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ASSESSING COGNITIVE STRAIN IN EMPLOYEES WORKING WITH LARGE-SCALE DIGITAL ARCHIVAL REPOSITORIES

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Abstract
The increasing complexity of digital archival repositories and the proliferation of content written in a digital format have placed considerable cognitive strain on staff who play a role in the management, identification, retrieval, and preservation of that content. This research project explored three forms of cognitive strain through the use of a mixed-methods approach using psychometric measures, visual representations of the complexity of tasks, and observational ergonomics. Participants, particularly metadata curators, digital preservation specialists, and access coordinators, experienced considerable cognitive strain in the form of cognitive fatigue, decision overload, and stress from task switching. The paper discusses how an interface design, workflow automation, and digital literacy can help mitigate, or exacerbate cognitive load. By identifying workplace predictors of cognitive strain, and associating work roles and number of system interactions this study offers solutions to improve the redesign of digital archival environments. The proposed intervention model includes role-based simplifications of interfaces, task reallocation depending on cognitive task load, and monitoring of cognitive strain experienced by staff to enhance the experiences of employees and improve the efficiency of information systems in archives.

Keywords: Cognitive strain, digital archives, employee well-being, task complexity, archival systems, information ergonomics, mental workload

INTRODUCTION

Cognitive strain within office circumstances can be described as the mental strain that employees experience in relation to extraneous demands, when dealing with long and complex information streams, performing multiple tasks simultaneously, or making important decisions while under time pressure. Within current knowledge-based contexts, where software, infrastructures and data-heavy work ultimately govern our daily performance, cognitive strain has emerged as a critical determinant of efficiency, accuracy, and employee well-being. Prolonged and sustained exposure to high mental demands has the potential to lead to generalized fatigue, chronic burnout, and lower axiom selection under uncertainty, indicating interfaces with cognitive overload needs to be determined and stopped[2]. In digital archival repositories—structures designed for the storage, classification and re-accessing of large digital bodies of material—professional must grapple with particular cognitive challenges. Operators must traverse disjoint metadata schemes, uphold preservation schemes, coordinate concurrent ingest and retrieval streams, and abide by shifting digital compliance regimes. The multilayered interdependencies of such systems, fused with the obligation to guarantee data authenticity and custodial security, subjects archival personnel to pronounced, sustained mental strain[6] [13]. As the use of these repositories expands across cultural heritage institutions, scholarly information systems, and governmental record offices, a systematic investigation of the cognitive load borne by human stewards assumes both urgency and strategic significance [3].
The present investigation focuses on quantifying and tracing cognitive load experienced by custodians of expansive digital archival repositories. Through systematic measurement of task modalities and systemic attributes that correlate with elevated fatigue indicators, the inquiry intends to generate empirically grounded guidelines for iterative design and institutional policy. The overarching ambition is to inform the creation of archival ecologies that optimise user welfare and institutional durability, thereby advancing the long-term viability of memory organisations within complex digital landscapes.

II. Cognitive Strain in Archival Work Environments

2.1 Definition of Cognitive Strain and Its Impact on Employee Performance

Cognitive strain refers to the encounter with a more strenuous level of mental effort when processing complex information under high task demand. Mental workload may be caused by multitasking, simultaneous rapid decision making and rapid movement through complex digital systems. Prolonged cognitive strain has the potential to affect attention, memory, and judgment, leading to reduced productivity, greater error, and dissatisfaction with work performance. In digital work environments, cognitive strain is further heightened by poor design, lack of clarity with workflows, and repetitive micro-tasks. Without intervention, these circumstances may surpass our cognitive capacity, further leading to burnout and turnover. So the significance of the constraints on cognitive load is critical for maintaining employee health and work effectiveness for high intensity knowledge work[4][8].

2.2 Previous Research on Cognitive Strain in the Workplace

The construct, cognitive strain, has been extensively studied in medical, aviation, and IT environments, where cognitive overload occurs as a result of both multitasking, and system or task complexity. In examples like the process of patients reporting medical history, physicians using EHRs (or electronic health records) face significant cognitive overload with more complex decision making and multistep processes[7] [14]. Cognitive strain is also a characteristic of roles which involve switching between tasks or switching quickly between tasks. Digital archival work – while perhaps cognitive demanding – has rarely been subjected to the same level of vigorous definition or debate. Digital archival work and its related activities (metadata creation, digital preservation, and managing compliance) entails cognitive effort, then it is worthy of the attention and study in archival circles[11].

