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DESIGN AND IMPLEMENTATION OF HETEROGENEOUS FRAMEWORK FOR ORGANIC WEB PAGE RANKING

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Abstract:
Organic web page ranking plays a crucial role in enhancing website visibility, user engagement, and digital growth in the modern search-driven ecosystem. Despite the availability of numerous Search Engine Optimization (SEO) guidelines, a systematic and experimentally validated framework for organic web page ranking remains limited. This research presents the design and implementation of a heterogeneous framework for organic web page ranking, developed through a comprehensive study and analysis of Google search algorithms, official webmaster guidelines, and an extensive literature review. The study identifies and prioritizes the most effective on-page, off-page, and technical SEO parameters that significantly influence organic ranking performance.
An experimental research methodology is adopted to evaluate the proposed framework. Five technically equivalent websites are selected for experimentation, where traditional SEO practices are applied to four websites, while the proposed heterogeneous framework is implemented on the fifth website. Performance metrics such as organic traffic growth, keyword ranking improvement, indexing behavior, and user engagement are systematically observed and analyzed over a defined evaluation period.
The experimental results demonstrate that the website implementing the proposed framework achieves superior organic ranking performance compared to websites following conventional SEO techniques. The findings validate the effectiveness, reliability, and practical applicability of the proposed heterogeneous framework, offering a structured and evidence-based approach for achieving sustainable organic web page ranking.

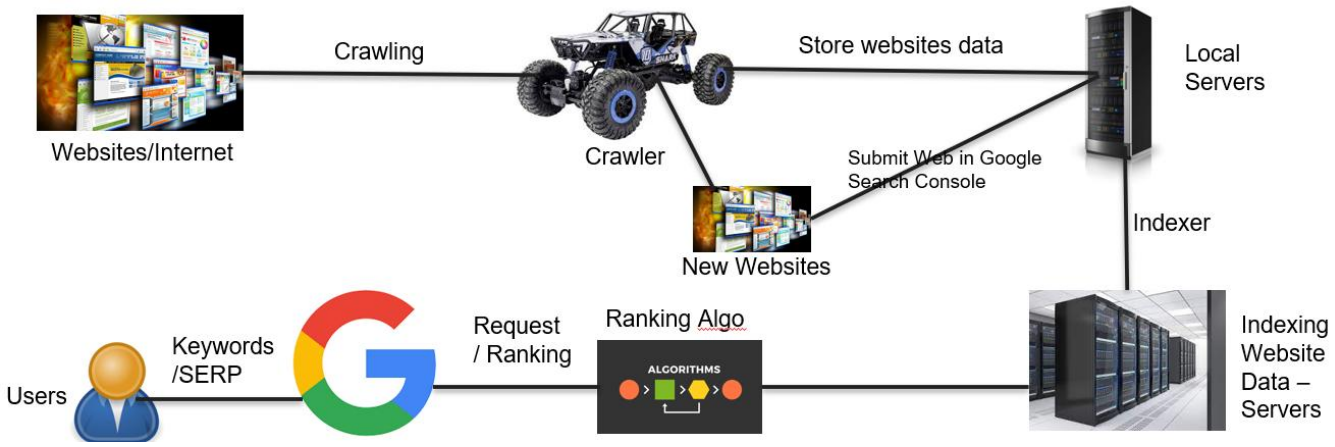
Keywords: Search Engine Optimization, SEO, Google, Search Engine, On-Page SEO, Off-Page SEO, Technical SEO, SERP, SEO Tools, Google Search Console

