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Current Practice of Construction Waste Minimization: A Case Study in Nepalese Contractors

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Abstract

Effective construction management relies on an efficient waste minimization system that processes updated information accurately. This study aims to assess the current practices and knowledge in construction waste management and propose a system to minimize and control waste. The objective is to reduce waste on construction sites and provide easy access to project status information through a comprehensive database, ultimately increasing contractor profits. A survey and fieldwork research were conducted to examine existing waste minimization practices and gather contractors' insights on implementing a new system. The findings revealed that current practices are primarily manual and lack effective systems or software for waste minimization. Most contracting companies do not track the quantities, amounts, or percentages of material waste. The main challenge identified was the absence of user-friendly software for waste management and control. Contractors attributed the waste problem to reliance on traditional manual methods and the lack of a structured waste minimization system. While contractors acknowledged a limited focus on waste minimization, they did not perceive a shortage of qualified personnel as a significant issue. Survey responses varied widely, reflecting a lack of accurate knowledge due to the absence of consistent feedback and record-keeping from past projects. The materials with the highest waste percentages were identified as formwork (22.69%), sand (18.23%), and aggregate (15.77%). Contractors expressed a strong willingness to adopt user-friendly software, with many preferring Microsoft Excel spreadsheets for their ease of use.

Keywords: *Contract company; Construction project; Construction waste minimization, MS-Excel, Waste minimization software,*

1. Introduction

Waste in the construction industry has been the subject of several research projects worldwide in recent years. These studies have explored both the environmental damage, resulting from material waste generation and the economic implications associated with it (Agyekum, 2012; Elshaboury et al., 2022; Formoso et al., 2002). Material waste on construction sites varies in cause. Still, it is notably significant due to its substantial contribution to construction costs (Kennouche et al., 2022), typically accounting for about 50% to 60% (Popoola et al., 2018; Tafesse, 2021). This finding is particularly concerning, given the scarcity of these resources. Recognized as a significant problem, material waste in the construction industry impacts both operational efficiency and environmental sustainability (Can et al., 2023; Khalas & Patel, 2018). According to Ekanayake & Ofori (2004), construction material waste is defined as any material, excluding earth materials, that needs to be transported away from the construction site or repurposed within it due to damage, excess, non-use, non-compliance with specifications, or as a by-product of the construction process.In the United Kingdom, an investigation by Skoyles (1976) conducted during the 1960s and 1970s across 114 building sites distinguished between direct waste, i.e., irreparably damaged or lost materials, and indirect waste, i.e., monetary loss without physical material loss (Formoso et al., 2002; Ogunseye et al., 2023). A similar municipal solid waste problem in Lebanon is also being faced (Sawaya et al., 2023). In the United States, Gavilan & Bernold (1994) analyzed waste in masonry foundations, timber frames, and sheetrock drywall, identifying significant waste from cutting residuals, non-reusable consumables, packaging, and improper handling. Research in the Netherlands monitored waste from seven materials in five house-building projects, attributing waste to design flaws, material supply issues, and poor handling during transportation and storage (Bossink, 2002). In Brazil, it is estimated that direct and indirect waste account for 18% of the total material weight in an 18-storey residential project, revealing high waste percentages in materials such as mortar, resulting in additional costs (Formoso et al., 2002). In Egypt, a survey of 35 top contractors found that timber frameworks had the highest waste rate, followed by sand, steel, and cement, with waste percentages exceeding accepted norms for most materials (Daoud et al., 2021). In Nepal, studies on 30 building projects reported reinforcement waste ranging from 2% to 9%, with an average of 4.4%, which falls within the permissible limits set by Nepal's building construction norms (Adhikari et al., 2021; Dhungana et al., 2023). The 3R approach (Reduce, Reuse, and Recycle) is a common term in solid waste management but is rarely applied in the construction sector (Ogunmakinde et al., 2022). There is a perception among contractors that waste is not valueless if it can be sold to waste dealers (Siregar & Kustiani, 2019).

