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Software Accounting Information System Design for Costing of Production of Low Carbon Concrete Products

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Abstract
Human behavior emerges from the dynamic interplay between cognitive processes and endocrine activity, yet these This research aims to design an accounting information system to determine the cost of production (HPP) of low-carbon concrete as an effort to support the development of environmentally friendly construction materials. The construction industry produces high carbon emissions, so accurate and structured cost calculations are needed to control production efficiency. However, companies still use manual recording which has the potential to cause errors and inaccuracies in information. This study uses the Full Costing method to determine the components of HPP, including raw material costs, direct labor, and factory overhead costs. The system design was carried out using the Waterfall method, but this research stopped at the design stage and has not yet produced an application. The results of the research are in the form of system modeling which includes context diagrams, DFD, flowcharts of the HPP calculation process, and ERD as the basis for software design. This design is expected to be the foundation for the development of low-carbon concrete HPP calculation applications in future research.

Keywords: Accounting Information Systems, Data Flow Diagram, Flowchart, Low Carbon Concrete HPP, System Design..

INTRODUCTION

The construction sector is currently facing major challenges related to the issue of climate change. The construction industry globally accounts for a large amount of greenhouse gas emissions, contributing about 30 to 40 percent to the world's total energy consumption (H. Li et al., 2019). Carbon emissions from construction generally come from building materials, production processes, and transportation of construction materials. Carbon emissions occur starting from the extraction of raw materials to the dismantling stage (Wang et al., 2024). In addition, the demolition of buildings will generate construction waste that has an impact on the environment (X. Li et al., 2022). This is a special concern for the industrial sector in reducing carbon emissions to support industrial sustainability. One way to reduce carbon emissions is to develop low-carbon concrete products that can be used as an alternative material to environmentally friendly products (Shi et al., 2018; Zhao et al., 2025).

Concrete is the most widely used material in the world compared to other materials such as steel and wood used in the construction industry, but most of the content in concrete is cement, which produces large amounts of carbon emissions during the production process (Wasim et al., 2022). The production of environmentally friendly concrete materials is carried out by reducing material materials that can have an impact on the environment. The use of environmentally friendly materials supported by technological advances can reduce the carbon emissions produced. Several previous studies have examined sustainable eco-friendly concrete materials (Abeer et al., 2023; Agrawal et al., 2024; Doye, 2017; Phuyal et al., 2023; Wasim et al., 2022). However, the study has not specifically discussed the calculation of the cost of production of environmentally friendly concrete materials.

The use of environmentally friendly materials can help reduce concrete production costs. Therefore, it is necessary to calculate the HPP correctly. The determination of environmentally friendly concrete HPP can help the operational activities of an entity engaged in construction, especially for entities that produce environmentally friendly concrete products. With the right calculation of HPP, companies can effectively determine the selling price of products so that products can compete effectively in the market. The determination of the cost of a product can be done by various methods, but in this study, the researcher chose the Full Costing approach to design the calculation of the cost of environmentally friendly concrete. The Full Costing method is used to improve the accuracy of cost analysis by charging all costs and factory overhead costs into a product (Ratnasih & Sulbahri, 2022).

In addition to the selection of the right HPP calculation method, the use of technology in the application of this method can play an important role in supporting the sustainability of the environmentally friendly concrete production process. Business entities need information systems to be able to do their work effectively and efficiently (Thottoli, 2021). An accounting information system is a system in an organization that is responsible for presenting information on transaction data that is beneficial to interested parties (Hosain, 2019; Turner et al., 2017). The main problem faced by entities to produce environmentally friendly concrete products is the lack of an accounting information system that can calculate the cost of production of low-carbon concrete products efficiently and accurately.

So far, companies have relied on conventional and manual recording that has the potential to cause errors in recording and calculating costs, inconsistencies in financial reporting, and non-real-time data presentation to meet the needs of management in the decision-making process. This research is important to carry out because low-carbon concrete is a new product that is a product of research by the Manado State Polytechnic together with a construction company partner, namely CV. Eternal Ray. Therefore, an accounting information system is needed to determine an integrated cost of production to help the process of recording, calculating, processing data and reporting costs in a structured manner. In addition to improving the accuracy of HPP calculations, this system also supports transparency and accountability in managing the cost of environmentally friendly products. The design of an accounting information system for low-carbon products makes it easier for companies to control cost efficiency, comply with government regulations related to the environment, and increase competitiveness for environmentally friendly products. The designed system should take into account ease of use, operational efficiency and cost, recording accuracy, and user satisfaction (Pantow et al., 2024)

This research aims to design an accounting information system that can accurately calculate the cost of production (HPP) of low-carbon concrete using the Full Costing method and the Waterfall development approach. The benefits of this research include: (1) providing a structured system design blueprint that can be implemented by construction companies producing environmentally friendly concrete; (2) improving accuracy and efficiency in HPP calculation processes, thereby reducing manual recording errors and enhancing data reliability; (3) supporting transparency and accountability in production cost management, which is essential for meeting environmental regulations and sustainability standards; (4) serving as a foundation for future research in developing software applications for sustainable construction material costing; and (5) contributing to the body of knowledge in green accounting and environmental cost management within the construction industry.

