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A Function Point Model for Measuring the Development Cost of Information Services using Wireless Data Broadcast

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Abstract

Software applications have a huge and inseparable impact on our lives. The complexity of the applications increases rapidly to support high performance and multifunction. Accordingly, the cost model for applications is increasingly important. Line of Code (LOC) and Man-Month (M/M) as the cost model measure the quantitative sides of the applications. Unlike them, Function Point (FP) measures the functionalities of the application. FP is efficient for estimating qualitative characteristics, but it is restricted to measuring the cost of an application using the wireless data broadcast which can support any number of clients. In this paper, we propose, a Function Point model for Information services using wireles data Broadcast (FPIB) to measure the development cost of an application that serves using the wireless data broadcast environment. FPIB adopts critical parameters of the wireless broadcast environment and the complexity of them to measure effectively the cost developing the application. Through the evaluation comparing the proposed FPIB with FP, we reveal the effectiveness of the proposed FPIB.

Keywords: *Cost Model, Line of Code, Man-Month, Function Point, Information Service, Wireless Data Broadcast.*

1. Introduction

Software applications have a huge and inseparable impact on our lives. Information systems are effectively handling the needs of a large number of clients to provide efficient services and handle different contexts effectively. It is important to provide the gigantic clients efficiently with the information they need. To do this effectively, the complexity of software is increasing, and the cost of software development is also increasing. This situation increases the importance of models to estimate the development cost of software [1, 2, 3, 4].

The cost models estimate the quantitative aspects like the number of lines of the source code, or the qualitative aspects like functions and complexity of the implemented functionalities of applications. LOC is the way estimating cost for a software with the number of the source code of the application. LOC is simple but may overestimates the cost in the case that the source code contains many lines of comments. M/M estimates the cost of a software using the number of developers and the estimated period for developing it. M/M cannot avoid the problems that it may estimate with only empirical and subjective views. LOC and M/M

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depend on the quantitative aspect of the software instead of the qualitative side. FP is proposed as an alternative for LOC and M/M, that considers functions of the application as the qualitative sides of it [5, 6, 7]. FP is configured as two parts, Data Function and Transaction Function. Data Function estimates the complexity of data processing of an application. Transaction Function estimates the complexity of the functions of the application like the function of reading from files or databases. and writing to them. Function Point is suitable for the cost of the software that process transactions and files because it concentrates on the complexity and functionality of file processing and database processing at the back end of the system. Use Case Point (UCP) is proposed for coping with the object oriented programming methodology that develops an application in the unit of use cases [6, 8]. UCP is suitable for the object-oriented paradigm because it estimates the developing cost for use cases identified from the software. FP and UCP are more reasonable cost models because they emphasize on the qualitative side of the applications. They, however, are insufficient to estimate the applications based on machine learning like deep learning because they cannot consider the complex optimization processes of the machine learning applications.

The modern information service environment is characterized by a great number of clients try to access information anytime, anywhere using high-speed networks. In this environment, wireless data broadcasting is an effective way to provide seamless information services to a large number of clients [9, 10]. In wireless data broadcasting, the broadcast server broadcasts data to the wireless channel and the clients download data from the wireless channel, so it is possible to provide information services regardless of the number of clients. And even if the number of clients increases, the broadcast server can avoid burning down [11, 12, 13]. The software for the information service provided in the wireless data broadcasting environment requires high development complexity because both server-side and client-side software must be developed. Therefore, it is very important the way to estimate effectively the development cost of the software. Since the existing function point method cannot fully reflect the functional complexity of the server-side software and the client software developed in wireless data broadcasting, a function point method that can reflect these development complexities is important and necessary.

In this paper, we propose a Function Point model for Information services using wireless data Broadcast (FPIB) for estimating the developing cost of the system. The wireless data broadcast system is effective way to implement information services that can support any number of clients effectively without the server never burn out. In Section 2, we review function point as a cost model for developing applications. Then, we propose the function point cost model for dealing effectively with the information service using wireless data broadcast in Section 3. Next, we show the effectiveness of the proposed model FPIB by comparing with FP in Section 4. Finally, we conclude the paper in Section 5.

2. Function Point Model

Estimating the function point of an application system follows the procedure shown in Figure 1 as below. The procedure consists of 5 steps as follows.

