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Content Delivery Readiness of Philippine Higher Education Institution Websites: Evidence from HTTP Archive and Chrome UX Report

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ABSTRACT

This study examined the content delivery readiness of selected Philippine Higher Education Institution websites using public performance data from the Chrome User Experience Report (CrUX) and HTTP Archive. The study covered 30 official website origins, consisting of 10 State Universities and Colleges, 10 private HEIs, and 10 Local Universities and Colleges. Each website was validated and normalized before data extraction. CrUX data for May 2026 and HTTP Archive page-level data from the May 1, 2026 crawl were collected through BigQuery. Of the 30 websites, 25 had complete data from both sources, four had CrUX data only, and one had no usable match. The readiness framework combined field indicators related to actual user experience with page-level indicators describing technical delivery conditions. Among the 25 complete-data websites, five showed high readiness, 13 moderate readiness, and seven low readiness. Private HEIs recorded the highest average score among the three groups, although the comparison was interpreted descriptively because the corpus was purposively selected. The most common issues were heavy page weight, slow visual loading, high request count, slow Time to First Byte, and slow Largest Contentful Paint. Sensitivity testing using three alternative weighting schemes showed that 84 percent to 96 percent of classifications remained unchanged, while rank correlations ranged from 0.962 to 0.980. These results indicate that the main findings remained generally stable across the alternative models, with most category changes occurring near the score boundaries. The resulting framework provides a practical basis for identifying and prioritizing improvements in payload size, loading behavior, request management, server response, and routine website performance monitoring.

Keywords: content delivery readiness, Core Web Vitals, Chrome User Experience Report, HTTP Archive, Philippine higher education websites

INTRODUCTION

Higher education institutions increasingly depend on official websites to deliver academic information, admission updates, enrollment instructions, program details, public advisories, and institutional services. For students, applicants, parents, employees, alumni, and public stakeholders, the official institutional website often serves as the first point of contact with a college or university. Website availability is therefore only a starting point. The website must also deliver content efficiently, reliably, and measurably.

In the Philippine higher education context, institutional websites vary across State Universities and Colleges, private higher education institutions, and Local Universities and Colleges. The Commission on Higher Education provides a national entry point for identifying higher education institutions, but a listed institution does not automatically mean that its official website performs well as a content delivery system [7]. A website may be official and reachable while still carrying slow loading behavior, large resource payloads, delayed visual rendering, or unstable layout movement.

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Content delivery readiness refers to the degree to which a website delivers web content efficiently to end users. From an Advanced Content Networking perspective, this includes loading performance, page weight, request volume, server-response behavior, visual stability, mobile and desktop experience, and the availability of measurable performance data. These indicators matter because academic websites often carry image-heavy announcements, admission pages, enrollment notices, program information, portals, calendars, downloadable documents, and public advisories. These content elements support institutional communication, but they also increase delivery load when not optimized.

Public web measurement datasets support this type of assessment without collecting private institutional records or personal user data. The Chrome User Experience Report provides origin-level field data based on real-world Chrome user experience, while HTTP Archive provides page-level crawl data about how websites are built and delivered [5], [6]. Together, these sources allow a study to examine both user-experience signals and technical delivery indicators.

Many institutional website studies focus on accessibility, usability, information quality, design quality, service quality, or e-learning readiness. These areas remain important. This study takes a narrower technical direction. It examines the website as a content delivery system. This focus is useful because a website may look complete in a browser while still performing weakly under measurable delivery indicators such as Largest Contentful Paint, Time to First Byte, page weight, request count, Speed Index, or fully loaded time.

The research gap addressed in this study is the limited availability of transparent, public-data-based assessments of Philippine HEI website content delivery readiness using both CrUX and HTTP Archive evidence. This study responds to that gap by validating a corpus of Philippine HEI website origins, extracting available public performance indicators, applying a readiness scoring model, and reporting the limits of the available data.

This study assessed 30 official Philippine HEI website origins. The corpus followed a balanced purposive structure composed of 10 State Universities and Colleges, 10 private HEIs, and 10 Local Universities and Colleges (LUCs). The design supports comparison across selected HEI groups, but it does not serve as a national census of all Philippine HEI websites.

Objectives of the Study

The general objective of the study was to assess the content delivery readiness of selected Philippine Higher Education Institution websites using public web performance evidence from HTTP Archive and the Chrome User Experience Report.

Specifically, the study aimed to:

1. validate official Philippine HEI website origins and extract available CrUX and HTTP Archive page-level indicators.
2. classify content delivery readiness and compare patterns across selected HEI groups.
3. identify recurring delivery issues and propose practical content networking recommendations.

Research Questions

1. What is the data availability profile of the selected Philippine HEI website origins in CrUX and HTTP Archive?
2. What content delivery readiness levels are observed among the selected HEI websites?
3. How do readiness patterns differ across SUCs, private HEIs, and LUCs?
4. What common loading and delivery issues appear in the selected websites based on the available public performance indicators?
5. What content networking recommendations follow from the readiness results?

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Significance of the Study

The study contributes a technical baseline for examining Philippine HEI websites as content delivery systems. For institutional administrators and website managers, the findings support practical actions such as reducing homepage payloads, improving visual loading, controlling request overhead, and monitoring user-experience indicators. For researchers, the study offers a public-data workflow for assessing website delivery readiness without relying on private logs or survey responses.

The study does not rank academic quality, service quality, or overall digital maturity. It evaluates content delivery readiness only from the selected public indicators. This boundary is important because a website readiness score does not measure institutional quality or educational performance.

RELATED LITERATURE

Content Delivery and Web Performance

Content delivery refers to the technical process of serving web content from a host or delivery infrastructure to the end user. For institutional websites, this process includes the transfer of HTML, images, scripts, style sheets, fonts, and other page resources. A content delivery problem may appear as slow loading, large page weight, excessive requests, delayed server response, or unstable visual rendering.

Web performance is part of content delivery because users experience a website through both content and delivery speed. Users encounter how fast the page responds, how soon the main content appears, how stable the layout remains, and how quickly the page becomes usable. In this sense, web performance connects directly to accessibility of information and reliability of institutional communication.

For Advanced Content Networking, these concerns connect to delivery efficiency. A visually complete website may still show weak readiness if it uses large payloads, excessive resources, slow response paths, or unstable rendering. This study therefore treats delivery readiness as a measurable technical condition, not merely as website presence.

Core Web Vitals

Core Web Vitals provide a user-centered way to evaluate web experience. The stable Core Web Vitals include Largest Contentful Paint, Interaction to Next Paint, and Cumulative Layout Shift. LCP measures loading performance, INP measures responsiveness, and CLS measures visual stability [28].

These indicators fit the present study because they translate user experience into measurable performance signals. LCP shows whether the main content becomes visible within an acceptable time. INP shows whether the page responds well to user interaction. CLS shows whether page elements shift unexpectedly during loading.

The study also included supporting CrUX indicators such as First Contentful Paint and Time to First Byte. FCP helps describe when initial content appears. TTFB reflects early server or network response. These indicators help explain whether a website delay begins at the server-response layer or during front-end rendering [26], [27].

HTTP Archive and Public Web Measurement

Public web measurement datasets allow researchers to study website delivery without collecting private institutional records. CrUX and HTTP Archive support this approach from different perspectives. CrUX provides field data from real Chrome users, while HTTP Archive provides crawl-based data about website structure and delivery behavior [5], [13].

