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Research Article

Performance Evaluation of Faffa Food Share Company through Computerized Maintenance Management System (CMMS)

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Since 1962 EC, the Faffa Food Share Company has been producing and supplying flour in Ethiopia both for relief and commercial markets. However, it is incompetent in the market due to a poor maintenance management system. So, the aim of this research is to overcome the poor maintenance management problems by using the CMMS application. The data collected from the company by survey studies, unstructured interviews, and stopwatches and from company records revealed that frequent failure machines, as well as a poor maintenance management system, cause production downtimes, resulting in a 29.19% decrease in production from the planned production. The collected data are analyzed by, tools such as time and motion study, SPSS software and CMMS effectively. The finding from the outcome of the bivariate correlation of CMMS elements and manufacturing performance dimension has an alpha α value of greater than 0.5, which indicates that the relationships between CMMS and manufacturing performance are positive. The findings from company records and stopwatch equipment and manpower (technicians) should be managed to activate machine servicing. Finally, the proposed smart maintenance management system tool, CMMS improves the availability of machines, reduces the frequency of equipment failure, reduces the breakdown time, decreases the cost of maintenance, and then improves the manufacturing performance by 5 percent.

1. Introduction

To ensure the continuous process, planned equipment has a high reliability and consistency, and all manufacturing companies and other organizations such as forest machinery have included various types of tools in the production system[1]. To ensure the consistency of all of these equipment and tools, the maintenance department must be accountable within the organization. However, maintenance costs and unexpected breakdowns have a significant impact on company productivity; thus, companies should begin to focus on maintenance as a primary source of profit and performance improvement.

The ability of an organization to provide quantity, quality, and timely benefits to customers, as well as its survival in the global market, is significantly influenced by machine maintenance and system reality [2]. Software that streamlines maintenance operations and gathers maintenance data is known as a computerized maintenance management system (CMMS). It facilitates the efficient use of resources such as machinery, vehicles, communications, plant infrastructures, and other assets [3].

A CMMS implementation in the organization is required to achieve these types of goals [4]. Since there are already other practices in place, it can be difficult for small and medium enterprises or newly established businesses to implement CMMS. This condition encourages people to look for simple, new ways and methods of doing things in order to change their habits. As a result, the expected method is used to select the significantly affected assets and equipment area and then apply CMMS to achieve better results that impact their performance and for the adaptation of CMMS in organizations [5]. Furthermore, a few researchers contend that developing a computerized maintenance management system for one company is multipurpose, less complex, less expensive, and less time-consuming computer software [6–8]. There is a researcher who presented a proposal for the maintenance and support model to prevent or reduce the failure of machines in the company by ERP, and the model includes many maintenance activities and has the advantage to evidence the role of support between operation and maintenance [9]. The reason CMMS was chosen is that it can be easily created, is appropriate, and satisfies the research's goals. CMMS, or enterprise asset management, is a type of maintenance-based software that is used to schedule, manage, and track maintenance tasks for vehicles, machinery, equipment, and other buildings and services. The use of CMMS in industries boosts organizational accomplishments, productivity, safety, health, and the environment. It also reduces costs and makes better use of resources in industrial sectors [5]. The researcher [10] integrates maintenance management and business process management using information technology. A CMMS-based conceptual module model is suggested, which employs the data currently available in CMMS to measure the degree of synchronization between departments within an organization by using process mining. This conceptual model serves as a blueprint for creating higher-value CMMS software. This system serves as a performance measurement tool in three critical areas such as organizational analysis, workflow analysis, and future simulation of maintenance operations to reduce future failures.

This researcher focuses on the manufacturing performance (MP) of FFSC flour production in order to improve it. The CMMS software or application is used to make simplification, monitoring, inspections, and maintenance operations, and it minimizes the downtimes of the systems [11]. The company manufactures various types of flour and supplies them to the local market. It is open 24 hours a day and seven days a week. The breakdown maintenance system is used in this company. During these shifts, breakdown maintenance groups respond to machine breakdowns or abnormalities. This implies that there is no good maintenance management and preventive and predictive maintenance practices in the company to avoid equipment breakdown before it occurs [12]. As a result, the purpose of this research is to investigate the major issues that impeded MP of the products in FFSC and their solutions from the standpoint of CMMS. It is vital to establish fresh plans in order to remain competitive in the manufacturing industry. The impact of information technology on manufacturing competitiveness is enormous. Both developed and developing countries are leveraging information technology to boost manufacturing competitiveness [13]. Among these, achieving equipment reliability and availability is critical for industries experiencing maintenance issues. This work focused on the impact of using CMMS in improving the company's manufacturing performance, and it is specifically aimed to answer the following questions:

(1) What are the factors impeding the FFSC's current manufacturing performance and maintenance management system?
(2) What is the connection between CMMS components and manufacturing performance?
(3) What are the main CMMS aspects to consider when improving manufacturing performance in the case of FFSC?
(4) How can CMMS be used to improve FFSC manufacturing performance?

2. Literature Review and Research Gaps

CMMS has been developed and published by many authors as shown in Table 1 whereas the current work has a performance evaluation of the Faffa Food Share Company through a newly developed CMMS concept (Section-5) using HTML and MySQL (from the XAMPP server). HTML was used for making the graphical user interface (GUI) or frontend.