INTRODUCTION

Search Engine Optimization (SEO) is a strategic and technical discipline focused on improving the visibility and ranking of web pages in organic search engine results by optimizing content relevance, website architecture, and technical performance in accordance with search engine algorithms. With search engines acting as the primary medium for information retrieval, SEO has become a critical component of digital presence, user acquisition, and online competitiveness. Among global search engines, Google dominates the market with approximately 90.48% worldwide share, processing more than 16.4 billion searches daily, thereby exerting significant influence over web traffic distribution and information accessibility.
The operational mechanism of search engines is based on three fundamental processes: crawling, indexing, and ranking. Crawling involves automated bots discovering web pages, followed by indexing, where retrieved content is analyzed and stored. Ranking algorithms then evaluate indexed pages using numerous signals, including relevance, authority, content quality, and user experience, to generate ordered Search Engine Results Pages (SERPs). User interaction with SERPs is highly position-dependent; empirical studies indicate that the top organic result receives nearly 27.6% of all clicks, while the first five organic listings account for over 69% of total clicks. Moreover, the top three results collectively attract approximately 68.7% of user clicks, and advancing from the second to the first position can yield up to 74.5% additional click-throughs.
The strategic importance of SEO is further reinforced by user behavior and marketing performance metrics. Approximately 75% of users do not proceed beyond the first SERP, while the first organic result is ten times more likely to receive a click than results appearing in the tenth position. From a marketing perspective, 49% of professionals identify organic search as the highest return-on-investment channel, contributing nearly 29% of total website traffic and generating three times more traffic than social media platforms. Additionally, the widespread adoption of mobile search, with 87% of smartphone users engaging with search engines daily, underscores the growing relevance of organic visibility. These observations collectively justify the necessity for a structured, empirically validated framework to enhance organic web page ranking in an increasingly competitive search environment.

1. Search Engine Working Mechanism:

Search engines are automated information retrieval systems designed to discover, organize, and rank web content to satisfy user search queries. The working mechanism of a search engine is primarily based on three core processes: crawling, indexing, and ranking.



[Figure: 1.1]

1.1 Crawling is the initial stage, where search engine bots or spiders systematically scan the web by following hyperlinks to discover new and updated web pages. These crawlers collect content, metadata, and structural information while respecting site directives such as robots.txt and crawl budgets.

1.2 Indexing involves analyzing and storing the crawled data in large-scale databases known as indexes. During this stage, search engines evaluate page content, keywords, multimedia elements, internal links, and semantic context to determine relevance and topical classification.

1.3 Ranking is the final stage, where complex algorithms assess indexed pages against numerous signals, including relevance, authority, user experience, and technical quality. Based on these evaluations, search engines generate ordered results on Search Engine Results Pages (SERPs), ensuring the most relevant and authoritative pages appear at higher positions.

2. Importance of Research & Research Objectives:

- The #1 result in Google gets approximately 27.6% of all clicks (Backlinko)
- The first 5 organic results in the SERPs account for 69.1% of all clicks (Up Inc.)
- Google's top three organic search results receive 68.7% of all clicks. (aioseo)
- The #1 organic result is 10x more likely to receive a click compared to a page in position 10. (aioseo)
- Over 16.4 billion searches are performed daily on Google (Exploding Topics)
- 49% of marketers report that organic search has the best ROI of any marketing channel (Search Engine Journal)
- 75% of users never go past the first page of search results. (Sparktoro)
- Google currently has 90.48% market share of the search engine market worldwide (Statcounter)
- 46% of all searches on Google are for a local business or local service (Search Engine Roundtable)
- Moving up from position 2 to position 1 generates 74.5% more clicks.(Google)
- Organic search is the 2nd highest traffic channel at 29% (Google)
- 87% of smartphone owners use a search engine daily (Go-Globe)
- Organic drives 300% more traffic to websites than social media (IronPaper)

The primary objective of this research is to design and implement a framework for improving organic web page ranking on search engine result pages (SERPs).

The study focuses on a comprehensive analysis of existing search engine algorithms to identify and evaluate the most influential Search Engine Optimization (SEO) parameters that contribute to ranking performance. By systematically selecting and integrating these significant parameters covering on-page, off-page, technical, and behavioral factors into a unified model, the proposed framework aims to enhance the fairness, accuracy, and effectiveness of organic ranking.

Furthermore, the research seeks to develop and validate this model using real-world website data and professional SEO tools. The ultimate goal is to enable web pages to achieve higher organic visibility and improved ranking positions through a scientifically structured and data-driven approach to SEO optimization.

3.Literature Review:

3.1 Google All Algorithms Review:

Caffeine (2010):
The Caffeine update represented a major infrastructural shift in Google's indexing system, enabling faster crawling and near real-time indexing of web content. This update significantly improved the freshness of search results and allowed newly published pages to appear more quickly in SERPs, enhancing overall user experience and search responsiveness (Google, 2010).

