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FACTORS CAUSING COST INCREASES IN BUILDING STRUCTURAL WORK IN MEDAN

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ABSTRACK

Swelling cost (cost overrun) is common problems happen in project construction, especially in work structure absorbing building portion cost biggest. Inaccuracy planning, change design, as well as fluctuations material prices become frequent factors cause cost current exceed Plan Budget Cost (RAB). Research This aim For identify and analyze factors reason swelling costs on the job structure buildings in Medan City.Research methods used is approach descriptive quantitative with studies cases in three project building multilevel. Data collected through studies RAB documents and realization fees, interviews with party projects, as well as observation field analysis done with count deviation costs and grouping factor reason based on level its influence.Research result show that the average deviation cost work structure reach more from 10% of cost plan. The dominant factor that causes swelling cost is inaccuracy volume calculation, changes design during implementation, fluctuation low material prices productivity power work, and lack of coordination between party project. Internal factors such as error estimates and changes design give influence the biggest, while factor external enlarge impact deviation cost.Study This expected can become material evaluation for contractors and planners For increase accuracy planning costs and control project structure buildings in the future.

Kata Kunci;
Pembengkakan Biaya, Struktur Gedung, RAB, Manajemen Konstruksi.

ABSTRAK

Pembengkakan biaya (cost overrun) merupakan permasalahan yang sering terjadi dalam proyek konstruksi, khususnya pada pekerjaan struktur gedung yang menyerap porsi biaya terbesar. Ketidaktepatan perencanaan, perubahan desain, serta fluktuasi harga material menjadi faktor yang sering menyebabkan biaya aktual melebihi Rencana Anggaran Biaya (RAB). Penelitian ini bertujuan untuk mengidentifikasi dan menganalisis faktor-faktor penyebab pembengkakan biaya pada pekerjaan struktur gedung di Kota Medan.Metode penelitian yang digunakan adalah pendekatan deskriptif kuantitatif dengan studi kasus pada tiga proyek gedung bertingkat. Data dikumpulkan melalui studi dokumen RAB dan realisasi biaya, wawancara dengan pihak proyek, serta observasi lapangan. Analisis dilakukan dengan menghitung deviasi biaya dan mengelompokkan faktor penyebab berdasarkan tingkat pengaruhnya.Hasil penelitian menunjukkan bahwa rata-rata deviasi biaya pekerjaan struktur mencapai lebih dari 10% dari biaya rencana. Faktor dominan yang menyebabkan pembengkakan biaya adalah ketidaktepatan perhitungan volume, perubahan desain selama pelaksanaan, fluktuasi harga material, rendahnya produktivitas tenaga kerja, serta kurangnya koordinasi antar pihak proyek. Faktor internal seperti kesalahan estimasi dan perubahan desain memberikan pengaruh terbesar, sementara faktor eksternal memperbesar dampak deviasi biaya.Penelitian ini diharapkan dapat menjadi bahan evaluasi bagi kontraktor dan perencana untuk meningkatkan akurasi perencanaan biaya dan pengendalian proyek struktur gedung di masa mendatang.

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1. INTRODUCTION

Development development building multi- storey building in Medan City a number of year final show quite an improvement rapidly, along with with growth economy and needs will facility offices, education, housing vertical, as well as center service public. Building construction the demand thorough planning, especially in aspects costs, because error in planning budget can impact direct to sustainability project. One of the most frequent problems appear in project construction is occurrence swelling cost *(cost overrun),* that is condition when cost current project exceed costs that have been planned in Plan Budget Cost (RAB) (Ardiputra et al., 2025).

Work structure building is component main absorbent portion cost the biggest in project construction. Structure covering foundations, columns, beams and slabs the floor in general use concrete boned. Due to the complexity calculation, work structure own level risk error high estimate. Inaccuracy volume calculation, usage price units that are not latest, and change design in the middle implementation often become reason main occurrence swelling costs on the part structure (Atapattu et al., 2022).

In Medan City, field practice show that Still Lots project the building that experienced deviation between cost plans and costs realization, especially in work structure. Deviation the No only impact on losses financial contractor, but also can cause conflict between owner projects and parties implementer, disturbing cash flow, as well as slow down settlement project. In addition, the swelling costs can also be lower investor confidence in performance provider service construction (Herdiani et al., 2022).

