

Workload and task distribution in integrated pharmaceutical supply chain and service delivery: a time and motion study in Ethiopia's primary health care facilities

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Research Article

Keywords: Time and motion study, WOMBAT, Workflow efficiency, Primary health care, Pharmaceutical supply chain, Health workforce, Ethiopia

Posted Date: August 28th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10422080/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

Integrating pharmaceutical supply chain management with primary health care delivery is essential to improving health system performance in resource-limited settings. However, evidence on how health workers allocate time across these functions remains limited. This study assessed time allocation patterns and workflow efficiency among health workers in primary health care facilities in Ethiopia.

Methods

A facility-based cross-sectional time–motion study was conducted in 36 primary health care facilities across selected woredas of the Amhara, Oromia and Somali regions of Ethiopia from 15 to 31 May 2025. Using the Work Observation Method by Activity Timing (WOMBAT) framework, 65 health workers were continuously observed during routine working hours. Activities were categorized as supply chain and logistics, clinical and patient care (or public health services), administrative and management, community-level, or non-value-adding. Workflow efficiency was defined as the proportion of total observed time spent on value-adding activities. Data were analyzed using descriptive statistics, one-way analysis of variance and Kruskal–Wallis tests.

Results

A total of 22,825 minutes (380 hours) of observation was completed. Non-value-adding activities accounted for 42.20% of the time observed in health centers and primary hospitals and 56.63% at health posts, with system-induced idle time comprising the largest share at both levels (86.57% and 87.62% of non-value-adding time, respectively). In health centers and primary hospitals, supply chain and logistics activities represented 29.32% of total observed time and 50.72% of value-adding time. In contrast, clinical and public health services dominated value-adding time at health posts (53.44%), while supply chain activities accounted for only 2.09% of total observed time. Value-adding time differed significantly by facility level (202.15 ± 88.11 versus 153.23 ± 62.85 minutes/day; $p < 0.001$) but not by region ($p = 0.156$).

Conclusions

Health workers in Ethiopian primary health care facilities spend a substantial share of their time on non-value-adding activities, while productive time at health centers and primary hospitals is dominated by supply chain functions rather than patient-facing care. Addressing underlying system bottlenecks through task shifting, workflow redesign and digitalized logistics systems is essential to improve pharmaceutical service delivery at the primary care level. Because service demand was not measured,

idle time should be interpreted as reflecting both workflow inefficiency and possible structural underutilization.

Background

Primary health care services serve as the first point of contact within the health system, providing accessible and integrated care to meet essential health needs across diverse population groups [1]. The efficient delivery of pharmaceutical and primary health care services is critical for a well-functioning system, particularly in low- and middle-income countries (LMICs) with limited resources [2, 3]. Pharmaceutical services encompass both supply chain management functions, such as procurement, storage, distribution and inventory control, and clinical service delivery, including prescription processing, dispensing and patient counselling. Effective integration of these components is essential to ensure continuous medicine availability, promote rational drug use and improve patient outcomes [4, 5].

Despite ongoing health system strengthening efforts, inefficiencies in pharmaceutical and service delivery processes remain a major challenge in many LMICs. Weak supply chain systems contribute to stock-outs, overstocking and wastage, while delays in dispensing and patient flow negatively affect service quality and patient satisfaction [2, 5, 6]. These challenges reduce system efficiency and strain limited resources.

Time-and-motion studies provide a rigorous approach to assessing workload distribution, staff productivity and process efficiency in health care settings by directly and continuously observing tasks [7]. Originally developed in industrial engineering, this method has been widely applied in health care to capture the duration and sequence of tasks and to identify opportunities to improve efficiency [8, 9]. Evidence from diverse settings indicates that health workers often spend a substantial proportion of their time on administrative and non-clinical activities, reducing time available for direct patient care [10, 11]. Similarly, studies in primary health care settings show that health professionals, including health extension workers, allocate considerable time to documentation and administrative tasks rather than service delivery [12–16].

Within pharmaceutical practice, time-and-motion studies have shown considerable variability in time allocation across clinical, administrative and logistical roles, identifying opportunities to improve efficiency and optimize workforce utilization [17–20]. However, most existing studies focus on isolated components of service delivery rather than on the integrated pharmaceutical supply chain and clinical services.

In Ethiopia, strengthening pharmaceutical supply chains and primary health care services has been a key priority under national health sector reforms. Nevertheless, persistent challenges remain, including inefficient workflows, suboptimal workforce utilization and variability in service delivery across facility levels [21–23]. Health workers frequently perform multiple roles spanning clinical, logistics and administrative functions, which may compromise efficiency and quality of care [15, 24–26]. Previous studies have identified gaps such as limited patient counselling time, high workload and inefficiencies in

dispensing and inventory management [5, 12–15, 27–31]. However, there is limited empirical evidence examining how health workers allocate time across integrated supply chain and service delivery activities, particularly across different levels of primary health care.

Understanding how time is distributed across supply chain, clinical, administrative and community-level activities is critical for improving workforce efficiency and strengthening health system performance in resource-constrained settings. In this study, workflow efficiency is conceptualized using a value-based framework adapted from lean management principles [32, 33]. Value-adding activities are those that directly contribute to patient care, public health service delivery or essential pharmaceutical supply chain functions, whereas non-value-adding activities include idle time, interruptions and tasks that do not directly support service delivery. While this classification provides a useful framework for assessing efficiency, some non-value-adding time may reflect contextual factors such as fluctuations in service demand.

This study therefore aimed to assess time allocation patterns and workflow efficiency using a time-and-motion approach across integrated pharmaceutical supply chain and service delivery activities in primary health care facilities in Ethiopia. The findings are intended to inform strategies to optimize workforce utilization, improve service quality and strengthen health system performance.

Methods

Study design

A facility-based cross-sectional time–motion study was conducted using a direct observational approach. Trained data collectors continuously observed health workers and recorded the time spent on predefined activities using standardized tools (Supplementary file 1). Workflow efficiency was operationalized quantitatively as the proportion of time spent on value-adding activities relative to total observed time. The study is reported in accordance with the STROBE statement for cross-sectional studies (Related file 1).

Study setting and period

This study was conducted across primary health care facilities in three regions of Ethiopia: Amhara (Kalu woreda), Oromia (Shebe woreda) and Somali (Erer woreda), selected to represent diverse geographic, socioeconomic and health system contexts. Ethiopia's primary health care system is organized as a three-tier primary health care unit comprising primary hospitals, health centers and health posts. Health centers and primary hospitals are staffed predominantly by pharmacy professionals (pharmacists and druggists) alongside clinical cadres, whereas health posts are staffed almost exclusively by health extension workers who deliver preventive and community-based services. A multistage sampling approach was used to select facilities across different levels of care. Data collection was conducted from 15 to 31 May 2025.