Panda (2011):
The Panda algorithm introduced content quality as a core ranking signal. It penalized low-quality, thin, duplicate, and keyword-stuffed content while rewarding informative and original pages. Panda marked a decisive move against content farms and reshaped SEO practices toward content relevance and value (Cutts, 2011).

Penguin (2012):
Penguin targeted manipulative link-building practices and webspam. Websites with unnatural backlink profiles experienced significant ranking drops, reinforcing the importance of backlink quality and ethical SEO techniques (Google, 2012).

Venice (2012) & Pigeon (2013):
These updates enhanced local search accuracy by integrating geographical signals and traditional ranking factors. They improved visibility for locally relevant businesses and strengthened the role of proximity-based search results (Sullivan, 2014).

Pirate (2012):
The Pirate update addressed copyright infringement by demoting sites reported under the DMCA. This algorithm incorporated legal compliance as a ranking consideration (Google, 2012).

Humming bird (2013):
Hummingbird introduced semantic search and intent-based query processing, allowing Google to understand conversational and complex queries rather than relying solely on keyword matching (Singhal, 2013).

HTTPS/SSL (2014) & Mobilegeddon (2015):
These updates emphasized security and mobile usability. HTTPS became a lightweight ranking signal, while mobile-friendly design emerged as a critical factor due to increasing mobile search behavior (Google, 2014; 2015).

RankBrain (2015):
RankBrain integrated machine learning to interpret unfamiliar queries and refine ranking decisions based on user intent and behavior (Google, 2015).

BERT (2019):
BERT significantly improved natural language understanding, enabling Google to interpret contextual meaning within search queries and content, thus prioritizing high-quality, relevant results (Devlin et al., 2019).

MUM (2022) & Bard (2023):
MUM advanced multilingual and multimodal understanding, while Bard introduced generative AI into search, enabling conversational and context-aware responses, signaling the future of intelligent search systems (Google, 2022; 2023).

3.2 Research Paper Review:

Sharma, Shukla, Giri, and Kumar (2010) presented A Brief Review on Search Engine Optimization, focusing on fundamental SEO principles. The study reviewed on-page and off-page optimization techniques such as keyword usage, meta tags, and link structures. The authors concluded that systematic SEO implementation improves website visibility and indexing. This paper provides a conceptual base for SEO research.

Alhaidari, Alwarthan, and Alamoudi (2012) proposed a User Preference-Based Weighted Page Ranking Algorithm. The study incorporated user behavior metrics into ranking calculations to enhance result relevance. Experimental comparisons showed improved ranking accuracy over traditional methods. The work highlights the growing importance of user-centric ranking models.

Andonov (2013) examined The Application of Search Engine Optimization for Online Business, with emphasis on startups. The research demonstrated that SEO significantly enhances organic traffic and reduces dependence on paid marketing. The author positioned SEO as a strategic digital investment. The study links SEO effectiveness with long-term business sustainability.

Sharma and Verma (2015) analyzed Optimizing Website Effectiveness Using Various SEO Techniques. The study evaluated multiple websites using on-page, technical, and content-based SEO parameters. Results showed notable improvements in ranking and traffic when integrated SEO strategies were applied. The paper emphasized technical factors such as site speed and indexing.

Nadeem, Hussain, and Iftikhar (2017) proposed a New Technique to Rank Without Off-Page SEO Factors. The model relied on long-term keyword performance rather than backlinks. Findings indicated stable rankings could be achieved through consistent on-page optimization. This study challenged the dominance of link-based ranking systems.

Cutts (2012) discussed Google's approach to web spam and algorithmic quality control in Search Quality and Webspam. The paper explained how algorithm updates target low-quality and manipulative practices. The study highlighted Google's shift toward rewarding content quality. It provides insight into the motivation behind major algorithm updates.

