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# A Quantitative Comparative Analysis of NASA-TLX Workload between Staff and Non-Staff Employees in a Pharmaceutical Manufacturing Organization: Implications for Knowledge Management

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**Abstract.**
**Purpose:** In pharmaceutical production, personnel may be exposed to different workload situations, since their job functions are affected by strict operational and regulatory standards. Non-personnel workers and personnel workers have different duties which can affect their perception of workload and their participation in knowledge sharing activities. However, empirical evaluations of the workload characteristics of these employee cohorts by means of the NASA Task Load Index (NASA-TLX) are still scarce. This study explores the perceived workload attributes of staff and non-staff workers on six modified NASA-TLX scales. The implications of the identified trends for knowledge management strategies are discussed.
**Methods:** The method used for this research was quantitative, comparative and cross-sectional. The study's data were collected using a structured questionnaire. The sample selected for the study was 30 staff and non-staff members of a pharmaceutical manufacturing company using purposive sampling. The tool assessed six modified NASA-TLX workload factors; Mental Demand, Physical Demand, Temporal Demand, Performance, Effort and Frustration Level using a five-point Likert scale. Dimension total Pearson correlation analysis and Cronbach's alpha reliability test were performed to assess the instrument with the same data set. Descriptive analyses of the workload characteristics of staff and non-staff personnel were conducted using group mean scores and mean differences. No assertions regarding statistical significance were provided.
**Result:** Non-staff personnel had higher mean scores than staff personnel in Mental Demand, Physical Demand, Temporal Demand, Effort and Frustration Level. For workload, the largest mean differences were found in Temporal Demand and Effort. Non-staff personnel also reported a higher Performance score. The Performance items, however, are positively worded and imply that higher scores reflect a more positive view of work accomplishment and quality, not a greater workload. The patterns shown here indicate that role-specific knowledge management practices can support continued improvement, learning and knowledge sharing activities.
**Novelty:** This study presents the analysis of staff and non-staff employees according to their role and a complete workload analysis in the context of a pharmaceutical manufacturing environment with the modified NASA-TLX framework. The results provide a pragmatic basis for the development of knowledge management strategies relevant to the operational tasks and workload characteristics of each category of employees.

**Keywords**: Knowledge management, NASA-TLX, Occupational workload, Pharmaceutical manufacturing, Staff and non-staff employees
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## INTRODUCTION

In a highly regulated quality environment, it is essential for pharmaceutical manufacturing to ensure product quality, process consistency, traceability and data integrity throughout the entire product lifecycle. These provisions make organizational knowledge including standard operating procedures, validation documentation, deviation reports, corrective and preventive action records, and lessons learned an essential operational asset [1], [2], [3]. Effective knowledge management supports systematic acquisition,

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structuring, dissemination and application of knowledge and results in improved compliance, operational reliability, continuous improvement and organizational effectiveness [3], [4], [5].

In this sense, knowledge management is an organizational capability that leverages people, processes, and technology to provide the right knowledge to the right people at the right time [4], [6]. Pharmaceutical companies can achieve reduced process inconsistency, better decision-making, innovation, and more efficient responses to regulatory and operational changes through the documentation of lessons learned, internal records, and cross-departmental knowledge sharing [3], [5], [7], [8]. Pharmaceutical industry data show that practitioners learn and share job-relevant information by means of internal documentation, colleagues, domain specialists and defined knowledge-sharing mechanisms [9], [10]. How well these practices work depends on whether employees have enough time, attention and opportunity to participate. Higher work demands and mental or physical exhaustion may impair this ability, but may also contribute to knowledge hiding behavior [11], [12], [13].

Knowledge management is the process of creating, acquiring, organizing, sharing and using knowledge to help meet organizational and strategic goals [4], [6]. In pharmaceutical manufacturing, these processes are part of the supervision of standard operating procedures, validation documentation, deviation analyses, corrective and preventive action records, employee education, and interdisciplinary communication [1], [3], [9]. The dependence on employee's ability to access, interpret, share and use organizational knowledge means that differences in job roles, time availability and workload situations may impact the effectiveness of knowledge management implementation [7], [8], [11], [12], [13].

For the purposes of this study, personnel and non-personnel were defined by their organizational role and not employment classification. Personnel generally performed managerial, administrative, supervisory, quality assurance and control, engineering, or production-planning functions; By contrast, non-staff personnel were mainly engaged in frontline operational work including production, maintenance, material handling, packaging, and warehousing.

Differences in task characteristics may result in different workload profiles for staff and non-staff members. Staff jobs generally require sustained attention , critical thinking , record keeping , planning , organizing , collecting and processing information and accountability for results . Frontline operational roles often involve physical activity , repetitive actions , time constraints , equipment operation and limited discretion over activities . Studies in industrial environments indicate that cognitive load, physical demands, complexity of operations, automation, and rapid changes in workload may affect fatigue, safety behavior, and task performance [11], [12], [14], [15], [16], [17], [18]. Under such conditions staff may have less time and less opportunities to provide training, reflection, writing and sharing their knowledge. Therefore, knowledge management systems should match the specific workload features and operational settings of each group of employees [4], [7], [8], [13].

Previous studies in knowledge management have examined digital transformation, performance in the pharmaceutical industry, supply chain agility, information seeking behavior, organizational innovation, collaborative manufacturing and factors that promote and inhibit knowledge sharing [4], [5], [7], [8], [9], [10], [19], [20], [21], [22], [23]. The studies show the importance of knowledge acquisition, internal documentation, organizational culture, interdisciplinary collaboration and available ways of exchanging tacit and explicit knowledge.