2.3 Challenges Specific to Employees Working with Large-Scale Digital Archival Repositories

When employees manage large-scale digital archival repositories, they simultaneously engage with a unique constellation of cognitive challenges[9]. For example, classifying archival content, metadata creation, data traceability, and version control,are all tasks that are typically accuracy-sensitive and attention-demanding [10]. Archival workers are often expected to continue these tasks using outdated or siloed software (that lacks intuitiveness and eliminates any real-time automation) -- often leading to excessive reliance on human memory recall, manual cross-referencing, and repeated error correction, all of which stack on the cognitive workload mental debt. Additionally, the domains of data ingestion, migration, access controls, and archiving some legal compliance documentation, require archivists to switch between several layers within the architecture of archival access and repositories so that each layer (e.g. system quality, archival information quality, human cognitive inability), come with a variable technical cognitive load[12]. Given this, and when mounted with high levels of data input, intervention from stakeholders, and distracted working environments, it all adds to the continuing cognitive workload and often leads to elevated mental fatigue. In absence of any formal ergonomic support, cognitive workload assessments, or assistive tools, these employees are left highly vulnerable to endorsement of continuous strain on themselves, and problematic impacts to the archival record itself[15].

III. Cognitive Strain Assessment

3.1 Description of the Study Participants and Recruitment Process

The study consisted of sixty employees (n = 60) performing a variety of roles across the various large-scale digital archival repositories from academic, governmental, and private institutions. Participants were chosen to represent the myriad of archival roles, including and not limited to metadata curator, digital preservation, systems administrator, and access services. Participants also needed to meet the following inclusion criteria: there must be at least one year of working in a digital archival system and choose to work in digital repository every day.Recruitment was accomplished through internal communication methods and professional archival networks. They utilized methods of email and organizational announcements inviting participation and summarizing the purpose of the study, confidentiality information, and terms of voluntary participation. The study received ethical approval from an Institutional Review Board, and informed consent was delivered to all participants before starting the collection of data[5].

3.2 Data Collection Methods: Surveys and Cognitive Assessments

To assess cognitive strain a mixed-methods approach was taken that combined subjective self-reporting tools and objective cognitive performance measures.

- Surveys included a validated Cognitive Strain Inventory (CSI) that had been adapted to a digital archiving context. The CSI measures dimensions of cognitive strain, namely mental fatigue, attentional effort, and task-related frustration. Each dimension uses a 5 point Likert scale.
- The NASA Task Load Index (NASA-TLX) was used specifically to measure perceived workload along six dimensions (mental demand, physical demand, temporal demand, performance, effort, frustration).
- Contextual dimensions (i.e., task complexity, usability, stressors) were measured using open-ended questions.
- Cognitive performance tasks (e.g., Stroop Test, Digit Symbol Substitution Task) measured reaction time, attention span, and speed of mental processing under mock archival task conditions.

All measures were collected in an equivalent context, either on-site for all measures or off-site via secure platforms, to always preserve a pre-moniionted situation for each participant.

3.3 Analysis Techniques for Assessing Cognitive Strain Levels

Data analysis employed a mixed-methods approach:

- Survey items were first coded and entered into a centralized database, from which aggregate scores were derived for each respondent. Descriptive measures—arithmetic mean, median, and standard deviation—provided a summary of dispersion and central tendency; these were complemented by inferential techniques, including analysis of variance (ANOVA) and independent-samples t-tests, to evaluate how cognitive strain varied by occupational roles and by tiers of professional experience.
- Multivariate regression models were used to look for predictors of cognitive strain (i.e., system complexity, frequency of multitasking, time on task).
- We analyzed performance data from cognitive tests for statistical significance as measures of attention control, speed, and accuracy to provide objective correlates to survey self-reported cognitive strain.
- Qualitative data in the form of responses to open-ended questions were thematically coded for patterns of repeated strain (e.g., cluttered interface, repetitive tasks, unclear workflow).

This integrated assessment method allowed for the triangulation of subjective and objective data to develop a stronger understanding of cognitive strain in digital archival environments.

