Best Practice on Cost Estimation and Priority with Use Case Point(UCP) for Renewable Energy System

2016. 1. 19.

Bokyung Park

Hongik Univ. Selab

Advisor : R. Young Chul Kim

Table of Contents

I. Research Motivation

II. Why use UCP, But not FP?

III. SW Effort Estimation based on UCP

IV. Case Study

V. Contribution

VI. Contribution & Future Works

1. Research Motivation

- As an alternative solution for recent energy problems in the world, most countries focus on renewable energy.
  - Renewable Energy have Unique Properties per each resource, and variously produce Electric Power depended on weather change.
  - So, Need to install a monitoring system to manage the renewable energy.

- The Problems of The Existing Monitoring Systems
  ① Their systems are structurally Heterogeneous
  ② Difficult to interoperate data at each device, and to integrate Real-time Information

So, need to develop an Integrated monitoring system to control it.

- For Developing a successful monitoring system,
  requires to estimate cost and effort spent for system development.

1. Research Motivation

Previous Research

- Most cases, they used Function Point for SW Project effort estimation

- Extracted and verified the priority of requirements based on UCP

[So Young Moon, "Verification of Requirements Extraction and Prioritization using Use Case Points"]

- Problems :
  - ① This method can not make 'effort estimation' results
  - ② difficult to make a systematic system planning

Our idea

❖ **Our idea uses the use case point (UCP) to the effort estimation of SW for the renewable energy monitoring system**

2. Why use UCP, but not FP?

❖ FP Definition

- A function point is a "unit of measurement" to express the amount of business functionality an information system (as a product) provides to a user.
- Function points measure software size.
- The cost (in dollars or hours) of a single unit is calculated from past projects.

❖ UCP Definition

- Use Case Points (UCP) is a software estimation technique used to forecast the software size for software development projects.
- The concept of UCP is based on the requirements for the system being written using use cases, which is part of the UML set of modeling techniques.
- The software size (UCP) is calculated based on elements of the system use cases with factoring to account for technical and environmental considerations.
- The UCP for a project can then be used to calculate the estimated effort for a project.

2. Why use UCP, but not FP?

❖ With FP, They had used the previous system which are developed with the procedural language.

❖ But now, in most of systems, we are developed by object-oriented language.

❖ So, we used UCP for renewable monitoring system to measure SW effort(estimation).

⇒ Which mechanisms are more important to measure SW cost estimation?

3. SW Effort Estimation based on UCP

❖ **Use Case Point**

- Developed by Gustav Karner
- Actors and use cases in a use case diagram are used to measure the number of use cases, sizes and complexity.

❖ **The Problem of his Use Case Point**

① The UCP does not indicate the structure of a specific use case or how to write it.
=>So, vary Use case model and specification per each user(developer)

② The UCP does not allow for "Include" and "Extends" relations between use cases.

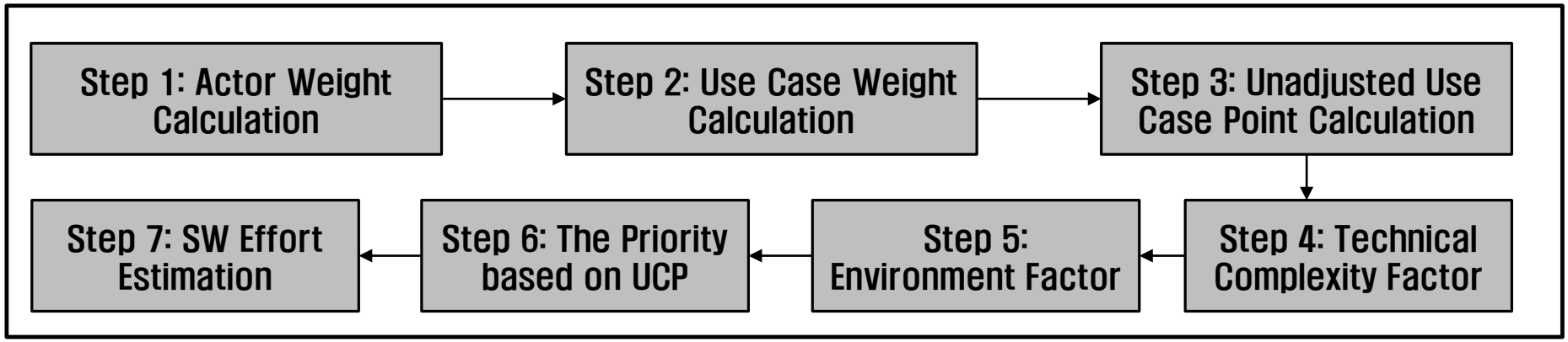
▪ Our SW Effort Estimation based on Use Case Point(UCP)

