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Measuring What Matters: Extended-Cosmic Functional Points as a Foundation for Government Software Cost Estimation

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ABSTRACT

The East Java Provincial Government has established standards for application development through Governor Regulation No. 98 of 2018; however, it lacks a standardized method for estimating development costs based on system complexity. This discrepancy leads to significant budget variations across regional agencies, impacting consistency, transparency, and accountability in budgeting. This study proposes an extended method for cost estimation using Extended-COSMIC Function Points (FP), aimed at providing a reliable and measurable basis for government application development. System complexity is first assessed using COSMIC FP, followed by the conversion of the functional size into estimated effort, which is then translated into cost estimates according to the pay rates stipulated in the Decree of the Minister of Communication and Information Technology No. 117 of 2024. The method was tested on 15 applications, yielding a Mean Relative Error (MRE) of 12.30% and a Predictive Accuracy (PRED) of 93.33%. The results demonstrate that the Extended-COSMIC FP method provides accurate, consistent, and transparent cost estimates, ensuring more reliable budget planning in government application projects. The method's high accuracy and practical applicability make it a valuable tool for standardizing cost estimation across governmental IT projects.

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INTRODUCTION

The development of government applications that are effective, efficient, and aligned with the tasks and functions of the regional apparatus requires clear standards, both in terms of technical aspects and budgeting. In this context, the East Java Provincial Government established Governor Regulation Number 98 of 2018 concerning Application Standards for Regional Apparatus, which provides systematic guidance for application development starting from the planning stage, user needs analysis, application system needs analysis, design, programming, testing, implementation, to post-implementation review. This regulation standardizes application system components that must be met by regional apparatus so that application development runs in a directional and integrated manner (Abdallah et al., 2025; Al Asheeri & Hammad, 2019; Angara et al., 2018; Arman et al., 2025; Asmoro et al., 2024).

Although Governor Regulation Number 98 of 2018 has comprehensively regulated application system components, the regulation has not outlined the method that can be used to calculate the estimated cost of application development based on the complexity of the set system components (Bluemke & Malanowska, 2022; Bushong et al., 2021; Chirra & Reza, 2019; Commeyne et al., 2016; COSMIC, 2021). At the planning stage, especially in the preparation of the Software Needs Specification (SKPL) document, regional apparatus are

faced with the need to propose a realistic and accountable application development budget. Cost estimates that are not based on measurable methods have the potential to cause significant differences between projects with similar characteristics, making it difficult to standardize the budget (Desharnais & Trudel, 2022; Dewi et al., 2024; Di Martino et al., 2016, 2020; Kaur & Kaur, 2022).

Application development cost estimation is an important activity in software project management, especially since most development costs are affected by personnel costs that are directly related to the amount of effort required (Hossain, 2023; Putri & Subriadi, 2018; Saini & Chomal, 2020). The amount of effort is determined by the complexity of the system developed, including the number of functional processes, the need for integration with other systems, and the technological infrastructure used. The more complex the application system, the greater the effort required, which ultimately results in increased development costs. This condition causes the cost of developing applications in the government environment to be very varied and difficult to standardize (Sari Dewi & Sarno, 2020; Sholiq et al., 2023).

On the other hand, the mechanism for submitting application development budgets within the East Java Provincial Government refers to the General Cost Standard (SBU), which is used as the basis for the preparation of Work Plans and Budgets for regional apparatus. The preparation of the application development SBU requires supporting data in the form of cost analysis based on the complexity of the system described in the SKPL document. This provision is in line with East Java Governor Regulation Number 11 of 2024 concerning Electronic-Based Government Systems, which emphasizes that application development must refer to business processes and regional apparatus functional tasks. However, to date, there is no standard method that explicitly links the complexity of functional needs in the SKPL with the amount of application development costs.

Various methods of estimating effort based on functional measures have been developed, such as COCOMO II, Function Point Analysis, Use Case Points, and COSMIC Function Points. There is no single method that can be considered the most superior for all application development contexts, but previous research has shown that a functional size-based approach provides more objective and consistent estimation results. COSMIC Function Points, as the international standard ISO/IEC 19761, are considered more suitable for service-based government applications because they measure the system functions that are actually needed by users.