IV. Cognitive Strain Findings in Digital Archival Roles

4.1 Summary of Cognitive Strain Levels Among Employees Working with Digital Archival Repositories

Analysis showed that many employees have moderate to high-level cognitive strain while working in digital archival environments. Besides orientation and demographics, 68% of participants self-reported regular incidental and mental fatigue, a difficult time maintaining sustained focus, and feelings of cognitive overload while working during standard work hours on the modified Cognitive Strain Inventory (CSI). Use of the NASA-TLX workload scale indicated that mental demand and effort was rated highest in all roles, with average composite workload located between the values 65 and 78 (out of 100). Digital preservation specialists and metadata curators used the most cognitive effort, particularly with system intensive tasks such as bulk metadata entry and long-term storage validation. Cognitive performance measures substantiated self-reported measures. Within simulated task switching exercises, cognitive performance measures for reaction times and accuracy were consistently slower or declined, much more when time-limited or with noticeable inconsistencies in the interface. Taken together, these findings indicate that the mental demands of archival work require more than sheer information retrieval—requiring prolonged concentration and working memory while executing without error in the context of often rigid work processes.

4.2 Factors Contributing to Increased Cognitive Strain

Cognitive strain was largely driven by system complexity, with workers reporting fragmented interfaces; lack of navigation; inconsistent metadata as cognitive stressors. Frequent task-switching for access coordinators, also increased mental load and chances of error. Manual and repetitive tasks for workers such as tagging metadata without automated suggestionstired workers out. Workers also had to re-check their entries due to not having real time feedback from the system, which increased decision stress and vigilance demands [1].

4.3 Comparison of Cognitive Strain Levels Across Different Job Roles

By role, there were very different levels of strain. Metadata curators and preservation specialists were the roles with the most strain because they were doing accuracy focused tasks and processes that were tightly scripted. Systems administrators mostly felt less overall strain, but there were strain spikes when they were responding to outages or audits. Access coordinators felt moderate-to-high strain from constant multitasking and interruptions which were user-facing. These differences indicate the need for ergonomics and design interventions to accommodate the different roles in the system.

Table 1. Average Cognitive Strain Scores by Job Role

Job Role	No. of Participants (n)	Avg. CSI Score (0–5 scale)	Avg. NASA-TLX Score (0–100)	Key Cognitive Stressors
Metadata Curators	15	4.2	78	High precision tasks, repetitive metadata entry
Digital Preservation Specialists	12	4.0	75	System monitoring, archival integrity checks
Access Coordinators	14	3.7	70	Task switching, user communication overload
Systems Administrators	10	2.8	62	Downtime troubleshooting, audit preparation
Records Managers	9	3.4	68	Legal compliance, classification ambiguity

Table 1 provides the average levels of cognitive strain by employee roles in digital archival repositories. CSI (Cognitive Strain Inventory) scores were based on a 0-5 rating scale while NASA-TLX workload scores were based on a 0-100 rating scale. Metadata curators and digital preservation specialists reported the highest level of strain suggesting the need for cognitive support in these two areas.

DISCUSSION ON COGNITIVE ERGONOMICS IN ARCHIVAL SYSTEMS

5.1 Implications of Findings for Employee Well-Being and Organizational Performance

The findings from this research underscore an important and often neglected aspect of digital archival work—the cumulative mental load that staff contend with while engaged in complex, high-volume systems. Significant cognitive load not only negatively impacts individual well-being—characterized through experiences of mental fatigue, diminished motivation, and burnout—but also diminishes the organizational value.More cognitive load causes higher errors in metadata description and creation, longer processing times for archival access requests, and less capacity to respond to preservation monitoring. Related organizational effects can put data integrity at risk, negatively impact user experience and satisfaction, and expose the institution to reputational and/or regulatory risk. In addition, on a cultural level, chronic cognitive load may erode the workforce in critical archival roles, especially in settings with limited ergonomic or psychological support systems around this work. Institutions that do not take account of cognitive ergonomics in their work and workflows not only risk short-term performance issues, but will suffer from long-term loss of talent and institutional memory. Improvements to cognitive work conditions is not only about worker welfare—it is about ensuring continued archival quality and continuity.

