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An Integrated Qualitative and Quantitative Analysis Module (QQAM) for Comprehensive Web Design Quality Evaluation

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Abstract
The quality of website design significantly affects user experience and accessibility. Evaluating website quality requires a holistic approach that encompasses both quantitative factors, such as performance and validation errors, and qualitative factors, such as usability and compliance with standards. This paper proposes an Integrated Qualitative and Quantitative Analysis Module (QQAM) that systematically assesses website quality by leveraging multiple automated tools including PowerMapper, HTML Validator, GTMetrix, and SortSite. QQAM integrates sitemap analysis, HTML validation, performance metrics, and quality characteristic assessment to produce a comprehensive evaluation of website quality status. Experimental application of QQAM on a sample site demonstrates its effectiveness in identifying structural, validation, performance, and compliance issues, providing actionable insights for website improvement.

Index Terms— Website quality, qualitative analysis, quantitative analysis, web design evaluation, performance assessment, QQAM.

I. INTRODUCTION

The rapid expansion of web-based services has placed heightened importance on the quality of website design and implementation. Quality websites promote usability, accessibility, faster load times, and standards compliance, which directly impact user satisfaction and engagement [1], [2]. Consequently, reliable methods for evaluating website quality are essential.
Website quality evaluation traditionally involves two complementary dimensions:

- Quantitative metrics, such as page load performance, code validity, and error counts, which can be objectively measured; and
- Qualitative characteristics, including usability, accessibility, and compliance with recognized standards, which require more nuanced evaluation [3].
  Existing approaches often treat these dimensions independently, limiting the scope of evaluation. This paper introduces the Qualitative and Quantitative Analysis Module (QQAM), which integrates multiple analysis tools and techniques to provide a unified framework for comprehensive website quality assessment.

II. RELATED WORK

User interface usability and website quality have been extensively studied, with Nielsen's heuristics setting foundational principles [1], [2]. The ISO/IEC 25010 standard defines software quality models that include usability and performance efficiency, emphasizing their relevance to

web systems [4].

Quantitative analysis tools such as GTMetrix and Google PageSpeed have been widely adopted for assessing website load times and optimization [5], [6]. HTML validation, supported by W3C tools, ensures compliance with markup standards, enhancing compatibility and maintainability [7].

Qualitative evaluation tools like SortSite and WAVE focus on accessibility and usability compliance with guidelines such as WCAG [8], [9]. However, most studies and tools address either quantitative or qualitative dimensions in isolation. The QQAM seeks to bridge this gap by combining these complementary perspectives into a singular analytical process.

III. PROPOSED QUALITATIVE AND QUANTITATIVE ANALYSIS MODULE (QQAM)

A. Module Overview

The QQAM is designed to integrate multiple dimensions of website quality evaluation into a single workflow. The module consists of the following key components:

1. Website Structure Analysis: Using PowerMapper to generate a sitemap visualizing the hierarchical organization of the website.
2. Web Page Validation: Employing HTML Validator to identify markup errors and deprecated code.
3. Performance Assessment: Utilizing GTMetrix to measure page load speed and optimization.
4. Quality Characteristic Assessment: Applying SortSite to detect accessibility, compatibility, usability, and standards issues.

B. Website Structure Analysis

PowerMapper automatically generates a comprehensive sitemap that depicts the hierarchical structure of website pages and resources. This structure serves as the backbone for subsequent validation and performance checks by defining the scope and relationships between pages.

An example sitemap generated by PowerMapper for a sample website is shown in Fig. 1. The diagram illustrates the multi-level organization of the Sanskrit Heritage Site, revealing key sections such as the Sanskrit Portal, Heritage Dictionary, and Linguistic Resources.