A maintenance management concept should take into account all pertinent aspects of the current business environment. For instance, by depending on the demands of the business, researchers must design and implement maintenance management systems as shown in Figure 1. As a result, each company has a different maintenance management system concept. The maintenance management system concept will also need to be periodically revised because industrial systems change quickly, considering both the systems and changing environment into account. Numerous maintenance management system concepts are discussed in the literature, providing interesting and practical ideas. However, the majority of these concepts require a lot of management time and manpower to implement, making them less practical than maintenance concepts completed for other businesses. A new maintenance concept, according to researchers in this field [19], must, however, fit the company's goals and culture as well as the current maintenance organization.

3. Methodology

As the extension of this research work [18], this study was based on a survey (questionnaire, interview, and observation). It was intended for obtaining CMMS-related information from the technical manager, maintenance supervisor, maintenance technicians, operators, storekeeper, and quality inspection department in order to identify the current maintenance problems in the company and the relationship between CMMS and MP. The questionnaire was divided into three sections, the first of which contained general information about respondents and the second of which contained a five-point Likert scale for identifying features of CMMS' role in MP and for investigating the existing problems that impede the company's manufacturing performance. The third section also includes five scale points for determining the MPD affected by maintenance management issues.

Table 1: Summary of literature review and research gaps.

Authors	Title	Method	Finding
[14]	Web-based computer maintenance management system (CMMS)	Experiments conducted on manual activities before and after CMMS implementation	Improving manpower and resources by decreasing efforts through easy retrieval of data
[15]	Applying computerized maintenance management system (CMMS) in healthcare equipment maintenance	Survey study on elements of CMMS to integrate it into other software	Simplifying the monitoring inspections and maintenance operations by increasing availability of the device and decreasing downtime
[16]	Principles of CMMS implementation	Benchmarking the maintenance performance to improve performances which are less than excellent	CMMS was designed to be used, both as a transactional tool (accounting purposes) and a control tool (strategic/tactical purposes)
[11]	Using computerized maintenance management system (CMMS) in healthcare equipment maintenance operations	Sample devices were taken and calculate their times of failure frequency and then apply CMMS to avoid failures when reaching those times	It determines the inspection and maintenance duration and so such devices are ready to be used at all times
[8]	The effect of computerized maintenance management system (CMMS) in enhancing the firm productivity	By using questionnaires, data are collected before and after implementation of CMMS	Smoothening up the process of daily maintenance activities and creating a clean environment in terms of reducing the build-up pressures caused by the delay in such processes, as well as reducing the papers used by the team for the purpose of having records filed, checklists, and material/tools dispatched
[7]	General framework of computerized maintenance management information system (CMMS) for automobile industry	Analyzing the existing CMMS model from different literature reviews	Reducing downtimes and frequency of failure and increasing life span of machine
[17]	The effects of computerized maintenance management information system (CMMS) in enhancing firm productivity	Collecting data through questionnaires for machine efficiency, product quality, and labor productivity before and after CMMS implementation	Increasing machine availability, product quality, and working time of labor and then totally improving the productivity of the company
Alemayehu et al. [18]	Performance evaluation of Faffa Food Share Company through newly developed CMMS concept (Section-5) using HTML and MySQL (from XAMPP server). HTML is used for making the graphical user interface (GUI) or frontend	Survey, time, and motion study Developing CMMS software suitable for facilities available in FFSC	Problems identified clearly, flow of information simplified, working times increased, and unnecessary motion reduced. Generally manufacturing performance of the case company improved by about 5%

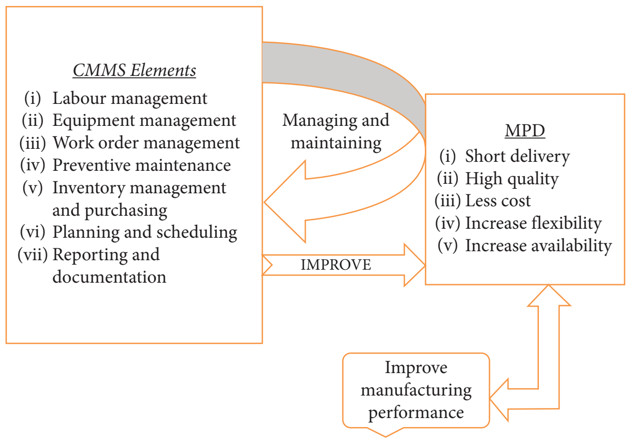

Figure 1: Relationship between CMMS elements and MPD.

In this study, two types of sampling techniques were used: purposive and simple random sampling. As a result, the researcher will use purposive sampling because the research area includes those with maintenance skills, such as maintenance managers, supervisors, and technicians. Because of the large number of people working in the production department and those who have a direct relationship with the maintenance activities, it is not possible to study the entire population, so for them simple random sampling is used.

Furthermore, time and motion studies, as well as various company documents, were thoroughly examined in order to determine the company's current problems. CMMS is the preferred solution to reduce the problems.