Source and study population

The source population included all primary health care facilities and health workers involved in pharmaceutical supply chain and service delivery activities within the selected woredas: Kalu (Amhara), Shebe (Oromia) and Erer (Somali). The study population comprised selected primary hospitals, health centers and health posts, together with health workers engaged in pharmaceutical supply chain and service delivery activities during the data collection period.

Sample size determination and sampling technique

The sample size was determined based on time–motion study requirements, prioritizing depth of observation over statistical representativeness. A total of 36 facilities and 65 health workers were included, with 380 hours (22,825 minutes) of observation conducted to capture variability in workload and task distribution. A multistage sampling technique ensured representation across facility levels and geographic contexts. Three woredas (Kalu, Shebe and Erer) were selected to reflect diverse settings. Within each woreda, one primary hospital was purposively selected based on service availability and functionality, health centers were selected using simple random sampling, and two health posts were randomly selected per health center (or all health posts where fewer than two were available).

Within each facility, health workers involved in pharmaceutical supply chain and service delivery activities were observed during routine working hours. The unit of analysis was the individual health worker, with observed time aggregated per participant (Fig. 1).

Data collection method

Data were collected prospectively using the Work Observation Method by Activity Timing (WOMBAT) [34], which enables continuous real-time recording of tasks performed by health workers. Activities were classified into supply chain and logistics, clinical and patient care (or public health services), administrative and management, community-level and non-value-adding categories. Workflow efficiency was assessed by classifying activities as value-adding or non-value-adding based on their contribution to service delivery.

Trained data collectors continuously observed participants throughout routine working hours and recorded tasks sequentially using a standardized tool (Additional file 1) with precise start and end times. Observations covered all facility levels during full working shifts. A brief acclimatization period preceded each observation session to minimize observer reactivity (Hawthorne effect). In total, 380 hours of observation were completed.

Data collection tools and procedures

Data were collected using a structured time–motion observation checklist designed to capture the types, sequences and durations of activities performed by health workers. The tool included predefined activity categories with standardized coding: supply chain and logistics; clinical and patient care (or public health services); administrative and management; community-level; and non-value-adding activities.

Observers recorded all activities continuously in real time using a stopwatch or digital timing device. Each activity was assigned a predefined code based on a structured task taxonomy. Additional contextual information, such as the type of interaction and activity location, was recorded where applicable. The tool was developed based on relevant literature and adapted to the local context (Additional file 1). It was pretested in a comparable facility and modified accordingly. Data collectors received comprehensive training prior to data collection. Continuous supervision and daily review of completed forms ensured completeness, consistency and accuracy.

Study variables

The primary dependent variable was workflow efficiency, defined as the proportion of total observed time spent on value-adding activities. Secondary outcomes included time spent on each activity (in minutes) and the proportion of time allocated across activity categories. Independent variables included facility level (primary hospital, health center, health post), region/woreda (Amhara/Kalu, Oromia/Shebe, Somali/Erer), health worker cadre (e.g. pharmacist, druggist, health extension worker, nurse) and activity category/task code. Derived variables included classification of activities as value-adding or non-value-adding and total observed time per participant. Workload-related contextual factors were recorded for interpretation but excluded from inferential analyses.

Each observed activity was assigned to a single category using pre-specified coding rules. Value-adding activities were defined as tasks directly contributing to pharmaceutical or primary health care service delivery, including patient consultations, counselling, public health services and supply chain functions that moved stock or information to end users (e.g. issuing, recording, ordering and inventory verification). Non-value-adding activities included idle time, interruptions, informal interactions and personal breaks, during which no direct service output was produced. To improve consistency, task-coupled waiting was coded under the parent activity, short transitions (< 5 minutes) were assigned to the preceding task, and supportive supervision was classified as administrative and management. In this taxonomy, “informal interactions” refers to worker-to-worker exchanges not linked to a service task; brief worker-to-patient exchanges occurring within a service encounter were coded under the parent clinical or dispensing activity. This distinction is important because worker-to-patient informal interaction (for example, rapport-building or incidental health information exchange at the dispensing counter) may influence patient experience and care-seeking behavior and is not straightforwardly non-value-adding from a patient-centered perspective; where such interactions could not be attributed to a service task, any resulting misclassification would tend to overstate non-value-adding time.

Recognizing that “value-adding” is a normative construct and that unoccupied time may partly reflect demand-side constraints, non-value-adding time was classified into three domains defined by the reason the time was not spent on value-adding work (Table 1):

Table 1
Task taxonomy and activity coding framework for time and motion study

Activity Category		Code	Activity Description
A. Health Centers and Primary Hospitals			
Value adding activities	Supply Chain and Logistics	SC1	Preparation of orders and requisitions
		SC2	Receiving and inspecting supplies from external suppliers
		SC3	Internal order processing to dispensing units
		SC4	Issuing and dispatching medicines to dispensing units
		SC5	Recording stock transactions (LMIS, bin cards)
		SC6	Organizing and arranging stock/store management
		SC7	Stock status analysis and report preparation
		SC8	Physical inventory/stock counting
	Clinical and Patient Care Activities	CP1	Patient reception and prescription evaluation
		CP2	Prescription processing and medication preparation
		CP3	Billing and financial recording
		CP4	Packaging and labeling of medicines
		CP5	Dispensing medications with patient counseling
	Administrative and Management Activities	AM1	Routine documentation and reporting
		AM2	Meetings and official correspondence
		AM3	Training, supervision, and staff coordination
Non-value adding activities		NV1	System-induced idle time (no-activity)
		NV2	Work disruption
		NV3	Personal and break time
B. Health Posts			

Activity Category		Code	Activity Description
A. Health Centers and Primary Hospitals			
Value adding activities	Supply Chain and Logistics	SC1	Preparation and submission of requisitions to health center
		SC2	Receiving supplies from linked health center
		SC3	Recording stock transactions
		SC4	Organizing medicines and supplies
		SC5	Stock monitoring, analysis, and physical inventory
	Clinical and Public Health Services	PS1	Provision of health education
		PS2	Family planning services
		PS3	Antenatal care (ANC) services
		PS4	Immunization and vaccination services
		PS5	Diagnosis and treatment of common illnesses
	Community-Level Activities	CL1	Community mapping
		CL2	Outreach and household visits
		CL3	Community mobilization and health promotion
	Administrative and Management Activities	AM1	Recordkeeping and reporting
		AM2	Management of family folders
		AM3	Meetings and official correspondence
Non-value adding activities		NV1	System-induced idle time (no-activity)
		NV2	Work disruption
		NV3	Personal and break time

System-induced idle time: time during which staff were present and available but not working.