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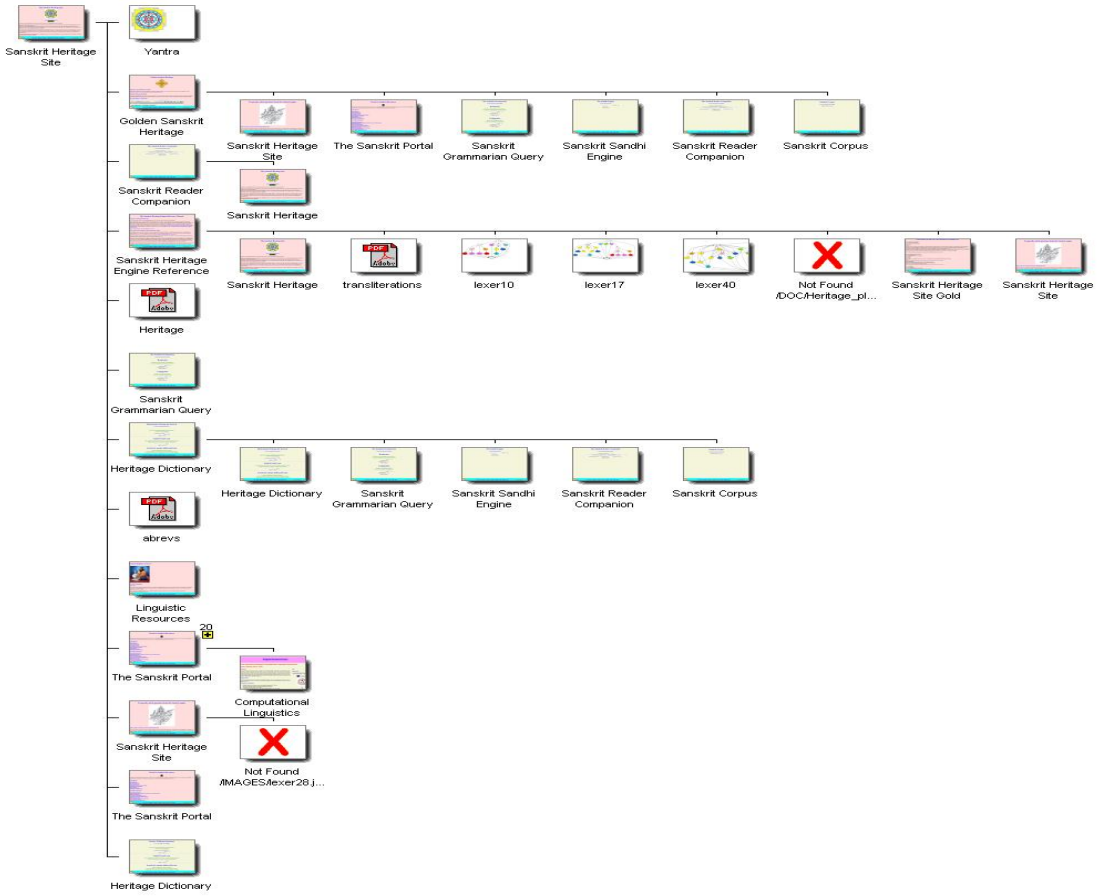

Figure 1. Example Website Sitemap of the Sanskrit Heritage Site Generated by PowerMapper

C. Web Page Validation Analysis

Each webpage is analyzed using an HTML Validator to detect syntactical errors, missing attributes, and obsolete tags. Validation errors are aggregated to provide site-wide insight into code quality and standards compliance.

Fig. 2 presents sample HTML validation warnings and errors encountered during evaluation, including missing language declarations, obsolete profile attributes, viewport restrictions that hinder resizing, and unnecessary type attributes in style elements. Addressing these issues improves browser compatibility and accessibility.

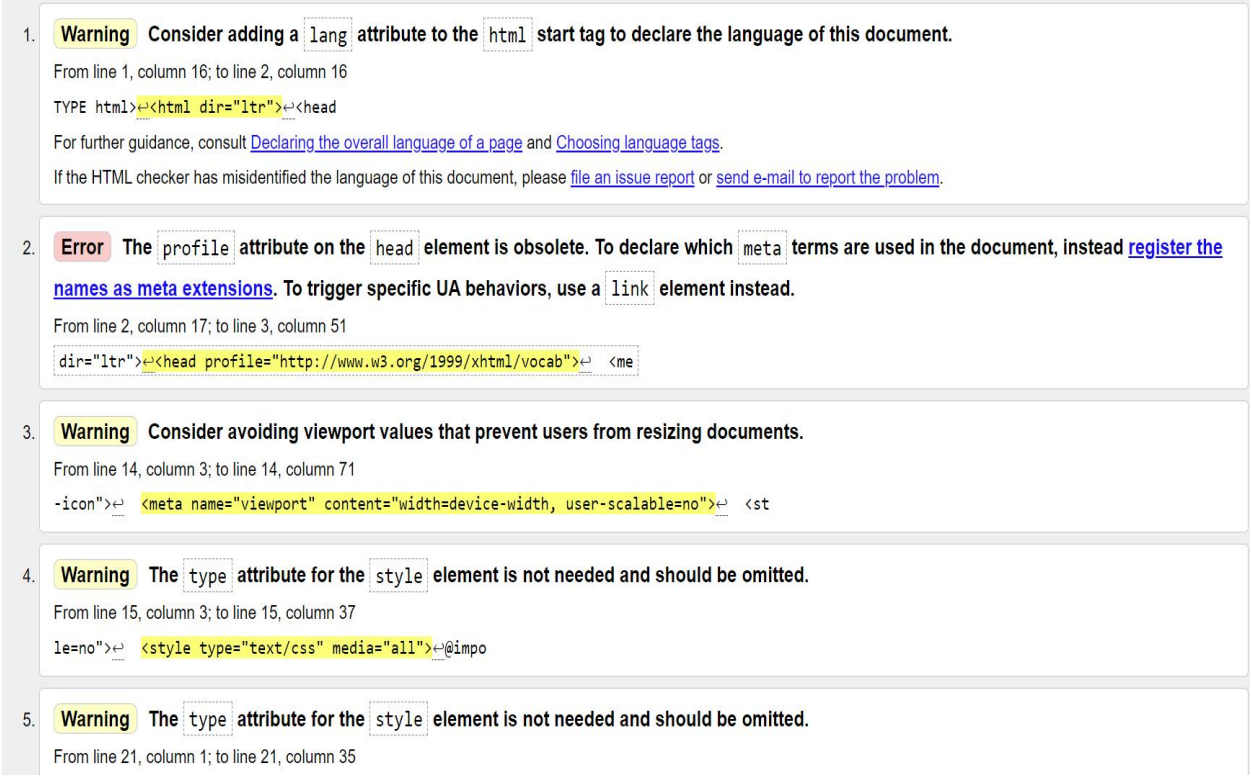

Figure 2. Sample HTML Validation Warnings and Errors Detected in Web Page Analysis