Causative factor swelling cost No only originate from aspect technical, but also from aspect managerial and external (Carapella, 2023). From the side technical, error in read image, lack of accuracy in calculate volume, as well as assumptions productivity power work that is not realistic often happened. From the side managerial, weak coordination between planners, estimators, and implementers field participate enlarge potential error. While that, factor external like fluctuations material prices, limitations supply, as well as change condition the economy also contributes to increasing cost project (Hussain et al., 2022).

Remember size impact swelling cost to success project, required further study deep about factors the cause, especially at work structure building in Medan City. With understand source problem in a way systematic, expected can formulated improvement strategies in planning and control cost project (Abdelhaleem & gad, 2022). Therefore that, research This done For identify factors dominant reason swelling costs on the job structure building in Medan, so that can become material evaluation and references for

practitioners construction in increase accuracy planning future costs (Goggins & Hajdukiewicz, 2022).

Problem Formulation

Study This designed For answer question :

1. Anything factors that cause swelling costs on the job structure building in Medan?
2. How each factor the contribute to magnitude deviation cost ?
3. What are the recommendations ? improvements that can be made implemented in planning cost structure building ?

Research Objectives

main purpose study This is :

1. Identifying factor reason swelling costs on the job structure building in Medan.
2. Analyze contribution factors the to deviation cost.
3. Give recommendation For increase accuracy planning and control cost structure.

2. LITERATURE REVIEW

1. Planning Cost Construction

Planning cost is part important in management project purposeful construction For estimate funding needs in general accurate before implementation project started. Planning This poured in form Plan Budget Cost (RAB), which is compiled based on picture plans, specifications technical, as well as Unit Price Analysis Jobs (AHSP). According to Soeharto (Nababan et al., 2020) good RAB must reflect condition realistic field, including all over component work, and use price the latest unit. Error in planning cost can cause significant deviation between cost plans and costs actual.

2. Swelling Cost *(Cost Overrun)*

Swelling cost defined as difference between cost current more projects big compared to planned costs. Kerzner (Rani et al., 2025) stated that cost overrun is indicator weakness system planning and control costs. Swelling cost often happened on the project with complexity high, such as building tiered, because involving many work items interconnected structures related. Love et al. (Sari et al., 2022) also confirms that optimism excessive at the stage planning often become reason main occurrence deviation cost.

3. Job Building Structure

Structure building covering foundations, columns, beams and slabs functional floor withhold burden and care stability building. In the structure concrete bony, precision Calculation of concrete and reinforcement volume is very important accuracy costs. According to Dipohusodo (Simamora et al., 2023) work structure usually absorb more from 40% of total costs project building. Therefore that's a mistake small in calculation structure can impact big to total costs project.

4. Causal Factors Swelling Cost

A number of study mention that swelling cost influenced by internal and external factors. Internal factors include error volume calculation, changes design, low productivity power work, and weakness coordination team project (Susilowati et al., 2023).External factors covering fluctuations material prices, delays supply, as well as

change condition economics and policy (Hidayat, 2020). Kaming et al. (2017) also mentioned that poor communication between party project can enlarge risk deviation cost.

5. Control Efforts Cost

Control cost done through monitoring realization cost in a way periodically and compare them with RAB. Use technology like BIM 5D can help increase accuracy volume and cost calculations. Eastman et al. (Tafida et al., 2024) explain that BIM allows design data integration with estimate cost in real time, so that minimize errors and changes that are not controlled.

3. METHODOLOGY STUDY

Approach

Study This use approach descriptive quantitative purposeful For identify and analyze factors reason swelling costs on the job structure building in Medan City. Approach This chosen Because capable describe condition real in the field in a way systematic based on measurable cost data as well as opinion respondents involved direct in project (Tayong et al., 2025).

Location and Object Study

Study implemented on several project building multi- storey building located in Medan City. The object study focused on work structure concrete bones that cover foundations, columns, beams and slabs floor. Selection project done by purposive sampling, namely based on availability of RAB data and reports realization cost as well as willingness party contractor For become respondents (Theresa, 2022).

Types and Sources of Data

Data used in study This consists of from primary data and secondary data.