METHOD

The research method used was the elaboration of the Full Costing Method to determine the cost of production and the Waterfall Method for system development. The first stage was to determine the cost of production of low-carbon concrete products using the Full Costing Method. The Full Costing Method was a method to determine production costs that took into account all elements of production costs, including raw material costs, direct labor costs, and factory overhead costs, both fixed and variable in nature (Melati et al., 2022).

The stages carried out in this research began with a literature study related to cost accounting and green accounting to analyze cost components relevant to environmentally friendly concrete production. The researcher then processed the collected data—such as production equipment lists, raw materials, auxiliary materials, and supporting documents—and analyzed these inputs to calculate the cost of production for low-carbon concrete using the Full Costing Method. The results of this calculation became the foundation for designing a software-based Accounting Information System.

The second major stage involved designing this accounting information system using the Waterfall model, a structured and systematic approach that began with requirement specification and proceeded through planning, modeling, construction, and finally deployment to users. During communication and requirement gathering, the researcher conducted discussions and observations with potential users, collected and refined data, and reviewed literature from journals, books, and online sources. The planning phase included task estimation, scheduling, risk identification, and determining resources needed; the modeling phase focused on designing the system architecture, data structures, interface layouts, and programming logic; construction included coding and system testing to identify and correct errors; and deployment covered software delivery, maintenance, evaluation, and further development based on user feedback.

This study adopted a qualitative research approach aimed at understanding the characteristics of the research subject by examining components of specific phenomena and formulating problem potentials for future analysis. The research sought to understand the need for environmental cost accounting in the production of environmentally friendly concrete. The study was conducted at a construction company preparing to use low-carbon concrete materials, namely CV Sinar Abadi, and utilized two types of data sources: primary and secondary data.

Primary data came from direct interviews with business owners or key informants to explore how environmental costs were identified and calculated in construction projects, while secondary data was obtained from construction project reports and cost accounting documents. For software design, the RAD method was used in designing the application, while the SDLC method was applied for system development; these methods were integrated through several stages, beginning with business modeling—which included developing entity and activity tables, visualizing DFDs, and creating document flowcharts—followed by data modeling using ERD and LRS concepts to map data components and relationships. The process modeling stage implemented the designed business functions through form design and query design, which defined how data would be processed within the application; application formation represented the implementation of all modeling results into a functional software program, including report generati

on as system outputs and menu design to support user navigation; and the final stage involved testing and turnover, where each feature and component was tested for operational accuracy before further development progressed. Only after all components functioned properly did the researcher proceed with implementing additional modules or enhancements. This structured combination of Full Costing analysis, qualitative research methods, and systematic software development ensured that the resulting Accounting Information System effectively supported the calculation of low-carbon concrete production costs and fulfilled operational needs within the construction company.

RESULTS AND DISCUSSION

Overview of Eco-Friendly Concrete Production Process

Eco-friendly concrete is concrete that is made to reduce adverse impacts on the environment. The process starts from the selection of raw materials, the production process, to disposal or recycling. This process aims to create environmentally friendly concrete in an energy-efficient, resource-efficient and low-carbon emission manner.

Overview of Low Carbon Concrete Products

Low Carbon Concrete Product Description

Eco-friendly concrete is concrete that is made to reduce adverse impacts on the environment. The process starts from the selection of raw materials, the production process, to disposal or recycling. This process aims to create environmentally friendly concrete in an energy-efficient, resource-efficient manner and with low carbon emissions.

Main Raw Material Characteristics

Cement

Function: Cement has the function of hydraulic binding which hardens when mixed with water.Technical Characteristics: It has high pressure strength and stable volume. Environmental Contribution: It is the largest source of CO_2 emissions in concrete due to calcination processes and high energy consumption

Kaolin

Function: Pozolan material that improves long-term strength and reduces the porosity of concrete. Technical Characteristics: Stable at low temperature. Environmental Contribution: Carbon emissions are lower compared to cement. Kaolin also comes from local minerals, thus reducing the transportation footprint.

