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Budget Control Mechanism in Budgeting Function PT XYZ

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Abstract: Budget control plays a strategic role in ensuring cost effectiveness and operational sustainability, particularly in state-owned enterprises operating within a holding company structure. PT. XYZ, as part of the Integrated Marine Logistics Subholding under PSI, faces high operational complexity and diverse cost structures that require effective budget control mechanisms. This study analyzes the implementation of budget control within the Budgeting Function of PT XYZ and its contribution to effective cost management. This research employs a descriptive qualitative approach. Data were collected through direct observation of budget control activities, informal interviews with Budgeting Function staff, and documentation reviews, including the Company Work Plan and Budget (RKAP), standard operating procedures, and budget realization reports. Data analysis was conducted descriptively by examining workflows, control mechanisms, and factors influencing the effectiveness of budget control implementation. The results indicate that budget control at PT. XYZ has been systematically implemented with strong emphasis on pre-transaction control. The verification and authorization process of Purchase Requisitions (PR) through the MySAP system, including a double-release mechanism, ensures budget availability, compliance with approved allocations, and organizational authority. The effectiveness of budget control is influenced by cost center clarity and budget classification into Operational Expenditure.

Keyword: Budget Control, Cost Management, State-Owned Enterprise, Mysap, Budgeting System.

INTRODUCTION

Budget Control is a strategic element in maintaining the continuity of a company's operational activities, especially in large-scale companies within a holding structure. In State-Owned Enterprises (SOEs) and their subsidiaries, the budget not only functions as a plan for the use of funds, but also as a managerial control instrument to ensure that cost realization remains within predetermined limits. In this context, the budget control mechanism is a crucial part of cost management because it plays a role in ensuring the effectiveness, efficiency, and accountability of the use of the company's financial resources (Dissanayake et al., 2022).

As part of the Subholding Integrated Marine Logistics (SH IML) under PSI (PIS), PT . XYZ has a strategic role in supporting maritime services and energy logistics for the Pertamina Group. PT. XYZ's operations cover four main business segments, namely Port Operation, Support Vessel Provider, Marine Service, and Shorebase, each of which has complex and intensive cost characteristics. Activities ranging from operating a fleet of vessels, docking and maintenance, safety and pilotage services, to managing land logistics facilities require large budget allocations and strict supervision. This high level of complexity requires the implementation of an effective budget control mechanism so that every expenditure is in line with the Company's Work Plan and Budget (RKAP) and efficiency policies established by the Pertamina Group (Das et al., 2023).

Within PT XYZ's organizational structure, the Budgeting function plays a central role as budget controller at the operational level. This function is responsible for analyzing, verifying, and controlling financial data sourced from the Controller function, ensuring that every spending activity proposed by the user unit aligns with the budget allocation in the RKAP. Through this function, the company strives to maintain budget discipline and prevent overbudgets and expenditures that are inconsistent with operational objectives (Dahlan, 2018).

The operational implementation of budget control is reflected in the Purchase Requisition (PR) verification and authorization process through the SAP system. This process is carried out to ensure compliance between procurement requests and cost centers, General Ledger (G/L) accounts, and budget availability before proceeding to the Purchase Order (PO) stage managed by Pertamina's Shared Service Center (SSC). This mechanism demonstrates that budget control functions not only as a monitoring tool but also as a preventive instrument in cost decision-making (Crawford et al., 2023).

Although the budget control system has been structured and integrated with the company's information system, empirical studies specifically analyzing the budget control mechanism within the budgeting function within state-owned enterprise subsidiaries in the maritime and logistics sector are still relatively limited. Most previous studies have focused more on budget planning or general financial performance evaluation, thus failing to fully describe how the budget control process is implemented at the operational level and its contribution to cost management effectiveness (Chiluka et al., 2023).

Based on these conditions, this study aims to analyze the budget control mechanisms applied in the Budgeting function of PT XYZ and examine how the implementation of these mechanisms contributes to the effectiveness of the company's cost management. The results of this study are expected to provide academic contributions to the development of budget control studies in state-owned enterprises (BUMN) and provide practical input for management in strengthening a sustainable cost management system (Bhalodiya et al., 2023).