5.2 Strategies for Reducing Cognitive Strain in Employees Working with Digital Archival Repositories

This research advocates for a layered approach to relieving cognitive demand in archival settings, incorporated across system design, work policy, and training:

• System redesign should be driven by cognitive sophistication, with User Interface (UI) design promoting cognitive energy conservation through user-centered layouts; predictive workflows; in situ error feedback; progressive disclosure of features; auto-fill metadata prompts; and varying options for dashboards and user views to fit workflows. These methods will mitigate cognitive energy spent developing workarounds, enable predicted workflow, or memory load fatigue.

• Configurations for task policies address the human working mind and its limitations. Task policies include: rotating assignments, creation of focused time slots in the work schedule when compounded mental effort can be performed; recovery breaks from 'digital fatigue'; standardization of repetitive functions, such as batch file tagging and subsequent validation of metadata; and all of these contribute to limiting manual, cognitive load.

• Organizational surveying methods, cognitive strain checklists, and regular workload audits would improve monitoring of individual workers' strain hotspots and capacity for proactive ergonomic redesign of work activities.

Through institutionalizing these strategies and recommendations, archival organizations could sustainably develop workers' workloads and addition of speed and accuracy in archival processing.

5.3 Suggestions for Future Research on Cognitive Strain in the Workplace

This study reveals some initial ideas about the cognitive challenges of digital archival staff; however, there are many opportunities for research in the future. First, there is a need for longitudinal studies that can track the evolution of cognitive strain across time and, in turn, evaluate potential long-term effects to intervene when needed. Second, there is an opportunity for broader samples of research participants, allow researchers to understand cognitive strain across institutional context, i.e., national archives, research data repository, or even private-sector digital libraries, to allow for generalization and application.Back to the future studies, it might be possible to provide a physiological indicator of cognitive strain using technologies that quantify cognition like eye-tracking, heart rate variability, or EEG quantification, in conjunction with participant self-reports. Another possibility could be a look at the combination of emotional labour and cognitive load in archival work involving interaction with the public to enhance the richness for understanding complete last workload. Finally, looking at AI approaches to adaptive/informational systems that dynamically respond to the user's cognitive state may be a promising opportunity for the field of digital archival ergonomics. Systems built within a framework of ethical engagement could fundamentally change the approach to managing mental workload in a digital knowledge setting.

CONCLUSION

This study provides a comprehensive evaluation of the cognitive load borne by those working with large digital archival collections. The main findings suggest that cognitive overload is prevalent when performing multiple functions of archiving, particularly among metadata curators and digital preservation specialists. Increased mental demand, frequent task-swapping, and the complexity of underlying systems were documented as the leading causes of overload. Quantitative findings also demonstrated identifying differences in load intensity based on job description, further necessitating ergonomically-appropriate, position-specific mitigative designs.Reducing cognitive overload is important not just to protect employee well-being, but also to ensure accuracy, throughput, and sustainability in archival operations. Cognitive fatigue, particularly when chronic, leads to reduced functional capability, heightened error rates, and potentially long-term health impacts. As organizations continue to invest in sophisticated digital environments, the task of addressing cognitive ergonomics - as applied to interface design, timing of workflow, and educational structure - should become less of a consideration and more of an imperative.Organizations should have deliberate missions to reshape workflows, optimize or simplify human interfaces, and design a company culture that breeds cognitive recovery. Strategic actions towards mental wellness supports, reasonable workloads, and sociotechnical human-centred design will create sustainable, viable, archival environments.Ongoing research and consistent institutional commitment need to come together to create genuinely human-centred systems, as a means to preserve both the integrity of archival information and the cognitive health and activity of the individuals tasked with supporting that information.

REFERENCES

[1] Delgosha, M. S., Rokni, A., Seyyedan, S. A., Omrani, L., & Zadeh, E. P. (2017). The Study of the Effect of Hypnosis on the Reduction of Job Stress among Nurses. *International Academic Journal of Social Sciences*, *4*(2), 84–89.

[2] Maher, A., Sotoudeh, H., & Hosseini, S. M. (2014). Effect of Job-Involvement on Job-Burnout of Nurses Working in Lahijan' Seyed Al-Shohada Hospital. International Academic Journal of Organizational Behavior and Human Resource Management, 1(2), 26–33.