Based on these conditions, this study proposes the Extended-COSMIC FP method, which is a method of estimating application development costs based on functional size that refers to the components of the application system in Governor Regulation Number 98 of 2018. Estimated effort is calculated using COSMIC Function Points and then converted into cost estimates by referring to the GovTech HR Price Standard as stipulated in the Decree of the Minister of Communication and Information Number 117 of 2024. This method is expected to provide a more objective, measurable, and realistic cost estimate and can be used as a basis for the preparation of General Cost Standards for application development within the East Java Provincial Government.

This study aims to develop a method of estimating the cost of application development based on functional size using Extended-COSMIC Function Points (FP) as the basis for determining the standard cost of government application procurement. In addition, this study

also aims to test the accuracy and consistency of the Extended-COSMIC FP method in producing more objective and measurable cost estimates for government applications within the East Java Provincial Government. Another goal is to prepare a proposal for a General Cost Standard (SBU) for application development that can be used as a reference in planning the budget of application projects in local government agencies.

The benefit of this research is that it provides a practical solution in determining the estimated cost of government application development in a more transparent and measurable manner, which can reduce budget variations between agencies. This research is also useful in improving efficiency and accountability in application budget planning in the East Java Provincial Government, using a methodology based on the functional size of the application. In addition, this research provides a more objective and accountable basis in calculating the cost of developing government applications, which is in accordance with applicable regulations, especially in terms of compliance with the Governor's Regulation and the Decree of the Minister of Communication and Informatics. This research also strengthens the supervision and control of the budget for government information technology projects, as well as increasing transparency in the management of government application development budgets.

RESEARCH METHOD

This research uses a method engineering approach with a case study of application development within the East Java Provincial Government. The main purpose of this methodology is to design and test a method of estimating the cost of developing applications based on functional size that is in line with the Governor's Regulation Number 98 of 2018 and the Decree of the Minister of Communication and Information Number 117 of 2024. The flow of the research methodology as well as the method of calculating the estimated cost of application development is shown in the following Figure of the Application Development Cost Estimation Calculation Method.

Stage 1. Identify System Components and Requirements

The initial stage of research begins by identifying the components of the application system as stipulated in Governor Regulation 98/2018. This component includes functional, non-functional, and environmental needs that are the scope of government application development standards.

Identification of requirements is carried out with two main sources, namely:

1. Software Requirements Specification Document (SKPL/SRS) of the running application,
2. Application development budget realization data is in the form of information on the actual cost of application development which is used as comparative data.

The result of this stage is in the form of a structured requirement document that represents the needs of the system according to regulations and real implementation conditions.

Stage 2. Data Movement Classification and Functional Size Measurement

The required documents that have been prepared are then analyzed to classify the types of data movements according to the COSMIC Function Points standard, namely Entry, Exit, Read, and Write. This classification is performed for each functional process identified in the system.

Based on the results of the classification, the functional size calculation was carried out using the COSMIC Function Points (COSMIC-FP) method. The functional size value is expressed in units of Cosmic Function Points (CFP) and represents the functional complexity of the system objectively based on the needs of the user.

Stage 3. Convert Functional Size to Effort

The functional size (CFP) value obtained is then converted into an effort estimate using the effort rate parameter. Estimated effort is calculated using the equation:

Effort = Functional Size (CFP) × Effort Rate

The effort rate used in this study was 8.2 man-hours per CFP, which was selected based on literature review and suitability with the context of government application development.

Stage 4. Distribution of Effort to Application Development Cycles

The estimated total effort is then distributed to each activity in the application development cycle in accordance with Governor Regulation 98/2018, such as needs analysis, design, coding, testing, and implementation. This effort distribution uses the percentage of effort distribution which refers to (Saleh's, 2011) research, so that each activity gets a proportionate portion of effort.