Fly Ash

Function: As a partial cement replacement material. Characteristics: Reduces hydration heat, improves workability without the addition of water. Environmental Contribution: Reduce energy consumption of raw material production.

Limestone

Function: Filler material and cement partial replacement. Characteristics: Fills micro-cavities and can accelerate the initial hydration reaction. Environmental Contribution: Limestone powder as a cement replacement has been documented to reduce overall carbon footprint while maintaining acceptable performance characteristics in structural applications (Phuyal et al., 2023).

Fine Aggregates and Coarse Aggregates

Function: As the largest volume constituent material of concrete, a determinant of strength and stability. Characteristics: Provides structure and mechanical strength and fills cavities between coarse aggregates. Environmental Contribution: has potential emission sources

Superpasticizer

Function: Increase workability without adding water. Characteristics: Produces high slumps Environmental Contribution: Helping to improve concrete strength and material efficiency.

Water

Function: Activates cement hydration and pozolan reaction. Characteristics: Cleanliness and quality affect the strength of concrete. Environmental Contribution: Efficient Use of Water is at the core of the concept of green construction

The system needs analysis consists of functional and non-functional requirements. The functional requirements include the system's ability to input raw material data, direct labor data, factory overhead costs, and production batch information, perform automatic cost of goods manufactured (HPP) calculations, and generate cost and HPP reports. Meanwhile, the non-functional requirements emphasize system security, ease of use, integration between modules, optimal system performance, and robust backup and reliability features to ensure data integrity. The proposed system process design includes the development of a Context Diagram that outlines the system boundaries and interacting external entities, followed by Data Flow Diagrams (DFD) at Level 0, Level 1, and optionally Level 2 to illustrate the movement of data across processes. Additionally, a series of process flowcharts—covering material usage, overhead allocation, production batch creation, and HPP calculation—are constructed to visually represent the workflow and procedural logic of the entire system.

Low Carbon Concrete HPP Accounting Information System Design

As part of the Modeling stage in the development of an accounting information system using the Waterfall model, a series of system modeling was carried out to describe the functions, data flows, calculation processes, and database structures required in the system. This modeling aims to provide a comprehensive representation of how the system works before it is implemented in the form of software.

The modeling stage begins with a Use Case Diagram that illustrates the relationship between actors and key features of the system. This model is used to identify the functional needs of the system from the user's point of view. After that, the system analysis is followed by Data Flow Diagram (DFD) modeling to show the data flow and internal processes in stages, followed by a Flowchart to describe the logic of HPP calculation based on the Full Costing method. The final stage of modeling is carried out through an Entity Relationship Diagram (ERD) which maps the structure of the database to store all system production, cost, calculation, and audit information.

Use Case Diagram of Low Carbon Concrete HPP Accounting Information System

Figure 1 shows a Use Case Diagram illustrating the relationship between the actors and the key functions provided by the Low Carbon Concrete HPP Accounting Information System.

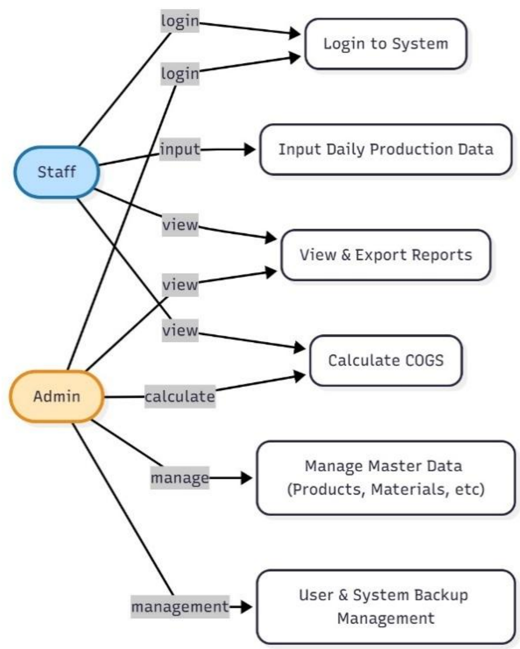

Figure 1. Use Case Diagram of Low Carbon Concrete HPP Accounting Information System

There are two main actors interacting with the system—Production/Accounting Staff and the System Admin—each with distinct access rights and responsibilities aligned with their operational roles within the company. The Production/Accounting Staff are responsible for daily operational activities related to recording and monitoring production processes. They have access to log in to the system, input daily production data such as raw materials, labor, and batch activities, view and export HPP reports generated by the system, and monitor the status of processed production data. Meanwhile, the System Admin functions as the system manager with broader access privileges, including logging in with full authorization, executing HPP calculations using the Full Costing method, managing master data such as materials, products, pricing, and production parameters, and performing user management and system backups, including adding, modifying, deleting user accounts, and maintaining overall data integrity.