METHOD

This research uses a qualitative descriptive approach. According to (Farmakis et al., 2022), qualitative research is a research method based on post-positivism philosophy used to examine the natural conditions of objects, with the researcher acting as a key instrument. The qualitative descriptive approach aims to systematically, factually, and accurately describe the phenomena or objects being studied. This approach was chosen because the research focuses on understanding the processes, workflows, and budget control mechanisms within the Budgeting function at PT XYZ , particularly in the management and oversight of budget realization. This research is not intended to test statistical hypotheses, but rather to obtain an in-depth overview of budget control practices and the effectiveness of their implementation in supporting the company's cost management.

The data sources in this study consist of primary and secondary data. Primary data is the main data obtained directly by the researcher during the research process from parties directly related to the research object. According to Undari and (Ahmadi et al., 2024), primary

data can be obtained through observation, interviews, and other data collection techniques that involve direct interaction with respondents or informants. In this study, primary data was obtained through direct observation of budget control activities carried out by the Budgeting function, as well as informal interviews with related staff to obtain information regarding workflow, authorization processes, and obstacles encountered in implementing budget control.

In addition to primary data, this study also uses secondary data as supporting data. Secondary data were obtained from various documents and archives relevant to budget control activities at PT XYZ, including the Company's Work Plan and Budget (RKAP) document, the Budgeting function's Standard Operating Procedure (SOP), budget realization reports, as well as academic literature in the form of books, scientific journals, and government regulations related to budget management and BUMN financial management. Secondary data serves as complementary and comparative material to strengthen the analysis results obtained from primary data (Barton & Parker, 2024).

Data collection techniques in this study were conducted through observation, interviews, and documentation. Sugiyono (2017) stated that data collection techniques in qualitative research can be carried out through observation of the research object, interviews to obtain in-depth information, and documentation to support and verify the research findings. The combination of these three techniques was used to obtain comprehensive and in-depth data regarding the budget control mechanisms in the Budgeting function of PT XYZ (Faruqi et al., 2024).

RESULTS AND DISCUSSION

Budget control is a strategic element in maintaining the sustainability of a company's operational activities, particularly in large-scale companies operating within a holding structure. In State-Owned Enterprises (BUMN) and their subsidiaries, the budget functions not only as a financial planning tool but also as a managerial control instrument to ensure that cost realization remains within the predetermined limits. In this context, the budget control mechanism becomes an essential component of cost management, as it plays a role in ensuring the effectiveness, efficiency, and accountability of the company's financial resource utilization. (Drago et al., 2022).

In practice, budget control at PT. XYZ is predominantly carried out at the stage prior to the occurrence of transactions (pre-transaction control). The focus of control at this stage is intended to prevent budget deviations from the outset, thereby minimizing the risk of overbudget before transactions are realized in the financial system. (Beudeker et al., 2022).

The RKAP, which serves as the baseline in the budget control mechanism, is prepared using a hybrid budgeting approach. Budget proposals originate from work units and subsidiaries, and are subsequently compiled and evaluated through a tiered challenge session process until they are established as the final RKAP. With such characteristics in budget preparation, the budget control mechanism at PT. XYZ is designed in a layered manner to ensure alignment and continuity between planning, decision-making, and budget implementation. (Weiskirchen, 2025).

Cost Center Structure and Budget Responsibility

The cost center structure constitutes the primary foundation of the budget control system at PT. XYZ. Each manager and each vessel has its own cost center, which functions as a responsibility center for budget utilization. This allocation enables the company to distribute budgets specifically according to operational activities and the work units responsible for carrying out those activities. (Taher et al., 2025).