Simultaneously, the research on occupational workload has focused on physical and mental demands, fatigue, ergonomics, automation, cognitive processing, task switching and employee performance in industrial environments [11], [12], [14], [15], [16], [17], [18], [24]. Both research domains offer important organizational perspectives, but knowledge management and occupational workload have been studied in isolation so far. Thus, there is little empirical evidence on how different workload profiles between staff and non-staff employees can inform role-specific knowledge management strategies in the pharmaceutical manufacturing sector. Such differences are even more critical in organizations where regulatory compliance, process accuracy, complete documentation, uninterrupted operations and ongoing knowledge sharing are paramount [1], [2], [3], [5], [8], [9], [10].

This study intends to fill this gap by comparing the perceived workload profiles of staff and non-staff employees using the six modified dimensions of NASA-TLX, namely Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration Level. The implications of the identified characteristics of the workload for the design of knowledge management practices tailored to the roles in a pharmaceutical manufacturing organization are further discussed. The main contribution of this work is the combination of multidimensional workload evaluation with tangible guidance on knowledge management, considering the different responsibilities and work settings of staff and non-staff personnel.

**Knowledge management concept**

Knowledge management is a systematic organizational process through which knowledge is created, acquired, organized, shared and applied to support operational and strategic objectives [4], [6], [25], [26]. Organizational knowledge consists of tacit knowledge embodied in employees' experience, professionalism, practical skills and problem-solving capabilities, as well as of explicit knowledge documented in protocols, databases, reports and official organizational documentation [25]. Successful knowledge management relies on a combination of people, processes and technology, underpinned by leadership commitment, a collaborative culture and accessible information systems [4], [6], [26]. This integration is particularly important in pharmaceutical manufacturing, where people need to consistently follow defined procedures and communicate technical, operational, and regulatory knowledge across different functions and levels of the organization [1], [3], [5], [8]–[10].

Knowledge management enables employees to find, share and use relevant knowledge when and where they need it, helping the organization be more agile, innovative, collaborative and effective in operations. As an example of an industry with strict regulation, in the pharmaceutical production organizational knowledge has to be exact, verifiable, current, and consistent in all departments [5], [7], [8], [22], [26]. Knowledge storage and dissemination can be improved by digital repositories, internal documentation, professional networks, collaborative practices and engagement with colleagues or domain experts [1]–[3], [5]. But for these systems to be effective, employees need adequate access, time and opportunity to interact [3], [4], [9], [10], [19]–[21]. High workloads, fatigue and conflicting job responsibilities can also hinder documentation, participation in training, knowledge sharing and organizational learning [11]–[13]. Therefore, knowledge management should be seen as a strategic organizational competence and not as an administrative or technological activity.

**Content and process of knowledge management**

The knowledge in an organization is normally split into explicit or tacit [25]. In pharmaceutical manufacturing, explicit knowledge includes standard operating procedures, validation documentation, audit reports, deviation reports, regulatory documents and structured training materials [1], [3], [9]. Tacit knowledge is found within the employees' experiential learning, professional judgment, analytical skills and understanding of the operational processes [10], [25]. For the effectiveness of knowledge management, systems are needed that would acquire, systematize, secure and disseminate both types of knowledge among employees, departments and organizational tiers. Their integration enables process traceability, compliance, operational consistency, acquisition of organizational knowledge and retention of critical expertise [4], [6], [19]–[23], [26].

Knowledge management includes related processes such as knowledge creation, acquisition, codification, retention, sharing, interpretation, application and evaluation [4], [6], [25], [26]. In pharmaceutical manufacturing, knowledge can be obtained from deviation analysis, corrective and preventive actions, internal audits, employee training, equipment operation and routine troubleshooting [1], [3], [9], [10]. This information can then be incorporated into standard operating procedures, technical manuals, educational materials, digital repositories, and organizational knowledge systems. Research in manufacturing and knowledge-based environments indicates that collaborative practices, internal dialogue, professional engagement and accessible information systems can improve the transfer of knowledge and support innovation within organizations [19]–[23], [26].

**Staff and non-staff employee roles**

***Staff employees***

Personnel typically work in functions such as management, administration, supervision, the professions, quality assurance and control, engineering, planning and documentation. Their duties may include evaluating performance, implementing policy, analyzing data, coordinating, making decisions and reviewing technical or regulatory documents. Such tasks demand sustained attention, data processing, critical thinking and inter-organization collaboration, which can place considerable cognitive load, effort and performance demands [11], [12], [16]–[18], [24]. These expectations can be raised when employees are expected to be accurate, compliant and quick decision-makers while handling multiple responsibilities.

The manufacturing personnel may also be responsible for implementing corrective and preventive actions, maintaining quality systems, reviewing production and validation records and ensuring compliance to established procedures and regulatory requirements. These responsibilities include the review of documents, interdepartmental cooperation, organizational decision making, and ongoing information management [1]–[3]. So staff jobs often involve more cognitive challenges, longer periods of exertion, information processing duties, and performance accountability than jobs that are largely boring physical work [11], [12], [16]–[18], [24].

Personnel are central in formalizing, coordinating and disseminating organizational knowledge from a knowledge management perspective. They may be responsible for developing and revising standard operating procedures, reviewing compliance reports, scheduling audits, reviewing operational effectiveness and communicating management decisions to operational units [1], [3], [5], [9], [10]. These duties are facilitated by digital archives, interdisciplinary cooperation, organized knowledge dissemination practices and systematic documentation processes [19]–[23], [26]. Thus, employee engagement is crucial for the retention of institutional knowledge, consistency of information, operational coordination and continuous improvement.

***Non-staff employees***

Non-staff personnel are primarily engaged in frontline and operational roles that directly support pharmaceutical manufacturing activities. They may be responsible for production, packaging, material handling, storage, machine operation, maintenance and compliance with established work procedures. Production goals, repetitive tasks, machine-paced activities, physical requirements, and limited flexibility in task performance may result in substantial physical, temporal, and cognitive strain on these workers [11], [14]–[18], [24].