The CMMS developed for Faffa Food Share Company was prepared by using HTML and MySQL (from the XAMPP server). HTML was used for making the graphical user interface (GUI) or frontend, i.e., all the modules as per the requirement and maintenance functionalities of the company. The user interface of the modules eases the maintenance personnel to enter the data and information in application forms by inputting it with the help of a keyboard or mobile button and the same can be retrieved back anytime by just filling up specific fields in the form of SMS. XAMPP's MySQL (backend) has been used as the database system which is connected with the modules made in HTML language. The data and information are stored in MySQL (backend) of this database in the form of predefined tables with specific data types and properties.

Finally, CMMS software is used for management and maintenance [20], and any activities related to improving a company's manufacturing performance by using the conceptual framework are shown in Figure 2.

4. Results and Discussion

4.1. Time and Motion Study. The findings from the time and motion study were obtained by investigating the key maintenance parameters that activated the maintenance activity of the equipment. These parameters include the main maintenance actors such as the operators (the location where the machine is damaged) and the maintenance managers, technicians, and storekeepers (for tools and spare parts). In this regard, the following parameters should be avoided or reduced in order to reduce downtimes caused by them and thus improve the company's manufacturing performance: operators to report a failure and proceed to the maintenance department. The maintenance manager/supervisor walks into the technicians' room to assign tasks. Technicians walk to the factory to check for failure while waiting for their allocation. It includes the time to detect a problem, walk to the store to arrange the equipment, search for and adjust the equipment, walk to the spare parts store, search for and adjust the spare parts, and walk from the spare part to the factory for maintenance, cleaning, and mechanical adjustments. Downtimes for each parameter are collected by using time and motion study methods from the company and are analyzed as follows in terms of machines.

The first downtime is caused by the wait for spare parts required for maintenance, i.e., the replacement of broken parts. These downtimes occurred as a result of all necessary spare parts being unavailable in stores; companies purchase approximately 48.8% of the spare parts after the machines stop working. The lack of spare parts in the store is due to the fact that they do not know or cannot predict which machines will be damaged. The reason for the downtime of spare parts and tools is that technicians waste time searching for the required spare parts needed for maintenance in a store rather than directly spending time in repairing that machine as it requires maintenance because the company does not have kaizen implemented.

Another issue is that the allocation of technicians for maintenance takes longer because there are no written documents that describe the working ability and experience of the technicians who are assigned. This means that they are randomly assigned, and then he or she goes to try to maintain the machine and comes back without properly repairing it, and then another technician is assigned, and in this, more time is killed without the work being accomplished. If written documents about each laborer's ability and experience are available on a computer, then the supervisor can simply review and assign the correct technicians at once for work. As a result, as shown in Figure 3, the downtimes caused by problem detection are high, followed by spare part waiting. This means that problems are not easily and timely identified by technicians, and technicians do not know whether they are being assigned or allocated unless they come to the technicians' department, which can also cause downtime. Unnecessary motion information denotes the time spent in moving to report the machine damage. Operators whose machines stop working go directly to the maintenance department to inform them that the machine has stopped working, and then the technical manager goes to the maintenance supervisor department to assign them to check the problems of the stopped machine, and then the maintenance supervisor checks and returns to assign technicians and goes to the equipment management department to allocate the necessary equipment and spare parts for maintenance.

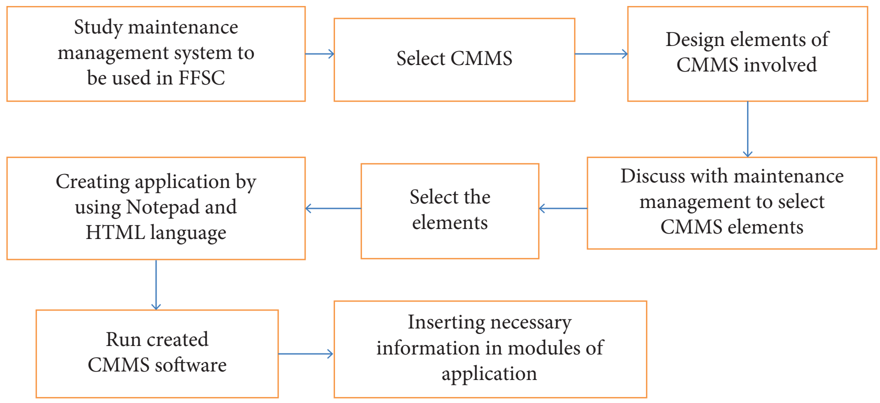

Figure 2: Major procedure for developing CMMS software.

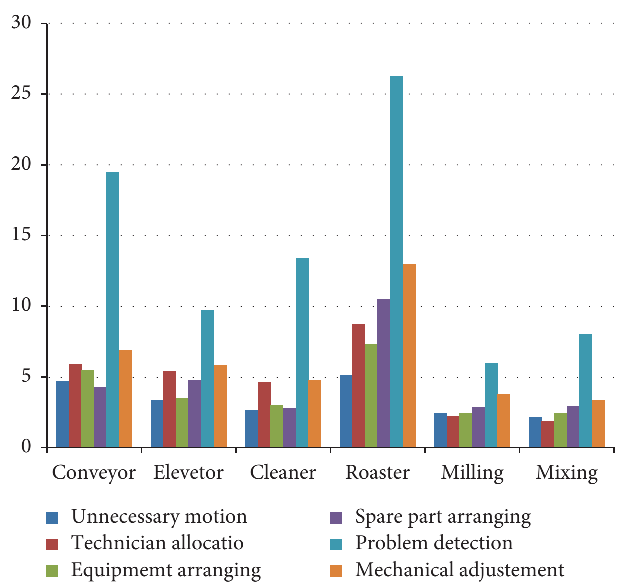

Figure 3: Reasons for the top seven downtimes across the machines in five months (Faffa Food Share Company, Ethiopia).