① Subdivide the types and weights of actors and use cases.

② Just add a weight of 0.25 to the use case of "Include," "Extends" relations based on Periyasamy's method

3. Our UCP Process for SW Effort Estimation

SW Effort Estimation based on UCP Process



3. SW Effort Estimation based on UCP

❖ **Step 1 : Actor Weight Calculation**

- We improve the existing actor weight values.
- Actor Weights is classified as follows

  => Very Simple(0.5), Simple(1), Average(2), Complex(2.5), Very Complex(3)

❖ **Step 2 : Use Case Weight Calculation**

- Use Case Weight is classified as follows

  => Very Simple(transaction ≥ 2: 0.5), Simple(transaction = 3: 1), Average(3<transaction≤6: 2),

  Complex(transaction ≥ 7: 3)
- Use Case Weight is subdivided based on the numbers of transactions, that is, reflected as a size.
- Make Prior Use Cases based on weight's value

❖ **Step 3 : Unadjusted Use Case Point(UUCP) Calculation**

- UUCP = Actor Weight + Use Case Weight

3. SW Effort Estimation based on UCP

❖ **Step 4 : Technical Complexity Factor(TCF) Calculation**

- A Weight between 0(no effect) and 5(large effects) is applied to each component.

Technical Factor	Factor Description	Weight
T1	Distributed System	2
T2	Response or Throughput Objectives	1
T3	End-User Efficiency	1
T4	Complex Internal Processing	1
T5	Code must be reusable	1
T6	Easy to install	1
T7	Easy to use	0.5
T8	Portable	2
T9	Easy to change	1
T10	Concurrent	1
T11	Includes special security features	1
T12	Provides direct access to third-party SW	1
T13	Special user Training facility is required	1

❖ **Step 5 : Environment Factor(EF) Calculation**

- The EF is calculated by applying a weight between 0 and 5.

Environment Factor	Factor Description	Weight
E1	Familiarity with UML	1.5
E2	Part-Time Workers	-1
E3	Analyst Capability	0.5
E4	Application Experience	0.5
E5	Object Oriented Experience	1
E6	Motivation	1
E7	Difficult Programming Language	-1
E8	Stable Requirements	2