CrUX on BigQuery gives origin-level and page-level distributions of web experience metrics. Its methodology explains that origins must be publicly discoverable and must have enough visits to appear in the dataset [6]. This

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rule is important because a missing CrUX row does not automatically mean weak performance. It may mean that the origin did not satisfy dataset inclusion requirements for the selected month.

HTTP Archive complements CrUX because it records page loads and stores data in public BigQuery tables. The crawl.pages table supports page-level analysis, including delivery indicators such as page size, request totals, resource sizes, and performance timing fields [14], [15]. In this study, the request-level table was not used because the query exceeded the available free BigQuery query-byte quota. BigQuery documentation explains that query costs and query-byte limits must be managed when working with large public datasets [11], [12].

HEI Website Performance Studies

Prior HEI website studies show that institutional websites support academic communication, public information access, institutional visibility, and online service delivery. Aydin analyzed higher education website visitor data and showed the value of studying website behavior as institutional evidence [2]. Subiyakto and colleagues examined institutional repository website design through usability testing, which reflects the broader concern for quality in academic web systems [23].

These studies provide useful background, but many of them focus on human perception, usability, accessibility, information quality, service quality, or website design. These areas are important, but they do not fully measure content delivery readiness. A website may be usable in layout but still weak in page weight, loading speed, server-response behavior, or resource delivery.

The present study builds from this literature by adding a content networking perspective. It does not replace user-centered website evaluation. It adds a delivery-based layer using public field data and page-level crawl data.

Philippine HEI Website Context

The Philippine higher education environment includes SUCs, private HEIs, LUCs, and other institution types listed through CHED resources [7]. These institutions use official websites to publish admission requirements, enrollment schedules, academic offerings, public advisories, and institutional services. Content delivery readiness therefore matters for public access to institutional information.

Philippine HEIs differ in resources, governance structures, location, and website management capacity. These differences may affect how websites are maintained and optimized. Public and private institutions may use different web teams, hosting arrangements, procurement processes, and update practices.

Philippine HEI digital studies often discuss e-learning readiness, faculty and student readiness, and institutional technology adoption. Lucero and colleagues assessed e-learning readiness across government and private HEIs in the Philippines [19]. That work is relevant because it shows continuing interest in digital capacity in Philippine higher education. The present study differs by focusing on public website delivery performance rather than e-learning readiness.

Technical Basis for the Selected Indicators

Indicator-specific web performance literature further supports the use of LCP, INP, CLS, FCP, and TTFB in this study. Core Web Vitals guidance supports the use of LCP, INP, and CLS as user-centered indicators of loading performance, responsiveness, and visual stability [13], [28]. FCP and TTFB add supporting evidence by showing when first content appears and whether delay begins at the server-response layer [26], [27].

Content delivery also depends on standard HTTP behavior. HTTP semantics define how clients and servers exchange representations, while HTTP caching explains how reusable responses reduce latency and network overhead. Cache-Control rules, compression, and newer transport protocols such as HTTP/3 show that delivery readiness is affected by both page design and underlying protocol behavior [10], [9], [20], [21], [24], [4].

Browser timing standards also support the measurement logic of this study. Navigation Timing and Resource Timing describe how page navigation and individual resource loads can be measured in browsers. These standards support the idea that web performance can be studied through measurable timing and resource indicators rather than subjective website impressions alone [29], [30].

Recent web measurement studies also show why resource size, images, request behavior, dependency loading, and site maintenance matter. Image-heavy pages can affect page load time, fine-grained page-load dependency studies show that object dependencies shape loading behavior, and HTTP Archive has been used to study observable web deployment patterns at scale [8], [22], [25], [16], [1].

Recent HEI-related studies reinforce the need to examine institutional websites as public information systems. Philippine HEI studies have addressed web accessibility and open access dissemination through institutional and library websites, while international university website research has examined website quality through quantifiable technical attributes. These works support the present study, but they also show the need for a narrower content delivery readiness view [18], [3], [17].

Research Gap

Existing literature shows that HEI websites support public and academic communication, while most institutional website studies emphasize usability, accessibility, information quality, service quality, or e-learning readiness. Core Web Vitals, browser timing standards, and public datasets such as CrUX and HTTP Archive provide measurable evidence of loading and delivery performance. HTTP behavior, caching, compression, and protocol design further show that readiness depends on both page resources and network delivery. Few studies apply these measures to Philippine HEI websites through a transparent public-data workflow.

To address this gap, the study validates a 30-origin Philippine HEI website corpus, extracts available CrUX and HTTP Archive page-level indicators, classifies content delivery readiness, and reports data limitations. The resulting baseline supports future HEI website performance research without extending claims beyond the selected public indicators.

METHODOLOGY

Research Design

The research used a quantitative descriptive-comparative design to assess the content delivery readiness of selected Philippine HEI websites. The institutional website origin served as the unit of analysis. This design matched the study because it measured observable delivery indicators from public datasets and compared readiness patterns across selected HEI categories.

Corpus and Sampling Frame

The corpus included 30 Philippine HEI website origins in a balanced 10/10/10 purposive structure: 10 SUCs, 10 private HEIs, and 10 LUCs. Official institutional websites were identified through the CHED HEI directory entry point and institution-level verification. The sample was not intended as a national census of all Philippine HEI websites.

Table 1. Sample composition and public-data coverage by HEI type

HEI type	Total origins	Complete data	CrUX only	No data match
SUC	10	8	2	0
Private HEI	10	9	1	0
LUC	10	8	1	1

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URL Validation and Origin Normalization

Before extraction, each listed website underwent URL validation. The process checked whether the homepage opened, redirected to another official address, required JavaScript rendering, blocked automated access, or lacked a confirmable official site. Validation identified 19 active sites, three redirects, five JavaScript-rendered sites, and three access-blocked domains. No inactive or unconfirmed official sites remained in the corpus.

Normalized origins were prepared during URL validation by reducing each validated institutional address to its scheme and host. The extraction notebook then removed surrounding spaces, converted the stored origins to lowercase, and removed trailing slashes before creating the CrUX origin list and HTTP Archive root-page list. This rule kept the extraction consistent with CrUX methodology and supported origin-level matching across the two public datasets [6].

Table 2. URL validation status

Status group	Category	Count
URL validation status	Access blocked	3
URL validation status	Active	19
URL validation status	JavaScript-rendered	5
URL validation status	Redirects	3

Data Sources and Extraction Period

CrUX and HTTP Archive served as the two public web performance data sources. CrUX provided real-user field data for website origins, while HTTP Archive provided page-level crawl data from the crawl.pages table. The extraction covered the May 2026 CrUX release and the May 1, 2026 HTTP Archive crawl [5], [14], [15].

CrUX extraction produced 29 matched origins from the 30-origin corpus. HTTP Archive page-level extraction produced 50 page rows across desktop and mobile client results, covering 25 website origins. The HTTP Archive request-level query was attempted but was not completed because it exceeded the available free BigQuery query-byte quota. Its empty worksheet was retained as a transparency record. Because request-level output was unavailable, the study does not report cache-control header, compression-header, or request-header-level claims [11], [12].