Table 1 Effort Distribution by Software Development Phases and Ongoing Life-Cycle Activities

Activities	% distribusi effort	
	Medium-large	Small
Software phases		
Requirement	7,5%	1,17%
Specification	7,5%	6,75%
Design	10%	5,57%
Implementation	10%	55,65%
Integration testing	7,5%	6,42%
Acceptance & deployment	7,5%	5,60%
Ongoing life-cycle activities		
Project management	8,34%	2,55%
Configuration management	4,16%	3,58%
Quality assurance	8,34%	0,66%
Documentation	4,16%	9,76%
Training and support	4,16%	0,60%
Evaluation and testing	20,84%	1,67%

Source: Adaptation of COSMIC Function Points and Government Regulations

The result of this stage is the value of effort per activity in the application development cycle.

Stage 5. Convert Effort to Cost Estimate

Effort per activity is then converted into cost estimation by multiplying the percentage of effort per activity by the pay rate of application development HR. The pay rate used refers

to the GovTech HR Price Standard as stipulated in the Decree of the Minister of Communication and Information Number 117 of 2024.

The cost calculation is done using the equation:

Cost per Activity = %Effort per Activity × Pay Rate

The total estimated cost of app development is obtained by adding up all costs per activity.

Stage 6. Preparation of SBU Proposal Document

The estimated value of the total cost resulting from this method is used as data to support the preparation of the proposed General Cost Standard (SBU) application development document. Thus, this method results in measurable, transparent, and consistent cost estimates with local government budgeting technical standards and regulations.

The cost estimation method designed in this study was introduced under the name Extended-COSMIC FP, which is the development of COSMIC Function Points that not only measure the functional size of software, but also integrate it with the distribution of effort and government HR cost standards.

RESULTS AND DISCUSSION

Set Data

This research uses intangible asset data in the form of an application managed by the East Java Provincial Government. The data includes 15 web-based applications developed in the last 5 years, among others seen in the table.

Table 2. Table (adjust the numbering) List of applications managed by the East Java Provincial Government that are used as test data for this research

No.	Application Name	URL	Pricing
1.	East Java Provincial Government Website	https://jatimprov.go.id/	IDR 49.500.000
2.	Spatial Information System	https://sitr.jatimprov.go.id/	IDR 99.900.000
3.	Electronic Records System (TNDE))	https://tnde.jatimprov.go.id/tnde/	IDR 49.152.400
4.	Learning Information System and Cooperative Insight Improvement (SIJAWARA+)	https://sijawara.diskopukm.jatimprov.go.id	IDR 49.500.000
5.	Terminal Performance Information System (SIKENAL)	https://monitoring.dishub.jatimprov.go.id/	IDR 97.350.000
6.	Social Service Website	https://dinsos.jatimprov.go.id/	IDR 124.987.500
7.	Agriculture and Food Security Agency Website	https://pertanian.jatimprov.go.id/	IDR 74.250.000
8.	Website PPID Prov. East Java	https://ppid.jatimprov.go.id/	IDR 99.880.000
9.	Website DPMPTSP	https://dpmptsp.jatimprov.go.id/	IDR 49.672.500
10.	Animal Husbandry Service Website	https://disnak.jatimprov.go.id/web/	IDR 50.838.000

11.	JDIH Legal Bureau Website	https://jdih.jatimprov.go.id/	IDR 49.390.000
12.	Website Millenials Job Center (MJC)	https://mjc.jatimprov.go.id/home	IDR 99.955.500
13.	JDIH Website of the DPRD Secretariat	https://jdih.dprd.jatimprov.go.id/web/	IDR 99.825.000
14.	Regional Revenue Agency Website	https://bapenda.jatimprov.go.id/	IDR 48.951.000
15.	Regional Civil Service Agency Website	https://bapenda.jatimprov.go.id/	IDR 29.975.000

Source: East Java Provincial Government. (2025). List of Applications Managed by the East Java Provincial Government

Software Requirements Specifications for Test Data

The Software Requirements Specification Document (SKPL) is prepared as the main reference in identifying and defining the functional needs of the system to be developed. In this study, SKPL not only functions as a requirement document, but is also used as a basis for measuring system complexity. To ensure traceability and consistency between user needs and system functions, the writing uses a Requirement Traceability Matrix that maps user needs into functional needs, system processes, and implementation components.