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Partial studies from various countries confirm that waste represents a significant percentage of production costs, necessitating an effective system with updated information to reduce construction waste at the source (Formoso et al., 2002). The construction sector is a vital component of the Nepalese economy, employing over one million people and contributing approximately 10% to 11% of the GDP. About 60% of the nation's development budget is executed through contractors (Acharya & Shrestha, 2021). Over the past two decades, the sector has witnessed significant progress, marked by improvements in management skills, operational capacity, financial stability, and technical capabilities. Enhancements in this sector can have a substantial impact on the national economy (Kusi et al., 2018). The construction industry in Nepal faces several challenges related to material waste. These include the absence of an effective tracking system for construction materials, insufficient knowledge about material waste generated during construction, a lack of research on construction waste, inadequate waste minimization and control measures, and the lack of prioritization of waste minimization in the industry. Despite these advancements, a large amount of construction waste is generated, especially in major infrastructure, commercial building, and housing projects. Issues such as excessive material wastage, improper waste management, and low awareness of waste reduction are prevalent. However, research on construction waste in Nepal is limited, and there is no established system for recording quantitative data on waste generation. Thus, the main objective of this study is to understand and assess the systems and common practices for waste minimization currently adopted by Nepalese contractors.

This study provides contractors with a comprehensive understanding of waste tracking, the extent of material wastage on their construction sites, and the overall profit or loss associated with materials and projects. It includes material reconciliation at various stages of the project, comparing planned versus ordered, ordered versus actual supply, and actual supply versus actual usage. This data is crucial for monitoring project efficiency. The computerized system generates data on material wastage, which is vital for contractors from a quality and reputation perspective. Excessive material consumption indicates wastage and financial loss, while under consumption, raises quality concerns, affecting the contractor's reputation.

2. Methodology

The research methodology for this study was structured into three main stages: Literature Review, Field Survey, and Questionnaire. Initially, an extensive literature review was conducted focusing on the causes of construction waste, techniques for minimizing waste, systems for waste minimization and control, and international studies on measuring material waste. Following the literature review, a comprehensive field survey was conducted to evaluate the current practices in waste minimization and control. Data collection involved gathering documents such as stock books, running bills, and bills of quantities from three construction sites in Kathmandu, Nepal: the Kathmandu District Court Building at Babarmahal, the Telecom Building at Sundhara, and the Sanima Bikas Bank Building at Naxal (Figure 1). The collected data documents were reviewed and approved by the institute, and informed consent was obtained from all participants from the data-providing organization. The research concentrated on four units within these sites: the Engineering Unit, Purchasing Unit, Tracking Unit, and Store Unit, which are also current practices in Nepalese construction for management and control, as shown in Figure 2.

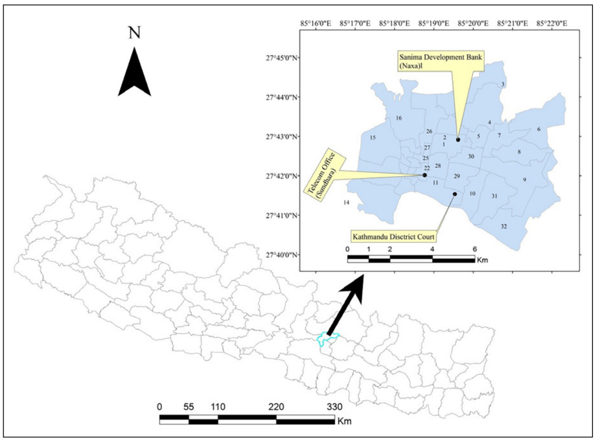

Figure 1. Study area

Based on insights from the literature review and field survey, a structured questionnaire was developed. This type of structured questionnaire aligns with the research work by Al-Rifai & Amoudi (. The questionnaire was divided into six sections: Company Profile, Waste Minimization and Control System, Problems with Current Waste Minimization and Control System, Importance of Waste Minimization and Control, Level of Material Waste in Construction Projects, and the Need for Computer Applications in Waste Minimization and Control. Designed in a closed format, the questionnaire aimed to gather specific responses regarding current practices and the perceived need for a computerized system. The data from the questionnaire were statistically analyzed using Excel Software.