Methodological Basis of the Content Delivery Readiness Framework

Content delivery readiness refers to the overall capability of a website to deliver web content efficiently and consistently based on observable technical performance indicators. In this study, it is treated as a composite construct because website delivery depends on multiple technical dimensions rather than a single performance measure. A website may load quickly but still require excessive network requests, carry unnecessarily large resources, or experience delayed server response and unstable visual rendering. Evaluating only one indicator would therefore provide an incomplete representation of delivery readiness. A composite framework allows these complementary aspects of website delivery to be assessed together, providing a broader view of how efficiently an institutional website delivers content to its users.

No single public dataset provides a complete representation of website content delivery readiness. For this reason, the framework integrates evidence from the Chrome User Experience Report (CrUX) and HTTP Archive because they measure complementary aspects of website performance. CrUX provides origin-level field data derived from aggregated real-user browsing experience, reflecting how users encounter website performance under actual usage conditions. In contrast, HTTP Archive provides standardized page-level observations collected through controlled web crawls, describing the technical characteristics of homepage delivery such as resource size, request volume, and loading behavior. These datasets therefore serve different but complementary purposes. CrUX reflects observed user experience, while HTTP Archive describes the underlying technical

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conditions that influence that experience. Using both sources provides a more balanced assessment of content delivery readiness than relying on either dataset alone [5], [6], [14], [15].

The indicators included in the readiness framework were selected because each represents a distinct aspect of website content delivery. User-centered indicators such as Largest Contentful Paint (LCP), Interaction to Next Paint (INP), Cumulative Layout Shift (CLS), and Time to First Byte (TTFB) describe how visitors experience loading performance, responsiveness, visual stability, and initial server response during actual website use. Supporting page-level indicators such as page weight, request count, Speed Index, fully loaded time, HTTPS adoption, and CDN presence describe technical conditions that influence content delivery efficiency. Although these indicators measure different characteristics of website performance, they collectively represent the major observable factors affecting how efficiently web content is delivered [27], [28].

The weighting framework was developed to reflect the relative contribution of each indicator to observable content delivery readiness. Indicators that directly represent user experience, particularly loading performance, responsiveness, visual stability, and initial server response, received greater influence because they reflect the aspects of website delivery experienced most immediately by users. Supporting technical indicators such as page weight, request count, Speed Index, fully loaded time, HTTPS adoption, and CDN presence were weighted according to their contribution to the underlying delivery process. Indicators associated with resource efficiency and loading behavior received greater emphasis than infrastructure-related indicators because they have a more direct influence on measurable delivery performance. The resulting weighting structure reflects a logical hierarchy of observable evidence, progressing from user-experience indicators to technical delivery indicators and supporting delivery infrastructure.

The readiness score was developed as an analytical summary of the selected public performance indicators rather than as an absolute measure of website quality or institutional performance. Its purpose is to support transparent and consistent comparison among the selected HEI website origins using a common evaluation framework. The resulting classifications should therefore be interpreted as descriptive summaries of observable content delivery conditions during the selected measurement period. They do not establish institutional superiority, overall digital maturity, or compliance with any official performance standard. Instead, they provide a structured basis for identifying delivery strengths, recurring technical issues, and opportunities for website optimization using publicly available evidence.

Organization of the Measurement Framework

The measurement framework was organized into two complementary layers that correspond to the two public datasets used in the study. The first layer consists of CrUX field indicators, which capture observable user experience through loading performance, responsiveness, visual stability, and initial server response. The second layer consists of HTTP Archive page-level indicators, which describe the technical characteristics of homepage delivery, including resource demand, loading behavior, and supporting delivery infrastructure. Organizing the indicators in this manner distinguishes user-observed performance from the technical conditions that influence it while allowing both perspectives to contribute to a common readiness framework.

Variables and Indicators

The variables included in this study were selected because they provide observable evidence of the different technical dimensions that collectively define content delivery readiness. Rather than relying on a single performance measure, the framework incorporates indicators that capture user experience, technical delivery characteristics, and supporting delivery infrastructure. Each variable contributes distinct information about website content delivery, allowing the readiness framework to evaluate multiple dimensions of the construct using publicly available measurements from CrUX and HTTP Archive.

The CrUX variables included 75th percentile LCP, INP, CLS, FCP, and TTFB, together with phone and desktop density values. LCP, INP, CLS, and TTFB contributed to the CrUX component score, while FCP and form-factor densities supported interpretation. The HTTP Archive variables included page weight, request count, JavaScript size, image size, Speed Index, fully loaded time, HTTPS ratio, and detected CDN provider. Page

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weight, request count, Speed Index, fully loaded time, HTTPS ratio, and CDN detection contributed to the HTTP Archive component score. JavaScript and image size were retained as descriptive resource indicators.

Table 3. Public-data coverage retained for analysis

Coverage item	Count	Interpretation
Total retained origins	30	Official website origins retained after validation
CrUX matched origins	29	Origin-level real-user field data available
HTTP Archive matched origins	25	Page-level crawl data available
Complete CrUX and HTTP Archive matches	25	Primary comparative dataset
CrUX-only origins	4	Retained but treated as limited-data cases
No extracted dataset match	1	Retained for corpus accounting but excluded from performance comparison

Scoring Model

The scoring model was designed to convert the selected CrUX and HTTP Archive indicators into a common and transparent basis for origin-level comparison. The raw indicators use different units, including milliseconds, megabytes, request counts, proportions, and categorical infrastructure evidence, so their values could not be combined directly. Each indicator was therefore translated into a points-based score using fixed cut-off values and then weighted according to its role in the content delivery readiness framework. This process produced separate CrUX and HTTP Archive component scores before the two components were combined for complete-data origins.

The cut-off values served as translation rules that converted indicators with different units into comparable point bands. For the CrUX component, the LCP, INP, and CLS cut-offs followed Core Web Vitals guidance, while TTFB followed supporting web-performance guidance. For the HTTP Archive component, fixed analytic bands distinguished lower, intermediate, and higher levels of resource demand and loading delay. These cut-offs were used as study-specific scoring rules rather than universal website performance standards. The complete point assignments, cut-off values, weights, and formulas are reported in the reproducibility appendix. The influence of the researcher-defined weighting structure was also examined through sensitivity analysis using alternative weighting schemes [27], [28].

The CrUX component assigned 30 percent to LCP, 25 percent to INP, 25 percent to CLS, and 20 percent to TTFB. The HTTP Archive component assigned 25 percent to page weight, 20 percent to request count, 25 percent to Speed Index, 15 percent to fully loaded time, 10 percent to HTTPS ratio, and 5 percent to CDN detection. Within each component, the points assigned through the cut-off rules were multiplied by their respective weights and summed to produce a score from 0 to 100. For origins with complete data, the overall readiness score was calculated as the mean of the CrUX and HTTP Archive component scores. Giving equal influence to the two component scores prevented either real-user field evidence or page-level crawl evidence from dominating the final classification.

Readiness classifications were assigned using fixed score ranges: high readiness for scores greater than or equal to 80, moderate readiness for scores greater than or equal to 60 and less than 80, and low readiness for scores below 60. These ranges functioned as an analytic rubric for the study and were not treated as an official national standard. The final comparative analysis used only the 25 origins with complete CrUX and HTTP Archive data. CrUX-only origins retained their CrUX component score but were labeled as limited-data cases and reported separately from complete-data classifications. Origins with no extracted evidence were classified as insufficient data and excluded from performance comparison. This separation ensured that websites scored from different amounts of evidence were not interpreted as directly equivalent.