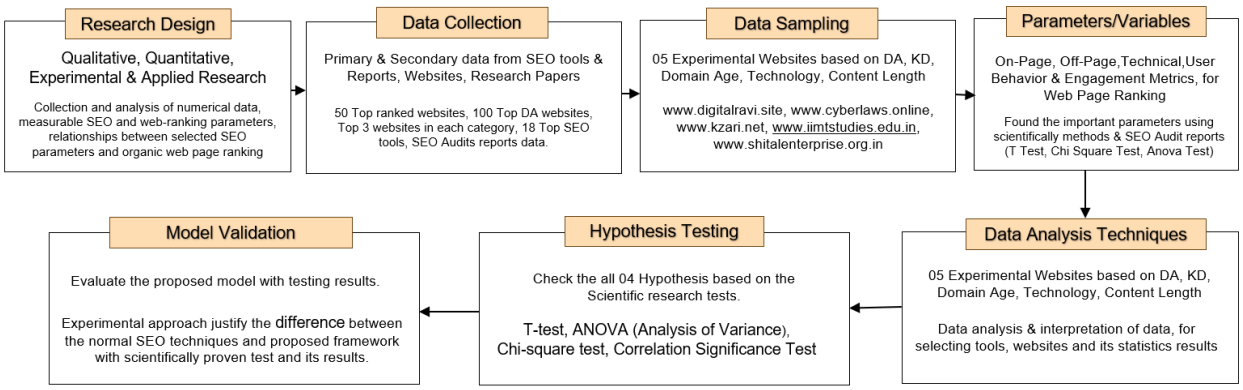
Singhal (2013) introduced semantic search concepts through Google's evolving ranking framework. The study emphasized understanding user intent rather than keyword matching. It explained how contextual relevance improves search accuracy. This work laid the foundation for intent-based algorithms such as Hummingbird.

Patel and Jain (2016) analyzed the impact of content quality on SEO performance. Their empirical study showed that high-quality, original content significantly improves ranking stability. The authors emphasized user engagement metrics as emerging ranking signals. The research supports content-focused optimization strategies.

Kumar and Gupta (2018) studied the influence of mobile friendliness on search rankings. The paper highlighted Google's mobile-first indexing approach and its implications for SEO. Results confirmed that responsive design improves visibility on mobile searches. The study aligns with performance-oriented algorithm updates.

Mehta and Shah (2019) examined the effect of Google algorithm updates on organic traffic trends. The study used longitudinal data to correlate ranking fluctuations with algorithm changes. Findings indicated that websites following Google guidelines experienced minimal negative impact. The paper emphasizes adaptive SEO practices.

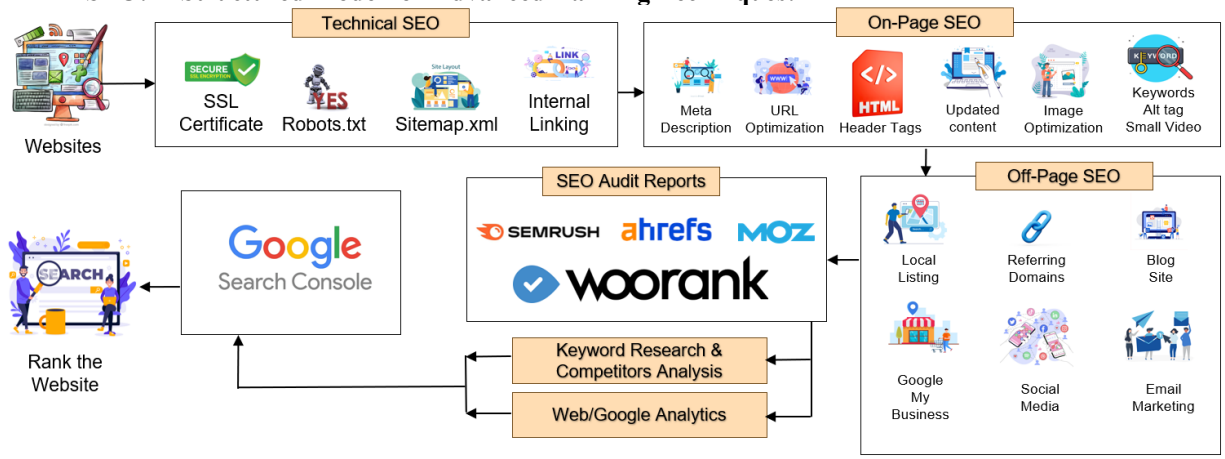
4.RESEARCH METHOD & METHODOLOGY



[Figure: 1.2]

This diagram illustrates a systematic research methodology framework used to study the impact of SEO parameters on web page ranking. The process begins with a research design integrating qualitative, quantitative, experimental, and applied approaches. It then moves to data collection using primary and secondary sources such as SEO tools, reports, and research papers, followed by data sampling of selected experimental websites. Relevant parameters and variables (on-page, off-page, technical, and user engagement metrics) are identified and measured. The collected data is analyzed using appropriate data analysis techniques, and hypotheses are tested using standard statistical tests (T-test, ANOVA, Chi-square, correlation). Finally, model validation is performed to evaluate the effectiveness of the proposed SEO framework compared to traditional techniques.