3. SW Effort Estimation based on UCP

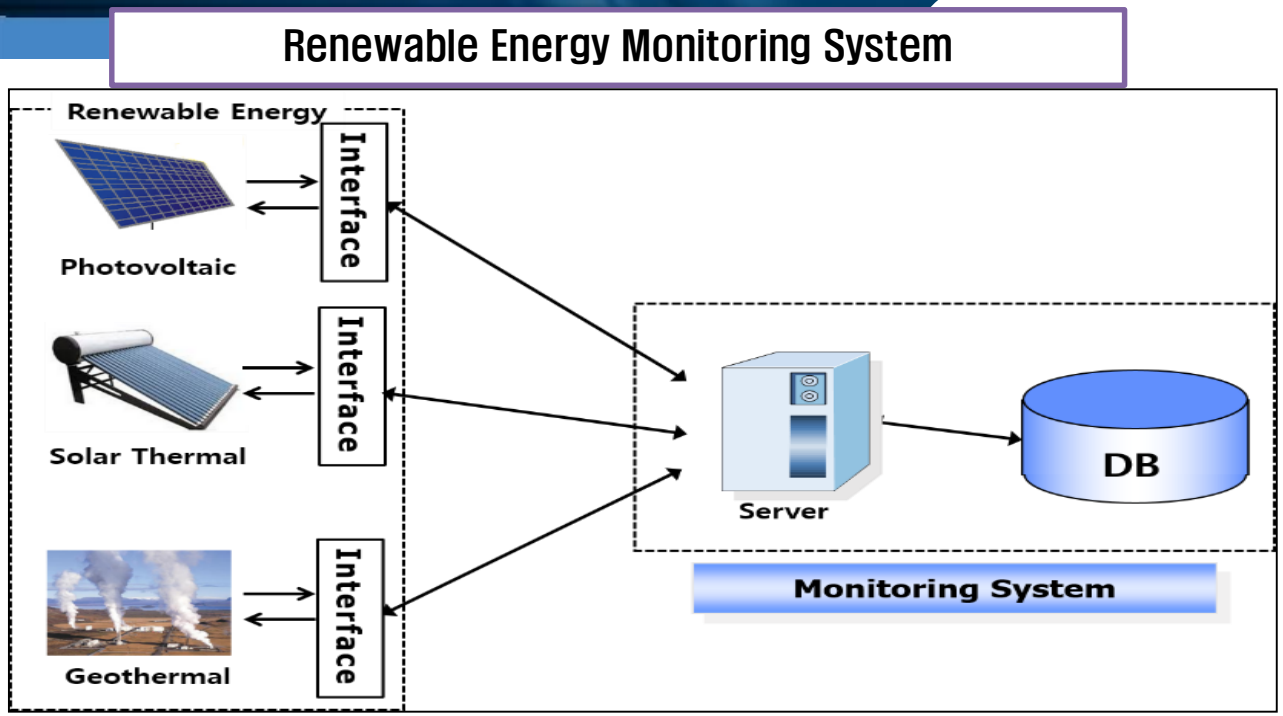
❖ **Step 6 : The Priority based on UCP**

- UCP = UUCP * TCF * EF
- Priority: Determined based on the extracted UCP values.

❖ **Step 7 : SW Effort Estimation**

- SW Effort = The estimated development effort(hours) * A developer's mean cost per hour
- A method suggested by Karner: 20 hours/UCP