Table 3 Consolidation of the Requirement Traceability Matrix of the East Java Provincial Government Information System

No	System/Application	Module	Name of Need	Flow Description
1	Website of the Province of Java.	Authentication	User and Admin Login	User/admin logs in, credential validation system, grants access if successful
2	Website of the Province of Java.	CMS	Website Content Management	Admins access the CMS, edit content, and save changes to the database
3	Website of the Province of Java	Multimedia Gallery	Gallery Media Management	Users access the gallery, admins upload new media along with metadata
4	Website of the Province of Java	Licensing Portal	Licensing Service Application	Users fill out and send permission requests stored by the system
5	Website of the Province of Java.	Community Complaints	Submission of Public Complaints	Users submit complaints through the form provided by the system
6	Website of the Province of Java.	Open Data Portal	Access and Download Dataset	Users access and download available datasets
7	Website of the Province of Java.	Agenda & Event	Management of Agendas and Activities	User sees the agenda, admin adds/updates activities
8	Website of the Province of Java.	Live Streaming	Live Stream Access	Users access live broadcasts with access tokens

9	Website of the Province of Java.	Static Pages	Managing Information Pages	Admin edit and save static page changes
10	Website of the Province of Java.	OPD Directory	Regional Apparatus Organization Information	System displays OPD information, admin updates data
11	Website of the Province of Java.	Data Visualization	Presentation of Graphs and Statistics	System renders graphs from available statistical data
12	Website of the Province of Java.	Dashboard Analytics	System Monitoring and Analytics	The system displays an analytical summary in the dashboard
13	Website of the Province of Java.	Search Engine	Website Information Search	User searches for information, the system displays search results
14	Website of the Province of Java.	Push Notification	Notification Delivery	The system sends and the user receives notifications
15	Website of the Province of Java.	REST API Integration	External Data Integration	System processes API requests and returns JSON responses
16	TNDE	Management Admission Letter	Access and Search for Incoming Mail	Users open and browse the incoming mailing list
17	TNDE	Electronic Disposition	Letter Disposition Management	Officials make dispositions, the system sends notifications and records history
18	TNDE	Creation Exit Letter	Outgoing Letter Creation	User creates a draft outgoing letter with complete metadata
19	TNDE	Workflow Approval Surat	Approval and Revision of Letters	Officials review and approve/revise letters, system records workflows
20	TNDE	Digital Signatures	Electronic Signing	Identity verification system and implementation of digital signatures
21	TNDE	Letter Template Management	Letter Template Management	Admin manages the letter template and its version
22	TNDE	Automated Digital Archive	Digital Mail Archiving	System classifies and archives mail automatically
23	TNDE	Smart Archive Search	Search and Access Archives	The user searches for the archive with keywords, the system displays the results
24	TNDE	Electronic Agenda Book	Mail Agenda Management	System to manage and display email agendas
25	TNDE	Notifikasi Real-Time	Sending Mail Notifications	The system sends real-time notifications related to mail activity

26	TNDE	Mail Monitoring Dashboard	Monitoring the performance of the letter	The system displays a graph of monitoring mail activity
27	TNDE	Periodic Correspondence Report	Preparation of Correspondence Reports	System to process and display periodic correspondence reports
28	TNDE	SIMPEG Data Synchronization	Staffing Data Integration	Synchronization and updating system of employee data from SIMPEG
29	TNDE	Audit Trail System	System Activity Logging	The system records all data activities and changes
30	TNDE	Mobile Application Support	Access TNDE Services via Mobile	Users access the system through a mobile application
31	SITR	GIS Map Layer Management	Map Layer Management	Officers manage and store GIS layer configurations
32	SITR	Interactive Map Visualization	Interactive Map Appearance	The system displays an interactive map of spatial data
33	SITR	Detailed Spatial Plan	RDTR Data Access and Update	User accesses and the officer updates the RDTR document
34	SITR	Land Suitability Analysis	Spatial Analysis of Land Suitability	The system analyzes land suitability based on zoning
35	SITR	Check Location Suitability Online	Location Suitability Check	User checks the status of location suitability based on coordinates
36	SITR	Spatial Planning Recommendations	Determination of Space Utilization Recommendations	The system provides recommendations for space utilization
37	SITR	Housing Project Tracking	Project Progress Monitoring	The system monitors and displays the progress of housing projects
38	SITR	Spatial Planning Violation Report	Breach Reporting and Monitoring	Users report violations, the system records and sends notifications
39	SITR	Inventory of Residential Areas	Residential Area Data Management	The system manages and records the history of data in residential areas
40	SITR	Periodic Spatial Planning Report	Preparation of Periodic Reports	System to process and store periodic spatial reports
41	SITR	API Geospasial	Provision of Geospatial Data Services	The system provides geospatial data access via API
42	SITR	RTRW Change Alert	RTRW Data Change Notification	System detects and notifies RTRW data changes