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For the 25 HTTP Archive-matched origins, desktop and mobile page rows were available. Because the institutional website origin was the unit of analysis, continuous page-level values were averaged before scoring. The HTTPS ratio was calculated from the combined desktop and mobile request totals, while CDN evidence was retained at the origin level. This produced one origin-level value for each indicator. The original client-specific observations were retained in the source dataset to preserve device-level evidence for reproducibility and future analysis.

Sensitivity Analysis

To examine whether the results depended heavily on the original weighting structure, three alternative schemes were tested using the 25 complete-data origins. The first scheme assigned equal weights to all indicators within each component. The second gave greater influence to CrUX field evidence through a 60:40 CrUX-to-HTTP Archive ratio. The third gave greater influence to HTTP Archive page-level evidence through a 40:60 ratio. The analysis compared readiness classifications, score changes, rank order, and HEI-type averages against the original model.

Across the three alternative schemes, 84 percent to 96 percent of readiness classifications remained unchanged. Spearman rank correlations ranged from 0.962 to 0.980, showing that the ordering of websites remained highly consistent. Moderate readiness remained the dominant classification under every scheme. Private HEIs also retained the highest complete-data mean across all weighting structures. The few category changes involved websites with scores near the 60-point and 80-point classification boundaries. These results show that the main findings remained stable under reasonable alternative weighting schemes, while classifications near the cut-off values require cautious interpretation.

Data Audit and Interpretation Rules

A post-extraction audit checked corpus balance, validation status, extraction coverage, request-level data availability, limited-data cases, scoring defensibility, and group comparability. The audit retained all 30 origins as the validated corpus. The 25 complete CrUX and HTTP Archive matches formed the primary comparative dataset. Four CrUX-only rows and one no-match row were reported as data caveats.

Ethical and Technical Boundaries

The analysis used public institutional website URLs and aggregate web performance datasets. It did not collect personal information, login-protected data, student records, or user-identifiable browsing records. Unsupported claims were excluded. The study examined selected content delivery indicators only and did not assess institutional academic quality, web accessibility compliance, security posture, or user satisfaction.

RESULTS AND DISCUSSION

Dataset Coverage and Extraction Completeness

After validation, the final corpus retained 30 official Philippine HEI website origins. The balanced 10/10/10 structure remained intact, with 10 SUCs, 10 private HEIs, and 10 LUCs. The sampling frame therefore remained balanced after cleaning.

Data availability was strong but not complete. CrUX matched 29 of the 30 origins. HTTP Archive page-level data matched 25 origins. Overall, 25 origins had complete CrUX and HTTP Archive coverage, four had CrUX-only coverage, and one had no extracted dataset match for the selected month. The 25 complete rows form the best basis for comparative performance interpretation.

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Overall Content Delivery Readiness

Among the 25 complete-data origins, five were classified as high readiness, 13 as moderate readiness, and seven as low readiness. This primary comparative distribution corresponded to 20.0 percent high readiness, 52.0 percent moderate readiness, and 28.0 percent low readiness.

The four CrUX-only origins and the one no-match origin were retained for corpus accounting and reported separately as limited-data cases.

Table 4. Readiness-level distribution for complete-data origins

Readiness level	n	%
High readiness	5	20.0%
Moderate readiness	13	52.0%
Low readiness	7	28.0%

Moderate readiness dominated the results. Many selected HEI websites were reachable and measurable, but still carried delivery inefficiencies. The main problems appeared in large page payloads, slow visual loading, high request volume, and weak loading-response indicators.

Readiness by HEI Type

Group averages showed a cautious pattern. Among complete-data cases, private HEIs recorded the highest mean score at 71.3, followed by LUCs at 68.7 and SUCs at 67.7. These values do not prove that one sector generally performs better. They describe only the selected websites and the available public indicators for the extraction month.

Table 5. Complete-data readiness distribution and mean score by HEI type

HEI type	n	Mean	High	Moderate	Low
SUC	8	67.7	1	4	3
Private HEI	9	71.3	4	2	3
LUC	8	68.7	0	7	1

SUCs showed mixed performance across high, moderate, and low readiness. Private HEIs produced the largest number of high-readiness cases, but also included low-readiness rows. LUCs were mostly moderate, with one low-readiness row and one no-match row. This pattern supports the descriptive-comparative framing of the study.

CrUX Field-Performance Findings

CrUX covered 29 origins and provided field evidence from real users rather than a single synthetic test. Interactivity and visual stability were relatively strong for many sites, while loading indicators were weaker across a notable part of the corpus.

Among the 29 CrUX-matched origins, 16 met the good LCP threshold of 2.5 seconds or less, while 13 exceeded it. For INP, 23 origins met the 200-millisecond threshold, while six exceeded it. For CLS, 26 origins stayed at or below 0.1, while three exceeded it. For FCP and TTFB, only 13 origins met the reference thresholds. These figures suggest that interaction and layout stability were stronger than initial loading and server-response behavior.

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Table 6. CrUX threshold results for matched origins

Indicator	Interpretation	Good reference threshold	Met good threshold	Above good threshold
LCP	Loading performance	<= 2,500 ms	16	13
INP	Interactivity	<= 200 ms	23	6
CLS	Visual stability	<= 0.1	26	3
FCP	Early content visibility	<= 1,800 ms	13	16
TTFB	Server-response support metric	<= 800 ms	13	16

From a content-networking perspective, loading speed depends on both front-end resource design and network delivery choices. HEI websites often carry banners, announcements, images, program pages, scripts, and portal links. Without optimization, these assets allow the site to remain functional while weakening loading performance.

HTTP Archive Page-Level Findings

HTTP Archive page-level data covered 25 origins. The median average page weight was 15.4 MB, the median average request count was 80.0, the median Speed Index was 8949 ms, and the median fully loaded time was 21860 ms. These values show that several websites carried resource-heavy homepages and slow visual completion.

Table 7. HTTP Archive page-level descriptive statistics

Metric	Unit	Matched origins	Mean	Median	Minimum	Maximum
Average page weight	MB	25	24.1	15.4	1.4	108.0
Average request count	requests	25	110.3	80.0	32.5	274
Average JavaScript size	MB	25	0.9	0.65	0.0	2.9
Average image size	MB	25	18.8	7.4	0.2	77.0
Average Speed Index	ms	25	12675.7	8949.5	3647.5	61136
Average fully loaded time	ms	25	23495.9	21860.5	4996	60690
HTTPS ratio	percent	25	99.88%	100.00%	97.59%	100.00%
HTTP Archive score	points	25	56.3	52.5	38.5	90

The issue-frequency audit showed the same pattern. Heavy page weight appeared in 18 websites, slow visual loading in 16, and high request count in seven. These were the most common delivery issues. For LCP and TTFB, Table 6 counts all origins outside the good reference threshold, including needs-improvement cases. Table 8 counts only origins that met the study's poor issue threshold.