4. Case Study – Our target Domain:



❖ The Existing Renewable Energy Monitoring System

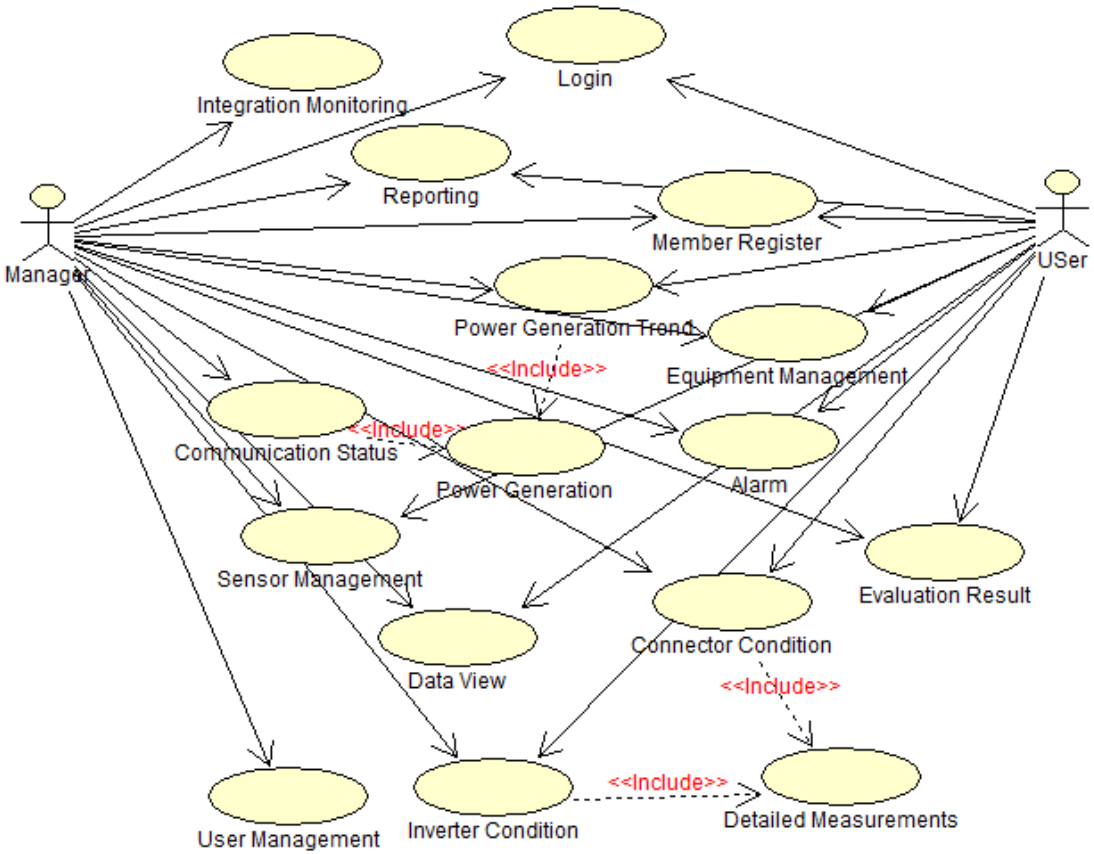
- is limited to a particular domain.
- Each company develops a different monitoring system.

❖ To provide an efficient monitoring system,

- Need each interface for diverse renewable energy property information

So, need to standardize interface,
and also Integrated management.
Then, easily interoperable with other existing renewable energy system.

4. Case Study
– Renewable Monitoring System Use Case Diagram



- **Results**
  - The number of Use Cases:16
  - The number of Actors: 2
  - Include: 4

4. How to calculate UCP?

Calculated UAW and UUCW

UUCP = Actor weight + Use Case Weight

No	Use Case	Unadjusted Actor Weight(UAW)			Unadjusted UseCase Weight(UUCW)					UUCP
		(User) Actor Weight	(Manager) Actor Weight	Actor Weight	Basic Flow	Alternative Flow	Exceptional Flow	Total Transaction	Use Case Weight	
UC1	Login	1	1	2	1	0	1	2	0.5	3
UC2	Power Generation Trend	1.5	1	2.5	1	5	1	7	3	5.5
UC3	Power Generation	1	1	2	1	6	1	8	3	5
UC4	Detailed Measurements	1	1.5	2.5	1	3	0	4	2	4.5
UC5							1	4	2	7
UC6							0	2	0.5	2
UC7							0	2	0.5	2
UC8	Alarm	2	1	3	1	1	1	3	1	4
UC9	User Management	No Use	2	2	1	4	1	6	2	4
UC10	Member Register	No Use	2	2	1	1	0	2	0.5	2.5
UC11	Communication Status	No Use	2	2	1	7	2	10	3	5
UC12	Inverter Condition	0.5	0.5	1	1	0	0			
UC13	Connector Condition	0.5	0.5	1	1	2	0			
UC14	Equipment Management	0.5	0.5	1	1	0	0			
UC15	Evaluation Result	0.5	0.5	1	1	0	0			
UC16	Sensor Management	0.5	0.5	1	1	1	0	2	0.5	1.5

Actor Weight = User Weight+ Manager Weight

UC3
Both User and manager

UC9
Only the Manager

Complex: Transaction ≥ 7
=> Use Case Weight: 3

- Actor Weight
  - Actor: User, Manager
  - Actor Weight: Actor weights are calculated in use cases.
  - User Management(UC9): Only the manager has an actor weight.
  - Power Generation(UC3): Both User and Manager have a actor weight.