Non-staff employees can find themselves in work situations involving production schedules, output goals, repetitive duties, machinery management and strict procedural requirements. Such situations can lead to increased physical demands, time pressure, exertion, fatigue, and mental workload [11], [12], [14]–[18], [24]. They might also reduce the time and attention available for formal training, reflection, documentation and knowledge sharing activities during work time [9], [13]. Organizational interventions should provide short, easily accessible, work-integrated ways of communicating, educating, and sharing knowledge on the job.

Non-staff workers are an invaluable source of tacit knowledge of operational processes obtained in first person, by touching the equipment, performing routine troubleshooting, and doing daily production work [10], [25]. These practical insights can help to quickly identify operational problems, improve processes, ensure quality and reduce risk. Knowledge management strategies should set up formal but informal systems for frontline staff to document and share operational insights, lessons learned and recommendations for improvement.

Engagement of non-staff personnel can be improved with well-structured shift handovers, deviation reporting systems, involvement in corrective and preventive actions, visual operational guidelines, short educational materials and simple digital platforms [1], [3], [9], [10]. These systems allow frontline staff to communicate operational challenges and practical insights without placing undue administrative burden on them. This knowledge can be integrated into formal protocols and organizational databases to promote procedural uniformity, safeguard operational acumen, reduce repetitive mistakes, and facilitate continuous organizational education [19]–[23], [25], [26].

## METHODS

The present study used a quantitative comparative and cross-sectional research design to describe the differences in perceived workload profiles of staff and non-staff employees in a pharmaceutical manufacturing organization. Average scores on six dimensions of the modified NASA-TLX were calculated for the two groups of employees. The data collected through a structured questionnaire were analyzed by descriptive statistics, Pearson’s correlation analysis of the dimension and the total, and Cronbach’s alpha reliability analysis. Intergroup comparison was made on the basis of mean scores and mean differences. The study does not purport to be statistically significant or different at the population level, as complete dispersion measures and inferential statistical results are lacking. Knowledge management was then used as an analytic framework to develop recommendations specific to the workload attributes of each employee class.

**Research workflow**

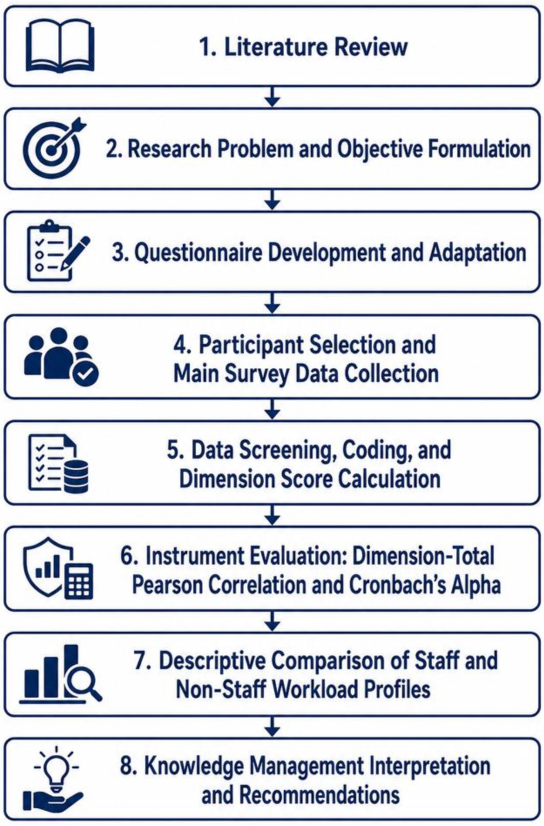

Figure 1 Research workflow of the study

The eight sequential phases used in this research are shown in Figure 1. The procedure was designed to standardize the development of questionnaires, selection of participants, data collection, data preparation, assessment of instruments, comparative description and development of knowledge management suggestions.

The first phase involved a literature review of the NASA-TLX framework, occupational workload, staff and non-staff employee roles, pharmaceutical manufacturing and knowledge management. The second phase consisted in establishing the research issue, the research aims and the level of depth of the role-based analysis. The third phase was to convert the six NASA-TLX workload dimensions into a structured questionnaire and to develop additional employee benefit metrics.

In phase four, purposive sampling was employed to select qualified personnel and non-personnel. The main survey instrument was the questionnaire. A separate pilot survey was not undertaken. In the fifth phase, the returned questionnaires were checked for completeness, the answers were categorized according to the 5-point Likert scale and the score of each measurement dimension was calculated as an average of the scores of individual items.

In the sixth phase, the instrument was analyzed for validity and reliability using the same 30 complete responses that were in the primary dataset. A Pearson correlation analysis across dimensions was performed to examine the association between each dimension-measurement score and the total score of the questionnaire. Internal consistency reliability was tested for items in each measurement construct using

Cronbach's alpha. The results are based on internal evidence from the present study cohort, and not independent validation from a pilot study, as the same responses were used for instrument assessment and primary analysis.

In the seventh phase, a descriptive comparison of workload profiles of staff and non-staff employees was made by group mean scores and mean differences for the six modified NASA-TLX dimensions. No inferential statistical testing was performed, as comprehensive measures of dispersion and inferential statistical results were not available. Finally, in the eighth phase, the identified workload patterns were reviewed in the light of relevant knowledge management literature to make recommendations for staff and non-staff personnel.

This research did not involve predictive modeling, model development or independent testing dataset. Therefore, data partitioning was not relevant. All 30 full responses were retained as one analytical data set.

**Population and sampling procedure**

The research was conducted on employees of a pharmaceutical manufacturing company at managerial, administrative, professional, technical, or frontline operational levels. Participants were classified as staff or non-staff based on their job functions and organizational duties and not based on their employment classification. "Personnel performed managerial, administrative, supervisory, professional, quality assurance and control, engineering, and planning functions. The non-staff were mostly involved in the frontline and operational activities, such as production, maintenance, material handling, packaging and warehousing.