43	SIJAWARA+	Course Management	Materials and Instructor Management	Admin/instructor manages course data and material list
44	SIJAWARA+	Learning Path	Learning Path Setup	Admin compiles the order of courses in the learning path
45	SIJAWARA+	Student Portal	Access to Participant Learning	Participants access courses, materials, and learning progress
46	SIJAWARA+	Video Learning	Learning Video Playback	The system plays videos and logs learning activities
47	SIJAWARA+	Quizzes and Exams	Quiz and Evaluation Implementation	The system displays questions, grades, and stores exam results
48	SIJAWARA+	Assignment Submission	Collection of Participant Tasks	Participants upload assignments, instructors conduct assessments
49	SIJAWARA+	Live Webinar	Implementation of Live Online Classes	Instructor opens webinar session, system records attendance
50	SIJAWARA+	Generate Certificate	Automatic Certificate Issuance	The system generates certificates for graduating participants
51	SIJAWARA+	Digital Library	Access Material Repository	Users search and access materials from digital libraries
52	SIJAWARA+	Community Forum	User Discussion Interaction	User discussion in the learning community forum
53	SIJAWARA+	Learning Report	Activity Monitoring and Reporting	Admin views progress reports and learning activities

Sourch: East Java Provincial Government. (2025). Consolidation of Requirement Traceability Matrix for East Java Provincial Government Information Systems

The consolidation table of the requirement traceability matrix above summarizes 53 functional needs of the four main information systems of the East Java Provincial Government, namely the Jatimprov Website (15 modules), TNDE (15 modules), SITR (12 modules), and SIJAWARA+ (11 modules). Each row in the table represents a single requirement that includes a system/application identification, module name, specific requirement name, and a business process flow description that describes the interaction between users, admins, or officers with the system. This table serves as a tracking document to ensure all user needs have been mapped into system features, facilitating the process of developing, testing, and maintaining the system in an integrated manner in supporting the digital transformation of the East Java government.

Results of effort calculation and cost estimation

The estimated cost of application development in this study uses the COSMIC Function Points (CFP) method which measures functional size based on the Entry, Exit, Read, and Write

data flow from the requirement traceability matrix. Each functional size is then multiplied by an effort rate of 8.2 man-hours to get a total effort in person-hours, which is then distributed to 12 application development activities according to the standard percentage, including software phases (requirement, specification, design, implementation, integration testing, acceptance & deployment) and ongoing life-cycle activities (project management, configuration management, quality assurance, documentation, training and support, evaluation and testing). The estimated final cost is calculated by multiplying the effort per activity by the pay rate of each position group based on the Ministry of Communication and Information Technology Number 117 of 2024, which regulates standard rates for Product Management, Engineer Architecture/System Analyst, Engineer Data/Data Analyst, Software Development Engineer, Engineer Quality, and Engineer Support with a person-hour rate range between IDR 110,625 to IDR 182,500.