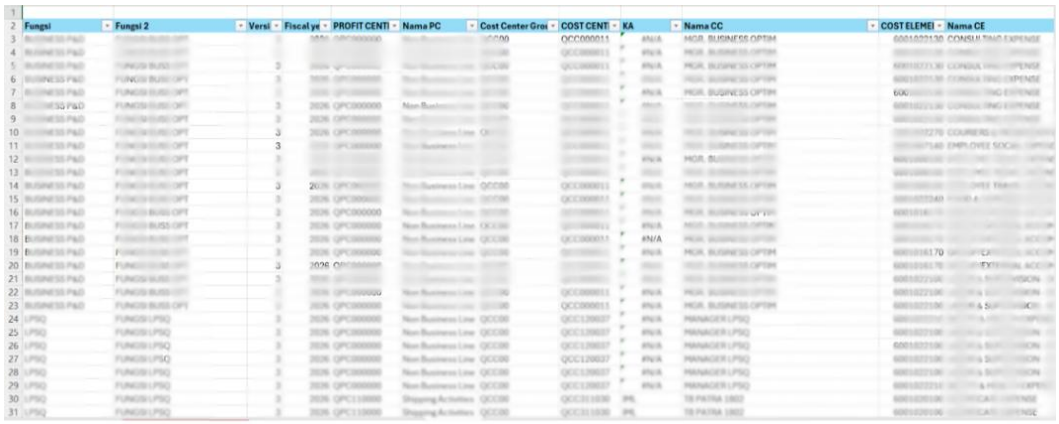

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Figure 5.1 Cost Center Structure

The existence of cost centers also facilitates the monitoring and evaluation of budget realization. Every transaction can be traced to its respective cost center, enabling the Budgeting Function and management to identify work units experiencing budget deviations more quickly and accurately. In addition to serving as a control tool, the cost center structure plays a significant role in decision-making when budget reallocation is required. With clearly defined divisions of responsibility, any budget reallocation must consider authority, operational impact, and the level of risk associated with the decision. (Taher et al., 2021).

Budget Classification and Control Approach

The budget in the RKAP of PT. XYZ is classified into Operational Cost Budget (ABO) and Investment Cost Budget (ABI). This classification not only serves to distinguish the types of expenditures but also becomes the basis for determining the budget control approach implemented by the company.(Ali et al., 2021).

ABO is related to the company's routine operational activities and involves a high frequency of transactions. Due to these characteristics, ABO has the potential to create risks of budget deviations if it is not strictly controlled. Therefore, ABO control is designed to be more layered and involves a combination of system-based controls and procedural controls. (Ahmed et al., 2022).In contrast, ABI is more selective in nature, involves larger values, and generally has undergone a thorough evaluation process during the RKAP preparation stage. With these characteristics, the ABI control approach is more focused on compliance with management decisions and approval mechanisms before transactions are realized. (Agustina et al., 2020).

Double Control on Operating Cost Budget (ABO)

ABO budget control at PT. XYZ is implemented through a double control approach, namely Systematic control and procedural control are implemented as complementary mechanisms. Systematic control is carried out through the utilization of the Fund Management (FM) module in the SAP system, which functions as a tool for monitoring budget availability and realization (Abbott Laboratories, 2021). Before users carry out transactions such as creating a Purchase Requisition (PR), they are required to first check budget availability using the T-code FMRP_RW_BUDCON. This process ensures that the proposed transaction remains within the limits of the allocated budget.

Within the ABO budget structure, the Work Breakdown Structure (WBS) used is generally coded as WOP. The FM module provides real-time visibility into the budget position, including the remaining budget and its realization. Through this systematic control, the company establishes an early warning mechanism before the budget approaches the predetermined limit.

In addition to systematic control, procedural control is implemented through verification processes and a double-release procedure for Purchase Requisitions (PR). The combination of these two forms of control ensures that ABO control does not rely on a single layer of control, thereby strengthening the overall effectiveness of budget oversight.. (Abbas et al., 2025).

Single Control on Investment Budget (ABI)

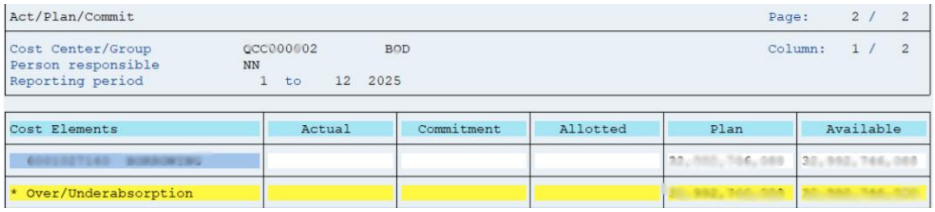
Budget control for ABI at PT. XYZ is implemented through a single control approach, namely procedural control through transaction approval mechanisms. ABI generally uses a Work Breakdown Structure (WBS) coded as WPC and has not yet utilized the FM module as the primary control tool in the transaction process.