4.2. Data from Survey Study Analysis. The survey's goal was to assess the company's maintenance practices, awareness of the CMMS concept, and the contribution of CMMS to improving the company's manufacturing performance. The data obtained from the questionnaire's primary sources were analyzed in this section. The collected data were sorted, organized, and coded. 37 questionnaires were distributed to maintenance technical managers and supervisors, production managers, manufacturing managers, quality supervisors, and operators and technicians. Sixty-six of the 37 questionnaires distributed were returned. As a result, the final response rate based on the valid responses was 97.3 percent. The collected data were then processed using SPSS software to test the research's reliability and validity by comparing the alpha value of Cronbach's range from 0.978 to 0.983 and KMO values for each factor range from 0.708 to 0.961. To be accepted, the alpha and KMO values must be greater than 0.6 as seen in this study; hence, this work was accepted.

4.3. Evaluating CMMS Elements Emphasis and Their Contribution towards Manufacturing Performance. Based on the responses of Faffa Food Share Company employees, an evaluation of the relationship between CMMS element emphasis and their contribution to several manufacturing performance dimensions was made.

The bivariate correlation procedure in SPSS is used to compute Pearson's correlation coefficient between CMMS elements' emphasis and manufacturing performance dimension (MPD) to display their relationship, as shown in Table 2. It can be used to determine the strength and direction of association between two scale variables. In this case, Pearson correlation is used to define the significant CMMS elements that contribute to the realization of various manufacturing performance levels.

4.4. The Relationship between CMMS Elements and Manufacturing Performance. The correlation results from SPSS' Pearson show that there are significant relationships between the first six CMMS elements and their contribution to the manufacturing performance as shown in Figure 4. Labor management (LM) or technicians' information regarding computer maintenance shows a significant relationship with improving flexibility (*F*), increased quality (*Q*), and improved availability (*A*); thereby lowering production costs (*C*) and achieving a high level of delivery (*D*). This is because the goal of labor management is to manage and assign technicians who have the experience and ability to avoid or reduce problems that occur and thus avoid or reduce the loss of time when machine breakage occurs. Similarly, equipment and tool management (ETM), work order and request management (WORM), spare parts inventory management and purchasing (SIMP), preventive maintenance (PM), and reporting and documentation (RD), all have had a significant impact on improving manufacturing systems.

4.5. Data from Company Records. The main cause of nonproductive time, as shown in Figure 5, is mechanical failure, which accounts for 216.3 hours. This shows that insufficient preventive maintenance (PM) is performed on the machines, and no action is taken when a failure first manifests

Table 2: Manufacturing performance dimension and various CMMS features of Pearson's correlation.

	A	Q	F	D	C
LM	0.883**	0.924**	0.932**	0.882**	0.833**
ETM	0.841**	0.853**	0.860**	0.844**	0.873**
WORM	0.881**	0.867**	0.892**	0.912**	0.786**
SIMP	0.853**	0.833**	0.835**	0.857**	0.809**
PM	0.925**	0.893**	0.887**	0.921**	0.824**
PS	0.765**	0.729**	0.708**	0.737**	0.700**
RD	0.600**	0.537**	0.582**	0.578**	0.573**

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.

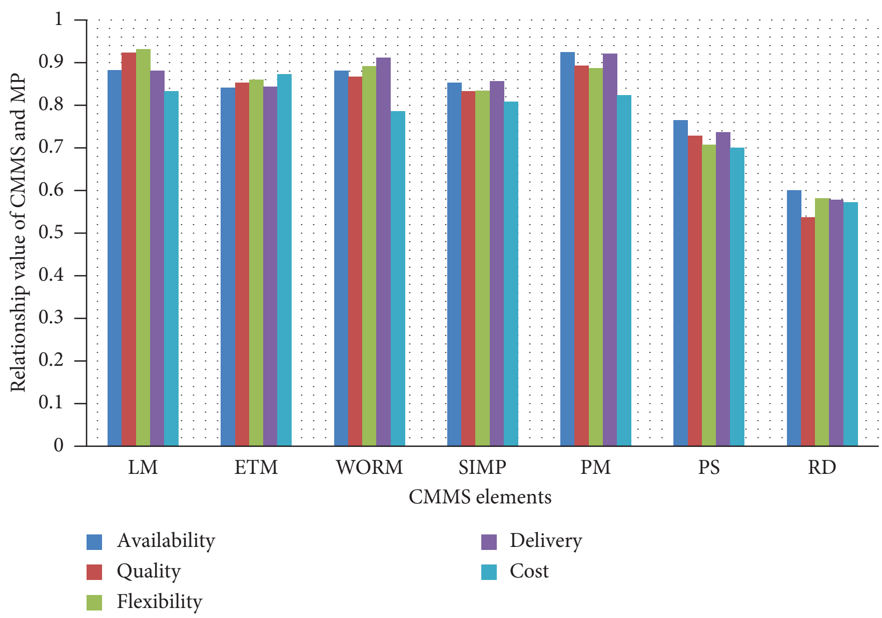

Figure 4: Relationship of CMMS element and MP.