Table 4 Consolidation of Application Development Cost Estimates Using COSMIC-FP

No	Application Name	Entry	Exit	Read	Write	CFP	Effort (person-hour)	Estimated Cost
1	Provincial Government Website	20	30	26	21	97	795,4	Rp108.127.500
2	TNDE	23	30	29	24	106	869,2	Rp118.135.000
3	SITR	20	24	22	18	84	688,8	Rp93.600.000
4	SIJAWARA+	16	22	21	18	77	631,4	Rp85.815.000
5	SIKENAL	14	20	19	15	68	557,6	Rp75.780.000
6	Website Dinsos	15	19	20	13	67	549,3	Rp74.661.250
7	Department of Agriculture Website	18	23	20	16	77	631,4	Rp85.815.000
8	Website PPID Prov. East Java	16	22	24	21	83	680,6	Rp92.481.500
9	Website DPMPTSP	17	26	31	24	98	803,6	Rp109.189.000
10	Website Disnak	17	21	18	15	71	582,2	Rp79.148.750
11	JDIH Legal Bureau Website	11	15	21	17	64	524,8	Rp71.320.000
12	Website MJC	20	27	24	22	93	762,6	Rp103.653.500
13	JDIH Website of the DPRD Secretariat	15	17	19	16	67	549,4	Rp74.677.500
14	Website Bapenda	18	28	28	19	93	762,6	Rp103.653.500
15	Website BKD	15	23	22	17	77	631,4	Rp85.815.000

Sourch: Decree of the Minister of Communication and Information Technology No. 117 of 2024. (2024). Standard Rates for Product Management, Engineering, and Software Development in Indonesia

Record of the Pay Rate of the Position Group (Kepmen Kominfo 117/2024):

1. Product Management: Rp180.625/hour
2. Engineer Architecture/System Analyst: Rp182.500/hour
3. Engineer Data/Data Analyst: Rp175.000/hour
4. Engineer Software Development: Rp130.000/hour
5. Engineer Quality: Rp175.000/hour
6. Engineer Support: Rp110.625/hour

Cost Estimation Accuracy Analysis

To assess the accuracy level of the Extended-COSMIC FP method, the cost estimation results were compared with the actual cost of application development recorded in the East Java Provincial Government's intangible assets data. This comparison results in a Magnitude of Relative Error (MRE) value for each application, which is further analyzed using MMRE, MdMRE, and PRED (0.25) metrics.

Table 5. Comparison of Estimated Cost and Actual Cost

No.	Application	Estimation	Actual	% MRE
1	Provincial Government Website	IDR 111,244,395	IDR 129,254,500	13.93
2	TNDE	IDR 121,566,040	IDR 108,900,000	11.63
3	SITR	IDR 96,335,353	IDR 98,304,800	2.00
4	SIJAWARA+	IDR 88,307,407	IDR 99,495,000	11.24
5	SIKENAL	IDR 77,985,762	IDR 97,350,000	19.89
6	Website Dinsos	IDR 138,768,782	IDR 124,987,500	11.03
7	Department of Agriculture Website	IDR 88,307,407	IDR 74,250,000	18.93
8	Website PPID Prov. East Java	IDR 95,188,503	IDR 99,880,000	4.70
9	Website DPMPTSP	IDR 112,391,245	IDR 99,345,000	13.13
10	Website Disnak	IDR 81,426,310	IDR 79,988,000	1.80
11	JDIH Legal Bureau Website	IDR 73,398,364	IDR 98,780,000	25.70
12	Website MJC	IDR 106,656,998	IDR 99,955,500	6.70
13	JDIH Website of the DPRD Secretariat	IDR 76,838,912	IDR 99,825,000	23.03
14	Website Bapenda	IDR 106,656,998	IDR 97,902,000	8.94
15	Website BKD	IDR 88,307,407	IDR 78,926,000	11.89
	MMRE			12.30

Sourch: Decree of the Minister of Communication and Information Technology No. 117 of 2024. (2024). Standard Rates for Product Management, Engineering, and Software Development in Indonesia