Work disruption: time associated with a discrete event in which a task already in progress was broken into by an external prompt, causing it to pause, be delayed or be abandoned.

Personal and break time: time during which staff were legitimately not working for personal reasons, such as scheduled coffee or tea breaks, incidental personal needs such as restroom visits, and absence from the workstation. Because the study recorded observed durations rather than verifying the cause of

each interval, this assignment is a conceptual reclassification of the observed activity codes rather than an independently measured attribution of cause.

Task taxonomy and activity coding framework

A standardized task taxonomy and coding framework was developed based on the WOMBAT methodology and adapted to the Ethiopian primary health care context. Each activity was assigned a predefined code and grouped into major functional categories. Separate taxonomies were developed for higher-level facilities and health posts to reflect differences in service delivery roles. Task categories and corresponding activity codes are summarized in Table 1.

Data processing and analysis

Data were entered, cleaned and analyzed using IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies, percentages, means and standard deviations) were used to summarize and compare time allocation patterns across activity categories, facility levels and staff cadres. Time data were standardized in minutes and aggregated by activity code.

Workflow efficiency, the primary outcome, was defined as the proportion of total observed time spent on value-adding activities and expressed as a percentage. The unit of analysis was the individual health worker.

One-way analysis of variance (ANOVA) was used to compare mean value-adding time across facility levels and regions. Assumptions of normality and homogeneity of variance were assessed using the Shapiro–Wilk and Levene tests, respectively. Where these assumptions were not met, the non-parametric Kruskal–Wallis test was used and is reported alongside the ANOVA result. Independent-samples t-tests (or Mann–Whitney U tests where appropriate) were used for two-group comparisons. Statistical significance was set at $p < 0.05$ (two-sided). Because the sample was not designed for population-level inference, the inferential tests should be interpreted as exploratory comparisons within the study sample.

Data quality assurance

Data quality was ensured through pretesting of the data collection tool, comprehensive training of data collectors and continuous supervision during data collection. Completed observation forms were reviewed daily for completeness and consistency, and standardized definitions and coding procedures were applied across all study sites.

Results

Characteristics of study participants

A total of 65 participants were included in the study. Participants were drawn from Oromia (n = 27; 41.54%), Amhara (n = 23; 35.38%) and Somali (n = 15; 23.08%) regions. The majority were observed at health centers (n = 35; 53.85%), followed by health posts (n = 26; 40.00%) and primary hospitals (n = 4; 6.15%). In terms of professional qualification, druggists (n = 27; 41.54%) and health extension workers (n = 24; 36.92%) constituted the largest groups, followed by pharmacists (n = 6; 9.23%), nurses (n = 5; 7.69%), health officers (n = 2; 3.08%) and one laboratory professional (1.54%) (Table 2).

Table 2
Characteristics of the study participants (n = 65)

Variable	Category	Frequency	Percent
Region/Woreda	Oromia, Shebe Woreda	27	41.54
	Amhara, Kalu Woreda	23	35.38
	Somali, Erer Woreda	15	23.08
Facility Level	Health Center	35	53.85
	Basic Health Post	26	40.00
	Primary Hospital	4	6.15
Qualification	Druggist (Level IV)	27	41.54
	Health Extension Worker	24	36.92
	Pharmacist	6	9.23
	Clinical Nurse	5	7.69
	Public Health Officer	2	3.08
	Medical Laboratory Professional	1	1.54
Total		65	100.00

Because facility level is an imprecise proxy for cadre composition, time-use results are reported primarily by facility level, with the caveat that health centers and primary hospitals were staffed predominantly by druggists and pharmacists, whereas health posts were staffed almost exclusively by health extension workers. A full cadre-level disaggregation of value-adding and non-value-adding time was constrained by the small number of participants across several cadres (pharmacists, nurses, health officers and laboratory professionals), which precludes stable per-cadre estimates; facility-level findings should therefore be read alongside this staffing composition.

Observed time distribution

Using the WOMBAT-based time–motion approach, a total of 13,639 minutes were observed in health centers and primary hospitals and 9,186 minutes at health posts. Non-value-adding activities accounted

for the largest proportion of observed time in both facility categories, representing 42.20% and 56.63%, respectively.

In health centers and primary hospitals, supply chain and logistics activities accounted for the largest value-adding workload (29.32% of total observed time), followed by clinical and patient care (15.57%) and administrative and management activities (12.92%). At health posts, clinical and public health services accounted for the largest share (23.18%), followed by administrative activities (11.93%) and community-level activities (6.17%), while supply chain activities accounted for the smallest share (2.09%) (Table 3).

Mean daily time spent on non-value-adding activities was 147.56 ± 68.30 minutes in health centers and primary hospitals and 200.08 ± 70.50 minutes at health posts. Corresponding mean times for supply chain activities were 102.54 ± 77.21 and 7.38 ± 14.67 minutes, respectively (Table 3). Health centers and primary hospitals demonstrated a greater proportion of value-adding activities (57.80%), whereas non-value-adding activities were more prominent at the health post level (56.63%) (Fig. 2).

Table 3
Time–motion distribution across facility levels

Category	HC/PH (Min)	Mean $\pm$ SD (min/day)	HC/PH (%)	Health Post (Min)	Mean $\pm$ SD (min/day)	Health Post (%)
Supply Chain & Logistics activities	3,999	102.54 ± 77.21	29.32	192	7.38 ± 14.67	2.09
Clinical and Public Health Services	2,123	54.44 ± 55.01	15.57	2,129	81.88 ± 49.94	23.18
Community-Level Activities	-	-	-	567	21.81 ± 26.86	6.17
Administrative & Management activities	1,762	45.18 ± 57.46	12.92	1,096	42.15 ± 38.57	11.93
Non-Value-Adding activities	5,755	147.56 ± 68.30	42.20	5,202	200.08 ± 70.50	56.63
Total	13,639	-	100.00	9,186	-	100.00
Notes: HC/PH – Health Centers/Primary Hospitals, SD – Standard Deviation						

Activity-level distribution of value-adding activities

Detailed activity-level analysis showed that, in health centers and primary hospitals, supply chain and logistics activities accounted for the largest share of value-adding time (50.72%), driven mainly by issuing and dispatching medicines (13.27%), recording stock transactions (12.25%) and internal order processing (9.27%). Clinical and patient care activities contributed 26.93%, largely through dispensing

and patient counselling (18.92%). Mean daily time spent was 102.54 ± 77.21 minutes for supply chain activities, 54.44 ± 55.01 minutes for clinical activities and 45.18 ± 57.46 minutes for administrative activities.