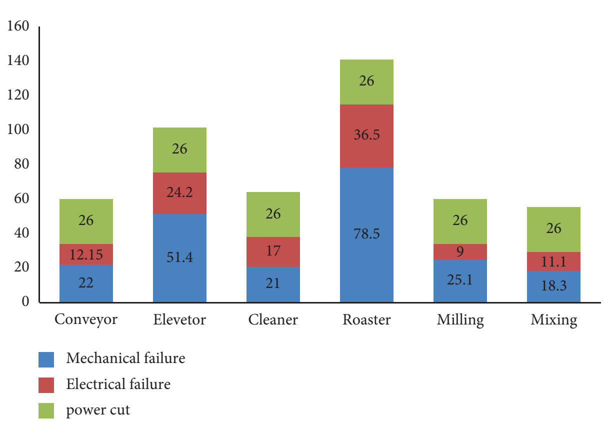

Figure 5: Reasons for downtime across the company from September 2020 to January 2021.

itself, and breakdowns take a long time to resolve primarily because the technicians lacked the necessary skills, timely reporting, and knowledge of the equipment's maintenance history. The downtime associated with an electrical failure is 110 hours; and this is primarily attributable to the failures that could not be promptly repaired because there were not enough spare parts and qualified technicians available.

Aside from the primary and secondary data, additional information was gathered through unstructured interviews and observations in businesses. In this case, the researcher preselected more frequently failed machines and manufacturing sections for research. As a result, the conveyor, elevator, cleaner section, roasting section, milling section, and mixing section were chosen, and the damping and packing sections, which have the lowest failure frequency of 3.4 percent and 4.56 percent, respectively, were not studied. The studied sections have been taken into account because the failure frequency is greater than 10%. The roasting section, with a production rate of 91.98 percent, is the company's most frequently failed and bottleneck machine. The company's problems with the highest machine breakdown time and poor MMS resulted in losses of 459.78 tons, 529.13 tons, 369.98 tons, 849.76 tons, 393.36 tons, and 418.67 tons of products through screw conveyor and elevator and in the cleaner section, roaster section, milling section, and mixing section, respectively.

A survey (questionnaire) study was also conducted in order to identify the existing manufacturing performance and maintenance management system issues. As a result, the plant's current maintenance value enabled it to significantly reduce maintenance costs by focusing on the root cause of failure because it spent more time on corrective maintenance rather than finding root causes of failure by using preventive maintenance. Participants agreed that proper management of maintenance equipment and machines is required in order to improve their effectiveness. However, maintenance practices were delayed due to poor technician allocation and poor equipment location, i.e., maintenance equipment was not easily accessible when the machine broke and an unnecessary motion between departments for reporting and equipment arranging. The exchange of information between departments is performed over the phone or by going directly to the offices of the necessary employees, which is both costly and adds unnecessary motion.

Training and motivation for an employee to improve maintenance practices are not considered a company benefit; instead, they are considered an individual's benefit; as a result, there is no training and proper employee allocation for the timely completion of incoming work orders. Due to insufficient technician allocation for maintenance, they spent more time attempting to correct malfunctioning machines through trial and error which is shown in Table 3.

According to Mamo [21], there is a significant correlation between CMMS and MP so that the operators can keep their machines healthy; and a regular inspection to prevent breakdowns, management practices, misplaced equipment, and equipment breakdowns becomes in time solution, according to the value of assessments. Operators no longer need to go to the maintenance department to report a broken machine; with a single click, the information is routed to the maintenance department, which quickly assigns technicians to repair the broken machine. As a result, when machine availability is high, product flexibility, quality, and timely delivery are achieved. Furthermore, the cost of production is reduced while the cost of the product increases. The following benefits are created by the recommended maintenance system; and CMMS as a maintenance management device organizes maintenance packages for critical machines or equipment [22, 23].

(1) A CMMS allows organizations to eliminate manual data recording and allows for the organization of various industry features into a single centralized, digital location. Its use results in shorter response times, higher information accuracy, better work order management, less paperwork, less information leakage, increased safety and risk management, and centralization of maintenance department units.

(2) Computerized maintenance management system (CMMS) is simply the use of computers to quickly and efficiently decide, plan, and organize various tasks for effective plant maintenance. Many factors need to be considered when determining whether a CMMS can benefit an operation, including cost savings, improved organizational methods, and improved communications. When operators submit work requests, maintenance technicians can use their desktops to design, prioritize, review, assign, and track work orders.

As a result, the computerized maintenance management system allows the company to improve its manufacturing performance.