With MdMRE = 11.63% and only 1 application with an MRE value > 25% so that the PRED value (25) = = 0.9333 = 93.33%. This value is very high and indicates that most estimates of COSMIC Function Points are close to the actual cost within the 25% tolerance limit. Statistically, these results show that the Extended-COSMIC FP method has a high level of accuracy and is consistent in estimating the cost of government application development. The relatively small deviation value indicates that the functional size calculated using COSMIC is able to adequately represent the complexity of the system.$\frac{14}{15}$

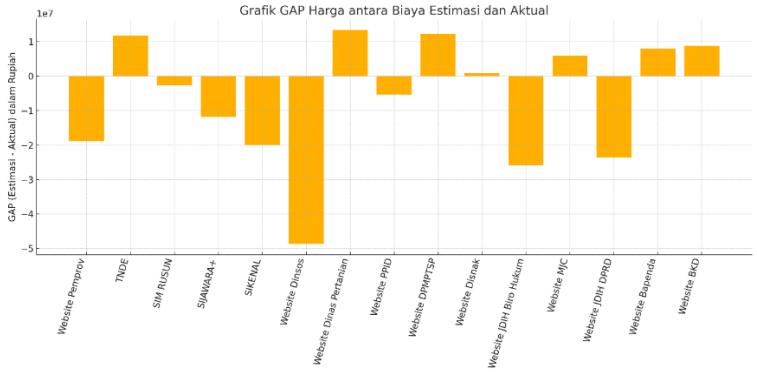
Estimated GAP Analysis and Actual Cost

The GAP analysis between the estimated cost and the actual cost shows that there is variation between projects. In some applications, such as the Agriculture Office Website,

DPMPTSP Website, and Disnak Website, cost estimates tend to be higher than actual realization (overestimation). This condition indicates that the Extended-COSMIC FP method produces conservative estimates, thus providing room for budget security in the planning stage.

On the other hand, in other applications such as the Social Service Website, the JDIH Legal Bureau Website, and the JDIH DPRD Secretariat Website, the actual cost exceeds the estimated results (underestimation). This is likely due to factors that are not fully captured in the measurement of functional size, such as scope creep, increased non-functional requirements, data security complexity, and operational and policy factors that arise during the project.

This fluctuating pattern of GAP suggests that although COSMIC excels in measuring functional complexity, the accuracy of cost estimates is also influenced by external and non-functional factors that are contextual. Therefore, calibration of cost conversion parameters per CFP based on local empirical data is important to improve the accuracy of estimates in the future. If depicted in the graph it looks like the image below



Graph 1. Price GAP between Estimated and Actual Costs

Validation and Verification Testing

The validation and verification test of the *Extended-COSMIC* FP method was carried out on 15 applications developed by regional apparatus within the East Java Provincial Government. This test aims to assess the accuracy of the cost estimation results generated by the Extended-COSMIC FP method to the actual cost of application development that has been realized. The data used includes the total actual cost of the project, the estimated cost of calculating *the Extended-COSMIC* FP method, and the GAP value or the difference between the two. The validation and verification testing scenarios are depicted in the flowchart below

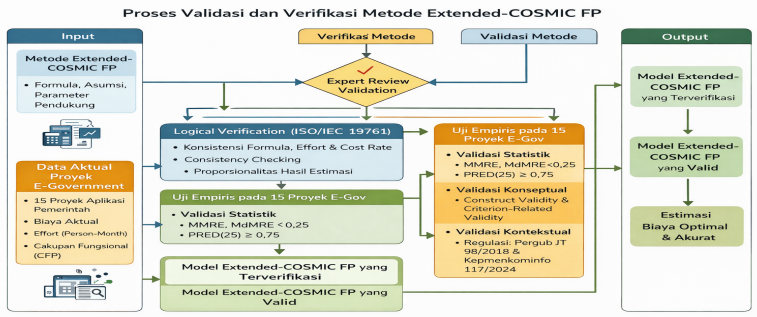


Figure 1. Validation and Verification Process of the Extended-COSMIC FP Method

In general, the test results show that the *Extended-COSMIC* FP method is able to produce cost estimates that are very close to the actual value with a relatively small deviation. Of the total 15 applications tested, 14 applications (93.33%) had a deviation value below 25%, while only one application deviated greater than the tolerance limit. Based on the results of the calculation using the statistical metrics described in Chapter II and Chapter III, the Mean Magnitude of Relative Error (MMRE) value was 0.123 or 12.30%, the Median Magnitude of Relative Error (MdMRE) was 0.1163 or 11.63%, and the Predictive Accuracy PRED (0.25) was 0.9333 or 93.33%.