Participants were selected through purposive sampling. They had to be currently employed within the organization in relevant managerial, administrative, technical or operational positions, as staff or non-staff; to be willing to participate voluntarily; and to be able to complete the questionnaire in its entirety. Incomplete surveys were not included in the final dataset.

A total of 30 completed and valid questionnaires were used for the study. However, the study documentation provided did not include data on the total size of the organization's workforce, the number of employees invited to participate, the exact number of staff vs. non-staff respondents, and detailed demographic data such as gender, age, tenure and functional area. Therefore, the response rate and the full demographic profile of the sample could not be established.

The same 30 detailed responses were used in the descriptive analysis of staff and non-staff workload profiles and in the assessment of dimension-level validity and reliability. No autonomous pilot study sample was available. Thus, the instrument evaluation and the first descriptive analysis were based on the same study sample, and this methodological limitation was considered when interpreting the results.

Table 1. Sample and study characteristics

| Characteristic | Description |
|---|---|
| Study setting | Pharmaceutical manufacturing organization |
| Research design | Quantitative comparative and cross-sectional |
| Final sample | 30 employees |
| Sampling technique | Purposive sampling |
| Employee classification | Staff and non-staff based on job roles and organizational responsibilities |
| Staff employee roles | Managerial, administrative, supervisory, professional, quality assurance and quality control, engineering, and planning |
| Non-staff employee roles | Production, maintenance, material handling, packaging, warehousing, and other frontline operational activities |
| Inclusion criteria | Active employees directly involved in relevant managerial, administrative, technical, or operational activities |
| Questionnaire completion | Only complete responses were included |
| Instrument evaluation | Conducted using the same 30 responses |
| Separate pilot-study sample | The main study sample was used for instrument evaluation |

The main characteristics of the study population and the sampling method are summarized in Table 1. Purposive sampling was employed to obtain 30 fully completed questionnaire responses, which made up the final data set. The pharmaceutical manufacturing entity's personnel and non-personnel job classifications were the participants. They were grouped according to their organizational responsibilities, not job title. The work was based on comparison of workload profiles by roles with the same sample for instrument evaluation and the main descriptive analysis.

**Instrument evaluation**

Based on the 30 complete questionnaire responses available in the primary dataset, the validity and reliability of the instrument were tested. There was no independent pilot study sample and hence the same respondents were used for both the instrument assessment and descriptive analysis of workload profiles for staff and non-staff.

Validity analysis was performed at the measurement-dimension level. The Pearson correlation analysis was used to correlate each dimension score of the measurements with the overall questionnaire score. The critical Pearson correlation coefficient for 30 participants and 28 degrees of freedom at a two-tailed significance level of 0.05 was 0.361. Satisfactory dimension-total correlation for a measurement dimension was considered if the Pearson correlation coefficient was more than 0.361 with a corresponding p-value of less than 0.05 [27].

Cronbach's alpha was used to evaluate internal consistency. A coefficient of 0.70 or higher was considered as an indicator of satisfactory reliability [28]. Cronbach's alpha was calculated for items included in each measurement construct. It is important to note that the results are internal evidence of the present sample, since the instrument evaluation and the first descriptive analysis were made with the same respondents and not from independent external validation.

The statistical results did not include the adjusted item–total correlations for the 29 different items of the questionnaire. Thus, item-level validity was not reported.

**Research instrument and measurement scale**

This study employed a systematic survey consisting of 29 assertive statements. 22 questions were associated with the six modified dimensions of the NASA-TLX, namely Mental Demand, Physical Demand, Temporal Demand, Performance, Effort and Frustration Level. Seven other items measured employee benefit assistance. The workload parameters were taken from the multidimensional NASA-TLX model proposed by Hart and Staveland and later evaluated by Hart [29], [30]. The metrics of employee benefits were used only to provide additional organizational context and were not included in the workload assessments.

The first model, NASA-TLX, assesses perceived workload from six dimensions and may use weighting to calculate an overall workload score [29], [30]. In the present research the framework was transformed into a non-weighted questionnaire with different declarative statements for each dimension. The resulting numbers were interpreted as average dimension scores, not as the original weighted NASA-TLX scores. The change made it easier to compare workload patterns for staff and non-staff employees in more detail.
Each item of the questionnaire was evaluated with a five-point Likert scale (1 = "strongly disagree," 2 = "disagree," 3 = "neutral," 4 = "agree," and 5 = "strongly agree"). The score for each measurement dimension was calculated through the average of answers to the individual items. A higher perceived intensity of the workload condition associated was shown by higher average scores of Mental Demand, Physical Demand, Temporal Demand, Effort and Frustration Level.

The Performance dimension required a separate interpretation because of the positively worded items. Higher Performance scores indicated a more positive perception of success, achievement, and quality of work, not a heavier workload. The Performance items were not reverse coded, so the Performance score was calculated separately and not combined with the other dimensions to provide a single overall workload score.

Table 2. Operational indicators of the adapted NASA-TLX workload dimensions

| Adapted NASA-TLX Dimensions [29], [30] | |
|---|---|
| Dimension | Variable |
| Physical Demand (PD) | PD1: My work requires considerable physical activity.<br>PD2: My physical fitness and endurance affect my ability to complete work tasks.<br>PD3: The amount of work assigned to me creates physical strain.<br>PD4: I need sufficient physical energy to perform my responsibilities effectively. |

| Adapted NASA-TLX Dimensions [29], [30] | |
|---|---|
| Dimension | Variable |
| Mental Demand (MD) | MD1: My work requires a high level of concentration and decision-making.<br>MD2: My work requires me to prioritize several tasks simultaneously.<br>MD3: My work requires substantial mental processing and problem-solving.<br>MD4: I experience considerable cognitive pressure when completing my work. |
| Temporal Demand (TD) | TD1: I experience time pressure when completing my work.<br>TD2: I am required to complete tasks within strict deadlines.<br>TD3: My work requires me to perform tasks quickly.<br>TD4: My workload makes it difficult to maintain a comfortable working pace. |
| Effort (EF) | EF1: I must exert considerable mental or physical effort to achieve the expected work results.<br>EF2: I need to work intensively to meet organizational performance expectations.<br>EF3: Completing my work successfully requires substantial effort. |
| Performance (P) | P1: I am expected to achieve high performance standards in my work.<br>P2: I am able to achieve the objectives established for my work.<br>P3: I am satisfied with the quality of the work that I complete. |
| Frustration Level (FR) | FR1: I experience stress while performing my work responsibilities.<br>FR2: I feel frustrated when work demands become difficult to manage.<br>FR3: I experience tension or discouragement when completing demanding tasks.<br>FR4: The tasks assigned to me sometimes create frustration rather than satisfaction. |