1. Primary data obtained through interview structured and questionnaire to manager project, estimator, and implementer field For know factors reason swelling cost.
2. Secondary data obtained from document project in the form of RAB, reports realization costs, images work, and timetable implementation.

Data Collection Techniques

Data collection was carried out with three method main :

1. Document Study, namely analyze comparison between RAB and costs current work structure.
2. Interview Structured, for get information about obstacles and causes deviation cost.
3. Observation, for ensure suitability between planning and conditions implementation.
4. Data Analysis Techniques

Data analysis was performed with count deviation cost use formula (Wahyudi et al., 2020):

$$\text{Deviasi (\%)} = \frac{\text{Biaya Aktual} - \text{Biaya RAB}}{\text{Biaya RAB}} \times 100\%$$

Next, the factors reason swelling cost analyzed based on frequency emergence and level its influence use scale assessment (Likert). Questionnaire results processed For determine factor dominant (Widyawati et al., 2022).

Validity and Reliability

For ensure data validity, carried out triangulation source between results interviews, documents projects and observations field (Alfakhri et al., 2021). Reliability test performed on the instrument questionnaire so that the results obtained consistent and able accountable (Agyekum et al., 2021). Methodology This expected capable give accurate depiction about factors main reason swelling costs on the job structure buildings in Medan City (Zaqout et al., 2025).

4. RESULTS OBSERVATION AND DISCUSSION

Observation result

Observation result obtained through observation directly in the field, study document projects, as well as interview with parties involved in work structure buildings in Medan City.

Deviation Cost Structure in Project

Table 1. Comparison results RAB costs and costs actual on three project buildings in Medan:

Project	Structure RAB Cost (Rp)	Cost Current Structure (Rp)	Deviation (%)
A	11,500,000,000	12,650,000,000	+10.0%
B	9,200,000,000	10,360,000,000	+12.6%
C	13,820,000,000	15,140,000,000	+9.6%

Based on Table 1. Average deviation cost structure as big as **+10.7%,** indicating swelling significant costs in each project.

Causal Factors Swelling Cost

Results of interviews and observations identify factor main as following :

Table 2. Observation Results Swelling Cost Building Structure

No	Observed Aspects	Condition Plan (RAB)	Condition Current	Impact to Cost
1	Column & beam volume calculation	Based on picture beginning	Change dimensions	Cost increase
2	Change design	n't any revision	Revision reinforcement	The volume of material increases
3	Material prices	Starting price	Rising price	Cost current more tall
4	Productivity power	Standard	More low	Cost wages increase
5	Coordination team	Formal	Late	Work repeat

Based on Table 2. Observations done on three project building medium and high level finished built. Focus observation directed at suitability between plan budget cost (RAB), method implementation, as well as realization costs on the job structure concrete boned.

1. Compliance with the RAB Field Conditions

Based on results studies document, found existence difference between work volumes listed structures in the RAB with the actual volume in the field. The difference This especially happened at work columns and beams, where the dimensions current experience change consequence adjustment design structure. Some changes the No quick updated in the RAB, so that cause difference sufficient cost big on stage realization.

2. Design Changes During Implementation

On two of three observed projects, occurred change design structure after work started. Changes the covering addition reinforcement, improvement quality concrete, and change dimensions element structure certain (Kometa et al., 2022). Changes This impact directly on increasing material volume and working hours energy, which in the end increase cost current exceed plan beginning (Flyvbjerg et al., 2023).

3. Material Price Fluctuations

Observations also show existence increase main material prices such as cement, sand, and reinforcing steel during the implementation period project. The unit price used in the RAB no Again in accordance with current market price work ongoing. Conditions This cause cost increased material purchases significant and become one of the contributor the biggest swelling cost (Flyvbjerg et al., 2018).

4. Labor Productivity

From the results observation field, productivity power Work often more low compared to assumptions used in RAB calculation. Weather factors, limitations equipment, as well as lack of power skilled influence speed work. As a result, the duration Work become more length and cost wages increase.

5. Project Team Coordination

Observation to the coordination process show that communication between planners, estimators, and implementers field Still not optimal. Information about change design or specification often late delivered, so that work that has been done done must repaired or repeated. This is cause waste of materials and time, which leads to increased cost (Ktaish & Hajdu, 2022).