This approach is applied because the ABI budget has undergone a rigorous planning and evaluation process during the RKAP preparation stage, including feasibility assessments and evaluations of its impact on company performance. Accordingly, the focus of control is directed toward ensuring compliance with established management decisions.

Although it relies on only one layer of control, the single control mechanism for ABI is considered adequate because the number of transactions is relatively limited while the investment values are significant. Control is exercised by ensuring that each investment transaction obtains approval from the authorized parties in accordance with applicable regulations.

PR Verification Process as a Budget Control Instrument

The PR verification process is an important stage in the budget control mechanism because it serves as the point of convergence between systematic control and procedural control. At this stage, the Budgeting Function examines various budget parameters before the PR can be processed further.



Act/Plan/Commit Page: 2 / 2

Cost Center/Group QCC000002 BOD Column: 1 / 2
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Cost Elements	Actual	Commitment	Allotted	Plan	Available
[redacted]				[redacted]	[redacted]
* Over/Underabsorption				[redacted]	[redacted]

Figure 5.2 Example of Remaining Budget SAP

The parameters examined include the remaining budget , cost center , general ledger account, budget period, transaction value, justification for the submission, and the suitability of the WBS used. This verification aims to ensure that the proposed transactions align with the company's RKAP and budgeting policies. Through the PR verification process, the Budgeting Function acts as a gatekeeper , preventing out-of-budget transactions from proceeding to the realization stage. Thus, PR verification is a crucial tool in maintaining budget discipline at PT. XYZ.

Double Release Mechanism as Budget Control

The parameters examined include the remaining budget, cost center, general ledger account, budget period, transaction value, justification for the request, and the appropriateness of the WBS used. This verification aims to ensure that the proposed transaction is consistent with the RKAP and the company's budgeting policies. Through the PR verification process, the Budgeting Function acts as a gatekeeper that prevents non-compliant transactions from proceeding to the realization stage. Therefore, PR verification becomes an important instrument in maintaining budget discipline at PT. XYZ.

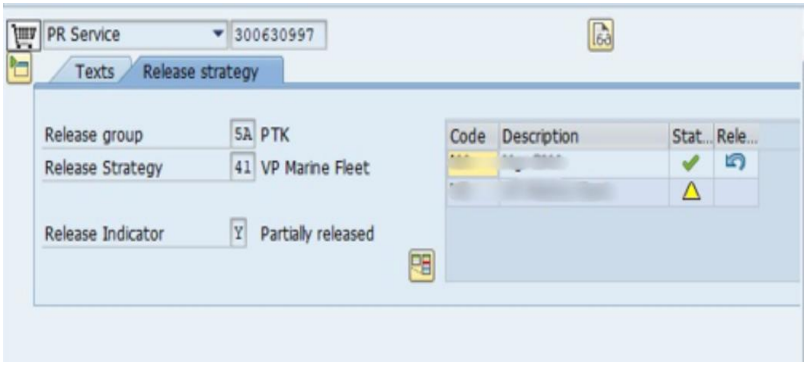

Figure 5.3 Double Release Mechanism

At the first stage, the release is carried out by the Manager of Budgeting as an initial validation of budgetary aspects, including budget availability, the appropriateness of account classification, cost center, general ledger, and the suitability of the WBS used. This first-stage approval ensures that the transaction is aligned with the RKAP and the company's budgeting regulations. After obtaining approval from the Manager of Budgeting, the PR proceeds to the second release stage by the authorized officials, such as the relevant Vice President (VP) or General Manager (GM).

Approval at this stage emphasizes authority, urgency of the requirement, and the alignment of expenditures with the operational or investment objectives of the respective work unit. The implementation of the double-release mechanism serves as an additional control layer (second layer of control) that separates the budget control function from the decision-making function. This separation enhances accountability and transparency while minimizing the risk of budgeting errors and overbudget occurrences.