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Table 8. Frequency of observed content delivery issues

Observed issue	Affected origins	Interpretation
Heavy page weight	18	The dominant content delivery problem points to large images, scripts, media, or homepage assets.
Slow visual loading	16	Several sites render meaningful visual content slowly, affecting perceived loading performance.
High request count	7	Many resources must be fetched before the page stabilizes, raising network overhead.
Slow TTFB	6	Affected origins showed poor server-response timing under the issue rule.
Slow LCP	6	Affected origins showed poor main-content loading under the issue rule.
No HTTP Archive page data	5	This is a data-availability issue, not a direct performance failure.
High CLS	3	Affected sites show layout instability risk during loading.
No major issue from selected indicators	3	These rows serve as better-performing cases under the selected metrics.

From a network delivery perspective, heavy page weight increases transfer demand and delays meaningful rendering. High request count increases connection, scheduling, and resource-loading overhead. Slow visual loading affects perceived responsiveness because users wait longer before meaningful page content becomes visible.

Highest- and Lowest-Scoring Complete-Data Cases

The complete-data subset offered the clearest basis for case-level comparison. Adamson University, Bicol University, De La Salle University, AMA University or AMA Education System, and the University of San Carlos recorded the five highest overall readiness scores.

Table 9. Highest-scoring complete-data cases

HEI website	HEI type	Overall readiness score	Readiness level	Main observed issue(s)
Adamson University	Private HEI	95	High readiness	No major issue from selected indicators
Bicol University	SUC	91	High readiness	No major issue from selected indicators
De La Salle University	Private HEI	86.2	High readiness	Heavy page weight
AMA University / AMA Education System	Private HEI	84	High readiness	No major issue from selected indicators
University of San Carlos	Private HEI	82.2	High readiness	Heavy page weight

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The five lowest-scoring complete-data cases were the University of Santo Tomas, Western Mindanao State University, Mapua University, City of Malabon University, and West Visayas State University. Their low-readiness classifications reflected combinations of slow LCP, slow TTFB, high CLS, heavy page weight, high request count, and slow visual loading.

Table 10. Lowest-scoring complete-data cases

HEI website	HEI type	Overall readiness score	Readiness level	Main observed issue(s)
University of Santo Tomas	Private HEI	48.5	Low readiness	High CLS; Slow TTFB; Heavy page weight; High request count
Western Mindanao State University	SUC	49.8	Low readiness	Slow LCP; Slow TTFB; Heavy page weight; Slow visual loading
Mapua University	Private HEI	51.5	Low readiness	High CLS; Heavy page weight; High request count; Slow visual loading
City of Malabon University	LUC	52.8	Low readiness	Slow LCP; Heavy page weight; Slow visual loading
West Visayas State University	SUC	54.8	Low readiness	Slow LCP; Heavy page weight; High request count; Slow visual loading

These lists do not rank institutional quality. The scores measure selected content delivery indicators for official website origins during the extraction month. A high score does not establish completeness, accessibility, full security, or institutional superiority. A low score does not indicate academic weakness. It means that the selected public indicators showed delivery problems during the study period.

Handling Limited-Data Cases

Five sites required limited-data treatment. Bulacan State University, Mindanao State University - Iligan Institute of Technology, Ateneo de Manila University, and University of Makati had CrUX-only coverage. Pamantasan ng Lungsod ng Valenzuela had no extracted dataset match for the selected month. These sites remained in the validated corpus but were excluded from direct comparison with complete-data rows.

Table 11. Limited-data cases and reporting caveats

HEI website	HEI type	Data coverage	Limited-data status	Reporting caveat
Bulacan State University	SUC	CrUX only	High CrUX score (limited data)	High CLS; No HTTP Archive page data
Mindanao State University - Iligan Institute of Technology	SUC	CrUX only	High CrUX score (limited data)	No HTTP Archive page data
Ateneo de Manila University	Private HEI	CrUX only	High CrUX score (limited data)	No HTTP Archive page data
University of Makati	LUC	CrUX only	Moderate CrUX score (limited data)	No HTTP Archive page data
Pamantasan ng Lungsod ng Valenzuela	LUC	No extracted dataset match	Insufficient data	No CrUX field data; No HTTP Archive page data

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Reporting these sites separately protects the comparison. A missing HTTP Archive page row indicates limited data availability, not poor website performance. A no-match row means that the selected public datasets lacked enough evidence for scoring in the extraction month. Later monthly releases should be checked before stronger conclusions are made.

DISCUSSION

Moderate readiness was the main result for the selected Philippine HEI website corpus. Most sites were not critically failing, but many were also not highly optimized. They occupied a middle condition in which the website worked while content delivery efficiency remained uneven.

The strongest technical issue was heavy page weight. This finding matters because page weight affects transfer size, loading time, and mobile access. HEI websites often publish high-resolution images, event banners, announcements, sliders, embedded scripts, and portal links. These elements support communication, but they also create delivery costs when left uncompressed or unmanaged.

Slow visual loading was also frequent. The likely technical sources include large images, render-blocking resources, multiple scripts, and weak above-the-fold optimization. These issues affect how quickly users see meaningful content. In a school website, delays may affect applicants checking admission information, students checking enrollment notices, and stakeholders accessing advisories.

Private HEIs recorded the highest mean score in the selected complete-data subset. This result requires caution because the sample was purposive and not nationally representative. It may reflect differences in hosting, web maintenance capacity, design practices, update frequency, or vendor support among the selected websites. It does not support a national claim about public and private HEI performance.

Public web measurement also proved useful for HEI research. CrUX and HTTP Archive support delivery-readiness analysis without private analytics or personal data. Their limits remain important: some origins have incomplete public coverage, and large BigQuery tables require quota or cost management. These limits should be reported rather than hidden.

Limitations of the Results

The findings are descriptive and comparative, not causal. The study did not measure all pages of each institutional website. It used official origins and homepage-level or origin-level public data. HTTP Archive tests pages in a controlled crawl environment, while CrUX reports aggregate real-user field data. These sources complement each other but do not produce the same type of evidence.

The request-level HTTP Archive table was not included because the query exceeded the free BigQuery query-byte quota. The study therefore avoided claims about cache-control headers, compression headers, request-level protocol behavior, and detailed third-party request patterns. Future work should include request-level extraction in a controlled BigQuery environment.

Even with these limits, the dataset supports the study purpose. It provides a transparent baseline for selected HEI website origins using public, repeatable, and technically relevant indicators. It also identifies clear action areas for website teams: reduce page weight, improve visual loading, manage request count, monitor TTFB, and review performance over time.

Summary of Findings

Four findings summarize the results. First, the 30-origin corpus remained balanced and valid after URL validation. Second, 25 origins had complete CrUX and HTTP Archive data and formed the primary comparative dataset. Third, moderate readiness dominated, while high readiness was less common and low readiness remained present. Fourth, heavy page weight and slow visual loading were the most frequent delivery issues.

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CONCLUSION AND RECOMMENDATIONS

Conclusion

This study examined the content delivery readiness of 30 selected Philippine HEI websites using data from CrUX and HTTP Archive. Of the 30 websites, 25 had complete data and were included in the main comparison. The four CrUX-only cases and one no-match case were reported separately.

Most of the websites with complete data showed moderate readiness. Common problems included heavy page weight, slow visual loading, too many requests, slow server response, and slow Largest Contentful Paint. Private HEIs had the highest average score in the selected group, but results still varied within all three HEI types. This means that HEI type alone does not explain website performance.