In a way overall, results observation show that swelling costs on the job structure buildings in Medan are influenced by a combination of factor technical, managerial, and external. Findings This strengthen importance more planning accurate, good coordination, and control tight fees since stage beginning project.

Discussion

Observation result show that swelling costs on the job structure buildings in Medan City are problems of a nature complex and influenced by various factors interrelated factors related. Average deviation costs incurred on the project being observed show that planning cost Not yet fully reflect condition implementation in the field. This is confirm

that Plan Budget Cost (RAB) no only functioning as document administrative, but also as tool control costs that must be arranged in a way accurate and updated in a way periodically (Mutisya & Wanyona, 2017).

The most dominant main factor is inaccuracy calculation of work volume structure. Error in read picture work, change dimensions element structure, as well as lack of accuracy in calculating the volume of concrete and reinforcement cause enough difference big between the planned volume and the actual volume. Findings This in line with opinion Dipohusodo (Tengan & Aigbavboa, 2020) stated that that work structure own risk error highest estimate Because complexity the calculation.

The next factor is change design during implementation project. In some project, revision design done after work structure started. This is cause additional material volume and time work that is not listed in the initial RAB. Conditions This show weakness coordination between planners and implementers, as well as lack of evaluation design in a way comprehensive before project started.

Apart from internal factors, fluctuations material prices also provide contribution big to swelling costs. Increase prices of reinforcing steel, cement and sand during the implementation period cause cost current Far more tall compared to estimate beginning. This is indicates that use price units that are not up to date and not consider risk increase price be one of weakness in planning cost.

Productivity power more work low from assumptions the beginning also has an effect significantly. Longer implementation time increases cost wages and costs No direct others. The low productivity This influenced by factors weather, limitations tools, and lack of power Work skilled (Waty & Sulistio, 2022).

Lastly, the lack of coordination and communication between party project enlarge potential swelling costs. Late information or No synchronous cause work must repaired or repeated, so that add costs (Yuliani & Kurniawan, 2020). Therefore that, swelling cost No only is problem technical, but also reflects weakness in management project.

With understand factors said, can concluded that effort prevention swelling cost must started from more planning accurate, more coordinated good, and control ongoing costs during project ongoing (Mutisya & Wanyona, 2017).

5. CONCLUSION

Swelling cost is real problems that occur throughout the world observed projects. Comparison results between Plan Budget Costs (RAB) and costs current show existence deviation positive, which indicates that cost realization exceed cost planning.

a. Identify factor reason swelling costs, have achieved. Factors main cause occurrence swelling cost covering inaccuracy calculation of work volume structure, change design during implementation projects, fluctuations low material prices productivity power work, and lack of coordination and communication between parties involved in project.
b. Analyze contribution factors the to deviation costs, showing that internal factors such as volume errors and changes design own the most dominant influence, whereas factor external like increase material prices also enlarge swelling cost.

c. Giving recommendation repair, can formulated that improvement accuracy planning, updating price data, control change design, as well as strengthening coordination team project is step important For minimize swelling costs on the job structure buildings in Medan City.

Suggestions

1. Increase Accuracy Planning Cost.

All parties involved in project recommended do structural volume calculation in detail and using price data units that always updated so that the RAB is more realistic and close cost actual.

2. Design Change Control

Every change design must through the evaluation process technical and cost before applied, as well as documented in a way official For prevent swelling costs that are not controlled.

3. Strengthening Project Coordination and Control

Need intensive communication between planners, estimators, and implementers field so that information changes and constraints can quick handled, so that risk deviation cost can minimized.