Threshold, Lock Budget, and Budget Transfer

As a form of advanced control, PT. XYZ implements threshold and budget lock mechanisms to regulate budget realization during the ongoing period. When budget realization reaches 80%, the system generates a warning (budget almost exhausted) as an early signal for the work unit to evaluate its budget utilization and to reassess spending priorities. This warning encourages the unit to ensure that the remaining budget is allocated only to essential activities and to prevent unnecessary expenditures.

If budget realization continues to increase and reaches the predetermined limit, the system can restrict further transactions until an evaluation and approval process is completed. This mechanism functions as a preventive measure to maintain budget discipline, ensuring that expenditures remain aligned with the RKAP and supporting the company's financial control objectives.

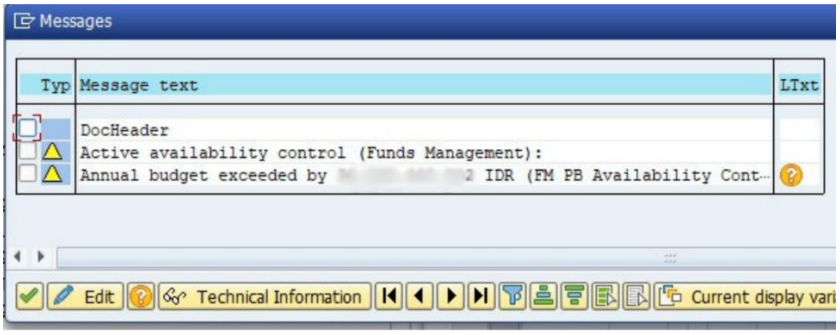

Figure 5.4 Overbudget Warning Messages

When budget realization exceeds 100%, the system automatically locks the related account or cost center, preventing any further transactions from being executed. This condition compels the work unit to conduct an internal evaluation and make decisions regarding the necessity of budget reallocation. The locking mechanism serves as a strict control measure to ensure that expenditures do not continue without formal review and authorization, thereby safeguarding financial discipline and preventing uncontrolled overspending.

Budget reallocation is processed through the Budgeting Function using a tiered approval mechanism. Transfers between cost centers within the same directorate require approval from the relevant Vice President (VP), while reallocations across different VPs or directorates must obtain approval from the respective Directors. This multi-level approval structure reflects the implementation of authority-based control, where the level of authorization corresponds to the risk and impact of the budgetary decision.

Furthermore, this mechanism ensures that every reallocation is supported by clear justification, aligned with operational priorities, and documented as part of the company's financial governance process. By integrating system restrictions with hierarchical approval procedures, PT. XYZ maintains a balance between flexibility in addressing operational needs and strict adherence to accountability principles in budget management.

Monitoring and Evaluation of Budget Realization

Monitoring and evaluation of budget realization are conducted periodically through budget-versus-actual reports and year-to-date (YTD) profit and loss statements. The Budgeting Function actively analyzes the variance between the planned budget and its realization to assess the effectiveness of the implemented budget control mechanisms. This analysis enables the company to identify trends, detect inefficiencies, and recognize potential risks at an early stage.

The monitoring results are used not only as reporting instruments but also as a basis for managerial evaluation and decision-making during the ongoing period. Management can use these insights to adjust spending priorities, implement corrective actions, and ensure that financial performance remains aligned with operational targets.

In addition, the evaluation of budget realization serves as an important input in the preparation of the RKAP for the subsequent period. Lessons learned from variance analysis, spending patterns, and operational challenges are incorporated into future planning, thereby creating a continuous budget control cycle that integrates planning, implementation, monitoring, and improvement.

Evaluation of the Effectiveness of the Budget Control Mechanism in the Budgeting Function of PT XYZ

The implementation applied by the Budgeting Function of PT. XYZ has been able to control budget realization and prevent the occurrence of overbudget. This evaluation focuses on the mechanisms described in Chapter 4.3, particularly the control exercised before transactions are realized (pre-transaction control).