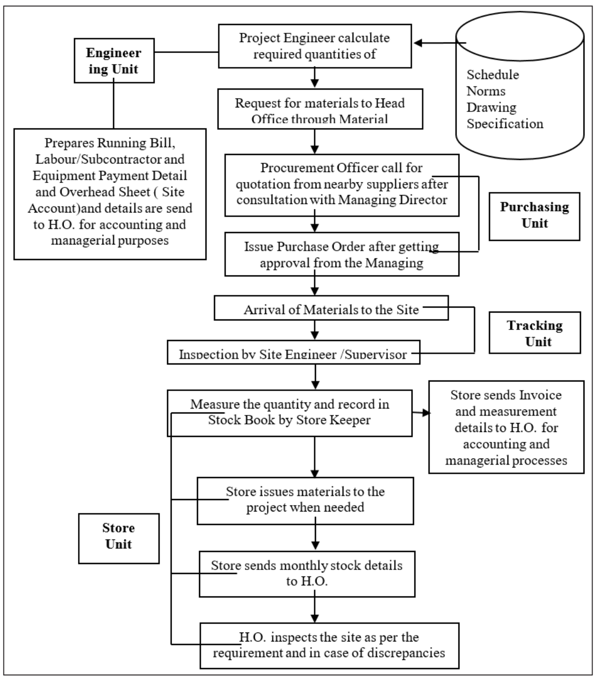

Figure 2. Current Practice of Nepalese Construction for Material Management and Control

Based on the findings of the field survey and questionnaire responses, conclusions and recommendations were formulated using the survey results and data analysis, as illustrated in the research flow chart (Figure 3).

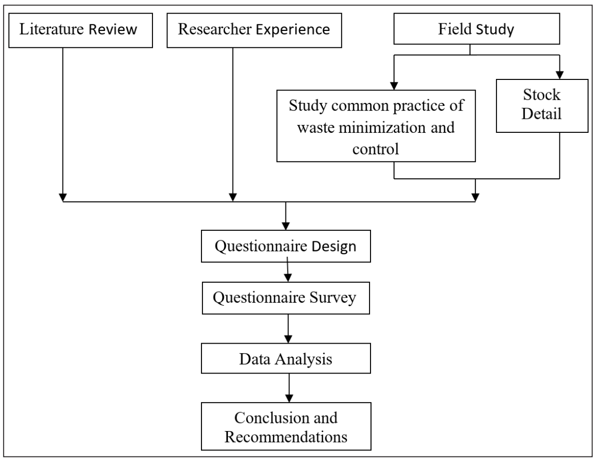

Figure 3. Flow Chart for Conducting Research

This research targeted contracting companies classified under the "A" category, as registered with the Contractor's' Association of Nepal. According to the association, there are 194 such companies. A sample of 19 "A" class Nepalese construction companies was selected, representing about 10% of the total population. Out of these, responses were obtained from 13 companies. The sample was chosen randomly, taking into account the companies' turnover and work experience. Data for this research was collected through site visits and questionnaires. Frequency distribution and percentage were used to describe various aspects of the data. Excel software was utilized for data analysis. The conclusions and recommendations were derived from the analysis of survey data and fieldwork research.

3. Results and Discussion

The results illustrate and discuss the characteristics of the study population, current practices for waste minimization and control, problems with current practices, the importance of waste minimization and control, and the level of material waste in construction projects.

3.1 Characteristics of the study population

The year of establishment, sector of specialization, total volume of construction works executed, annual net worth, and qualification of employees of contracting companies were examined to determine the financial and technical capabilities of these companies. Table 1 shows that 69.23 % of the contracting companies were established before 1989 AD, and 30.76 % were established after 1989 AD. This indicates that most of the companies are established, with more than 24 years of experience.