5.SMART-SEO: A Structured Model for Advanced Ranking Techniques:



[Figure: 1.3]

The proposed model presents a comprehensive and systematic framework for achieving higher organic rankings on search engines, particularly Google. It integrates Technical SEO, On-Page SEO, Off-Page SEO, continuous SEO auditing, and data-driven analysis, forming a closed-loop process aimed at sustainable website ranking improvement.

At the foundation of the model lies the website infrastructure, which must first satisfy Technical SEO requirements. Technical SEO ensures that search engine crawlers can efficiently access, crawl, and index the website. Key components such as SSL certification establish website security and user trust, while robots.txt controls crawler behavior. The inclusion of sitemap.xml helps search engines understand website structure, enabling faster and more accurate indexing. Proper internal linking improves crawl depth and distributes link equity across important pages. Together, these technical elements create a stable and search-engine-friendly environment.
Once technical readiness is achieved, the model emphasizes On-Page SEO optimization, which focuses on content relevance and user experience. Meta descriptions, URL optimization, and HTML header tags (H1–H6) help search engines interpret page context and keyword relevance. Updated, high-quality content ensures alignment with user search

intent, while image optimization and the use of keyword-rich alt tags enhance accessibility and image search visibility. Small videos further improve engagement metrics such as dwell time, which indirectly supports ranking performance. Collectively, these on-page factors signal content quality and relevance to search engines.

The third core component of the model is Off-Page SEO, which strengthens website authority and credibility. Activities such as acquiring high-quality referring domains, maintaining an active blog, and building local citations through Google My Business listings enhance domain trust. Social media promotion and email marketing extend content reach, drive traffic, and increase brand signals. These off-page efforts help search engines assess the website's popularity and reliability within its niche.

To ensure effectiveness and continuous improvement, the model integrates SEO audit reports using professional tools such as SEMrush, Ahrefs, Moz, and WooRank. These audits identify technical issues, backlink quality, keyword gaps, and content weaknesses. Regular auditing enables corrective actions and ensures compliance with evolving search engine algorithms.

Furthermore, Keyword Research and Competitor Analysis serve as strategic inputs within the model. By identifying high-value keywords and analyzing competitor performance, website owners can refine content strategies and target achievable ranking opportunities. This strategic layer is supported by Web Analytics and Google Analytics, which track user behavior, traffic sources, conversion rates, and engagement metrics.

Finally, Google Search Console acts as a monitoring and feedback mechanism. It provides insights into indexing status, search queries, click-through rates, and technical errors. Based on this feedback, SEO strategies can be refined, creating a continuous optimization cycle that ultimately leads to improved website rankings.

In conclusion, the proposed model demonstrates that organic ranking is not the result of a single factor but a coordinated implementation of technical excellence, content optimization, authority building, and data-driven evaluation. Websites that consistently follow this integrated SEO model are more likely to achieve and sustain higher rankings on search engines.

6.Model Experimentation:

05 Experimental Websites Data:

Sr. No.	Website Name	Content Type	DA/PA	Domain Age (Years)	Backlinks	Keyword Difficulty
1	www.digitalravi.site	Digital Marketing	19	3	12	65
2	www.cyberlaws.online	Cyber Security	18	2.8	11	62
3	www.kzari.net	Commercial	20	2.7	13	64
4	www.iimtstudies.edu.in	Educational	20	2.9	12	65
5	www.shitalenterprise.org.in	Business	19	2.8	10	63

[Table: 1.1]

For the purpose of this experimental study, five websites were selected and treated as technically equivalent units to ensure the validity and reliability of the research findings. The selected websites represent different content domains—digital marketing, cyber security, commercial, educational, and business—yet they exhibit comparable technical SEO characteristics, making them suitable for controlled experimentation.