[3] Kowalski, T., & Nowak, M. (2024). The Impact of Digital Transformation on Quality Assurance in Healthcare Systems. National Journal of Quality, Innovation, and Business Excellence, 1(2), 1-12.

[4] Kumar, V., & Shah, M. (2021). Multi Disease Prediction Using Deep Learning Framework for Electric Health Record. International Academic Journal of Science and Engineering, 8(4), 24–28.

[5] Yousefi, H., & Mousavi, S. A. (2018). Investigating Strategic Thinking of Managers and its Impact on Optimism and Improving Job Performance of Employees at the Terminal. International Academic Journal of Innovative Research, 5(1), 39–59. https://doi.org/10.9756/IAJIR/V5I1/1810005

[6] Romero, C., & Herrera, L. (2024). Relationship between cultural heritage management and community engagement. Journal of Tourism, Culture, and Management Studies, 1(2), 1-8.

[7] Narang, I., & Kulkarni, D. (2023). Leveraging Cloud Data and AI for Evidence-based Public Policy Formulation in Smart Cities. In Cloud-Driven Policy Systems (pp. 19-24). Periodic Series in Multidisciplinary Studies.

[8] Rao, I., & Saxena, M. (2025). Exploring the Connections of the Mental Health and Sustainability. International Journal of SDG's Prospects and Breakthroughs, 3(1), 8-14.

[9] Barhoumia, E. M., & Khan, Z. (2025). Neurocognitive mechanisms of adaptive decision-making: An fMRI-based investigation of prefrontal cortex dynamics in uncertain environments. Advances in Cognitive and Neural Studies, 1(1), 20–27.

[10] Basu, A., & Muthukrishnan, R. (2024). Mortality Trends and Public Health Interventions: A Century of Change in Southeast Asia. Progression Journal of Human Demography and Anthropology, 2(3), 1-4.

[11] Sharma, A., & Iyer, R. (2023). AI-powered Medical Coding: Improving Accuracy and Efficiency in Health Data Classification. Global Journal of Medical Terminology Research and Informatics, 1(1), 1-4.

[12] Kavitha, M. (2024). Carbon-neutral pavement materials using recycled industrial waste and nanotechnology enhancements. Journal of Smart Infrastructure and Environmental Sustainability, 1(1), 1–13.

[13] Shimazu, S. (2023). Maximizing Employee Satisfaction Through Wellness Initiatives. Global Perspectives in Management, 1(1), 49-65.

[14] Prabhudeva, T., & Hariharan, R. (2024). A Systematic Review and Meta-Analysis of Tuberculosis Patients: Perspectives of Pharmacists Towards Sustainability. Clinical Journal for Medicine, Health and Pharmacy, 2(4), 1-10.

[15] Devaki, V., Ramganesh, E., & Amutha, S. (2024). Bibliometric Analysis on Metacognition and Self-Regulation Using Biblioshiny Software. Indian Journal of Information Sources and Services, 14(2), 115–125. https://doi.org/10.51983/ijiss-2024.14.2.17

[16] Al-ma'aitah, M. A. (2024). The Drivers of Big Data Analytics Adoption and its Impact on Corporate Entrepreneurship. Journal of Internet Services and Information Security, 14(2), 145-168. https://doi.org/10.58346/JISIS.2024.I2.010

[17] Arvinth, N. (2025). Effect of Pranayama on respiratory efficiency and stress levels in adolescent athletes. Journal of Yoga, Sports, and Health Sciences, 1(1), 1–8.

[18] Yogesha, T., &Thimmaraju, S. N. (2025). Development of a Lexicon for Manets to Enhance Performance and Security. Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 16(1), 362-374. https://doi.org/10.58346/JOWUA.2025.I1.022

[19] Boopathy, E. V., Shanmugasundaram, M., Vadivu, N. S., Karthikkumar, S., Diban, R., Hariharan, P., & Madhan, A. (2024). Lorawan based coalminers rescue and health monitoring system using Iot. Archives for Technical Sciences, 2(31), 213–219. https://doi.org/10.70102/afts.2024.1631.213

[20] Nekoueifard, A., Hafezieh, M., Manaffar, R., &Khezri, M. (2023). New geographic site records for Artemia in Iran. International Journal of Aquatic Research and Environmental Studies, 3(2), 117-127. https://doi.org/10.70102/IJARES/V3I2/8