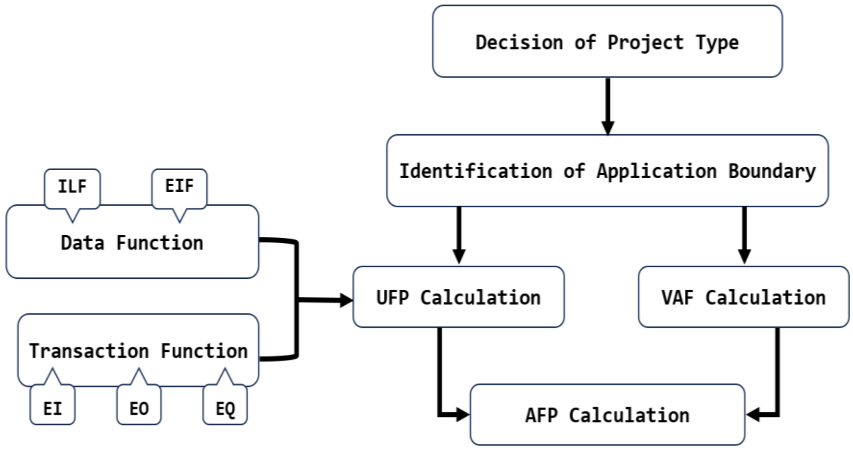

Figure 1. Estimating the function point of an application system

2.1 Decision of the project type

To estimate the function point of the software application, firstly we determine the type of the project among development project, enhancement project and application because the project type affects critical functionalities of the application.

2.2 Identification of application boundary

This step decides the measurement range of functionalities of the application and identifies the boundary of the application. In the case of development project, all functionalities the project should provide must be included into the measurement range. In this step, all logical functionalities must be identified for measuring function point [7].

2.3 Calculation of UFP

Unadjusted Function Point (UFP) is the sum of the values of the data function points and transaction function points as follows [6].

$$UFP = \sum (V_{ILF}, V_{EIF}, V_{EI}, V_{EO}, V_{EQ}) \quad (1)$$

(1) Measuring Data Function: two factors, Internal Logical Files (ILE) and External Interface File (EIF), for data function are identified and measured. ILE is the complexity on a group of identifiable and logically related data or control information and measured in the number of files in the application system. EIF is the complexity on files that the application system refers to. EIF is measured in the number of files same as ILF. EIF and ILF are measured with Data Element Type (DET) and Record Element Type (RET) [6]. DET means the number of unique fields in ILE and EIF. RET is the number of records as the subset of DET. EIF and ILE are calculated with the values of DET and RET shown in Table 1.

Table 1. Matrix for ILE and EIF

		DET		
		1 to 19	20 to 50	over 51
RET	1	Low	Low	Average
	2 to 5	Low	Average	High
	over 6	Average	High	High

(2) Measuring Transaction Function: three factors, External Input (EI), External Output (EO) and External Query (EQ), are identified and measured.

EI means the complexity about input data or unit process for control information like registration, modification, and deletion from the external to the application system and are measured with DET and File Type Reference (FTR) that is the referencing table [6]. EI is calculated with the values of DET and FTR shown in Table 2.

Table 2. Matrix for EI

		DET		
		1 to 4	5 to 15	over 16
FTR	0 to 1	Low	Low	Average
	2	Low	Average	High
	over 3	Average	High	High

EO means the complexity about output data or unit process of controls to the external of the application system after processing data. EQ means the complexity about input and output data queries between the external and the application system without data processing. EO and EQ also are measured with DET and FTR like EI [6]. EO and EQ are calculated with the values of DET and FTR shown in Table 3.

Table 3. Matrix for EO and EQ

		DET		
		1 to 5	6 to 19	over 20
FTR	1	Low	Low	Average
	2 to 3	Low	Average	High
	over 4	Average	High	High

2.4 Calculation of VAF

Value Adjustment Factor (VAF) is the factor for measuring the general functions of the application system. VAF is measured with General System Characteristics (GSC) containing 14 items as follow. Each item has a value called Degree of Influence (DI) that is from 0 to 5.