Table 1. Characteristics of Contracting Companies

Variable	Category	Frequency	Percentage (%)
Year of Establishment	Before 2045 B.S.	9	69.23
	2045 B.S. and After 2045 B.S.	4	30.76
Field of Specialization	Building	13	100
	Building + Road	12	92.3
	Building + Road + Water Supply/Sanitation	4	30.76
Volume of Construction Works (Rs. Million)	Less than 10	0	0
	10 – 30	0	0
	31 – 50	0	0
	51 – 100	3	23.07
	>100	10	76.92
Annual Net Worth (Rs. Million)	Less than 30	8	61.53
	31 – 50	2	15.38
	51 – 75	2	15.38
	76 – 100	0	0
	>100	1	7.69
Qualification of Employees	Ph.D.	0	0
	Masters	62	6.09
	Bachelor	165	16.22
	Certificate	273	26.84
	SLC and Less	505	49.65

The characteristics of contracting companies provide valuable insights into the structure and dynamics of the construction industry. In terms of the year of establishment, the majority of contracting companies (69.23%) were established before 1989 AD, while only 30.76% were founded in or after 1989 AD. This dynamic indicates that most companies in the sector possess long-standing experience, which could imply stability and expertise in the industry. However, the presence of newer firms suggests that the industry is evolving and attracting new entrants, possibly driven by growing infrastructure demands and business opportunities.

Regarding the field of specialization, all the surveyed contracting companies (100%) are involved in building construction. Additionally, a significant proportion (92.30%) of firms also undertake road construction, reflecting the need for well-developed transportation infrastructure. However, only 30.76% of companies have expanded their services to include water supply and sanitation projects, suggesting a relatively lower focus on public utility infrastructure. This specialization trend highlights a strong inclination toward building and road construction, with fewer companies diversifying into essential water and sanitation projects.

The volume of construction works in terms of financial capacity reveals that no companies operate on projects valued below Rs. 50 million. About 23.07% of firms handle projects ranging from Rs. 51–100 million, indicating a moderate level of construction activity. However, the majority (76.92%) are engaged in projects exceeding Rs. 100 million, signifying the dominance of large-scale firms capable of handling high-value infrastructure projects. The annual net worth distribution of contracting companies indicates that a significant proportion (61.53%) of firms have a net worth of less than Rs. 30 million, suggesting that most companies operate at a moderate financial level. Around 15.38% of firms fall within the Rs. 31–50 million and Rs. 51–75 million categories, showing a moderate distribution of financially stronger firms. However, only 7.69% of firms have a net worth exceeding Rs. 100 million.

In terms of employee qualifications, the distribution of educational backgrounds indicates a diverse workforce. There are no employees with Ph.D. qualifications, while only 6.09% hold a master's degree. A slightly higher percentage (16.22%) has a bachelor's degree, reflecting a moderate level of higher education among professionals in the industry. The majority of employees (26.84%) hold certificate-level qualifications, while the largest proportion (49.65%) has only an SLC or lower education level. This proportion suggests that the construction industry heavily relies on semi-skilled and unskilled labor, with a relatively smaller percentage of highly qualified professionals. Overall, the data highlights that the construction industry is largely composed of experienced firms with a strong focus on building and road projects. The workforce is primarily composed of semi-skilled labor, with limited representation from higher academic qualifications.

3.2 Waste Minimization and Control System

The survey was conducted to reveal the current practice of contracting companies for waste minimization and control systems. The store unit, project unit, purchasing unit, and tracking unit were examined during the survey. Table 2 shows that only 15.38% of respondents prepare waste minimization plan prior to the commencement of the project. This indicates that most contracting companies do not prepare a waste minimization plan prior to the commencement of the project.

The results demonstrate that 76.92% keep up-to-date stock details of materials. Regarding receiving consumed and balance quantities, 69.23% maintain an up-to- date activity-wise record of material consumed versus norms consumption. 76.92% keep proper record of scrap detail with quantity, price, and amount, but only 30.76% calculate material waste quantity.This result indicates that the contracting companies are not well-informed about the actual quantity and amount of waste they are generating from their construction projects.