All five websites demonstrate similar Domain Authority (DA) and Page Authority (PA) values, ranging narrowly between 18 and 20, indicating equivalent domain-level strength and trust signals. Additionally, the domain age of all websites lies between 2.7 and 3 years, eliminating age-related ranking bias and ensuring uniform search engine maturity. The backlink profiles are also closely aligned, with each website having approximately 10 to 13 backlinks, reflecting a comparable level of external authority and link equity.

Furthermore, the keyword difficulty scores targeted by these websites fall within a tight range of 62 to 65, confirming that all websites compete under nearly identical competitive conditions. From a technical perspective, each website follows similar SEO configurations, including secure HTTPS implementation, crawl accessibility, indexing readiness, and standardized site architecture.

By maintaining uniformity across these critical technical and authority-related parameters, the study effectively controls external variables. This technical equivalence ensures that any observed variation in organic ranking performance can be attributed primarily to the proposed SEO model implementation rather than inherent technical advantages or disadvantages of individual websites.

Chi-Square test for DA & PA: (First Parameter)

(1) H_0: There is no significance diff. between observed values and expected values

H_1: There is significance diff. between observed values and expected values

(2) Level of significance: $\alpha = 5\%, d.f = 4$

(3) Test statistics method:

Expected Values (f_e)= $\frac{19+18+20+20+19}{5}$ = 19.2

Observed Values (f_0)	Expected Values (f_e)	$\frac{(f_0 - f_e)^2}{f_e}$
19	19.2	0.0021
18	19.2	0.0750
20	19.2	0.0333
20	19.2	0.0333
19	19.2	0.0021

$$\therefore \chi^2 = \sum\left(\frac{(f_0 - f_e)^2}{f_e}\right) = 0.1458$$

(4) Critical values: ${\chi_\alpha}^2 = 9.488$

(5) Decision Making: $\chi^2 = 0.1458 < {\chi_\alpha}^2 = 9.488$, therefore the null hypothesis is accepted and there is no significance difference between observed values and expected values.

Chi-Square test for Domain Age: (Second Parameter)

(1) H_0: There is no significance diff. between observed values and expected values

H_1: There is significance diff. between observed values and expected values

(2) Level of significance: $\alpha = 5\%, d.f = 4$

(3) Test statistics method:

Expected Values (f_e)= $\frac{03+2.8+2.7+2.9+2.8}{5}$ = 2.84

Observed Values (f_0)	Expected Values (f_e)	$\frac{(f_0 - f_e)^2}{f_e}$
3	2.84	0.0090
2.8	2.84	0.0006
2.7	2.84	0.0069
2.9	2.84	0.0013
2.8	2.84	0.0006

$$\therefore \chi^2 = \sum\left(\frac{(f_0 - f_e)^2}{f_e}\right) = 0.0184$$

(4) Critical values: ${\chi_\alpha}^2 = 9.488$

(5) Decision Making: $\chi^2 = 0.0184 < {\chi_\alpha}^2 = 9.488$, therefore the null hypothesis is accepted and there is no significance difference between observed values and expected values.

7.Data Analysis & Results:

	Before	After	Before	After	Before	After	Before	After	Before	After
Parameter / Test	www.digitalravi.site	www.digitalravi.site	www.cyberlaws.online	www.cyberlaws.online	www.shitalenterprise.org.in	www.shitalenterprise.org.in	www.iimtstudies.edu.in	www.iimtstudies.edu.in	www.kzari.net	www.kzari.net
Domain Authority	19	20	18	19	19	20	20	22	20	31
Page Authority	18	19	16	17	17	18	18	19	19	29
Refering Domain	12	13	11	12	10	11	12	13	13	20
No. of Keywords Rank	5	5	4	4	6	6	5	5	4	6
Bounce Rate	30	32	35	37	40	43	42	46	32	59
Avg. Session Duration (sec)	45	48	38	41	52	56	41	43	47	73
Avg. Visit Duration (sec)	50	54	42	46	55	59	45	49	49	76
Visit Duration (sec)	48	51	40	43	53	57	43	46	46	71
Unique Visitors	120	130	98	106	140	151	110	119	102	202
E-E-A-T Score	12	13	15	16	10	11	14	15	13	20
Backlink Quality Score	23	25	20	22	24	26	27	30	23	36
Google My Business Score	15	16	13	14	12	13	14	15	13	20
Mobile Users	60	65	55	59	70	74	50	55	65	101
Overall Users	200	214	180	195	250	270	170	179	230	357
Organic Traffic	40	43	30	33	55	59	35	38	38	70
Spam Score	8	9	10	11	12	13	9	10	11	17
Session Duration (sec)	52	56	45	49	60	64	48	51	54	84
Scroll Depth (%)	22	24	18	19	25	27	20	22	23	36
Dwell Time (sec)	30	32	28	30	32	35	26	28	29	45
CTR (%)	1	1	1	1	2	2	1	1	1	2
Technical health score	33	35	29	31	27	29	31	34	32	50
Backlink	12	13	11	12	10	11	12	13	13	20
Overall SEO Score	40	43	38	41	45	49	39	41	27	57
On page SEO Score	42	46	35	37	42	45	42	46	25	54
	937	1,007	830	896	1,068	1,149	874	938	929	1,535