In general, the budget control mechanism at PT. XYZ demonstrates a good level of effectiveness because it emphasizes control at the initial stage of transactions. This approach enables potential budget deviations to be prevented before they affect the company's financial statements. The application of pre-transaction control is also consistent with managerial control principles that prioritize preventive actions rather than corrective measures.

For Operational Cost Budgets (ABO), the implementation of double control through the combination of the Fund Management module and verification and double-release procedures is considered effective in managing budgets with a high transaction frequency. The Fund Management module functions as a tool for monitoring budget availability, while the verification and tiered approval mechanisms ensure compliance with budgeting regulations and organizational authority. Meanwhile, for Investment Cost Budgets (ABI), the single-control

approach through tiered approval mechanisms is deemed adequate because investment budgets have undergone thorough planning and evaluation during the RKAP preparation stage.

The double-release mechanism represents one of the main strengths of the PT. XYZ budget control system, as it creates a clear separation of roles between the Budgeting Function as the budget controller and operational management as the decision-maker. In addition, the implementation of threshold warnings, budget locks, and budget reallocations with tiered approvals reinforces authority-based control. Nevertheless, potential weaknesses remain, including reliance on user accuracy and the complexity of the cost center structure. Overall, the PT. XYZ budget control mechanism has operated effectively and is aligned with the principles of responsible accounting.

This section describes the data collection process, the time frame and location of the study, and the results of data analysis, which may be supported by illustrations in the form of tables or figures rather than raw data or screenshots of analytical outputs. It also discusses the relationship between the findings and the underlying theoretical concepts, and, where applicable, the results of hypothesis testing, including their consistency or divergence from previous studies along with their respective interpretations. Furthermore, this section may outline the implications of the research findings, both theoretically and practically. Every figure and table used must be properly referenced and explained within the text, and each should include numbering and source attribution. The following provides examples of formatting for headings, subheadings, and subsequent hierarchical levels.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the budget control mechanism within the Budgeting Function of PT. XYZ has been systematically designed and implemented as an integral part of the company's internal control system. Budget control is focused on the stage prior to transaction realization (pre-transaction control), using the Company Work Plan and Budget (RKAP) as the primary reference for every transaction executed. Through continuous monitoring and evaluation of budget realization, the company seeks to ensure that all expenditures remain within the predetermined limits and are aligned with the organization's operational objectives.

The verification and authorization process of Purchase Requisitions (PR) through the MySAP system plays a critical role as a key instrument in the budget control mechanism. The implementation of a double-release mechanism enables multi-layered control, covering aspects such as budget availability, the appropriateness of cost allocation to the relevant cost centers and budget accounts, as well as compliance with organizational authority. This mechanism contributes to minimizing the risk of budget deviations and supporting budgetary discipline at the operational level (Kalas et al., 2021).

The effectiveness of budget control implementation within the Budgeting Function of PT. XYZ is influenced by several factors, including the clarity of the cost center structure, the classification of budgets into Operational Cost Budget (ABO) and Investment Cost Budget (ABI), and the application of distinct control mechanisms for each budget category. The adoption of double control for ABO and single control for ABI demonstrates an adaptive control approach based on the characteristics and risk levels associated with each type of expenditure.

In addition to system and structural factors, the level of user understanding regarding budgeting mechanisms and the complexity of the systems employed also affects the overall effectiveness of budget control (Hoffbrand & Steensma, 2020). Therefore, continuous capacity building, system familiarization, and procedural clarity are essential to ensure that the established control mechanisms function optimally and consistently support sound financial governance.

REFERENCE

Abbas, AB, Yahya, A., Aloqab, Z., AlHudhaifi, A., Alateef, AA, Morshed, A., & others. (2025). Determination of reference intervals for common liver function tests among healthy adults. Scientific Reports , 15 , 12896.

Abbott Laboratories. (2021). Aspartate Aminotransferase 2 for Use with Alinity c System: Package Insert .

Agustina, R., Mandala, Z., & Indah, RN (2020). Relationship between serum ferritin levels and SGOT and SGPT enzyme levels in beta thalassemia major patients. JISKH , 11 , 252–257.

