. UCP ESTIMATION APPROACH

The UCP approach proposed by Gustav Karner in 1993 [7] evaluates the effort to develop a software system. This assessment is based on the functional requirements outlined in use cases. The methodology considers the complexity of various use cases and offers a quantitative assessment of the effort required for development, measured in person-hours or person-days.

The UCP effort estimation approach typically operates as follows:

1) **Determining use case complexity:** The use case describes a distinct interaction between a user and the system, explaining the sequence of events and potential alternatives. A use case is considered "Simple" (U_s) when the total number of transactions falls within one to three. The complexity is classified as "Average" (U_a) when the number of transactions falls from four to seven. The use case is considered "Complex" (U_c) when the number of transactions reaches or exceeds eight.

2) **Assign a weight to each use case:** The weight for each use case is determined by the nature of the project. Typically, when the complexity level is categorized as "Simple," the corresponding weight assigned is five. When the complexity level is classified as "Average," a weight of 10 is assigned. The corresponding weight assigned is fifteen when the complexity level is classified as "Complex."

3) **Determining actor complexity:** An actor refers to any entity assuming a certain role within a system. The entity in question may be a person, another program, or an organization. An actor is classified as "Simple" (A_s) if it functions as a system interface. An actor can be classified as "Average" (A_a) if it possesses an Interactive or Protocol Driven Interface. The actor is considered "Complex" (A_c) when it pertains to a graphical interface.

4) **Assign a weight to each actor:** Assigning weight to an actor is analogous to the weighting assigned to use cases. The weight assigned to different levels of complexity is as follows: one for "Simple," two for "Average," and three for "Complex."

5) **Calculate unadjusted use case weight (UUCW):** Aggregate the weighted transaction types across all use cases to determine UUCW.

$$UUCW = \#U_s * 5 + \#U_a * 10 + \#U_c * 15 \quad (1)$$

6) **Calculate unadjusted actor weight (UAW):** Aggregate the weighted actor types to determine UAW.

$$UAW = \#A_s * 1 + \#A_a * 2 + \#A_c * 3 \quad (2)$$

7) **Calculate Unadjusted Use Case Points (UUCP):**

$$UUCP = UAW + UUCW \quad (3)$$

8) **Assess Technical Complexity Factors (TCF):** TCF is utilized in size estimation to include technical aspects and considerations about the system. TCF is determined by awarding a numerical score ranging from 0 (indicating

TABLE A.4
LIST OF TECHNICAL FACTORS WITH THEIR CORRESPONDING WEIGHTS FOR UCP ESTIMATION

Technical Factor	Description	Weight (W_t)
TF_1	Distributed system	2
TF_2	Response time/performance objectives	1
TF_3	End-user efficiency	1
TF_4	Internal processing complexity	1
TF_5	Code reusability	1
TF_6	Easy to install	0
TF_7	Easy to use	0
TF_8	Portability to other platforms	2
TF_9	System maintenance	1
TF_{10}	Concurrent/parallel processing	1
TF_{11}	Security features	1
TF_{12}	Access for third parties	1
TF_{13}	End-user training	1

irrelevance) to 5 (indicating significance) to each of the 13 factors enumerated in Table A.4.

The rating of each factor is multiplied by the designated weighted value. The weighted sum of all computed values will be used to calculate TCF using the following equation.

$$TCF = 0.65 + 0.01 * \sum_{i=1}^{13} TF_i * W_i^t \quad (4)$$

9) **Assess Environmental Complexity Factors (ECF):** ECF is utilized in size estimation to include environmental aspects and considerations about the system. ECF is determined by awarding a numerical score ranging from 0 (indicating irrelevance) to 5 (indicating significance) to each of the eight factors enumerated in Table A.5.

TABLE A.5
LIST OF ENVIRONMENTAL FACTORS WITH THEIR CORRESPONDING WEIGHTS FOR UCP ESTIMATION

Environmental Factor	Description	Weight (W_e)
EF_1	Familiarity with the development process used	1.5
EF_2	Application experience	0.5
EF_3	Object-oriented experience of team	1
EF_4	Lead analyst capability	0.5
EF_5	Motivation of the team	1
EF_6	Stability of requirements	2
EF_7	Part-time staff	-1
EF_8	Difficult programming language	-1

The rating of each factor is multiplied by the designated weighted value. The weighted sum of all computed values will be used to calculate ECF using the following equation.

$$ECF = 1.4 - 0.03 * \sum_{i=1}^{8} EF_i * W_i^e \quad (5)$$

10) **Calculate Adjusted Use Case Points (UCP):** ECF is utilized in size estimation to include environmental aspects and considerations about the system.

$$UCP = UUCP * TCF * ECF \quad (6)$$