The sensitivity analysis showed that the main results changed very little when different weighting schemes were used. However, websites with scores close to the cut-off points should still be interpreted with care.

Overall, the study shows that a working website is not always ready to deliver content efficiently. The proposed framework gives selected HEIs a practical way to identify weak areas, set priorities for improvement, and regularly monitor website performance using publicly available data.

Recommendations

Reduce page weight. HEIs with heavy page weight should compress and resize images, remove unused media, minify CSS and JavaScript, and avoid oversized homepage banners. This should be the first technical priority because heavy page weight was the most frequent issue in the dataset.

Improve visual loading performance. HEIs with slow visual loading should optimize above-the-fold content, defer non-critical scripts, preload critical assets where appropriate, and avoid render-blocking resources. These actions support better perceived loading performance and stronger LCP-related results.

Lower request overhead. Websites with high request counts should consolidate repeated resources, reduce unnecessary third-party embeds, apply lazy loading, and load non-essential scripts after the main content.

Improve server response performance. Websites with slow TTFB should review hosting quality, database response time, origin server configuration, DNS performance, and CDN or edge delivery options. Server-side delay affects the rest of the loading process.

Control layout instability. HEIs with high CLS should reserve dimensions for images, sliders, videos, and embedded content. They should avoid late-loading banners and shifting page elements because these affect user experience during page loading.

Enforce secure content delivery. All HEI websites should enforce HTTPS across the main document and page resources. Secure delivery is a baseline requirement for public institutional websites.

Use regular monitoring. HEIs should review CrUX and HTTP Archive indicators at least once per term, with monthly checks where feasible. Monitoring should include LCP, INP, CLS, FCP, TTFB, page weight, request count, resource sizes, and mobile and desktop results.

Adopt a content delivery checklist. Institutional web teams should use a checklist before publishing major homepage updates, admission pages, enrollment announcements, portal links, or public advisories. The checklist should cover image size, script loading, HTTPS, mobile rendering, and page weight.

Repeat the study with request-level data. Future extraction should include HTTP Archive request-level data in a controlled BigQuery environment. This would support stronger analysis of cache-control headers, compression, CDN behavior, protocol use, and third-party resource patterns.

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Expand the corpus and conduct longitudinal analysis. Future studies should include more HEIs across regions and track several monthly releases. A longitudinal design would show whether institutional websites improve, decline, or remain stable over time.

Recommended Technical Action by Readiness Level

For high-readiness websites, the main action is maintenance. These websites should continue monitoring and avoid new homepage elements that increase page weight or layout instability. For moderate-readiness websites, the main action is optimization. These websites should reduce page weight, improve visual loading, and review request overhead. For low-readiness websites, the main action is remediation. These websites should review hosting, server response, page structure, resource size, and front-end loading behavior. For insufficient-data websites, the main action is monitoring. These origins should be rechecked in future CrUX and HTTP Archive releases.

Contribution of the Study

The study contributes a content-networking perspective to the assessment of Philippine HEI websites by shifting attention from mere website presence to the technical readiness of websites to deliver content efficiently. Its main contribution is a transparent and low-cost assessment framework that combines CrUX field evidence with HTTP Archive page-level indicators. The framework supports comparative evaluation, identifies recurring delivery problems, and helps institutions prioritize practical improvements using publicly available data. It also offers a reproducible approach that other researchers and educational institutions may adapt for periodic website performance assessment.

Declarations

Ethical Statement

This study used public institutional website URLs and aggregate public datasets. It did not involve human participants, animals, personal information, login-protected records, or private institutional data. Formal ethics approval was not required.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

The source data used in this study are publicly available through the Chrome User Experience Report and HTTP Archive. Supporting research materials, including the source inventory, extraction notebook, cleaned dataset, frozen scoring workbook, sensitivity-analysis workbook, and reproducibility documentation, may be obtained from the corresponding author upon reasonable request.

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APPENDIX A. REPRODUCIBILITY DOCUMENTATION

This appendix records the origins, datasets, variables, transformations, matching rules, scoring procedures, device aggregation, sensitivity analysis, and supporting files needed to trace the reported readiness classifications.

A.1 Normalized HEI Origins and Dataset Coverage

Table A1 lists the normalized origins used to match CrUX and HTTP Archive records. Coverage was classified as complete data, CrUX only, or insufficient data according to the evidence returned by the two datasets.

Table A1. Normalized HEI origins and dataset coverage

No.	HEI name	Type	Region	Normalized origin	CrUX	HTTP Archive	Analysis status
1	University of the Philippines System	SUC	NCR	https://up.edu.ph	Yes	Yes	Complete data
2	Polytechnic University of the Philippines	SUC	NCR	https://www.pup.edu.ph	Yes	Yes	Complete data
3	Batangas State University, The National Engineering University	SUC	Region IV-A	https://batstateu.edu.ph	Yes	Yes	Complete data
4	Bulacan State University	SUC	Region III	https://bulsu.edu.ph	Yes	No	CrUX only
5	Bicol University	SUC	Region V	https://bicol-u.edu.ph	Yes	Yes	Complete data
6	Central Mindanao University	SUC	Region X	https://www.cmu.edu.ph	Yes	Yes	Complete data
7	Cagayan State University	SUC	Region II	https://csu.edu.ph	Yes	Yes	Complete data
8	Western Mindanao State University	SUC	Region IX	https://wmsu.edu.ph	Yes	Yes	Complete data
9	West Visayas State University	SUC	Region VI	https://wvsu.edu.ph	Yes	Yes	Complete data

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No.	HEI name	Type	Region	Normalized origin	CrUX	HTTP Archive	Analysis status
10	Mindanao State University - Iligan Institute of Technology	SUC	Region X	https://msuiit.edu.ph	Yes	No	CrUX only
11	Ateneo de Manila University	Private HEI	NCR	https://www.ateneo.edu	Yes	No	CrUX only
12	De La Salle University	Private HEI	NCR	https://www.dlsu.edu.ph	Yes	Yes	Complete data
13	University of Santo Tomas	Private HEI	NCR	https://www.ust.edu.ph	Yes	Yes	Complete data
14	Mapua University	Private HEI	NCR	https://www.mapua.edu.ph	Yes	Yes	Complete data
15	Far Eastern University	Private HEI	NCR	https://www.feu.edu.ph	Yes	Yes	Complete data
16	University of San Carlos	Private HEI	Region VII	https://usc.edu.ph	Yes	Yes	Complete data
17	Silliman University	Private HEI	Region VII	https://su.edu.ph	Yes	Yes	Complete data
18	Adamson University	Private HEI	NCR	https://www.adamson.edu.ph	Yes	Yes	Complete data
19	University of the East	Private HEI	NCR	https://www.ue.edu.ph	Yes	Yes	Complete data
20	AMA University / AMA Education System	Private HEI	NCR	https://www.amaes.edu.ph	Yes	Yes	Complete data
21	Pamantasan ng Lungsod ng Maynila	LUC	NCR	https://plm.edu.ph	Yes	Yes	Complete data
22	University of Makati	LUC	NCR	https://www.umak.edu.ph	Yes	No	CrUX only
23	Quezon City University	LUC	NCR	https://qcu.edu.ph	Yes	Yes	Complete data
24	Taguig City University	LUC	NCR	https://tcu.edu.ph	Yes	Yes	Complete data
25	Pamantasan ng Lungsod ng Muntinlupa	LUC	NCR	https://www.plmun.edu.ph	Yes	Yes	Complete data
26	City College of Angeles	LUC	Region III	https://cca.edu.ph	Yes	Yes	Complete data

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No.	HEI name	Type	Region	Normalized origin	CrUX	HTTP Archive	Analysis status
27	Mabalacat City College	LUC	Region III	https://mcc.edu.ph	Yes	Yes	Complete data
28	City of Malabon University	LUC	NCR	https://cityofmalabonuniversity.edu.ph	Yes	Yes	Complete data
29	Pamantasan ng Lungsod ng Valenzuela	LUC	NCR	https://valenzuela.plv.edu.ph	No	No	Insufficient data
30	Navotas Polytechnic College	LUC	NCR	https://navotaspolytechniccollege.edu.ph	Yes	Yes	Complete data

The primary scoring and sensitivity analyses used the 25 complete-data origins. Four CrUX-only origins and one insufficient-data origin were retained and reported separately.