At health posts, clinical and public health services represented the largest share of value-adding time (53.44%), primarily driven by immunization and vaccination services (33.03%), diagnosis and treatment of common illnesses (8.43%) and health education (5.75%). Community-level activities contributed 14.23%, while supply chain activities accounted for only 4.82%. Mean daily time spent was 81.88 ± 49.94 minutes for clinical and public health services, 42.15 ± 38.57 minutes for administrative activities, 21.81 ± 26.86 minutes for community activities and 7.38 ± 14.67 minutes for supply chain activities (Table 4).

Table 4
Activity-level time distribution of value-adding activities by facility level

Activity category	Activity description	Activity per day (min)	Within category activity/day (%)	Overall activity per day (%)	Mean $\pm$ SD (min/day)	Median (IQR), min/day
A. Health Centers and Primary Hospitals						
Supply Chain & Logistics Activities	Issuing & dispatching medicines	1,046	26.16	2.84	26.82 $\pm$ 27.44	25.0 [0.0–39.0]
	Recording stock transactions	966	24.16	2.55	24.77 $\pm$ 50.18	0.0 [0.0–37.5]
	Internal order processing to dispensaries	731	18.28	9.27%	18.74 $\pm$ 32.21	0.0 [0.0–28.0]
	Physical inventory/stock counting	350	8.75	13.27	8.97 $\pm$ 37.32	0.0 [0.0–0.0]
	Organization and management of store	331	8.28	12.25	8.49 $\pm$ 15.14	0.0 [0.0–15.5]
	Preparation of orders and requisitions	224	5.60	4.20	5.74 $\pm$ 14.61	0.0 [0.0–0.0]
	Receiving & inspecting products	201	5.03	1.90	5.15 $\pm$ 14.87	0.0 [0.0–0.0]
	Stock status analysis & reporting	150	3.75	4.44	3.85 $\pm$ 17.10	0.0 [0.0–0.0]
Clinical & Patient Care Activities	Dispensing & patient counseling	1,492	70.28	0.86	38.26 $\pm$ 47.1	22.5 [6.0–60.0]
	Billing & financial recording	250	11.78	2.22	6.41 $\pm$ 10.56	4.0 [0.0–10.0]
	Prescription & medication preparation	175	8.24	3.17	4.49 $\pm$ 8.78	2.0 [0.0–6.0]
	Packaging & labeling	138	6.50	1.75	3.54 $\pm$ 7.18	2.0 [0.0–5.0]
Notes: IQR – Interquartile Range, SD – Standard Deviation						

Activity category	Activity description	Activity per day (min)	Within category activity/day (%)	Overall activity per day (%)	Mean $\pm$ SD (min/day)	Median (IQR), min/day
	Patient reception & evaluation	68	3.20	18.92	1.74 $\pm$ 3.54	0.0 [0.0–2.5]
Administrative & Management Activities	Meetings & correspondence	1,041	59.08	6.35	26.69 $\pm$ 40.78	10.0 [0.0–45.0]
	Routine documentation & reporting	501	28.43	13.20	12.85 $\pm$ 29.10	5.0 [0.0–18.0]
	Training, supervision & coordination	220	12.49	2.79	5.64 $\pm$ 15.90	0.0 [0.0–6.0]
Overall total		7,884		100%		
B. Health posts						
Supply Chain & Logistics Activities	Recording stock transactions	84	43.75	1.61	3.23 $\pm$ 7.54	1.0 [0.0–4.0]
	Preparation & submission of requisitions	64	33.33	0.80	2.46 $\pm$ 6.87	0.0 [0.0–3.0]
	Receiving supplies from linked health center	32	16.67	2.11	1.23 $\pm$ 4.91	0.0 [0.0–1.0]
	Organizing medicines and supplies	12	6.25	0.30	0.46 $\pm$ 2.10	0.0 [0.0–0.0]
Clinical & Public Health Services	Immunization and vaccination services	1,316	61.81	5.75	50.62 $\pm$ 59.47	32.0 [10.0–78.0]
	Diagnosis and treatment of common illnesses	336	15.78	4.67	12.92 $\pm$ 22.63	6.0 [0.0–18.0]
	Provision of health education	229	10.76	1.56	8.81 $\pm$ 16.42	5.0 [0.0–12.0]
Notes: IQR – Interquartile Range, SD – Standard Deviation						

Activity category	Activity description	Activity per day (min)	Within category activity/day (%)	Overall activity per day (%)	Mean $\pm$ SD (min/day)	Median (IQR), min/day
	Family planning services	186	8.74	33.03	7.15 $\pm$ 13.38	4.0 [0.0–10.0]
	Antenatal care (ANC) services	62	2.91	8.43	2.38 $\pm$ 6.54	0.0 [0.0–3.0]
Community-Level Activities	Community mapping	302	53.26	7.58	11.62 $\pm$ 28.74	3.0 [0.0–10.0]
	Outreach and household visits	182	32.10	4.57	7.00 $\pm$ 16.85	2.0 [0.0–8.0]
	Community mobilization & health promotion	83	14.64	2.08	3.19 $\pm$ 10.11	1.0 [0.0–4.0]
Administrative & Management Activities	Recordkeeping and reporting	527	48.08	13.23	20.27 $\pm$ 29.56	12.0 [4.0–28.0]
	Management of family folders	393	35.86	9.86	15.12 $\pm$ 24.83	8.0 [2.0–22.0]
	Meetings and official correspondence	176	16.06	4.42	6.77 $\pm$ 18.42	2.0 [0.0–10.0]
Overall total		3,984		100%		
Notes: IQR – Interquartile Range, SD – Standard Deviation						

Distribution of non-value-adding activities

Non-value-adding time was reclassified into three domains reflecting the underlying reasons it was not spent on value-adding work: system-induced idle time, work disruption, and personal and break time. The distribution differed in magnitude but showed a similar pattern across facility types. System-induced idle time, time during which staff were present and available but unable to work because the system did not enable it, including any phone use or informal interaction used only to fill that gap, dominated at both levels, accounting for 4,982 minutes (86.57% of non-value-adding time) in health centers and primary hospitals and 4,558 minutes (87.62%) at health posts. Within this domain, idle time, no activity or duty rest was the single largest component (4,528 minutes, 78.68% and 4,190 minutes, 80.55%, respectively). Work disruption accounted for 242 minutes (4.21%) in health centers and primary hospitals and 144 minutes (2.77%) at health posts. Personal and break time accounted for 531 minutes (9.23%) and 500

minutes (9.61%), respectively, and was proportionally larger at health posts, driven mainly by absence from the workstation (272 minutes, 5.23%) (Table 5).

