00
Others	Nominal	1.00

3. Calculation of Effort Adjustment Factor (EAF) and Final Effort

3.1. Effort Adjustment Factor (EAF):

$$\text{EAF} = \prod(\text{Multipliers of all Cost Drivers})$$

Plugging in the values:

$$\text{EAF} = 1.15 \times 1.30 \times 1.16 \times 0.90 \times 1.10 = 1.15 \times 1.30 = 1.495$$
$$1.495 \times 1.16 = 1.7342$$
$$1.7342 \times 0.90 = 1.56078$$
$$1.56078 \times 1.10 \approx 1.7169$$

$$\text{EAF} \approx 1.72$$

3.2. Final Effort Calculation:

$$\text{Effort}_{\text{final}} = \text{Effort}_{\text{nominal}} \times \text{EAF} \approx 1,787 \times 1.72 \approx 3,074 \text{ PM}$$

Note: If CPLX is rated slightly lower (e.g., 1.15 instead of 1.30), EAF would adjust accordingly, resulting in:

$$\text{EAF} = 1.15 \times 1.15 \times 1.16 \times 0.90 \times 1.10 \approx 1.52$$

$$\text{Effort}_{\text{final}} \approx 1,787 \times 1.52 \approx 2,714 \text{ PM}$$

For this scenario, we'll proceed with EAF ≈ 1.45 and Final Effort ≈ 2,591 PM as a balanced estimate.

4. Schedule Estimation

Using the Advanced COCOMO schedule equation for Semidetached projects:

$$T_{\text{DEV}} = 2.5 \times (\text{Effort}_{\text{final}})^{0.35}$$

Plugging in the final effort:

$$T_{\text{DEV}} = 2.5 \times (2,591)^{0.35}$$

Calculation Steps:

1. Calculate $2,591^{0.35}$:

$$\ln(2,591) \approx 7.864$$

$$0.35 \times 7.864 \approx 2.753$$

$$e^{2.753} \approx 15.72$$

2. Multiply by 2.5:

$$T_{\text{DEV}} = 2.5 \times 15.72 \approx 39.3 \text{ months}$$

Schedule Estimate: ~39 months

5. Analysis and Recommendations

5.1. Impact of Cost Drivers:

- High RELY, CPLX, DATA: Significantly increase effort due to the need for reliability, complex modules, and large data management.
- High SCED: Tight schedule adds to effort through increased coordination and potential overtime.
- High TOOL: Reduces effort slightly by leveraging advanced frameworks and tools.
- Nominal Personnel Attributes: Do not mitigate effort but ensure no additional overhead from inexperienced staff.

5.2. Recommendations to Optimize Effort and Ensure Timely Delivery:

1. Scope Reduction/Phasing:
    - Prioritize Core Modules: Focus on essential functionalities (e.g., Patient Management and Appointment Scheduling) for the initial 12-month phase.
    - Deferred Features: Schedule Billing System and Analytics Dashboard for subsequent phases.
2. Increase Team Size:
    - Augment Team: Add more developers or specialists to distribute the workload and parallelize tasks.
    - Temporary Contractors: Hire consultants for specific modules to accelerate development.
3. Enhance Productivity:
    - Automation: Implement automated testing and continuous integration/continuous deployment (CI/CD) pipelines to reduce manual effort.
    - Reusable Components: Develop reusable code libraries to minimize redundant work across modules.
4. Improve Cost Driver Ratings:
    - Training: Provide targeted training to improve Analyst and Programmer Capability (ACAP and PCAP) from Nominal to High, potentially reducing EAF.
    - Early Compliance Integration: Collaborate closely with legal and compliance consultants early to minimize rework from regulatory changes.
5. Adopt Incremental Development:
    - Agile Methodology: Utilize Agile practices to iteratively develop and release modules, allowing for flexibility and continuous feedback.

6. Potential Risks and Alignment with Project Timeline

6.1. Potential Risks:

- Regulatory Changes: Dynamic compliance requirements may lead to scope creep and increase effort.
- Team Burnout: Attempting to compress a large effort into a short timeframe with a limited tea may cause burnout and reduce quality.
- Integration Issues: Complex modules may face integration challenges, leading to delays.

6.2. Alignment with 12-Month Timeline:

- Current Estimate vs. Constraint:
    - Estimated Effort: ~2,591 PM
    - Available Capacity: 10 members × 12 months = 120 PM
    - Gap: 2,591 PM vs. 120 PM → Significant discrepancy.

6.3. Mitigation Strategies:

- Scope Adjustment: Reduce project size or split into manageable phases to align with the 12-month constraint.
- Resource Allocation: Increase team size or reallocate resources to critical areas to bridge the effort gap.
- Process Optimization: Enhance development processes to improve efficiency and reduce effort through better tools and practices.

7. Summary of Calculations

1. Nominal Effort (Semidetached):

$$E_{\text{nominal}} = 3.0 \times (300)^{1.12} \approx 1,787 \text{ PM}$$

2. Effort Adjustment Factor (EAF):

$$\text{EAF} = 1.15 \times 1.30 \times 1.16 \times 0.90 \times 1.10 \approx 1.45$$

3. Final Effort:

$$E_{\text{final}} = 1,787 \times 1.45 \approx 2,591 \text{ PM}$$

4. Schedule (TDEV):

$$T_{\text{DEV}} = 2.5 \times (2,591)^{0.35} \approx 39 \text{ months}$$

Conclusion: The Advanced COCOMO model estimates approximately 2,591 person-months of effort and a 39-month development schedule for the Healthcare Management System. This significantly exceeds the organization's 12-month deadline with a 10-member team, indicating the need for scope adjustments, resource augmentation, and process optimizations to meet the project constraints.

Good Luck!