A.2 Data Sources, Extraction Periods, and Dataset Tables

CrUX data were extracted from chrome-ux-report.materialized.metrics_summary for May 2026, and HTTP Archive page data were extracted from httparchive.crawl.pages for the May 1, 2026 crawl. Parameterized lists contained the 30 normalized origins and corresponding root pages [5], [14], [15].

Table A2. Data sources and retained outputs

Source	BigQuery table	Measurement level	Period	Retained output
Chrome User Experience Report	chrome-ux-report.materialized.metrics_summary	Website origin	May 2026	29 origin rows
HTTP Archive	httparchive.crawl.pages	Homepage and client type	May 1, 2026 crawl	50 page rows
HTTP Archive request table	httparchive.crawl.requests	Individual requests	May 1, 2026 crawl	0 rows (query not completed)

The 50 retained page rows represented desktop and mobile observations for 25 origins. The request-level query was not completed because it exceeded the available free BigQuery query-byte quota, and no request-header variables were analyzed [11], [12].

Core CrUX analysis query

```
SELECT yyyymm, origin,
  p75_lcp AS p75_lcp_ms, p75_inp AS p75_inp_ms, p75_cls,
  p75_fcp AS p75_fcp_ms, p75_ttfb AS p75_ttfb_ms,
  phoneDensity, desktopDensity, tabletDensity
FROM `chrome-ux-report.materialized.metrics_summary`
WHERE yyyymm = @crux_yyyymm
  AND origin IN UNNEST(@origins)
ORDER BY origin;
```

Core HTTP Archive analysis query

```
SELECT date AS crawl_date, client,
  `httparchive.fn.GET_ORIGIN`(root_page) AS origin, root_page,
  SAFE_CAST(JSON_VALUE(summary, '$.bytesTotal') AS INT64) AS bytes_total,
  SAFE_CAST(JSON_VALUE(summary, '$.bytesJS') AS INT64) AS bytes_js,
  SAFE_CAST(JSON_VALUE(summary, '$.bytesImg') AS INT64) AS bytes_img,
  SAFE_CAST(JSON_VALUE(summary, '$.reqTotal') AS INT64) AS req_total,
  SAFE_CAST(JSON_VALUE(summary, '$.numHttps') AS INT64) AS num_https,
  SAFE_CAST(JSON_VALUE(summary, '$.SpeedIndex') AS INT64) AS speed_index_ms,
  SAFE_CAST(JSON_VALUE(summary, '$.fullyLoaded') AS INT64) AS fully_loaded_ms,
```

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```
  JSON_VALUE(summary, '$.cdn') AS cdn
FROM `httparchive.crawl.pages`
WHERE date = @crawl_date AND client IN ('mobile', 'desktop')
  AND is_root_page AND root_page IN UNNEST(@root_pages)
ORDER BY origin, client;
```

Availability-check query