The MMRE value of 12.30% indicates that on average the difference between the estimated cost and the actual cost is only about 12% of the actual value of the project. This figure is well below the 25% threshold recommended by Ferrucci et al. (2010) for a reliable estimation model. In addition, a PRED value (0.25) of 93.33% indicates that more than nine out of ten applications have estimated results that are in the range of ±25% of their actual cost. This shows that *the Extended-COSMIC* FP method is stable and consistent in generating a high level of accuracy of government software project cost estimates. A summary of the results of the validation and verification test is described in the table below.

Table 6 Summary of Validation and Verification Results Based on Test Data of 15 Applications

Accuracy Test Indicator	Test Result Value	Success Criteria	Interpretasi
Number of trial applications	15 Local Government Application	≥10 Application	Sufficient datasets for empirical validation
MMRE (Mean MRE)	0,123 (12,30%)	≤ 0,25	Accurate and consistent
MdMRE (Median MRE)	0,1163 (11,63%)	≤ 0,25	Accurate, stable against outliers
PRED (0.25)	0,9333 (93,33%)	≥ 0,75	Very high, statistically valid
Proportion of apps by deviation ≤ 25%	14 dari 15 (93,33%)	≥ 75%	Accurate and empirically valid
Estimated yield trends	Conservative estimates (tend to be slightly higher)	–	Safe for budget planning
Final result of validation	Valid and Verified	–	Suitable for use as an SBU model

Sourch: Decree of the Minister of Communication and Information Technology No. 117 of 2024. (2024). Standard Rates for Product Management, Engineering, and Software Development in Indonesia

Research Discussion and Implications

The results of this study show that the Extended-COSMIC FP method is able to provide a systematic, measurable, and consistent application development cost estimation framework in line with government regulations. The integration between the measurement of COSMIC's functional size with the development cycle structure of Governor's Regulation 98/2018 and the GovTech HR cost standard in Kepmenkominfo 117/2024 is the main contribution of this research.

Compared to the experience-based estimation approach or vendor offering, this method offers greater transparency and traceability, as each component of the cost can be traced back to the functional needs of the system. These findings are consistent with previous research that states that functional size-based estimation provides a better level of accuracy than non-algorithmic methods.

Nonetheless, the results also show that the accuracy of the method can still be improved through empirical adjustments, particularly in accommodating non-functional factors and project dynamics. Thus, the Extended-COSMIC FP method is suitable for being used as a basis for the preparation of General Cost Standards (SBU) for application development within the East Java Provincial Government, as well as as a tool for evaluating the effectiveness of the implementation of information technology projects.

CONCLUSION

This research successfully developed the Extended-COSMIC FP method for estimating the cost of developing applications based on functional size, which measures application functions through the four main components of COSMIC and converts them into cost estimates using effort rates and pay rates according to government regulations. The results of the application of this method show objective, measurable, and transparent cost estimations, in line with the structure of the application development stages regulated in the regulations of the East Java Provincial Government. Trials on 15 government applications showed that this method has high accuracy, with an MMRE of 12.30% and a PRED (0.25) of 93.33%, meeting the criteria for estimating feasible software costs.

This method has proven to be valid, reliable, and feasible to use as a basis for the preparation of General Cost Standards (SBU) for application development within the East Java Provincial Government. In terms of budget planning, this method allows OPDs to objectively set cost estimates based on the functional size of the application, increase financial transparency and accountability, and provide an auditable footprint of calculations.

This method also helps with project control by monitoring the cost-effectiveness and productivity of the development team, as well as supporting strategic decision-making in establishing application SBUs that strengthen efficiency and transparency in managing government information technology budgets. The application of this method can also help increase uniformity and objectivity in application development budgeting at the government level.

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