Table 2 describes the operational metrics used to assess the six modified NASA-TLX dimensions. Mental Demand is how much concentration, decision-making and thinking is required to do your work tasks. Physical Demand refers to the physical effort and energy required to perform work duties. Temporal Demand refers to the urgency of time, deadlines and the pace of work. Effort refers to the mental and physical resources required to perform the tasks effectively. Frustration Level refers to the tension, pressure, discouragement and dissatisfaction experienced while performing the tasks.

The modified tool defines Performance as employees' thoughts on success at work, achievement of goals and quality of work. The Performance items were worded positively so a higher Performance score was interpreted as a better perspective of performance instead of increased workload [29], [30].

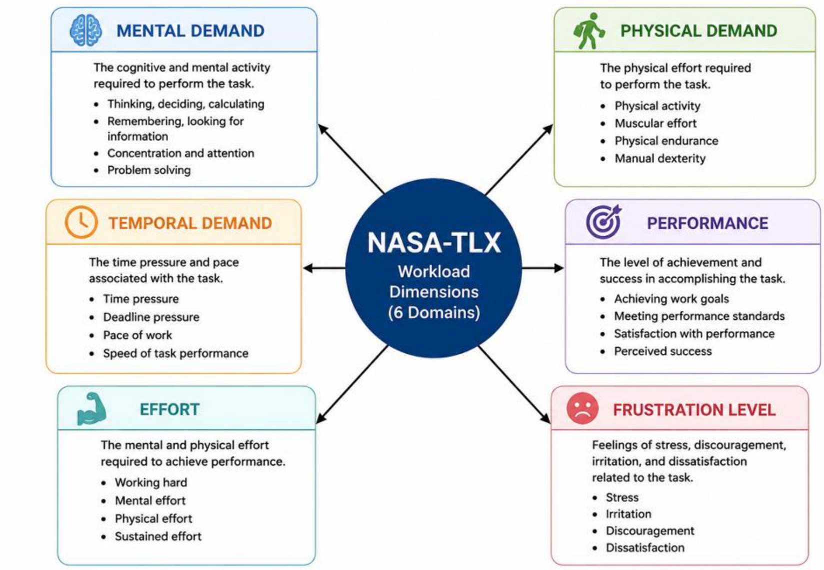


Figure 2. Workload dimensions of the NASA-TLX framework

The modified questionnaire is based on the six facets of the NASA-TLX framework, as presented in Figure 2. The framework describes workload as a multidimensional construct that includes cognitive workload, physical workload, time pressure, perceived performance, effort, and emotional reactions during task performance [29], [30]. In the present research these dimensions were operationalized by declarative questionnaire items and were investigated separately.

The Performance score was based on the positive framing of the Performance items that reflected the positive opinions of work accomplishments and quality by the employees. Thus, it was not understood in the same context as Mental Demand, Physical Demand, Temporal Demand, Effort and Frustration Level.

The survey contained six modified NASA-TLX dimensions and seven additional indicators of employee benefits support. The metrics were designed to provide context on how employees were accessing organizational assets and welfare assistance. The indicators covered education and training, housing or transport, occupational safety and health, sports and recreational facilities, holidays and vacations, and family and holiday benefits. NASA-TLX workload model did not include the evaluation of employee benefit assistance, and it was evaluated separately.

Table 3. Operational indicators of employee benefit support

| EMPLOYEE BENEFIT SUPPORT | | |
|---|---|---|
| Dimension | Code | Variable |
| Education and Training Support | BEN 1 | The organization provides adequate education and training opportunities to support my work responsibilities. |
| Housing and Transportation Support | BEN 2 | The housing or transportation support provided by the organization adequately supports my work needs. |
| Occupational Safety and Health Support | BEN 3 | The organization provides adequate occupational safety and health protection for employees. |
| Sports and Recreational Support | BEN 4 | The organization provides adequate sports or recreational facilities to support employee well-being. |
| Leave Support | BEN 5 | The leave arrangements provided by the organization adequately support employees' personal and work-related needs. |
| Family Allowance | BEN 6 | The family allowance provided by the organization adequately supports employees' welfare needs. |
| Holiday allowance | BEN 7 | The holiday allowance provided by the organization adequately supports employees' financial well-being. |

Table 3 displays operational metrics used to represent employee perceptions of organizational benefit assistance. All metrics for the workload items were assessed using a traditional five-point Likert scale. Higher scores indicated more positive employee perceptions of the relevant organisational support. The employee benefit metrics were analyzed separately for supplementary context and were not part of the six modified NASA-TLX workload dimensions.

**Data analysis**

We then examined the detailed workload profiles within a knowledge management context to generate actionable recommendations for the two employee cohorts. The psychometric evaluation of knowledge management was not performed independently and the empirical evaluation was not conducted to establish causal links between workload and employee engagement in training, documentation, knowledge dissemination, operational learning or continuous improvement. Thus, the proposed knowledge management strategies are interpretative insights based on the workload trends analysis and related literature instead of empirically validated results.