REFERENCES

Abdelhaleem, H., & gad, manal. (2022). Model Biaya Sistem Pipa Air yang Digunakan dalam Irigasi. *Research Square*. https://doi.org/10.21203/rs.3.rs-2355474/v1

Agyekum, K., Ayarkwa, J., & Adinyira, E. (2021). Cost overrun in construction projects: A review of contributory factors. *Journal of Engineering, Design and Technology*, *19*(3), 565–582. https://doi.org/10.1108/JEDT-07-2020-0296

Alfakhri, M. A., Ismail, S., & Subramaniam, C. (2021). Critical factors contributing to cost overrun in construction projects: A case study in Saudi Arabia. *International Journal of Construction Management*, *21*(6), 543–555. https://doi.org/10.1080/15623599.2019.1592909

Ardiputra, S., Milyan, M., Akhmad, Z., Sulthan, M., & Ardiputra, M. A. (2025). Mengoptimalkan kebijakan anggaran dalam alokasi dana desa (ADD): perspektif tata kelola dan administrasi publik tentang pembangunan pedesaan. *Frontiers in Political Science*, *7*. https://doi.org/10.3389/fpos.2025.1581806

Atapattu, C. N., Domingo, N. D., & Sutrisna, M. (2022). Pemodelan biaya statistik untuk estimasi biaya tahap awal proyek infrastruktur. *IOP Conference Series: Earth and Environmental Science*, *1101*(5), 52031. https://doi.org/10.1088/1755-1315/1101/5/052031

Carapella, P. (2023). Cara Menilai Kebutuhan Pengeluaran Tujuan Pembangunan Berkelanjutan. *Catatan Cara IMF*, *2023*(005), 1. https://doi.org/10.5089/9798400258787.061

Flyvbjerg, B., Ansar, A., Budzier, A., Buhl, S., Cantarelli, C., Garbuio, M., Glenting, C., Holm, M. S., Lovallo, D., Lunn, D., Molin, E., Rønnest, A., Stewart, A., & van Wee, B. (2018). Five things you should know about cost overrun. *Transportation Research Part A: Policy and Practice*, *118*, 174–190. https://doi.org/10.1016/j.tra.2018.07.013

Flyvbjerg, B., Holm, M. S., & Buhl, S. (2023). How common and how large are cost overruns in transport infrastructure projects? *Transport Reviews*, *23*(1), 71–88.

Goggins, J., & Hajdukiewicz, M. (2022). Peran Pembelajaran Berbasis Komunitas dalam Pendidikan Teknik untuk Pembangunan Berkelanjutan. *Keberlanjutan*, *14*(13), 8208. https://doi.org/10.3390/su14138208

Herdiani, A., Hermawan, A., Rahmawati, S. A., Palil, M. R., & Havies, R. (2022). *Urbanisasi Sektor Regional untuk Memperkuat Perekonomian dan Bisnis untuk Pulih dari Resesi BT - eBuku Routledge. Informasi*. https://doi.org/10.1201/9781003303336

Hussain, S., Maqbool, R., Hussain, A., & Ashfaq, S. (2022). Menilai Dampak Sosial Ekonomi Proyek Infrastruktur Pedesaan terhadap Pembangunan Masyarakat. *Bangunan*, *12*(7), 947. https://doi.org/10.3390/buildings12070947

Kometa, S., Olomolaiye, P., & Harris, F. C. (2022). Attributes of UK construction clients influencing project consultants' performance. *Construction Management and Economics*, *3*(2), 433–443.

Ktaish, B., & Hajdu, M. (2022). Success factors in projects. *IOP Conference Series: Materials Science and Engineering*, *1218*(1), 12034. https://doi.org/10.1088/1757-899X/1218/1/012034

Mutisya, M. M., & Wanyona, G. (2017). A study of cost overrun in construction projects in Kenya. *International Journal of Project Management*, *35*(6), 1113–1125.

Nababan, R. E., Amin, M., & Badaruddin, B. (2020). Implementasi Dana Desa dalam Mendukung Pembangunan Infrastruktur: Studi Kasus di Desa Purba Manalu, Kabupaten Humbang Hasundutan, Indonesia. *Jurnal Internasional Pemahaman Multikultural Dan Multiagama*, *7*(8), 251. https://doi.org/10.18415/ijmmu.v7i8.1847

Rani, N. I., Abdull Rahman, S. H., & Mat Isa, C. M. (2025). Keterlibatan Masyarakat Dan Pembelajaran Siswa Melalui Proyek Sulam Internasional: Wawasan Dari Simposium Internasional Pertama Tentang Komunitas Berkelanjutan. *Jurnal Internasional Pendidikan Modern*, *7*(24), 878–886. https://doi.org/10.35631/ijmoe.724063