Table 5
Distribution of nonvalue-adding activities per day by type of the health facility

Non-value-adding domain	Activity per day (min)	Within category activity per day (%)
A. Health Centers and Primary Hospitals		
System-induced idle time (no-activity)	4,982	86.57
Work disruption	242	4.21
Personal and break time	531	9.23
Total NVAA	5,755	100.00
B. Health Posts		
System-induced idle time (no-activity)	4,558	87.62
Work disruption	144	2.77
Personal and break time	500	9.61
Total NVAA	5,202	100.00
Notes: NVAA = non-value adding activities		

Time distribution of value-adding and non-value-adding activities by facility level

At health centers and primary hospitals, non-value-adding activities had the highest mean duration (147.56 ± 68.30 minutes), followed by supply chain and logistics activities (102.54 ± 77.21 minutes). Clinical and patient care activities accounted for 54.44 ± 55.01 minutes, whereas administrative activities averaged 45.18 ± 57.46 minutes. Similarly, at the health post level, non-value-adding activities had the highest mean duration (200.08 ± 70.50 minutes). Clinical and public health services averaged 81.88 ± 49.94 minutes, followed by administrative activities (42.15 ± 38.57 minutes) and community-level activities (21.81 ± 26.86 minutes). Supply chain activities had the shortest mean duration (7.38 ± 14.67 minutes) (Table 6).

Table 6
Time distribution by activity category and facility level (Mean, SD, Median, %)

Activity category	Facility level	N	Mean $\pm$ SD (min/day)	Median (IQR), min/day	Percentage
Supply Chain & Logistics activities	HC/PH	39	102.54 $\pm$ 77.21	105.0 [44.5–134.0]	29.32
	Health Post	26	7.38 $\pm$ 14.67	4.0 [1.0–9.0]	2.09
Clinical & Patient Care / Public Health Services	HC/PH	39	54.44 $\pm$ 55.01	45.0 [20.0–85.0]	15.57
	Health Post	26	81.88 $\pm$ 49.94	65.0 [40.0–110.0]	23.18
Community-Level Activities	HC/PH	–	–	–	–
	Health Post	26	21.81 $\pm$ 26.86	10.0 [3.0–28.0]	6.17
Administrative & Management activities	HC/PH	39	45.18 $\pm$ 57.46	30.0 [10.0–70.0]	12.92
	Health Post	26	42.15 $\pm$ 38.57	30.0 [12.0–65.0]	11.93
Non-Value-Adding activities	HC/PH	39	147.56 $\pm$ 68.30	150.0 [100.0–200.0]	42.20
	Health Post	26	200.08 $\pm$ 70.50	193.5 [152.8–241.8]	56.63
Notes: IQR – Interquartile Range, N – Number of Participants, SD – Standard Deviation					

Comparison of value-adding time across facility levels and regions

The proportion of value-adding time did not differ significantly across regions ($p = 0.156$), consistent with the Kruskal–Wallis test ($p = 0.164$). In contrast, value-adding time differed significantly across facility levels ($p < 0.001$). Mean value-adding time was significantly higher in higher-level facilities than at health posts (202.15 ± 88.11 versus 153.23 ± 62.85 minutes/day; $p = 0.004$), whereas non-value-adding time was significantly greater at health posts (200.08 ± 70.50 versus 147.56 ± 68.30 minutes/day; $p = 0.002$) (Table 7).

Table 7
Comparison of value adding activities by region and facility level, with effect sizes

Variable	Category	n	Mean ± SD (min/day)	Median [IQR]	p-value	Effect size (95% CI)
Value-adding activities						
Region	Amhara	23	168.09 ± 63.83	159.0 [120.0–227.5]	0.156	η² = 0.031 (small)
	Oromia	27	183.85 ± 77.85	206.0 [168.5–259.5]		
	Somali	15	148.53 ± 98.30	139.0 [79.5–210.5]		
Facility level	HC/PH	39	202.15 ± 88.11	160.0 [110.0–250.0]	0.004	d = 0.62 (medium); MD = 48.92 min, 95% CI (11.48–86.36)
	Health Post	26	153.23 ± 62.85	150.0 [110.0–210.0]		
Non-value-adding activities						
Region	Amhara	23	143.14 ± 56.09	164.0 [113.0–230.5]	0.121	η² = 0.105 (medium)
	Oromia	27	127.40 ± 58.81	165.0 [109.5–211.0]		
	Somali	15	184.00 ± 87.11	155.0 [101.5–228.0]		
Facility level	HC/PH	39	147.56 ± 68.30	150.0 [100.0–200.0]	0.002	d = - 0.76 (medium); MD = - 52.52 min, 95% CI (- 87.89 to - 17.15)
	Health Post	26	200.08 ± 70.50	193.5 [152.8–241.8]		
Notes: CI = confidence interval; IQR = interquartile range; SD = standard deviation; HC/PH = health centers/primary hospitals. Effect sizes were interpreted using Cohen's conventions: eta square (η²) of 0.01, 0.06, and 0.14 correspond to small, medium, and large effects, respectively; Cohen's d: d of 0.2, 0.5, and 0.8 correspond to small, medium, and large effects, respectively. MD: mean difference, min: minutes						

Discussion

This study applied the WOMBAT framework to quantify time allocation patterns among health workers engaged in pharmaceutical supply chain and service delivery activities across primary health care facilities in Ethiopia. The findings reveal a clear imbalance in time utilization, characterized by a high share of non-value-adding activities and a disproportionate supply chain and logistics workload, particularly in health centers and primary hospitals. These patterns have important implications for workforce efficiency and the delivery of pharmaceutical services in resource-limited settings.

In the present study, non-value-adding activities accounted for 42.2% of the total observed time in health centers and primary hospitals and 56.6% at health posts. This proportion exceeds findings from several time-and-motion studies in primary health care settings, where non-productive time typically ranges from 20% to 40% [35, 36]. The higher levels observed, particularly at health posts, likely reflect workflow inefficiencies, variability in service demand and gaps in task organization and supervision. In interpreting these figures, it is useful to distinguish findings likely to be structurally stable from those that may be time- or context-specific. The structural dominance of supply chain and logistics tasks in value-adding time at health centers reflects the core function of these facilities and is unlikely to be an artefact of the observation window. In contrast, the absolute magnitude of idle time may be more sensitive to the specific fortnight, woredas and service-demand conditions observed, and would require repeated or longitudinal observation across seasons and reporting cycles to confirm at scale.