Table 4. General System Characteristics

GSC	Value

G_1	Data Communication	DI_1
G_2	Distributed Data Processing	DI_2
G_3	Performance	DI_3
G_4	Heavily Used Configuration	DI_4
G_5	Transaction Rate	DI_5
G_6	Online Data Entry	DI_6
G_7	End-User Efficiency	DI_7
G_8	Online Update	DI_8
G_9	Complex Processing	DI_9
G_{10}	Reusability	DI_{10}
G_{11}	Installation Ease	DI_{11}
G_{12}	Operation Ease	DI_{12}
G_{13}	Multiple Sites	DI_{13}
G_{14}	Facilitate Change	DI_{14}

Table 5 Degree of Influence

Value	Meaning
0	No influence
1	Incidental influence
2	Moderate influence
3	Average influence
4	Significant influence
5	Strong influence throughout

Using the values of DI for each GSC items, VAF is calculated as follows.

$$VAF = 0.01\sum (DI_i) + 0.65 \quad (2)$$

2.5 Calculation of AFP

Adjusted Function Point (AFP) is the function point of the application project. AFP means the adjusted UFP with VAF. With UFP and VAF, AFP is calculated as follows [6].

$$AFP = UFP \cdot VAF \quad (3)$$

Using AFP, we estimate the time to develop an application using the following equation [6].

$$T_{EST} = AFP \cdot F_{EST} \quad (4)$$

Here, T_{EST} means the time to develop an application and F_{EST} means the assumed time per function point.

3. Function point model for information services using the wireless data broadcast

3.1 Information service system using the wireless data broadcast

The information service by wireless data broadcast is configured with a server that broadcast data items and clients that download their necessary information from the wireless channel as shown in Figure 2.

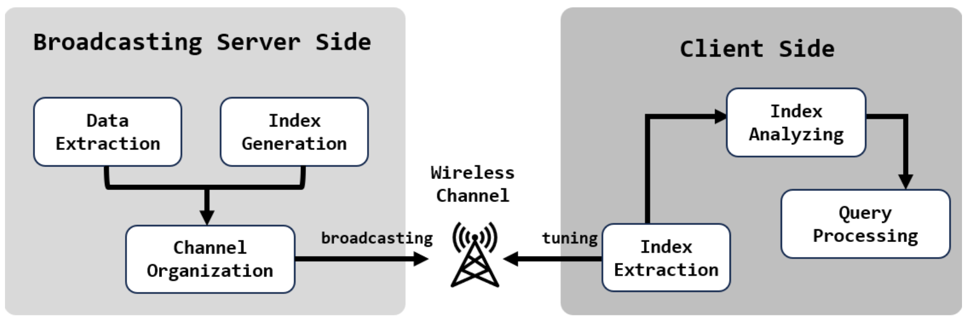

Figure 2. Information service system by wireless data broadcast

The broadcast server disseminates data items on the wireless channel after extracting them from databases. To help the clients efficiently search for the answers to the queries, the server generates an index information that holds the time when each data item appears on the channel. Then the server organizes the wireless channel by interleaving the data items to be broadcast and the index information for the clients to quickly access the index. After organizing the channel, the server disseminates the data items and the index on the wireless channel through a transmitter [3, 4].

The clients acquire information needed from the wireless channel as follows. The clients tune in to the wireless channel and access the index information first then extract the time information of the queried data items to be downloaded from the channel. The clients download the items from the channel with the extracted time information.

3.2 Function point model for information service using wireless data broadcast

In the wireless data broadcast services, the complexity of data extraction to be broadcast, index generation and channel organization in the server side is critical factors for efficient information services. Also in the client side, the complexity of the index extraction and analysis and query processing is important factor for the time-efficiency of the services. Accordingly, the factors must be considered in the cost model for the information service by wireless data broadcast. We propose FPIB reflecting the effects of the critical factors in the broadcast system, the complexity of the index generation and channel organization in the server side and the complexity of index analyzing and query processing.

(1) UFP for proposed FPIB

For the proposed FPIB, we extract parameter Index Generation (IG) from the server side that means the complexity of index generation. Parameter IG reflects the effect that the index generation complexity influences on development cost. We treat IG as one of the transaction functions because it is related to the transaction of the data extraction. The value of IG has one of Low, Average and High as with other transaction functions.

We extract parameter Index Analysis (IA) from the client side that means the complexity of index analysis. Parameter IA reflects the effect that the index analysis complexity influences on development cost. We treat IA as one of the transaction functions because it is related to the transaction of the time information extraction. The value of IA has one of Low, Average and High as with other transaction functions.

$$UFP_{FPIB} = \sum (V_{ILF}, V_{EIF}, V_{EI}, V_{EO}, V_{EQ}) + N_{IG}\cdot IG + N_{IA}\cdot IA$$
$$= N_{UF}\cdot ILF + N_{EI}\cdot EIF + N_{UI}\cdot EI + N_{UO}\cdot EO + N_{UQ}\cdot EQ + N_{IG}\cdot IG + N_{IA}\cdot IA \quad (5)$$

Where, NUF is the number of user files; NEI is the number of external interfaces; NUI is the number of user inputs; NUO is the number of user output; NUQ is the number of user queries; NIG is the number of the index segments in a broadcast cycle; NIA is the average number of index segments that the clients access while processing the queries.