Table 2 shows that most contracting companies (84.61%) prepare the required material file needed for the project. 76.92% maintain an up-to-date record of material, labor, and equipment to know profit or loss at any stage of the project. However, only 38.46% of the records show activity-wise material requirements and material consumption. This result indicates that the amounts demanded by the site are not thoroughly checked to determine whether the demands are justified or not. The figure shows that most contracting companies do not maintain activity-wise material consumption data. 46.15% cross-check for quantity error in Running Bills with actual cost of construction, i.e., the contracting companies generally compare the quantity of running bills with the consumed quantity of material, labour/subcontractor, equipment, and overhead. In general, contracting companies compare the quantity of Running Bills with the consumed quantities of material, labour/subcontractors, equipment, and overhead at the project site. Contracting companies (100%) cross-check the quantities demanded by the project site before issuing P.O. Only 61.53% maintain a systematic procedure for vendor rating. Other observations: 76.92% of contracting companies tally materials with the specifications and quantities mentioned in the P.O. and invoice before receiving the materials.

Table 3 represents the major problems with the current waste minimization and control system. The results show that the respondents (92.30%) agree that the lack of user-friendly software is the major problem for waste minimization and control. Most contracting companies (76.92%) believe the current situation of waste is due to the following simple traditional manual management. On the other hand, results show that 69.23% of contracting companies believe that the lack of a waste minimization system is another major problem. 53.84% of contracting companies partially agree with the lack of attention and non-realization of contractors towards waste minimization. 38.46% of respondents intermediately agree, which reveals that a significant number of respondents agree, suggesting that the shortage of Qualified Personnel is not a significant problem for waste minimization and control. The above results show that most contracting companies feel the need for computer software and a system for waste minimization and control.

Table 2. Current Practice of Waste Minimization and Control Systems

S.N.	Description	Contractors Response (Yes)	
		Frequency	Percentage (%)
A	Prepare a waste minimization plan prior to the commencement of the project	2	15.38
B	Store Unit		
1	Keep up-to-date stock details of materials regarding receiving, consumed & balance quantities	10	76.92
2	Calculation of material waste quantity, amount, and its percentage	4	30.76
3	Up-to-date activity-wise record of material consumed vs. normative consumption	9	69.23
4	Keep a proper record of scrap detail with quantity, price, and amount	10	76.92
C	Project Unit		
1	Prepare the required material file needed for the project	11	84.61
2	Record activity-wise material requirements and material consumption	5	38.46
3	Up-to-date record of material, labor, and equipment to know profit or loss at any stage of the project	10	76.92
4	Cross-check for quantity error in Running Bills with the actual cost of construction	6	46.15
D	Purchasing Unit		
1	Cross-checks for the quantities demanded by the project site before issuing P.O.	13	100
2	Maintain a systematic procedure for Vendor Rating	8	61.53
E	Tracking Unit		
1	Tally materials with specifications and quantity mentioned in the P.O. and invoice before receiving the materials	10	76.92

Table 3. Problems with the Current Waste Minimization and Control System

S.N.	Problem	Agree %	Intermediately Agree %	Disagree %
1	Little attention and non-realization of contractors towards waste minimization	15.38	53.84	30.76
2	Lack of a waste minimization system	69.23	30.76	
3	Simplicity in traditional manual management	76.92	23.07	
4	Lack of user friendly software for waste minimization and control	92.30		7.69
5	Shortage of Qualified Personnel	38.46	38.46	23.07

Table 4 presents the factors regarding the views, opinions, and realization of contractors on having a system for waste minimization and control. The results show that the majority of contracting companies believe that most of the factors listed in Table 4 help in waste minimization on construction sites. They believe that the systems that have the biggest impact on waste minimization are waste reduction (100%), eliminating duplication of material orders and addressing material issues (100%), and resolving problems related to late delivery and the required quantity needed for the project (100%).

On the other hand, the factor which they believe that the system helps is, to know exact quantities of materials required (84.61%), maintain up-to-date stock detail (92.30%), the total profit or loss of the project (84.61%), helps in preparing accurate bill of quantities (92.30%), increase awareness among contractors to decrease waste (92.30%), and reduce final cost of the project (84.61%). 61.53% of contracting companies believe the system helps in maintaining better relations with suppliers, and 76.92% view the system as helping in pricing bids.