The relatively large standard deviations observed reflect the inherent variability of time–motion data, in which differences in workload, service demand and task distribution across facility levels and individual health workers produce substantial dispersion. This variability is likely attributable to intermittent service demand, task fragmentation and differences in workload intensity that characterize real-world primary health care settings. The observed variation therefore represents true practice variation rather than measurement error and supports the appropriateness of presenting mean $\pm$ standard deviation. To account for skewness in the time data, medians and interquartile ranges were also examined; these were consistent with the mean-based findings, supporting the robustness of the results.

At higher-level facilities, supply chain and logistics activities accounted for 29.3% of total observed time, representing a major component of the workload. This finding is consistent with studies indicating that pharmacy and supply chain personnel devote a substantial proportion of time to inventory management and logistics functions [28, 36]. Within this category, issuing and dispatching medicines, stock recording and internal order processing were the dominant activities, indicating that routine operational tasks consume a large share of productive time. While essential for maintaining medicine availability, their high proportion suggests inefficiencies that could be mitigated through process optimization and digitalization.

Clinical and patient care activities accounted for only 15.6% of total time at health centers and primary hospitals, which is lower than reported in comparable settings, where clinical pharmacy services constitute a larger share of the workload [35, 37]. This suggests that logistical and administrative responsibilities may displace patient-centered pharmaceutical services. Ethiopian evidence supports

this pattern, with prior research identifying workforce capacity and management limitations as key constraints to effective pharmaceutical service delivery [38]. Similarly, time–motion studies of health extension workers have demonstrated limited engagement in direct service provision: one Ethiopian study reported that only 12.8% of working time was devoted to health services, with substantial time spent waiting (24.9%) and on reporting activities (13.2%) [15], whereas another reported that curative services accounted for only 16% of weekly time [13]. These findings are consistent with the crowding-out of clinical activities observed in the present study. Health extension workers comprised approximately 37% of the present sample and were the primary workforce at health posts, where non-value-adding time was highest (56.6%). Compared with these earlier Ethiopian studies, the present findings suggest that the crowding-out of direct service time among health extension workers has persisted, and possibly widened, since 2014 and 2017, with a large residual share of time spent neither on clinical or public health services nor on core logistics. This continuity across nearly a decade reinforces the interpretation that the pattern is structural rather than a transient feature of any single survey period, although differences in setting, task taxonomy and observation method limit direct numerical comparison.

The high proportion of non-value-adding time observed in this study exceeds levels reported in several international settings, where non-productive time typically remains below 20% [35, 39, 40]. However, similar patterns have been documented in other LMIC contexts. A study conducted in Albania reported that 40.7% of working time in primary health care facilities was unproductive, largely due to waiting [41]. At a broader level, evidence from sub-Saharan Africa highlights systemic inefficiencies such as absenteeism driven by low wages and weak supervision [42]. Together, these findings suggest that the high level of non-value-adding time observed here reflects systemic inefficiencies rather than isolated facility-level issues.

Idle time accounted for the largest share of non-value-adding activities, though some of this may reflect service-demand variability. At the primary health care level, low patient flow or structural demand-side constraints, rather than inefficiency alone, may be the operative issue. While some level of idle time is expected due to fluctuations in patient demand, the magnitude observed here may indicate inefficiencies in workload distribution, scheduling and task allocation. Because patient volume and service utilization were not formally measured, it is not possible to distinguish idle time arising from inefficient workflow from idle time arising from structural underutilization of facilities relative to their catchment population. This distinction is central rather than peripheral to interpretation, since the two mechanisms imply different responses: workflow-driven idle time calls for scheduling and task redesign, whereas demand-driven idle time points to catchment-level mismatches between facility capacity and population need. Characterizing service demand at each facility level should therefore be a priority for future work using this observational approach. The literature on lean management identifies waiting time and unnecessary movement as key sources of inefficiency in pharmaceutical supply chains [43, 44].

At the health post level, supply chain activities accounted for only 2.1% of total time, whereas clinical and public health services dominated value-adding activities. This reflects the role of health extension workers in delivering preventive and community-based services. However, the high proportion of non-

value-adding time (56.6%) indicates underutilization of workforce capacity. This is consistent with evidence that health extension workers often engage in non-core activities [24] and operate within constrained systems. Broader supply chain challenges, including stock-outs and low order fulfilment rates [45], further limit effective service delivery. Efficiency analyses reinforce these findings: only a small proportion of health posts in Ethiopia have been found to operate efficiently, with substantial variation across regions [46]. National assessments also highlight systemic constraints, including limited equipment availability and moderate workforce satisfaction [47].

Stock recording alone accounted for 12.3% of value-adding time, reflecting the intensity of inventory management tasks. This aligns with evidence highlighting challenges in stock accuracy and the importance of training [48], as well as the benefits of pharmacist-managed inventory systems [49]. These challenges are well documented in Ethiopian settings. Studies in the Jimma Zone reported high stock-out rates and infrastructure-related barriers [50], whereas evidence from the Amhara region indicates limited utilization of digital systems due to poor connectivity [51]. Similarly, low bin card accuracy has been reported in West Wollega [52], and weak inventory management practices have been documented in Adama [53]. Collectively, these findings highlight the persistence of manual systems and the potential gains from digitalization. The concentration of time in a limited number of dominant tasks (e.g. dispensing, stock recording and immunization services) further indicates task clustering, in which a few activities disproportionately consume working time, potentially reducing flexibility in task allocation.

The proportion of value-adding time was significantly higher in primary hospitals and health centers than at health posts ($p < 0.001$), reflecting differences in organizational capacity and resource availability. In contrast, no significant differences were observed across regions ($p = 0.156$), suggesting that inefficiencies in time utilization are systemic rather than region-specific. These findings imply that common operational constraints, such as workflow design, supervision and resource limitations, may similarly affect facilities across regions. The results are consistent with evidence that higher-level facilities tend to achieve greater efficiency through specialization and more structured workflows [54]. Ethiopian studies further support this observation, showing that variability in productivity is more strongly influenced by management practices than by staffing levels [55], while declining inventory performance has been reported at lower levels of care [56].

In addition to proportional differences, absolute time allocation further highlights inefficiencies across facility levels. Compared with higher-level facilities, health posts exhibited significantly higher non-value-adding time ($p = 0.002$) and significantly lower mean value-adding time ($p = 0.004$). Taken together, these patterns suggest that lower-level facilities not only operate less efficiently but also underutilize available working time, pointing to structural mismatches between staffing, task allocation and local service demand.