Data analysis was performed in four stages. Initially, the questionnaire responses were rated for completeness and classified using a 5-point Likert scale . The scores for each measurement dimension were calculated by averaging the scores of the individual items comprising it. Second, Pearson correlation analysis was used to assess the correlation between the total scores of the various measurement dimensions with the overall questionnaire score. Third, Cronbach's alpha was employed to assess the internal consistency of each measurement construct. Finally, the group mean scores and mean differences were used to perform a descriptive analysis of the workload profiles of staff and non-staff personnel.

Standard deviations at the group level, confidence intervals, test statistics, degrees of freedom and p-values for the inter-group comparisons were not examined. Hence, the observed differences were interpreted as representative trends in the sample of participants, and not as evidence of statistically significant differences in the entire population of employees.

## RESULT AND DISCUSSION

### Instrument validity and reliability results

The assessment tool was analysed with the 30 complete questionnaire responses in the primary data set. Due to the lack of a separate pilot-study sample, the same responses were used for the dimension-total Pearson correlation analysis, the internal consistency evaluation, and the descriptive comparison between staff and non-staff employees. The tool had 22 elements including 6 modified NASA-TLX workload categories and 7 other employee benefit components.

Table 4 shows the internal consistency results for the six modified NASA-TLX dimensions plus the additional employee benefit construct.

Table 4. Reliability test results

| Dimension | Cronbach's Alpha | Decision |
|---|---|---|
| MD | 0.796 | Reliable |
| PD | 0.804 | Reliable |
| TD | 0.812 | Reliable |
| P | 0.887 | Reliable |
| EF | 0.829 | Reliable |
| FR | 0.798 | Reliable |
| Benefit | 0.804 | Reliable |

As seen in Table 4, all Cronbach's alpha coefficients were higher than the minimum required value of 0.70. The coefficients ranged from 0.796 (Mental Demand) to 0.887 (Performance) and the employee benefit construct had a coefficient of 0.804. These results show a good internal consistency of the elements inside each construct. Reliability, however, was tested on the same sample as the main study, and so the findings should be taken as evidence for internal consistency based on the current sample, rather than as validation of an independent instrument.

Pearson correlation was used to test the association between each dimension score and total questionnaire score. The critical Pearson correlation coefficient at a two-tailed significance level of 0.05 with 30 participants and 28 degrees of freedom was 0.361 [27]. The measurement dimension was regarded as having an acceptable dimension-total correlation with its Pearson correlation coefficient >0.361 and the corresponding p-value <0.05. The results are presented in Table 5.

Table 5. Dimension-total pearson correlation results

| Dimension | *Critical r* | *Pearson r* | p-value | Decision |
|---|---|---|---|---|
| MD | 0.361 | 0.495 | 0.005 | Acceptable |
| PD | 0.361 | 0.512 | 0.004 | Acceptable |
| TD | 0.361 | 0.544 | 0.002 | Acceptable |
| P | 0.361 | 0.689 | < 0.001 | Acceptable |
| EF | 0.361 | 0.501 | 0.005 | Acceptable |
| FR | 0.361 | 0.533 | 0.002 | Acceptable |
| Benefit | 0.361 | 0.673 | < 0.001 | Acceptable |

A measurement dimension was considered to have an acceptable dimension-total correlation if the critical value for Pearson's r was greater than 0.361 and the corresponding p-value was less than 0.05. As shown in Table 5, all measurement dimensions had Pearson correlation coefficients higher than the critical value of 0.361 and p-values less than 0.05. Coefficients ranged from 0.495 for Mental Demand to 0.689 for Performance, with the employee benefit support dimension having a coefficient of 0.673. The results suggest that the scores of the individual measurement dimensions are correlated acceptably with the score of the overall questionnaire in the present sample.

The results should not be interpreted as psychometric validity at the item level because the analysis was based on aggregated scores across measurement dimensions. The original item-level responses are needed to recalculate the item-total correlations for each questionnaire item, and these cannot be derived from the dimension-level statistics provided.

The internal consistency and the dimension-total correlations of the questionnaire were satisfactory in the current sample (see Tables 4 and 5). However, both the instrument evaluation and the initial analysis were carried out with the same group of 30 participants. The findings therefore constitute initial internal corroboration from the study cohort rather than independent external validation. Future research should test the instrument using an independent pilot sample, item-level data from real subjects, and a larger number of participants.

**Comparison of staff and non-staff workload**

Table 6 provides a descriptive analysis of the modified NASA-TLX six dimension scores for staff compared to non-staff employees. The mean difference was calculated by subtracting the non-staff mean from the staff mean. The average difference was calculated as the non-staff average minus the staff average. So a negative mean difference means the mean for non-staff is larger than the mean for staff.

Table 6. Descriptive comparison of workload scores between staff and non-staff employees

| Dimension | Staff Mean | Non-Staff Mean | Mean Difference |
|---|---|---|---|
| MD | 3.92 | 4.01 | -0.09 |
| PD | 3.85 | 4.05 | -0.20 |
| TD | 3.60 | 4.18 | -0.58 |
| P | 3.88 | 4.25 | -0.37 |
| EF | 3.95 | 4.51 | -0.56 |
| FR | 4.10 | 4.28 | -0.18 |

Note that the higher mean scores on the subscales of Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration Level are the more perception of the associated workload condition. In terms of performance, an increase in mean score indicates a more positive view of work accomplishments and quality relative to an increased workload. The Performance score was examined separately and excluded from the overall workload score.

Non-staff personnel had better average scores than staff personnel in the five dimensions of workload-related dimensions of Mental Demand, Physical Demand, Temporal Demand, Effort and Frustration Level. The greatest mean difference for workload was found for Temporal Demand (−0.58) and Effort (−0.56). The findings show that non-staff personnel felt more time pressure and put forth greater mental or physical effort to fulfill their work obligations. The items of the Performance dimension were analyzed separately because of their affirmative phrasing.