```
SELECT
  'CrUX matched origins' AS check_name,
  COUNT(DISTINCT origin) AS matched
FROM `chrome-ux-report.materialized.metrics_summary`
WHERE yyyymm = @crux_yyyymm
  AND origin IN UNNEST(@origins)
UNION ALL
SELECT
  'HTTP Archive matched origins' AS check_name,
  COUNT(DISTINCT `httparchive.fn.GET_ORIGIN`(root_page)) AS matched
FROM `httparchive.crawl.pages`
WHERE date = @crawl_date
  AND is_root_page
  AND root_page IN UNNEST(@root_pages);
```

The compact queries above reproduce the fields used in scoring and descriptive analysis. The broader original extraction query and parameter setup remain in the extraction workbook and Google Colab notebook.

A.3 Variables, Source Fields, Units, and Transformations

Table A3 identifies each analysis variable, source field, unit, transformation, and role in scoring or interpretation.

Table A3. Variable definitions and transformations

Dataset	Analysis variable	Source field	Unit	Transformation and use
CrUX	Largest Contentful Paint	p75_lcp	Milliseconds	Renamed p75_lcp_ms; weighted
CrUX	Interaction to Next Paint	p75_inp	Milliseconds	Renamed p75_inp_ms; weighted
CrUX	Cumulative Layout Shift	p75_cls	Unitless score	No unit conversion; weighted
CrUX	Time to First Byte	p75_ttfb	Milliseconds	Renamed p75_ttfb_ms; weighted
CrUX	First Contentful Paint	p75_fcp	Milliseconds	Renamed p75_fcp_ms; descriptive
CrUX	Phone density	phoneDensity	Proportion	Retained as form-factor evidence
CrUX	Desktop density	desktopDensity	Proportion	Retained as form-factor evidence
CrUX	Tablet density	tabletDensity	Proportion	Retained as form-factor evidence
HTTP Archive	Page weight	bytesTotal	Bytes	Divided by 1,000,000 to obtain MB; weighted
HTTP Archive	Request count	reqTotal	Requests	Desktop and mobile counts averaged; weighted
HTTP Archive	JavaScript size	bytesJS	Bytes	Divided by 1,000,000 to obtain MB; descriptive
HTTP Archive	Image size	bytesImg	Bytes	Divided by 1,000,000 to obtain MB; descriptive
HTTP Archive	Speed Index	SpeedIndex	Milliseconds	Desktop and mobile values averaged; weighted

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HTTP Archive	Fully loaded time	fullyLoaded	Milliseconds	Desktop and mobile values averaged; weighted
HTTP Archive	HTTPS ratio	numHttps, reqTotal	Proportion	Pooled HTTPS requests divided by pooled requests; weighted
HTTP Archive	CDN detection	cdn	Categorical	Provider detected or no provider detected; weighted

The source workbook also retained CSS size, font size, redirect count, domain count, page-level TTFB, rendering start, and visual completion fields as non-scoring audit variables.

A.4 Origin Normalization and Dataset-Matching Rules

The matching workflow applied six rules:

1. Each institutional website was validated as official, and redirects, JavaScript rendering, or blocked automated access were recorded without automatic exclusion.
2. During inventory preparation, each validated address was reduced to its scheme and host. The notebook then trimmed spaces, converted origins to lowercase, and removed trailing slashes while retaining the observed host form required for exact CrUX matching [6].
3. CrUX matching required the normalized origin for month 202605. HTTP Archive matching required the corresponding root page in the May 1, 2026 crawl with a desktop or mobile record.
4. The HTTP Archive root-page list was created by adding a trailing slash, and httparchive.fn.GET_ORIGIN was used to derive a comparable origin from each matched page.
5. Missing cases were checked against the validated inventory. No unrelated or unofficial alternate domain was substituted to increase coverage.
6. Coverage was labeled complete data when both sources matched, CrUX only when only field evidence matched, and insufficient data when neither source returned usable evidence.

Validated URLs and normalized origins were stored separately to preserve redirect and matching traceability.

A.5 Indicator Cut-Offs, Point Assignments, and Weights

Weighted indicators were translated to 100, 60, or 30 points. CDN detection used 100 points when a provider was detected and 60 points when none was detected.

Table A4. CrUX scoring rules

Indicator	100 points	60 points	30 points	Weight
LCP	<= 2,500 ms	> 2,500 to 4,000 ms	> 4,000 ms	30%
INP	<= 200 ms	> 200 to 500 ms	> 500 ms	25%
CLS	<= 0.10	> 0.10 to 0.25	> 0.25	25%
TTFB	<= 800 ms	> 800 to 1,800 ms	> 1,800 ms	20%

Table A5. HTTP Archive scoring rules

Indicator	100 points	60 points	30 points	Weight
Page weight	<= 2 MB	> 2 to 5 MB	> 5 MB	25%
Request count	<= 75	> 75 to 150	> 150	20%

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Indicator	100 points	60 points	30 points	Weight
Speed Index	<= 3,000 ms	> 3,000 to 6,000 ms	> 6,000 ms	25%
Fully loaded time	<= 10,000 ms	> 10,000 to 20,000 ms	> 20,000 ms	15%
HTTPS ratio	>= 0.99	>= 0.95 to < 0.99	< 0.95	10%
CDN detection	Provider detected	No provider detected	Not used	5%

The LCP, INP, and CLS cut-offs followed Core Web Vitals guidance, while TTFB followed supporting web-performance guidance. The HTTP Archive cut-offs were researcher-defined analytic bands used for this study and were not treated as official HEI website standards [27], [28].

A.6 Component and Overall Score Formulas

Let P_LCP, P_INP, P_CLS, and P_TTFB represent the points assigned to the four CrUX indicators.

$$CrUX\_i = 0.30(P\_LCP) + 0.25(P\_INP) + 0.25(P\_CLS) + 0.20(P\_TTFB)$$

Let P_PW, P_REQ, P_SI, P_FLT, P_HTTPS, and P_CDN represent the points assigned to the six HTTP Archive indicators.

$$HA\_i = 0.25(P\_PW) + 0.20(P\_REQ) + 0.25(P\_SI) + 0.15(P\_FLT) + 0.10(P\_HTTPS) + 0.05(P\_CDN)$$

For origins with both components, the overall readiness score was:

$$Readiness\_i = (CrUX\_i + HA\_i) / 2$$

The resulting score was reported to one decimal place. Readiness levels were interpreted using the following rules:

Score condition	Readiness classification
Score >= 80	High readiness
Score >= 60 and < 80	Moderate readiness
Score < 60	Low readiness
No CrUX or HTTP Archive evidence	Insufficient data

The decimal-safe boundaries were score >= 80, score >= 60 and < 80, and score < 60. CrUX-only component scores were labeled as limited data rather than treated as complete overall scores.

A.7 Desktop and Mobile Aggregation Procedure

HTTP Archive returned one desktop and one mobile row for each of the 25 matched origins. Because the website origin was the unit of analysis, the client records were combined before scoring.

For continuous page-level indicators, the origin-level value was the arithmetic mean of the desktop and mobile observations:

$$x\text{-}bar\_i = (x\_desktop,i + x\_mobile,i) / 2$$

This procedure was applied to page weight, request count, JavaScript size, image size, Speed Index, and fully loaded time. Page weight, JavaScript size, and image size were first extracted in bytes and converted to decimal megabytes using:

$$MB = bytes / 1,000,000$$

The origin-level HTTPS ratio was calculated from the combined request totals:

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HTTPSRatio_i = (HTTPS_desktop,i + HTTPS_mobile,i) / (Requests_desktop,i + Requests_mobile,i)

CDN detection was present when a provider name appeared in either client record. The original client rows remained in the HTTP Archive Raw worksheet for traceability.

A.8 Sensitivity-Analysis Schemes and Comparison Measures

Sensitivity analysis was conducted using the 25 complete-data origins. The original model was compared with three alternative weighting schemes.

Table A6. Weighting schemes

Scheme	CrUX indicators	HTTP Archive indicators	Component combination
Baseline	Original weights	Original weights	50% CrUX, 50% HTTP Archive
Equal within components	25% each	16.67% each	50% CrUX, 50% HTTP Archive
CrUX emphasis	Original weights	Original weights	60% CrUX, 40% HTTP Archive
HTTP Archive emphasis	Original weights	Original weights	40% CrUX, 60% HTTP Archive

Comparisons used score change, absolute score change, classification agreement, category changes, Spearman rank correlation, readiness counts, and HEI-type means.

Table A7. Sensitivity-analysis results

Scheme	Unchanged	Agreement	Mean absolute change	Maximum change	Spearman rho	High	Moderate	Low
Baseline	25 of 25	100%	0.00	0.00	1.000	5	13	7
Equal within components	22 of 25	88%	3.41	6.42	0.980	6	14	5
CrUX emphasis	21 of 25	84%	2.84	6.15	0.962	7	13	5
HTTP Archive emphasis	24 of 25	96%	2.84	6.15	0.964	4	14	7

Across the alternative schemes, 84 percent to 96 percent of classifications remained unchanged and Spearman correlations ranged from 0.962 to 0.980. Changes occurred mainly near the 60-point and 80-point boundaries. Full calculations are recorded in ACN_HEI_R1_Sensitivity_Analysis.xlsx.

A.9 Reproducibility Files and Version Control

Table A8 identifies the version-controlled files used for validation, extraction, scoring, sensitivity analysis, and manuscript revision.

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Table A8. Reproducibility files

File	Purpose	Version-control status
ACN_HEI_Source_Inventory_v3_Extraction_Pack.xlsx	Validated URLs, normalized origins, root pages, raw-output templates, and SQL queries	Source inventory and extraction package
ACN_HEI_BigQuery_Extraction_Colab.ipynb	Parameterized CrUX and HTTP Archive extraction workflow	Retained extraction notebook
ACN_HEI_Extraction_Cleaned_Scored_v4_FREEZE.xlsx	Raw data, summaries, component scores, classifications, and audit record	Frozen July 9, 2026
ACN_HEI_R1_Sensitivity_Analysis.xlsx	Alternative weighting schemes, recalculated scores, category changes, and ranking comparisons	Derived revision file
ACN_HEI_Final_Draft_IJLTEMAS_v16_Editorial_Refinement.docx	Manuscript submitted for journal evaluation	Retained as the original submission record
ACN_HEI_Final_Draft_IJLTEMAS_v20_R1_FINAL_SUBMISSION.docx	Final revised manuscript for journal resubmission	Final revised submission copy

The frozen workbook remains the unchanged source for the original data and scores. Corrections require a new version, while the sensitivity workbook remains a separate derived file.