Table 6. Values of complexity for UFP for FPIB

Value	Complexity		
	Low	Average	High
EI	3	4	6
EO	4	5	7
EQ	3	4	6
ILF	7	10	15
EIF	5	9	15
IG	5	9	16
IA	5	9	16

(2) VAF for proposed FPIB

For the proposed FPIB, we extract parameter CO from the server side that means the complexity of channel organization. Parameter CO reflects the effect that the channel organization complexity influences on development cost. We treat CO as one of the general functions because it affects the performances of the information system that is time-efficiency while searching and downloading the data items.

We extract parameter QP from the client side that means the complexity of query processing. Parameter QP reflects the effect that the complexity of query processing influences on development cost. We treat QP as one of the general functions because it affects the time-efficiency of the information system as with CO.

$$VAF_{FPIB} = 0.01(\sum DI_i + DI_{CO} + DI_{QP}) + 0.65 \quad (6)$$

Here, $\sum DI_i$ means the sum of the degree of influence of 14 items in GSC by FP; DI_{CO} is the value of CO that means the degree of the complexity of channel organization. DI_{QP} is the value of QP that means the complexity of query processing. AFP for FPIB is calculated as the production UFP_{FPIB} with VAF_{FPIB} in the same way with FP using Eq. (3).

4. Evaluation of the Proposed Model FPIB

We show the suitability and effectiveness of the proposed FPIB to the applications using the wireless data broadcast. For the suitability, we compare FPIB to FP in the context of the applications in the aspect of UFP, AFP and estimated time to be consumed for developing the application from AFP. Table 6, 7, and 8 show the parameters used for the evaluation. IG and IA in Table 6, N_{IG} and N_{IA} in Table 7, and G_{16} and G_{15} in Table 8 are the parameters to be adopted to FPIB for describing the characteristics of the application using wireless data broadcast.

Table 7. The value of parameters for UFP

Parameters		Value
N_{UI}	The number of user inputs	5
N_{UO}	The number of user outputs	75
N_{UQ}	The number of user queries	25
N_{UF}	The number of user files	5
N_{EI}	The number of external interfaces	15
N_{IG}	The number of index segments	25
N_{IA}	The number of indexes accessed	7

Table 8. The value of parameters for VAF

Parameters		Value
G_1	Data Communication	5
G_2	Distributed Data Processing	5
G_3	Performance	4
G_4	Heavily Used Configuration	3
G_5	Transaction Rate	3
G_6	Online Data Entry	3
G_7	End-User Efficiency	5
G_8	Online Update	4
G_9	Complex Processing	4
G_{10}	Reusability	3
G_{11}	Installation Ease	2
G_{12}	Operation Ease	2
G_{13}	Multiple Sites	4
G_{14}	Facilitate Change	3
G_{15}	Channel Organization	5
G_{16}	Query Processing	5

Here, G_{15} and G_{16} mean DI_{CO} and DI_{QP} in Equation (6), respectively.

4.1 Comparison of UFP

UFP is calculated using Eq. (5) with the given parameters in Table 6 and 7. Figure 3 shows the value of UFP against the complexity in FP and the proposed FPIB. Figure 3 reveals that FPIB is more effective and suitable cost model for the information applications using the wireless data broadcast. That is because UFP by

FP does not reflect the important factors in the wireless data broadcast. UFP of FPIB rapidly increases with the complexity of the parameters.