The researcher hopes that the company will implement the CMMS and will reap the benefits of the new system. CMMS which is simply seen as a tangibly recommended system allows the company to avoid downtime due to unnecessary motion. This means that the downtimes caused by unnecessary movements of maintenance personnel in companies to complete maintenance tasks are 25.5 hours. If the company implements CMMS, then the technician allocation system is changed so downtimes occur only for searching or identifying knowledgeable and experienced technicians from the database (4 min) and for examining experiences, age, educational background, and time taken for writing issues on the prepared assigned form and for sending it (1.30 min) which takes a total time of around 5.30 min. This is the total time for the 86 failures ($86*5.30 = 455.8$ min., $455.8/60 = 7.59$ hrs). As a result, the improved time is 17.29 hrs ($28.75–7.59 = 21.16$ hrs) (28.75 hrs of total downtime was observed due to technician allocation). The time required to assign one technician is 4 minutes, which includes the time spent in activities such as reading the names of technicians (17 for this company), experience year, age, educational background, and departments in order to assign the correct technicians for correct maintenance. This time is reduced from time to time when this system is used in a company for an extended period of time because the manager knows (adopts) the information of the technicians without having to read it. It takes about 1.30 minutes to fill out the information on the prepared forms and to send them to the storekeeper.

Downtime caused by searching for tools and spare parts was also reduced tangibly after CMMS implementation; an issue has been typing in the form of message, and sending to storekeeper can take approximately 1.27 min by technicians. Storekeeper can take 1.40 min to complete his/her task and convey it to storekeeper assistant. storekeeper asiistant can accomplish his/her work in 2.45 min. Other minor activities include grasping, holding (2.10 min), and releasing of tools or spare parts at the workplace (1.25 min), for a total time of 8.47 minutes. For 86 failures, the time spent was $86 * 8.47 = 728.42$ min, $728.42/60 = 12.14$ hrs. As a result, the improved time for both the equipment and the spare parts is 39.66 hours ($23.95 + 27.85–12.14 = 39.66$ hrs). It should be noted that when searching for and arranging tools and spare parts, the size and shape of the tools and spare parts should be taken into account. As a result, to test the time taken, flat, cylindrical, and a combination of flat and cylindrical shape tools and spare parts were tested because the time for searching, selecting, grasping, holding, and releasing at the working place was not the same (Table 4).

The total improved times are 25.5 hrs + 21.16 hrs + 39.66 hrs = 86.32 hrs, resulting from the avoidance of unnecessary motion which thereby reduces the technician allocation time and time required for searching and arranging tools and spare parts. So, even if only an unnecessary motion is avoided, technician allocation and equipment and spare parts management would be greatly

Table 3: Summary of downtimes and loss of production due to these downtimes.

S. no.	Machines	Downtimes (hrs)		Total downtimes (hrs)	Loss of products (tons)
		Primary data (stopwatch)	Secondary data		
1	Conveyor	70.26	60.15	130.41	459.78
2	Elevator	48.48	101.6	150.08	529.13
3	Cleaner	40.94	64	104.94	369.98
4	Roaster	100.02	141	241.02	849.76
5	Milling	51.47	60.1	111.57	393.36
6	Mixing	63.35	55.4	118.75	418.67
	Total	**374.52**	**482.25**	856.77	**3020.68**

Authors have been collected and shown the downtime data in company by using both STOP WATCH and Through survey (secondary) so that the production has been lost almost 3020.68 tons. CMMS software was developed to minimize this downtime of the production.

Table 4: Testing table to calculate the time taken for searching and arranging tools and spare parts for maintenance activities.

Tools and spare parts			Tools and spare parts arranging activities: Time taken (minutes)				
			Recording and sending	Searching on documents	Selecting in store	Grasping and holding	Releasing
Tools	Flat	Wrench 19	0.21	0.29	0.42	0.14	0.9
	Cylindrical	Makita grinder	0.17	0.17	0.38	0.19	0.17
	Combination	7 hp motor	0.27	0.23	0.40	0.29	0.28
Spare parts	Flat	Elevator box	0.13	0.20	0.36	0.16	0.13
	Cylindrical	PPC pipe (5″)	0.20	0.25	0.43	0.20	0.11
	Combination	Motor pulley	0.26	0.24	0.41	0.21	0.18
Total			1.27	1.40	2.45	2.10	1.25

improved, and the company will gain an additional 86.32 hours of production time after implementing CMMS. Then, in five months, 86.32 hrs $*$ 10605.31 tons/3008 hrs = 304.33 tons of additional flour products can be produced, representing 4.45 percent and 0.88 percent of flour products produced monthly. The production loss is thus reduced from 3096.48 tons to 2792.14 tons (3096.48 tons–304.33 tons = 2792.14 tons), resulting in 7813.17 tons of product gain. Consequently, the production loss has been minimized from 29.19% to 24.74% for 5 months. percent).

As a result, the summary comparisons of the company's target, observed, actual, and improved production after implementation of the recommended maintenance system are shown in Table 5.

5. Proposed Maintenance Management System and Main Maintenance Actors

The main procedures for maintaining machines when they breakdown, as well as the main actors in the maintenance process, must be identified, as well as the factors stimulating the maintenance process during machine maintenance, in order to reduce or avoid machine breakdown, must also be identified. The four main actors/departments/factors that play a significant role in maintenance are as follows (Figure 6):

(1) Operators
(2) Maintenance management
(3) Technicians
(4) Storekeeper (for both tools and spare parts)

The information between actors addresses each other by using software such as MySQL, PHP, and HTML as shown in Figure 7.