D. Website Performance Evaluation

Performance metrics of the homepage, including page load time and resource optimization, are collected using GTMetrix. These metrics directly affect user experience and engagement [6]. The performance results help identify bottlenecks and areas for optimization.

E. Quality Characteristic Assessment

SortSite performs automated checks for accessibility, browser compatibility, SEO, standards compliance, and usability. It reports the number of pages affected in each category and compares them to industry benchmarks.
Fig. 3 summarizes the quality issues detected by SortSite, revealing that a large portion of pages suffer from accessibility problems, browser-specific issues, broken links, and W3C standards violations. This highlights critical qualitative weaknesses needing attention.

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Category	Issues	Pages	Benchmark
Overall Quality		47 pages with quality issues	48% have issues, worse than average
Errors		18 pages with broken links or other errors	19% have issues, worse than average
Accessibility		44 pages with accessibility problems	44% have issues, worse than average
Compatibility		42 pages with browser specific issues	43% have issues, worse than average
Search		43 pages with search engine issues	44% have issues, worse than average
Standards		43 pages have W3C standards issues	44% have issues, worse than average
Usability		43 pages with usability issues	44% have issues, worse than average
Totals		100 pages and files checked	

Figure 3. Summary of Website Quality Issues Detected by SortSite

F. QQAM Algorithm

The overall QQAM process can be summarized in the following pseudocode:

```
Algorithm QQAM
Input:
    PH  // Website Home Page URL
    PN  // Website Last Page URL or last page index
Tools:
    PowerMapper, HTML Validator, GTMetrix, SortSite

Begin
    // Step 1: Generate website sitemap
    WSsmp ← PowerMapper(PH)
    WSstruct ← WSsmp

    // Step 2: Validate each web page from PH to PN
    for each Pi in [PH ... PN] do
        WPVerr(Pi) ← HTML_Validator(Pi)
        WSVerr ← WSVerr ∪ WPVerr(Pi)  // Aggregate all page validation errors
    end for

    // Step 3: Analyze homepage performance
    WSper ← GTMetrix(PH)

    // Step 4: Identify quality characteristic issues from homepage
    WSqci ← SortSite(PH)
```

```
End

Output:
    WSsmp    // Website sitemap
    WSstruct // Website structure
    WPVerr   // Validation errors per page
    WSVerr   // Aggregated validation errors
    WSper    // Website performance metrics
    WSqci    // Website quality characteristic issues
```

IV. OUTPUT PARAMETERS

The QQAM produces the following outputs:

- **WSsmp:** Website sitemap
- **WSstruct:** Website structure model
- **WPVerr(Pi):** Validation errors for the ith webpage
- **WSVerr:** Aggregated website validation errors
- **WSper:** Website performance metrics
- **WSqci:** Website quality characteristic issues
  These outputs collectively provide a comprehensive snapshot of the website's quality status.

V. EXPERIMENTAL OBSERVATIONS

Applying QQAM to a sample website demonstrated the ability to detect structural, syntactical, performance, and quality characteristic issues effectively.
The PowerMapper-generated sitemap (Fig. 1) guided systematic analysis of each webpage. HTML validation (Fig. 2) uncovered several markup warnings and errors, pointing to missing language declarations and deprecated elements. Performance analysis via GTMetrix identified load-time bottlenecks. SortSite results (Fig. 3) revealed significant accessibility and usability deficiencies, with nearly half the pages affected by issues worse than the industry average. These results highlight QQAM's strength in integrating multi-dimensional quality evaluation, enabling stakeholders to prioritize remediation efforts comprehensively.

VI. DISCUSSION

The QQAM framework bridges the gap between qualitative and quantitative website evaluation methods. By combining structural analysis, markup validation, performance metrics, and quality characteristic checks, QQAM provides a holistic and scalable solution adaptable to diverse web environments.
The reliance on automated tools ensures repeatability and objectivity, though tool-specific limitations and updates must be considered. Future enhancements may include user experience analytics and weighted scoring to quantify overall site quality numerically.

VII. CONCLUSION

This paper proposed the Qualitative and Quantitative Analysis Module (QQAM) for comprehensive web design quality evaluation. QQAM integrates website structure analysis, HTML validation, performance assessment, and qualitative characteristic evaluation using established automated tools. Experimental application confirmed its effectiveness in revealing critical quality issues across multiple dimensions, enabling more informed and systematic website improvement strategies.

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