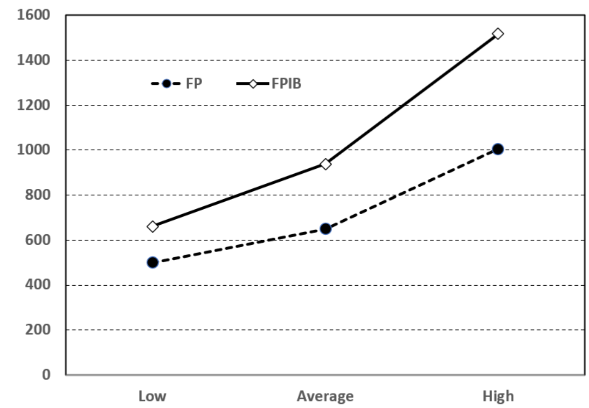

Figure 3. UFP of FP and FPIB

4.2 Comparison of AFP

AFP represents the cost developing an application that takes into account UFP and VAF altogether. Figure 4 shows AFP by FP and FPIB against the complexity. The values of AFP are larger than those of UFP in Figure 3. That is because AFP is the value multiplied with the value of VAF of FP and FPIB. The deviation of AFP between FP and FPIB is larger than that of UFP in Figure 3. That results from that the value of VAF by FPIB is larger than that by FP. It is obvious that VAF of FPIB is applied with two factors, channel organization and query processing in the client side.

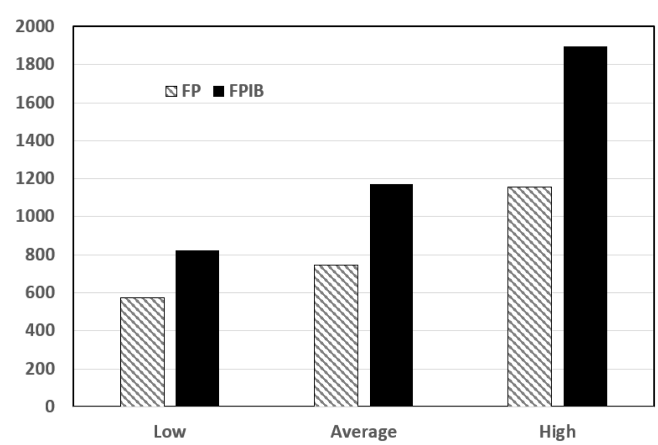

Figure 4. AFP of FP and FPIB

4.3 Comparison of estimated time to develop an application

We can estimate the consumed time for developing the application using the wireless data broadcast with Equation (4). Figure 5 shows the estimated time when the value of F_{EST} in Equation (4) is 2.5. In the figure, FPIB_L means the case when the complexity of parameters related to wireless data broadcast is low. Thus

FPIB_A and FPIB_H mean the cases when the complexity of the parameters is average and high, respectively.

The figure depicts that the estimated time from AFP by FPIB is larger than that by FP. This results from that the FPIB reflects the parameters related to the wireless data broadcast more effectively than FP.

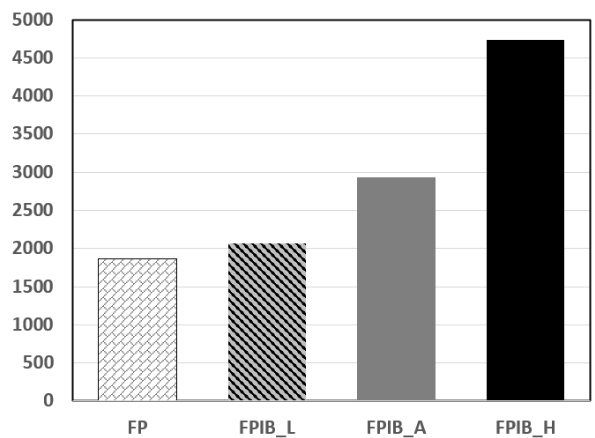

Figure 5. Estimated time for developing an application

5. Conclusion

In this paper, we have proposed FPIB, a function point model for information services using wireless data broadcast. The proposed FPIB has solved the problem that the existing function point method does not effectively estimate development costs that reflect the characteristics of software running on the wireless data broadcasting. The proposed model adopts the characteristics of the wireless data broadcast to a common function model. For raising the effectiveness of UFP, FPIB adopts the complexity of critical parameters related to the wireless data broadcast, i.e., index generation in the server side and index analysis in the client side. Also, GSC of FPIB has two added factors, the degree of influence of channel organization in the server side and query processing in the client side. To evaluate the proposed FPIB, we compare FPIB with a common function point model for UFP, AFP and consumed time for implementing the application using wireless data broadcast. The evaluation reveals that the proposed FPIB is suitable for estimating effectively the cost implementing the application using wireless data broadcast by considering the critical parameters of the broadcast environment.

Although the proposed FPIB effectively estimates the cost of software development based on wireless data broadcasting, it is necessary to further refine the cost of analyzing the indexes according to the different indexes used in the wireless data broadcasting environment. This is an area for further research in future work.

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