Table 4. Importance of Waste Minimization and Control Systems

S.N.	Importance	Agree (%)	Intermediately Agree (%)	Disagree (%)
1	To know the exact quantities of materials required	84.61		15.38
2	Maintain up-to-date stock details	92.30	7.69	
3	Waste reduction	100.00		
4	Reduce duplication of material orders and material issues	100.00		
5	To know the total profit or loss of the project	84.61	15.38	
6	Better relations with suppliers	61.53	23.07	15.38
7	Reduce problems related to late delivery and the required quantity needed to the project	100.00		
8	Helps in preparing an accurate bill of quantities	92.30		7.69
9	Helps in pricing Bids	76.92	23.07	
10	Increase awareness among contractors to decrease waste	92.30	7.69	
11	Increases contractor's profit	69.23	30.76	
12	Reduce the final cost of the project	84.61	15.38	

As presented in Table 5, it highlights significant variations in waste percentages across different materials. Among all materials, formwork exhibited the highest waste rate, with an average of 22.69%, followed by sand (18.23%), and aggregate (15.77%). These high percentages suggest that temporary or bulk materials, which are prone to damage, loss, or inefficiencies in handling and usage, contribute significantly to construction waste. In contrast, steel (10.12%), cement (5.12%), and bricks (9.92%) displayed relatively lower waste percentages, indicating better control over these materials or their inherent durability.

A notable observation is the wide variation in reported waste percentages for all materials. It indicates inconsistencies in data collection and estimation across different projects. For instance, formwork waste ranged from 15% to 30%, while sand waste varied between 10% and 25%, and bricks between 1% and 20%. This broad range of responses suggests a lack of precise waste tracking mechanisms, potentially due to the absence of a standardized database or systematic documentation of material losses from past projects. The discrepancies in reported values could also be attributed to differences in project management practices, material handling efficiency, and on-site monitoring methods.

The findings underscore the importance of enhanced record-keeping and regular feedback mechanisms to accurately quantify and minimize material waste. Implementing data-driven waste management strategies and promoting awareness among construction professionals about material wastage can significantly reduce project inefficiencies and enhance sustainability in the construction sector.

Table 5. Material Waste and Variations in Construction Projects

S.N.	Material	Average Waste (%)	Variation Answer in Waste Variation Range (%)
1	Steel	10.12	4.5 - 15
2	Cement	5.12	0.5 - 10
3	Sand	18.23	25-Oct
4	Aggregate	15.77	20-Oct
5	Bricks	9.92	20-Jan
6	Formwork	22.69	15 - 30

3.3 Need of Computer Application for Waste Minimization and Control

The computerized systems for waste minimization and control in construction companies reveal a strong inclination towards digital solutions but also highlight areas that require improvement. As indicated in Table 6, all surveyed companies (100%) reported following a computerized system for waste minimization and control. This advancement reflects a universal acknowledgment of the importance of technology in efficiently managing construction waste. The use of digital tools facilitates tracking materials, optimizes resource utilization, and reduces unnecessary losses.

Table 6. Computerized System followed by the Company

S.N.	Description	Contractors' Responses (No)	
		Frequency	Percentage (%)
1	Computerized system followed for waste minimization and control	13	100

Furthermore, Table 7 highlights the overwhelming necessity of computer software for waste minimization and control. All respondents (100%) agreed that a computerized system, an up-to-date database of materials, labor, equipment, and suppliers, as well as a dedicated database for waste quantity, cost, and percentage, are essential for effective waste management. A well-structured database can help contractors predict material requirements more accurately, minimize over-ordering, and improve project sustainability.

Table 7. Necessity of Computer Software for Waste Minimization and Control

S.N.	Description	Necessary (%)	Sometimes Necessary (%)	Unnecessary (%)
1	Computerized System	100		
2	Up-to-date database of material, labour, equipment and supplier	100		
3	Database regarding waste quantity, amount and its percentage	100		

However, despite the reliance on computerized systems, Table 8, suggests that there is a gap in software proficiency among contractors. While 92.3% of respondents were proficient in using Excel, which is commonly used for data analysis and project tracking, no responses were recorded for Word and Access, which could indicate a lack of familiarity or relevance in waste management applications. Additionally, only 7.69% of contractors reported using other software, suggesting that specialized construction management tools such as AutoCAD, MS Project, or BIM software may not be widely adopted for waste control purposes.