Ahmadi, A., Hosseini, S., Dorgalaleh, A., Hassani, S., Tabibian, S., Tavasoli, B., & others. (2024). Natural anticoagulant protein levels in patients with beta-thalassemia major: A case-control study. Journal of Hematology , 13 , 23–28.

Ahmed, MM, Al-Hakeem, AH, & Al-Abeadi, RS (2022). Overview on thalassemia: A review article. Medical Science Journal for Advanced Research , 3 , 26–32.

Ali, S., Mumtaz, S., Shakir, HA, Khan, M., Tahir, HM, Mumtaz, S., & others. (2021). Current status of beta-thalassemia and its treatment strategies. Molecular Genetics & Genomic Medicine , 9 , e1788.

Barton, J. C., & Parker, C. J. (2024). Hemochromatosis. Wintrobe's Clinical Hematology , 1378–1404.

Beudeker, BJB, Groothuismink, ZMA, Van Der Eijk, AA, Debes, JD, & Boonstra, A. (2022). Circulating cytokines reflect the etiology-specific immune environment in cirrhosis and HCC. Cancers , 14 , 4900.

Bhalodiya, VR, Valiya, LG, Mehta, N.A., & Padhariya, B.B. (2023). Correlation of serum ferritin levels in transfusion-dependent thalassemia major patients. International Journal of Contemporary Pediatrics , 10 , 330–333.

Chiluka, S., Blessy, P.S., Shanmuga, S.M., & Rajashekar, K. (2023). Clinical profile of transfusion-dependent thalassemia major children with reference to serum ferritin and liver function. Asian Journal of Medical Sciences , 14 , 260–265.

Crawford, DHG, Ramm, GA, Bridle, KR, Nicoll, AJ, Delatycki, MB, & Olynyk, JK (2023). Clinical practice guidelines on hemochromatosis. Hepatology International , 17 , 522–541.

Dahlan, SM (2018). Sample Size and Sampling Methods in Medical and Health Research . Salemba Medika.

Das, L., Mohapatra, A.P., Pradhan, P.A., & Upadhyay, S.K. (2023). Clinical profile and outcome of children with thalassemia admitted to a tertiary care teaching hospital. Research and Reviews in Pediatrics , 24 , 63–66.

Dissanayake, R., Samarasinghe, N., Waidyanatha, S., Pathirana, S., Neththikumara, N., Dissanayake, VHW, & others. (2022). Assessment of iron overload in transfusion-dependent beta-thalassemia. BMC Pediatrics , 22 , 344.

Drago, V.N., Dajnowicz, S., Parks, J.M., Blakeley, M.P., Keen, D.A., Coquelle, N., & others. (2022). Low-barrier hydrogen bonds preorganize the catalytic site of aspartate aminotransferase. Chemical Science , 13 , 10057–10065.

Farmakis, D., Eleftheriou, A., & Bain, B. (2022). Management of Transfusion Dependent Thalassemia (4th ed.). Thalassemia International Federation.

Faruqi, A., Zafar, T., Subuctageen, S., & Mughal, I. A. (2024). Iron overload and liver function in beta thalassemia major. Pakistan Journal of Medical Sciences , 40 , 2000–2004.

Hoffbrand, A. V, & Steensma, D. P. (2020). Hoffbrand's Essential Hematology (8th ed.). Wiley.

Kalas, M.A., Chavez, L., Leon, M., Taweesedt, P.T., & Surani, S. (2021). Abnormal liver enzymes: A review for clinicians. World Journal of Hepatology , 13 , 1688.

Taher, A.T., Farmakis, D., Porter, J.B., Cappellini, M.D., & Musallam, K.M. (2025). Guidelines for the Management of Transfusion-Dependent Beta-Thalassaemia (5th ed.). Thalassemia International Federation.

Taher, A.T., Musallam, K.M., & Cappellini, M.D. (2021). Beta-thalassemias. New England Journal of Medicine , 384 , 727–743.

Weiskirchen, R. (2025). From spark to wildfire: how hyperferritinemia fans the flames of metabolic dysfunction-associated steatotic liver disease. Exploratory Digestive Diseases , 4 , 100599.