Implications for policy and practice

These findings identify several clear priorities for intervention. The substantial logistics workload at higher-level facilities supports the need for task shifting and role specialization to enhance clinical service delivery. High levels of idle time indicate opportunities for workflow redesign, improved scheduling and better alignment of staffing with service demand. Strengthening digital inventory systems could reduce manual workload and improve data quality. Because the specific high-burden activities identified at health centers issuing and dispatching, stock recording and internal order processing correspond closely to functions that digitalized logistics management information systems (LMIS) and electronic inventory tools can automate or simplify, the case for targeted digital logistics investment is concrete rather than generic. Digitalized LMIS and inventory systems have demonstrated efficiency gains in analogous low- and middle-income settings, and directing them to these dominant supply chain tasks could free up time for value-adding patient-centered pharmaceutical care [57].

Beyond automation, the consistency of non-value-adding time across regions suggests that current facility design and staffing models may be structurally misaligned with actual community-level service demand. This points to a broader need for formal health system optimization and workforce modelling of the kind applied to immunization program costing and coverage in Pakistan [58] that could take time-allocation data of the type generated here as inputs and produce actionable recommendations on staffing mix, task redistribution and facility-utilization targets. Such gains are especially valuable in the Ethiopian context, where recent estimates place the cost of an additional health-adjusted life-year among the lowest in the world at the country's current level of health spending, implying exceptionally high marginal returns to efficiency improvement [59].

Strengths and limitations

This study has several strengths: the use of the WOMBAT time–motion method for precise, real-time measurement of workflow activities; inclusion of multiple facility levels across three diverse regions; and continuous direct observation to improve data reliability. However, several limitations should be noted. The cross-sectional design and short observation period may not capture seasonal or temporal variations in workload, reporting cycles, supervision visits or public health campaigns. Because a single two-week window in May 2025 was observed, the sample was not designed to capture seasonal supply chain, reporting or demand cycles, and the estimates should be read as a cross-sectional snapshot rather than an annualized profile. Although acclimatization periods and observer training were used to reduce the Hawthorne effect and improve coding consistency, some observer-related behavior change and subjectivity in activity classification may remain. In addition, idle time may partly reflect low patient flow or brief recovery periods rather than inefficiency alone. The study captured only observable activities and did not assess cognitive workload or unobserved responsibilities. The primary hospital subsample was small ($n = 4$; 6.15% of participants); health centers and primary hospitals were therefore combined into a single higher-level analytical category, recognizing that this may mask a distinct hospital-pharmacist workload profile and that the supply chain burden reported for this category is likely driven mainly by health center staff. Finally, because facilities were selected from only three woredas and contextual factors such as patient volume and seasonality were not formally measured, the findings

should be interpreted as indicative of the study settings rather than nationally representative of Ethiopia's primary health care system.

Conclusions

This study shows that health workers' time in Ethiopian primary health care facilities is heavily consumed by non-value-adding activities, reflecting substantial workflow inefficiencies. The consistent efficiency gradient across facility levels suggests that these challenges are systemic, driven by workflow design, task allocation and limited system integration rather than isolated operational problems. Addressing these gaps requires system-level interventions, including workflow redesign, workforce optimization, digitalization, stronger supervision and staffing aligned with service demand. Rebalancing time toward patient-centered pharmaceutical services is essential to improve efficiency and quality of care. These findings provide practical, context-specific evidence to guide policymakers and health system managers in strengthening pharmaceutical service delivery in resource-constrained settings.

Abbreviations

AM	Administrative and management
ANC	Antenatal care
ANOVA	Analysis of variance
CL	Community-level activities
CP	Clinical and patient care
HEW	Health extension worker
LMIC	Low- and middle-income country
LMIS	Logistics management information system
NVAA	Non-value-adding activities
SC	Supply chain and logistics
SD	Standard deviation
SPSS	Statistical Package for the Social Sciences

STROBE

Strengthening the Reporting of Observational Studies in Epidemiology

WHO

World Health Organization

WOMBAT

Work Observation Method by Activity Timing.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Ethical Review Board of the Department of Social and Administrative Pharmacy, School of Pharmacy, Addis Ababa University (Ref. No. ERB/SoP/74.25/17/25). All methods were performed in accordance with the relevant guidelines and regulations and with the Declaration of Helsinki. Official support letters were obtained from the Ethiopian Ministry of Health and communicated to the respective regional health bureaus, selected woredas and participating facilities. Written informed consent was obtained from all participants prior to data collection. Participants were informed of the study purpose and their right to withdraw at any time. No personal identifiers were recorded, and all data were anonymized and reported in aggregate form.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Funding

This work was supported by the Gates Foundation (grant number INV-072401). The funder had no role in the design of the study; in the collection, analysis and interpretation of data; in the decision to publish; or in the preparation of the manuscript.

Author Contribution

AMF conceptualized and designed the study, supervised data collection, analyzed and interpreted the data, and drafted the manuscript. ZTM and BDD contributed to study design, data curation and analysis. EEA contributed to the design of the task taxonomy and interpretation of findings. RB and IA contributed to study conceptualization, facilitated field access and contributed to interpretation of findings in the

national policy context. SP and SO contributed to methodological design and critically reviewed the manuscript for intellectual content. TGF conceptualized and supervised the overall study, acquired funding and critically revised the manuscript. All authors read and approved the final manuscript.

Acknowledgement

The authors thank the data collectors for their valuable contribution to this study, and the participating health facilities, woreda health offices and regional health bureaus for their cooperation.

Data Availability

The datasets generated and analyzed during the current study are not publicly available because they contain observational records collected in a limited number of identifiable facilities but are available from the corresponding author on reasonable request.