Data Flow Diagram

DFD is used to provide a gradual visualization of how data is processed in an accounting information system designed to calculate the Cost of Production (COGS) of low-carbon concrete.

DFD modeling on this system is presented in three levels, namely:

DFD Level 0 - Context Diagram of Low Carbon Concrete HPP Accounting Information System

Figure 2 shows the Data Flow Diagram (DFD) Level 0 or Context Diagram of the accounting information system for the calculation of the Cost of Production (HPP) of low-carbon concrete. This diagram depicts a system as a single process that interacts with multiple external entities through an inbound and outbound stream of data.

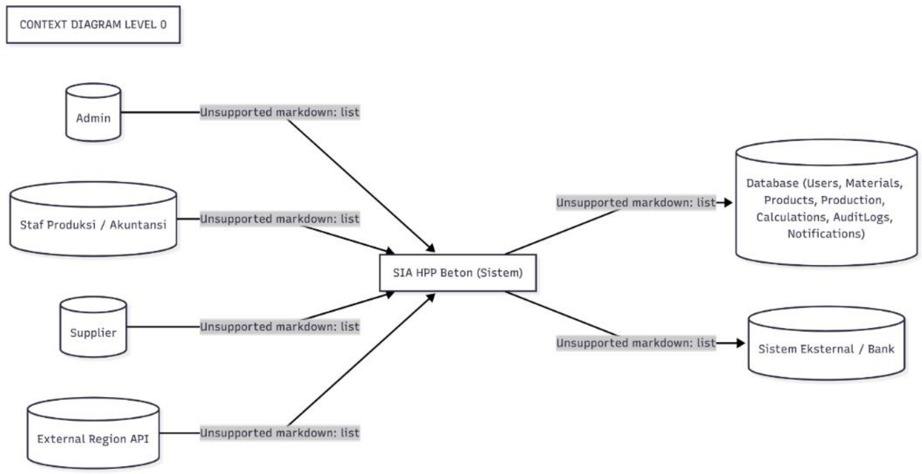

Figure 2. Data Flow Diagram (DFD) Level 0 showing the context of the Concrete HPP Accounting Information System in relation to external entities and key databases

At this level, the system is named SIA Concrete HPP (System) and is connected to the five external entities presented in table 2 below:

Table 2. SIA HPP Concrete and Connected with Five External Entities

External Entities	Interaction with the System
Admin	Login, access rights authorization, system configuration
Production / Accounting Staff	Production data input, HPP report request
Supplier	Delivery of raw material price data or material updates
External Region API	External data exchange (e.g. exchange rates, regulations, carbon emission data)
External System / Bank	Integration of payment or purchase transactions of production materials

In addition to interacting with user actors, the system is also connected to the main database, which contains important tables such as: (1) Users, (2) Materials & Pricing, (3) Products & Production Batches, (4) Calculations. (HPP calculation results), (5) AuditLogs (system activity logs), (6) Notifications (status, alerts, system messages). This diagram illustrates that all core processes, including data input, cost calculation, yield storage, and reporting, are carried out within the system and involve a variety of internal and external data sources.

DFD Level 1 - System Key Process Solving

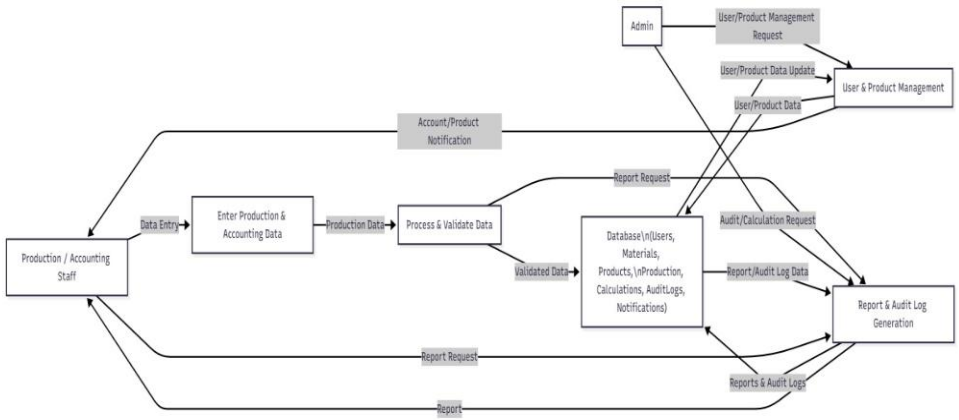

Figure 3. Data Flow Diagram (DFD) Level 1 showing the breakdown of the main processes of the low concrete HPP accounting information system