5.1. Operators. This actor is primarily involved in the production section, but the source of machine problems begins here. As a result, by clicking on submit, operators can report the reason and the time when the machine/s stopped working. The skill of the operator to run this system is a minor issue in this case; and this issue is avoided by providing training to all the staff in the maintenance department. The developed software can be translated into well-known local languages in the future. Figure 8 shows the information included in the maintenance notification form when reporting failure problems on a single machine.

5.2. Maintenance Manager. In this study, the maintenance manager assigns technicians as soon as the operator department's reports reach the maintenance manager department. When assigning technicians to a technical manager, it is important to carefully review the information about the technicians in order to properly allocate the technicians who will solve the problems that have occurred. As a manager, you do not need to go to the technician department to assign them; however, a technician assignment form in the company is required as a recommended system to avoid the distance between the technician and the technical manager. Figure 9 shows the information included in the technicians' assignment form for assigned technicians.

Table 5: Compression of target, observed, actual, and improved products.

Types of production	Products gained (tons)	Time used (hrs)	Products lost (tons)	Downtimes (hrs)
Target production	10605.31	3008	0	0
Observed production	7508.83	2129.74	3096.48	856.49
Actual production	6846.48	1941.88	3758.83	1066.11
Improved production	7813.17	2216.05	304.33	86.32

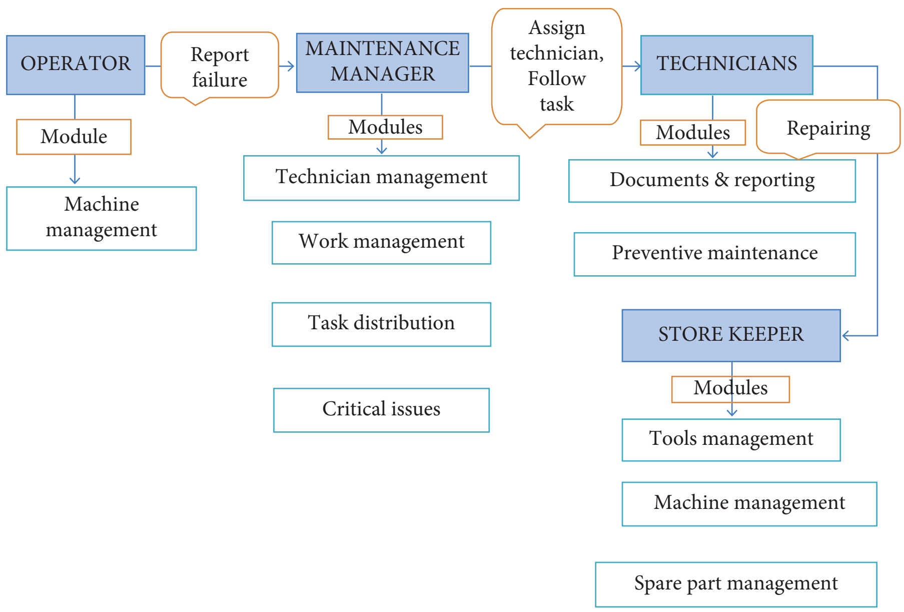

Figure 6: Maintenance procedure and main actors.

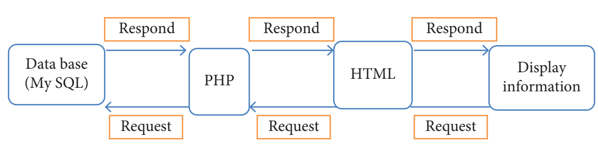

Figure 7: Relationship between the software used for the flow of information.

Figure 8: Maintenance notification form used by the operators for reporting failures.

5.3. Technician. Initially, technician has to visit t identify the cause of machine issue with his basic tools and spare parts. Once the technician identifes the issue, the meesage has to be passed to storekeeper by using the tools and spare parts request form as shown in Figure 10. Later, Storekeeper will come up with advanced/customised tools and spareparts to fix an issue if the store has sufficient equipment. whereas, sometimes the store has not sufficient customised equipments to fix an issue and then they approaches to maintenance department to make an order as shown in figure 11.

5.4. Storekeeper. The management tools and spare parts in stores are referred to as storekeepers, as the name implies. They send tools and spare parts requested by the technician as soon as possible through the maintenance management system. They check the availability of tools and spare parts in the store before sending them and then send the necessary tools and spare parts to the technicians as shown in Figure 12.