Sari, Y. K., Sholihah, Q., & Wanusmawatie, I. (2022). Evaluasi Program Pengembangan Kapasitas Aparatur Pemerintah Desa (Suatu Kajian Pelatihan Penyusunan RPJM Desa dan RKP Desa Kabupaten Bojonegoro di Balai Besar Pemerintahan Desa di Malang). *Jurnal Ilmiah Administrasi Publik*, *8*(2), 214–224. https://doi.org/10.21776/ub.jiap.2022.008.02.11

Simamora, W. T., Dalimunthe, A. A., & Daulay, A. N. (2023). Analisis Akuntabilitas dan Transparansi dalam Pengelolaan Anggaran Pendapatan dan Pengeluaran Desa (APBDes) di Desa Pakkat Hauagong, Kabupaten Humbang Hasundutan. *Jurnal Manajemen Ekonomi Dan Akuntansi*, *2*(2). https://doi.org/10.37676/jmea.v2i2.184

Susilowati, F., Adipradana, A. Y., & Puspitasari, E. (2023). Pemberdayaan masyarakat dalam perencanaan teknis pembangunan sebagai upaya peningkatan kualitas infrastruktur desa. *Pemberdayaan Masyarakat*, *8*(1), 68–75. https://doi.org/10.31603/ce.7576

Tafida, A., Alaloul, W. S., Zawawi, N. A. B. W., Musarat, M. A., & Abubakar, A. S. (2024). Tinjauan Inovasi Infrastruktur Jalan Ramah Lingkungan untuk Transportasi Berkelanjutan. *Infrastruktur*, *9*(12), 216. https://doi.org/10.3390/infrastructures9120216

Tayong, N. P., Sanoy, E. M., & Villamor, K. J. (2025). Menghubungkan Pengetahuan Penganggaran dengan Kinerja Pelayanan: Studi Kuantitatif Pejabat Desa. *Psikologi Dan Pendidikan: Jurnal Multidisiplin*, *37*(3), 292–303. https://doi.org/10.70838/pemj.370309

Tengan, C., & Aigbavboa, C. (2020). Analysis of causes of cost overrun in Ghanaian construction projects. *International Journal of Construction Supply Chain Management*, *10*(1), 55–66.

Theresa, M. (2022). *Estimasi Biaya dalam Operasi Negara: Catatan Panduan Teknis*. https://doi.org/10.22617/tim220067-2

Wahyudi, A., Sartika, D., Heru Wismono, F., Erinda Ramdhani, L., Rosalina, L., Kusumaningrum, M., & Zakiyah, S. (2020). Mengkaji Kapasitas Organisasi dan Sumber Daya Manusia Pemerintahan Desa: Studi Kasus di Kabupaten Kutai Kartanegara. *Tinjauan Kebijakan & Tata Kelola*, *4*(2), 99. https://doi.org/10.30589/pgr.v4i2.267

Waty, M., & Sulistio, H. (2022). Causes for the change orders in road construction: Reviewed from owner. *Communications - Scientific Letters of the University of Žilina*, *24*(2), D72–D84. https://doi.org/10.26552/com.C.2022.2.D72-D84

Widyawati, W., Rahmayanti Yusuf, N., & Sulmiah, S. (2022). Analisis Sumber Daya Desa Dalam Mewujudkan Pembangunan Desa Berkelanjutan: Studi Kasus Desa Bontorappo, Desa Arungkeke, dan Desa Pattiro Kabupaten Jeneponto Sulawesi Selatan. *Jurnal Ilmiah Ilmu Administrasi Publik*, *12*(2), 439. https://doi.org/10.26858/jiap.v12i2.38378

Yuliani, E. D., & Kurniawan, A. (2020). Analisis faktor-faktor penyebab pembengkakan biaya proyek konstruksi perumahan. *Jurnal Teknik Sipil Dan Lingkungan*, *5*(2), 93–101.

Zaqout, M., Martins, F., Koch, M., Hansford, M., & Parikh, P. (2025). Pengetahuan teknik: Lembaga Insinyur Sipil dan Tujuan Pembangunan Berkelanjutan PBB. *Prosiding Lembaga Insinyur Sipil - Teknik Sipil*, 1–12. https://doi.org/10.1680/jcien.25.00004