4. How to calculate UCP, Priority, Total Estimation?

UCP = UUCP*TCF*EF
Login UC = 2.5*5*3=37.5

Calculated UCP, Priority and Total Estimate

No	Use Case	TCF1	TCF2	TCF3	TCF4	TCF7	TCF9	TCF10	TCF11	TCF12	TCF13	TCF Value	EF1	EF3	EF4	EF5	EF7	EF8	EF Value	UCP	Priority	Total Estimate
		2	1	1	1	0.5	1	1	1	1	1		1.5	0.5	0.5	1	-1	2				
UC1	Login	0	1	1.5	0	1	0	0	1	0	1	5	1	0	1	0	1	1	3	37.5	15	750
UC2	Power Generation Trend	1	3	1.5	2	3	1	2	0	0	1	14	0	1	2	3	2	1	5	346.5	3	6930
UC3	Power Generation	2	3	2	3	2	1	2	0	0	1	17	0	2	2	2	2	1	4	340	4	6800
UC4																		2	5	202.5	6	4050
UC5																		2	8	918.75	1	18375
UC6																		2	6	72	11	1440
UC7																		2	6	99	9	1980
UC8																		2	7	294	5	5880
UC9																		1	9	144	7	2880
UC10	Member Register	0	1	1	0	2	2	0	0	0	0	5	1	2	0	1	0	1	6	68.75	12	1375
UC11	Communication Status	1	2	1	0.5	2	1	2	2	0	2	13.5										
UC12	Inverter Condition	0	3	2	0	4	3	0	2	0	1	13										
UC13	Connector Condition	0	2	3	0	2	1	0	1	0	1	9										
UC14	Equipment Management	0	2	2	0	2	1	0	1	0	1	8										
UC15	Evaluation Result	0	2	3	2	3	1	0	0	0	0	9.5										
UC16	Sensor Management	1	2	3	2	3	1	0	0	0	0	11.5	0	1	1	1	1	1	3	51.75	13	1035

TCF Value =
TCF2(1)*1+ TCF3(1)*1.5+ TCF7(0.5)*1+ TCF11(1)*1+ TCF13(1)*1=1+ 1.5+ 0.5+ 1+ 1= 5

EF Value =
EF1(1.5)*1+ EF4(0.5)*1+ EF7(-1)*1+ EF8(2)*1=1.5+ 0.5- 1+ 2=3

Total Estimation = UCP*20hours/UCP
= 37.5*20=750hours/UCP

- TCF: TCF5, TCF6, TCF8 measure 0 => Exception
- EF: EF2, EF6 measure 0 => Exception
- The Total Estimation is the result of effort estimation extracted from the renewable energy monitoring system.
  => These values indicate the effort estimation for each use case.
- For example: Login(UC1) UCP = 38, Total Estimation: 20 => SW Effort = 37.5 * 20 = 750

5. The Contribution of this paper

- With Priority Extraction
  - We got the prioritization of all use case, which means we decides to develop system based on the priority of use cases

- With UCP Extracted,
  - We can recognize which use cases are more complex.

- With Estimation Extracted,
  - We can estimated cost of development.

6. Conclusion & Future Works

✓ Conclusion

- The present paper estimates the efforts needed to develop the renewable energy monitoring system using the improved use case point
- This paper rectifies the existing studies to extract the values for SW effort estimation. [Verification of Requirements Extraction and Prioritization using Use Case Point, 2012]
- The Improved Use Case Point

  - Classify the weights into Actor and Use Case Weights

=> The present study enables a UCP-based use case priority and SW effort estimation.

✓ Future Works

- **The proposed method will be applied to renewable energy monitoring system development in future studies.**
- **We should compare to mechanism: FP and UCP**

Q&A

Thank You