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Figures

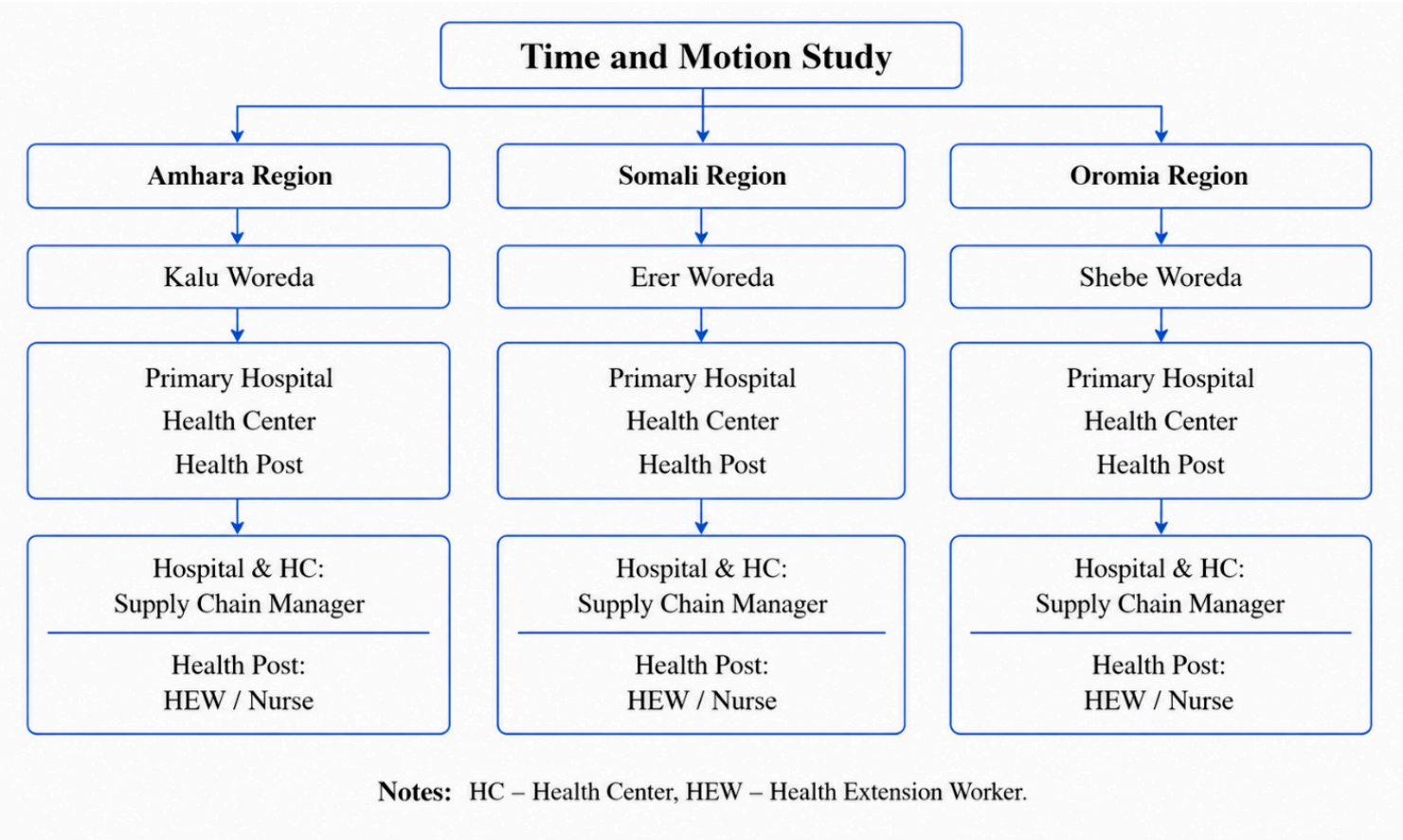


Figure 1

Schematic representation of the sampling procedure across regions, woredas and facility levels.

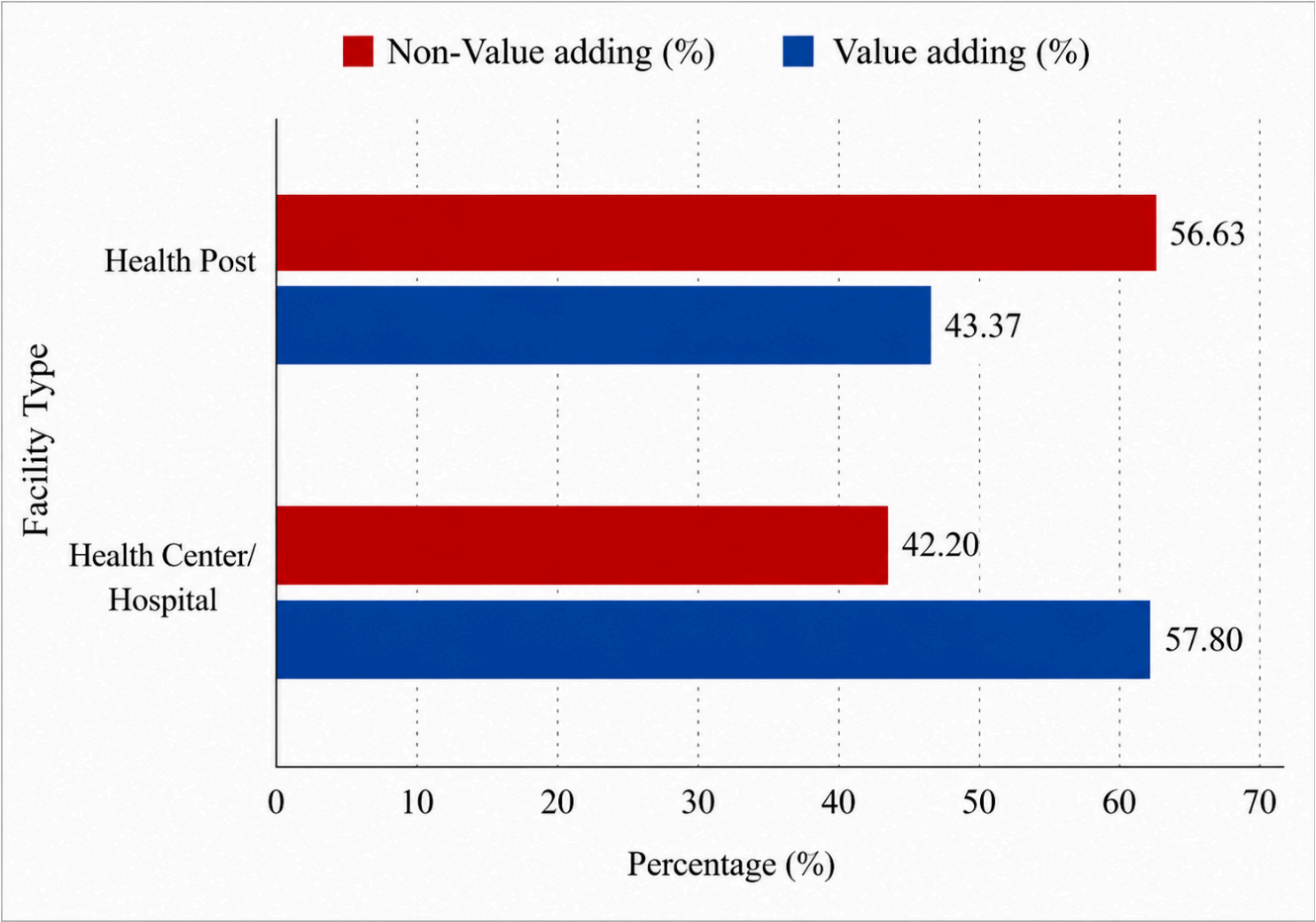


Figure 2

Distribution of value-adding and non-value-adding activities by facility level.

Supplementary Files

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