The mean difference was smaller for Physical Demand, with staff members having a mean of 3.85 and non-staff members having a mean of 4.05. This pattern is consistent with the operational characteristics of non-staff roles, which may include production tasks, handling of equipment, transportation of material, repetitive tasks, and adherence to production schedules. Prior industrial studies [11], [12], [14]–[18], [24] have suggested that physical demands, mental fatigue, task complexity, automation, speed of work, and task changes may influence perceived workload, safety behavior, and employee performance.

The Mental Demand scores were similar for both groups, with staff members scoring a mean of 3.92, compared to 4.01 for non-staff members. The mean difference was small (−0.09), suggesting that cognitive demands on the study participants were similar. These requirements may include regulatory analysis, documentation, cooperation, and personnel decision-making. Non-staff personnel may face cognitive challenges such as machinery management, adherence to complex protocols, maintaining operational precision, and managing process anomalies [16], [17], [24]. Both groups experienced high levels of frustration (average 4.10 for staff members; 4.28 for non-staff members. Previous studies show that long mental and physical work can lead to fatigue, stress, decreased attention and changes in work efficiency [11], [12], [17], [18].

The Performance dimension was analyzed separately from the five workload-related dimensions because of the affirmative wording of its questionnaire items. Average Performance score for non-staff personnel was 4.25 as against 3.88 for staff personnel. This difference indicates that in the current sample, non-staff personnel had more positive attitudes toward work accomplishment and quality. This does not mean that the Performance aspect was more demanding for non-staff personnel.

There were no reverse-coded Performance items, therefore the Performance score was not combined with Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration Level to create one overall workload score. The noted difference in performance should be taken descriptively as no inferential statistics were conducted.

The analysis presented in Table 6 is expository. Because standard deviations, confidence intervals, test statistics, degrees of freedom, and p-values are not included in the analysis at the group level, the statistical significance of the differences in means observed cannot be determined. Thus, the findings should be interpreted as trends in workload of the 30 participants in this study and not as evidence for differences between staff and non-staff employees at the population level.

From a knowledge management perspective, the high Temporal Demand and Effort metrics for non-staff personnel suggest that efforts to share knowledge should be part of everyday operations, not seen as extra administrative tasks. Concise educational materials, visual protocols, brief shift handoffs, and simple reporting systems can enable frontline staff to transfer knowledge between each other without requiring significant extra time. High values of Mental Demand and Frustration Level for both cohorts are indicative of the need for documentation, easy access to information, structured communication and efficient knowledge retrieval mechanisms.

**Knowledge management recommendations**

The granular workload profiles imply that knowledge management strategies should be tailored to the tasks and work settings of each employee cohort. Studies in the pharmaceutical, manufacturing and knowledge-intensive fields show that effective knowledge sharing is based on information availability, trustworthy in-house sources, collaborative practices, organizational support and systems to collect and transfer tacit and explicit knowledge [5], [7]–[10], [19]–[23], [25], [26]. Hence, a standardized knowledge-sharing system may not be adequate in the face of different work requirements and operational constraints faced by personnel and non-personnel.

***Recommendations for staff employees***

Management, administrative, supervisory, quality assurance, quality control, engineering, planning and documentation functions. The mean scores indicate a significant level of mental demand, effort and frustration. Standardized documentation, effective information retrieval, decision support, and interdepartmental coordination should be included in the knowledge management strategies for personnel, given the workload characteristics. The entity should have a centralized and current digital repository for standard operating procedures, validation documentation, deviation reports, corrective and preventive action records, audit findings, project assessments, regulatory data, and lessons learned. The documents must be classified systematically, version controlled, reviewed on a regular basis and made available according to the duties of the employees. These methodologies can improve traceability, reduce duplicative efforts, and help employees find relevant information more quickly [1], [3], [4], [9], [19]–[23].

Standardization of audit reports, corrective actions, project evaluations and process improvement initiatives. Standardization of deviation investigation documentation. Standardization can reduce unnecessary thinking, increase consistency between departments, and ensure that important information is captured systematically. Defined document ownership, review and version control procedures can also prevent employees from using outdated or inconsistent information [1], [3], [4], [9].

Facilitate lessons learned discussions after major projects, audits, discrepancies, equipment modifications and process improvement efforts. Lessons learned should be recorded and incorporated into appropriate training, procedures, and future decision-making processes. This method can convert personal experience into transferable organizational knowledge, and assist in avoiding the reoccurrence of known issues [4], [5], [10], [25], [26].

Mentoring and knowledge sharing initiatives should facilitate the transfer of relevant skills from senior staff to junior staff. Examples of possible techniques are: structured knowledge sharing sessions, succession planning documentation, technical mentoring, and on-the-job training by observation. Such systems may serve to protect tacit knowledge of regulatory interpretation, problem solving, quality management, and organizational decisions [10], [20], [25], [26].

The knowledge exchange platforms should be interdisciplinary for different disciplines such as Engineering, Quality Control, Quality Assurance, Management, Production Planning, Maintenance, and operational divisions. Such talks should cover issues of operation, inconsistencies, regulatory changes, ongoing challenges and ways to improve. Structured agendas and documented outcomes can facilitate collaboration, information sharing and institutional learning without imposing significant administrative burdens [8], [19]–[22], [26].

***Recommendations for non-staff employees***

The Temporal Demand and Effort were higher for non-staff personnel than for staff personnel. These findings suggest that knowledge management strategies for frontline staff should provide practical, readily accessible information with little additional time or documentation requirements. Knowledge dissemination activities should be integrated into existing operational processes. Organised shift handover meetings should be used to communicate the status of equipment, progress of production, outstanding issues, safety risks, quality concerns and any follow-up actions required. A uniform handover checklist can help ensure reliable information exchange between employees and shifts, thereby reducing information loss and fostering operational continuity [1], [3], [9], [10], [19].