Generally, by combining these four actors of maintenance management departments with performance improvement dimensions, CMMS increases the cumulative performance of manufacturing. Some of these performance indicators are compared in Table 6 before and after the implementation of CMMS for five months of data. Other manufacturing performance indicators are improved but they are not suitable for quantifying them. The performance indicators are calculated by using the following formula and are shown in Table 6.

$$
\begin{aligned}
&\text{Availability} = \frac{\textbf{run time}}{\textbf{planned production times}},\\
&\text{Quality} = \frac{\textbf{usable products}}{\textbf{total products produced}} = \frac{\textbf{total products} - \textbf{defect products}}{\textbf{planned production times}},\\
&❖\text{Availability} = \frac{\textbf{run time}}{\textbf{planned production times}},\\
&\text{Availability} = \frac{\text{run time}}{\text{planned production times}} = \frac{\mathbf{1941.88}}{\mathbf{3008}} * 100\% = 64.5\% \text{ (before CMMS)},\\
&\text{Availability} = \frac{\textbf{run time}}{\textbf{planned production times}} = \frac{\mathbf{2237.51}}{\mathbf{3008}} * 100\% = 74.38\% \text{ (after CMMS)},\\
&❖\text{Quality} = \frac{\textbf{usable products}}{\textbf{total products produced}} = \frac{\textbf{total products} - \textbf{defect products}}{\textbf{planned production times}},\\
&\text{Quality} = \frac{\textbf{6846.48 tons} - \textbf{143.35 tons}}{\textbf{6846.48 tons}} * 100\% = 97.90\% \text{ (before CMMS)},\\
&\text{Quality} = \frac{\textbf{7887.95 tons} - \textbf{74.01tons}}{\textbf{7887.95 tons}} * 100\% = 99.06\% \text{ (after CMMS)}.
\end{aligned}
\tag{1}
$$

For calculating the maintenance cost, first the frequency of failures that occurred in the company before and after the implementation of CMMS is collected. Consequently, the cost paid or spent for one failure is taken averagely, which is followed by the calculation of the improved cost to find the maintenance cost. Therefore, before CMMS was applied in the company, the main total failures were 86 and the cost of one failure was 1753 Ethiopia Birr (EB). So, the total maintenance cost is 150,758 EB ($86 * 1753 = 150{,}758$).

Therefore, after CMMS was applied in the company, the main total failures were 58 and the cost for one failure was 1917 Ethiopia Birr (EB). So, the total maintenance cost is 111186 EB ($58 * 1917 = 111{,}186$).

FIGURE 9: Technician assignation form by maintenance manager.

FIGURE 10: Tools and spare parts request form by technicians from the storekeeper.

FIGURE 11: Finished maintenance reporting form from technicians to the maintenance department.

Figure 12: Tools returned from the technicians to the storekeeper.

Table 6: Comparison of improved manufacturing performance before and after CMMS implementation.

Manufacturing performance indicators	Before CMMS implementation	After CMMS implementation
Machine downtimes	856.77	770.49
Machine availability	64.57%	74.38%
Products quality	97.90%	99.06%
Maintenance cost	150,758 E Birr	110,439 E Birr

Table 7: Cost-benefit analysis (CBA) ratio for five months.

	Benefits	Total
A	Cost of improved products	30432000 Birr
	Total benefits (A)	30432000 Birr
	Cost	
B	Cost of software developer	50,000 Birr
C	Cost of hardware (tablets, mobile, laptop, and desktop)	150,000 Birr
D	Cost of network	120,000 Birr
E	Cost of utility installation (power and space utilization)	100,000 Birr
F	Training cost	56000 birr
	Total cost (B + C + D + E + F)	476,000 Birr
	Cost of benefits ratio = (total benefits cost/total cost) = (30432000 Birr/476000 Birr) = 63.93	

6. Cost-Benefit Analysis (CBA)

To implement the proposed maintenance management system in FFSC, it is necessary to analyze the cost benefit of the company and the benefits gained from the research and cost spent to facilitate the preparation of CMMS for the FFSC company. Therefore, the cost benefits are determined as shown in Table 7.

7. Conclusions

This study presented the findings of an investigation conducted on FFSC with the goal of studying CMMS and their contribution to manufacturing performance dimensions. SPSS software was used to analyze the survey data/information, and the following results were obtained. According to the analysis, results, and discussion, the CMMS elements that have received the most attention are labor and equipment management, while documenting and reporting have received the least attention in terms of manufacturing performance. Analysis of data from a time and motion study by using a stopwatch revealed that there is a lot of unnecessary motion during maintenance activities, as well as a lot of downtime for allocating technicians for maintenance and searching for tools and spare parts needed during maintenance, because there is no wise documentation on the computer about the history and location of employees (technicians) in the company and on the machines, tools (hand tools), and spare parts in the store. According to an analysis of data from the company records, the company has become a problem of the highest machine breakdown time and a high monthly production reduction due to a poor maintenance strategy, a poor maintenance management system, and the repeated failure of the boiler machine in the roasting section. As a result, the company has lost more than 5.83 percent of its monthly product and has lost a significant amount of money due to the cost of the lost products. The suggested computerized maintenance system reduces machine downtime, increases machinery availability, improves product quality, improves on-time delivery of products, reduces maintenance costs, and increases product flexibility by creating a high chain between four actors (operators, maintenance manager, technicians, and storekeeper) and by solving maintenance problems as soon as they occur in the company. Applying the new software-programmed maintenance management system in the factory will increase the product efficiency by reducing product loss from 3096.48 tons to 2792.14 tons if the system used avoids only unnecessary motion and wisely manages tools and spare parts.

Data Availability

The data used to support the findings of the study are included within the article and are also available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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