Figure 3 is a Level 1 Data Flow Diagram (DFD) that breaks down the main processes in the low-carbon concrete HPP accounting information system into several more detailed sub-processes. At this level, the process that was previously described as a single block in DFD Level 0 is now described as several internal functions that are interconnected and directly involve interaction with system actors. carbon into six core processes: data management, production input, HPP calculation, storage, reporting, and authentication DFD Level 1 indicates that the system consists of several core processes, which are presented in the following table 3.

Table 3. DFD Level 1

No	Main Process	Function
(P1)	Master Data Management	Manage basic data such as raw materials, material prices, supplier data, products, and production cost components
(P2)	Production Data Input	Receive production batch data, number of material usage, and operational costs from production/accounting staff
(P3)	HPP Calculation	Processing material, labor, and overhead data into total HPP using the Full Costing method
(P4)	Data Retention & History	Saves calculation results to the database, including audit records and calculation history
(P5)	Reporting & Export Reports	Compile a printable or exportable HPP calculation report
(P6)	Authentication & Authorization	Set access rights based on user roles (admin, staff, supplier)

Data Flow at DFD Level 1

The supplier sends material price data or material information updates which are then processed through Master Data Management before being stored to the database.

Production/Accounting staff inputs production data containing the number of materials used, labor costs, and overhead for each production batch.

The stored data is then the source for the HPP Calculation process, which automatically calls data from the master table and production data.

Once the calculation is complete, the results are returned to the user in the form of a report view, as well as going into the Data Storage & History process to be recorded as historical data.

Users (Admin or Accounting Staff) can request the export of reports in PDF or Excel format through the Reporting & Export Reports process.

- All system access (logins, roles, feature permissions) is managed by the Authentication & Authorization process, which is connected to the users and audit_logs tables.

DFD Level 2 – Calculation Details of HPP

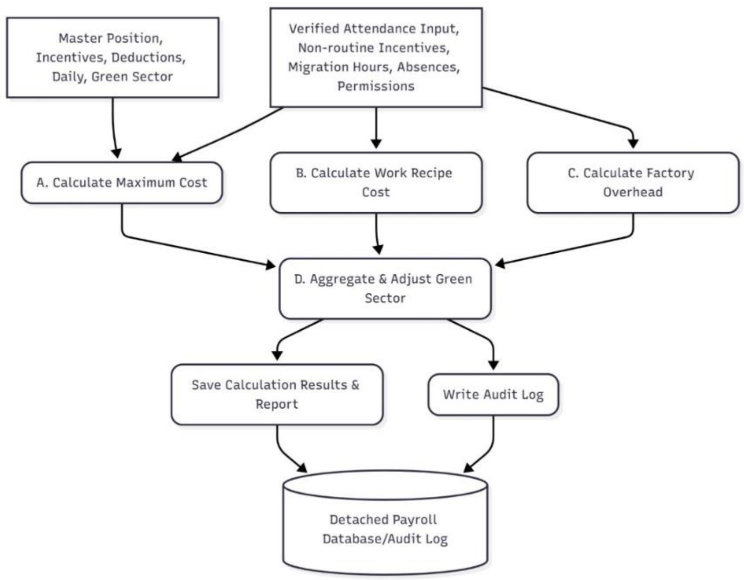

Figure 4. Data Flow Diagram (DFD) Level 2 showing detailed HPP calculation sub-processes

Figure 4 is a Level 2 Data Flow Diagram (DFD) that describes the detailed process of the HPP Calculation module which previously appeared as one of the main processes in DFD Level 1. At this level, the HPP calculation flow is broken down into several sub-processes that process production cost data based on the Full Costing method.

CONCLUSION

This research produced a blueprint for an accounting information system to calculate the cost of production (HPP) of low-carbon concrete, employing the Full Costing approach and Waterfall development method, including context diagrams, Data Flow Diagrams (DFDs), process flowcharts, and Entity Relationship Diagrams (ERD). The design addressed partner companies' challenges with manual cost recording, which risked errors, inconsistencies, and inadequate management insights, by enabling accurate data flows, HPP computations, and integrated reporting. Limited to the design phase, future research should prioritize application development, real-world testing, and implementation at sites like CV Sinar Abadi, potentially integrating BIM or LCA tools for holistic carbon lifecycle tracking and scalability in sustainable construction.

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