Visual standard operating procedures, short checklists, process-flow diagrams, warning labels, and short video learning resources should be available at or near the worksite. These formats can help employees get the information they need faster than long documents, especially when tasks need to be done on tight production schedules. Digital knowledge resources should be accessible through terminals or devices in the operating areas. Non-staff personnel should receive short, focused training activities that can be easily incorporated into their existing work routines. Refresher courses, safety orientations, microlearning modules, toolbox talks and equipment demonstrations, can help facilitate knowledge transfer while minimizing disruptions to operations. Training resources should cover practical problem solving, safety risks, procedural changes, common mistakes and urgent job needs [3], [9], [10], [20], [23].

The organization should establish simple systems for non-staff to report operational challenges, record lessons learned and suggest process improvements. These mechanisms may include electronic recommendation platforms, short enhancement meetings, anomaly-reporting documents, and supervisor-facilitated dialogues. Frontline workers have tacit knowledge that can help identify operational hazards and opportunities for improvement because they are directly involved with equipment, materials and production processes [19]–[23], [25], [26].

The knowledge sharing processes should be supported by feedback and recognition systems. Individuals who have offered valuable operational insights or suggestions for improvement should be informed of the actions taken in response. Proper recognition can help to keep people engaged and show that the organization values expertise on the front lines of operations. Thus, knowledge management systems for non-staff should be simple, visual, easy to access, naturally integrated in daily work and supported by immediate feedback. Such systems can be used to protect operational expertise, improve consistency of behaviour, and encourage continuous improvement, while recognising the time pressures and effort faced by frontline workers [7], [10], [13], [22], [26].

## CONCLUSION

The present study conducted a qualitative analysis of perceived workload characteristics of staff and non-staff in a pharmaceutical manufacturing company. The six modified NASA-TLX dimensions used were; Mental Demand, Physical Demand, Temporal Demand, Performance, Effort and Frustration Level . Non-staff personnel had higher average scores in the five workload-related dimensions, including Mental Demand, Physical Demand, Temporal Demand, Effort and Frustration Level. The largest mean differences were associated with workload for Temporal Demand and Effort. The observed patterns suggest that the frontline operational staff of the study cohort experienced increased time pressure and exerted more mental or physical effort in performing their duties.

Due to the affirmative formulation of the items used in the questionnaire, the Performance dimension was analyzed separately. Non-staff reported a higher average Performance than staff employees. This indicates a more positive view of work accomplishments and quality rather than an increased workload. Since the Performance items could not be reverse scored, this dimension was not combined with the other workload dimensions to create an overall workload score. The findings are a subjective interpretation within the present sample and are not indicative of objectively improved performance or a statistically significant difference between groups.

The results suggest the need to develop knowledge management practices for specific roles. Employees have centralized and version controlled knowledge databases, consistent documentation, structured lessons learned activities and systems for mentoring and cross-disciplinary knowledge sharing. These methodologies can enhance information retrieval, decision making, organizational memory and reduce unnecessary cognitive load.

Non-staff individuals can benefit from organized shift changeovers, visual standard operating procedures, short checklists, integrated microlearning, user-friendly reporting systems, and timely feedback on operational recommendations. These systems can foster knowledge sharing and improve organizational learning without significantly increasing the time pressures and workload on frontline staff.

This study contributes to the literature on knowledge management by emphasizing the importance of considering the characteristics of employee workload and job duties when designing knowledge processes in organizations. Strategies for knowledge management that neglect employees' cognitive capabilities, physical needs, time available, and access to organizational data may be less successful. Thus, the combination of workload assessment and knowledge management offers a pragmatic basis for constructing more accessible and role-specific knowledge sharing systems.

This work has a lot of limitations. The sample was initially made up of 30 participants from one pharmaceutical manufacturing company, which limited the generalizability of the results. Secondly, the cross-sectional design and self-reported questionnaire data are not conducive to causal inference. Thirdly, the NASA-TLX framework was modified to an unweighted five point Likert scale instead of the original weighted scoring method. Hence, the results should be considered as perceived workload-dimension profiles rather than the original global NASA-TLX workload scores.

The study compared workload profiles between staff job-role categories and non-staff job-role categories. Consequently, the results were evaluated according to organizational duties and operational characteristics, but not according to specific demographic groups. Future studies should consider a broader range of respondent characteristics and examine whether workload patterns differ across departments, job titles, work schedules, tenure, and other relevant occupational characteristics. The validity of the instrument was tested by correlating the sum of the measurement-dimension scores with the total score of the questionnaire. The single questionnaire items were not available for item total correlation and are therefore omitted from the statistical results. Therefore, the results reported allow a first dimension level internal validation but not a complete item level psychometric assessment . Future work should maintain and evaluate the original item level responses, use a different pilot sample, and apply additional construct validation techniques with a larger sample of respondents.

The instrument's reliability and validity were assessed using the same sample used for the descriptive comparison as an independent sample was not available for a pilot study. Also, the analysis was limited to mean group scores and mean differences, and not the full range of measures of variability and the inferential statistical results needed to establish statistical significance. Therefore, the results are indicative of descriptive trends within the study cohort and cannot be generalized to statistically significant differences in the larger workforce. Future research should consider larger samples from other pharmaceutical manufacturing companies and investigate workload differences across departments, shifts, and specific job functions.

Future studies should use a validated tool and report full descriptive statistics for each employee cohort including sample size, mean and standard deviation. When conducting an analysis of differences between groups, you must conduct and report appropriate assumption tests and inferential analyses (test statistic, degrees of freedom, p-value, confidence interval, and effect size). A combination of subjective workload assessments and objective measures, such as production output, hours worked, error rates, absenteeism rates, physiological indicators and time taken to complete tasks, might provide a more comprehensive understanding of employee workload. Longitudinal and mixed-methods studies could also examine the effect of workload on organizational effectiveness, compliance, continuous improvement, staff training, and knowledge sharing practices over time.

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