Table 8. Efficiency of Respondents in Using Popular Computer Software

S.N.	Description	Contractor's Responses (Yes)	
		Frequency	Percentage (%)
1	Excel	12	92.30
2	Word		
3	Access		
4	Other	1	7.69

This disparity between the acknowledgment of the need for computerized waste management systems and actual software proficiency indicates that training and capacity building are necessary. Contractors need to be equipped with advanced digital tools that go beyond Excel, including integrated database management systems, construction planning software, and waste tracking applications. Encouraging the use of industry-standard software and ensuring adequate training will significantly enhance the effectiveness of digital waste management strategies, leading to greater efficiency, cost savings, and environmental sustainability in the construction sector. The fieldwork research was conducted for three construction projects in Kathmandu, executed by United Builders & Engineers Pvt. Ltd., under a centralized control system. As shown in Table 9, the surveyed projects included the Sanima Bikas Bank Building at Naxal (NRs. 166.4 million), the Nepal Telecom Building at Sundhara (NRs. 174.4 million), and the Kathmandu District Court Building at Babarmahal (NRs. 289.1 million). These projects represent significant investments, emphasizing the need for efficient material management and waste control to minimize financial losses and enhance operational efficiency.

Table 9. Surveyed Projects

S.N.	Name of Project	Project Cost (NRs.)
1	Sanima Bikas Bank Building at Naxal	166.4 Million
2	Nepal Telecom Building at Sundhara	174.4 Million
3	Kathmandu District Court Building at Babarmahal	289.1 Million

A review of project records, including the stock Bbook, running bill, and bill of quantities, revealed that the current material management system is primarily manual, with Excel software used solely for recording purposes. However, data on material quantities, costs, and waste percentages are not systematically maintained, indicating inefficiencies in tracking and controlling material usage. The flowchart in Figure 2 illustrates the steps followed for material management, highlighting a lack of integration between different units and the absence of structured data analysis. This manual approach limits the ability to track material waste, optimize resource allocation, and effectively evaluate financial impacts.

The shortcomings in the existing system, categorized in Table 10, were analyzed across four key functional units: engineering, purchasing, tracking, and store units. The engineering unit lacks an activity-wise material tracking system, as it only prepares total quantity sheets rather than detailed breakdowns for each activity. This practice hinders the accurate monitoring of material consumption, making it challenging to determine whether usage aligns with standard norms. Furthermore, there is no systematic comparison of actual material consumption with expected norms, making it challenging to identify inefficiencies. Additionally, running bill quantities and amounts are not cross-checked against actual materials, labor, and equipment consumed, increasing the likelihood of errors and financial discrepancies.

In the purchasing unit, material procurement is based on material requisition slips from project sites; however, there is no verification process to ensure that the requested quantities are justified. This lack of oversight increases the risk of over-ordering and unnecessary expenditures. Additionally, there is no systematic vendor rating process, which can lead to potential inconsistencies in material quality and pricing. Purchase orders (P.O.s) are not properly issued to project sites, creating gaps in communication and material tracking. Moreover, the purchasing unit is not well-informed about the availability of tools and equipment on-site, which can result in unnecessary purchases and financial inefficiencies.

The tracking unit also exhibits significant deficiencies, as it does not verify whether the materials received on-site match the Purchase Orders or whether they meet the required specifications. This lack of verification increases the risk of accepting incorrect or substandard materials, which can lead to project delays, quality issues, and financial losses.

Table 10. Shortcomings of the Current System

S.N.	Shortcomings of Each Unit
1	**Engineering Unit**
i	The activity-wise material required sheet is not prepared. Only the total quantity of materials required for the sheet is prepared
ii	Don’t maintain an up-to-date activity-wise record of material consumed vs. normative consumption (to see whether material consumed is more than norms)
iii	Cross-checks are not made for the running bill quantity and amount with actual quantities of material, labor, and equipment consumed, and there are chances of error in running bill quantities
2	**Purchasing Unit**
i	Issue a Purchase Order based on the material requisition slip from the project site. Cross-checks are not made to determine whether the quantities demanded are justified
ii	No systematic procedure for vendor rating
iii	P.O.’s are not issued to the project site
iv	Not well informed about the tools/equipment available at the project site
3	**Tracking Unit**
i	Don’t tally quantity received in site with P.O. and are not well informed of the specifications mentioned in P.O.
4	**Store Unit**
i	Manual stock detail
ii	Issue materials to the project without a material Requisition slip
iii	Do not maintain the material consumed sheet
iv	Don’t keep record of waste quantity, waste percentage, and proper scrap detail.
v	Do not tally consumption norms before issuing materials.
vi	Rates are not entered in the stock book. Actual amount figures for the received quantity and consumed quantity are not known
vii	Excel Software is used for recording data
viii	Don’t know about total profit and loss on materials, even after the end of the project

The store unit relies on manual stock-keeping methods, which are highly inefficient for tracking material movement and consumption. Materials are issued to projects without formal material requisition slips, resulting in difficulties with inventory control. Additionally, the store does not maintain records of material consumption, waste quantities, waste percentages, or proper scrap details. There is no process in place to compare material usage against standard norms before issuing materials, leading to potential overuse and waste. Furthermore, material rates are not recorded in stock books, and the actual costs of received and consumed materials are not documented, making it impossible to assess profit and loss on materials even after project completion.

Furthermore, automated inventory management systems should be introduced to replace manual stock-keeping methods. Materials should only be issued against formal requisitions, and detailed records should be maintained for material consumption, waste percentages, and scrap management. The use of cost-tracking software would enable companies to accurately record material rates, financial transactions, and post-project profit-loss assessments, allowing for more transparent and data-driven decision-making.

5. Conclusion and Recommendations

The study concludes that the current waste minimization practices in Nepalese construction companies are manual-based mainly, with no structured or systematic approach to tracking and controlling material waste. Most contracting companies do not prepare a waste minimization plan before starting a project, nor do they maintain records of the actual quantity and financial impact of material waste. While some companies maintain general records of materials, labor, and equipment, they lack activity-wise tracking of material consumption, making it difficult to evaluate efficiency and identify sources of waste.

A key finding is the lack of user-friendly software for waste minimization and control. Contractors acknowledge that traditional manual management methods exacerbate material waste, duplication of material orders, delayed material deliveries, and inaccurate quantity estimations. The study reveals that formwork (22.69%), sand (18.23%), and aggregate (15.77%) contribute the highest percentage of waste, while reinforcing steel (10.12%), cement (5.12%), and bricks (9.92%) also show significant waste rates. The large variation in responses about waste rates indicates a lack of accurate knowledge due to the absence of a regularly updated database or systematic record-keeping.

Moreover, contractors do not utilize computerized systems for waste minimization and control, despite recognizing the need for such systems. As per the study, all contractors agree on the necessity of a construction waste minimization software to maintain databases of materials, labor, equipment, suppliers, and waste quantities. Currently, MS-Excel is the preferred software among contractors, as it is easy to use for maintaining databases and performing material reconciliations.

To improve material waste management in Nepalese construction, contractors should implement a user-friendly computerized waste minimization system to effectively track material usage, waste, and costs. Additionally, it is essential to prepare detailed waste minimization plans, maintain up-to-date databases of materials, and train staff on proper material management practices to reduce inefficiencies and ensure accurate waste tracking.

Author contribution statement

All authors contributed to the study conception and design. Sabir Baidya performed data collection, model generation and analysis. Raghu Nath Prajapati wrote the manuscript and modification, and both Authors read and approved the manuscript.

Ethics Declarations

The study adhered to the ethics guidelines of Nepal Engineering College, Pokhara University, Nepal, and followed the principles of the Declaration of Helsinki, including informed consent, voluntary participation and withdrawal, confidentiality, and the privacy of participants. The authors confirm they sought and got informed consent from all participants in the study. This research, along with its questionnaire and methodology, was approved by the Research Development Unit (RDU) of Nepal Engineering College.

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Data Availability

Data and materials are available from the authors upon request.

Competing Interests

The authors declare that they have no competing interests.

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