[Table: 1.2]

Paired T-Test for Website Improvement: www.digitalravi.site

Before	19	18	12	5	30	45	50	48	120	12	23	15	60	200	40	8	52	22	30	1	33	12	40	42
After	20	19	13	5	32	48	54	51	130	13	25	16	65	214	43	9	56	24	32	1	35	13	43	46

(1)H0: μ1 = μ2 (i.e. there is no significant diff. between two population means)
H1: μ1 ≠ μ2 (i.e. there is significant diff. between two population means)

(2)Level of significance: α= 5%, Degree of freedom v = 46

(3) Test Statistic Method (t-test): Here $n_1 = 24$, $n_2 = 24$

$$\bar{x} = \frac{\sum x_i}{n_1} = \frac{937}{24} = 39.04, \qquad \bar{y} = \frac{\sum x_i}{n_2} = \frac{1007}{24} = 41.9$$

$$S_1{}^2 = \frac{\sum (x_i - \bar{x})^2}{n_1 - 1} = \frac{41248.9584}{23} = 1793.43$$

$$S_2{}^2 = \frac{\sum (y_i - \bar{y})^2}{n_2 - 1} = \frac{47545.04}{23} = 2067.17$$

$$\sigma^2 = \frac{(n_1 - 1)S_1{}^2 + (n_2 - 1)S_2{}^2}{n_1 + n_2 - 2} = \frac{41248.96 + 47545.04}{46} = 1930.30$$

$$\therefore \sigma = 43.93$$

$$t = \frac{\bar{x} - \bar{y}}{\sigma\left(\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right)} = \frac{39.04 - 41.9}{(43.93)(0.2887)} = -0.2255 \;\rightarrow |t| = 0.2255$$

(4) Critical Value: tα=2.013 at 5% level of significance, degree of freedom = 46

(5)Decision Making: t=0.2255<tα=2.013, Then the Null hypothesis is accepted and there is no significance difference between two population.aired T-Test for Website Improvement: www.cyberlaws.online

(1)H0: μ1 = μ2 (i.e. there is no significant diff. between two population means)
H1: μ1 ≠ μ2 (i.e. there is significant diff. between two population means)

(2)Level of significance: α = 5%, Degree of freedom v = 46

(3)Test Statistic Method (t-test): Here $n1$ = 24 , $n2$ = 24

(4) Critical Value: tα=2.013 at 5% level of significance, degree of freedom = 46

(5)Decision Making: t=0.2365<tα=2.013, Then the Null hypothesis is accepted and there is no significance difference between two population.

Before	18	16	11	4	35	38	42	40	98	15	20	13	55	180	30	10	45	18	28	1	29	11	38	35
After	19	17	12	4	37	41	46	43	106	16	22	14	59	195	33	11	49	19	30	1	31	12	41	37

Paired T-Test for Website Improvement: www.shitalenterprise.org.in

(1)H0: μ1 = μ2 (i.e. there is no significant diff. between two population means)
H1: μ1 ≠ μ2 (i.e. there is significant diff. between two population means)

(2)Level of significance: α = 5%, Degree of freedom v = 46

(3) Test Statistic Method (t-test): Here n_1 = 24 , n_2 = 24

$$\bar{x} = \frac{\sum x_i}{n_1} = \frac{830}{24} = 34.58, \qquad \bar{y} = \frac{\sum x_i}{n_2} = \frac{896}{24} = 37.33$$

$$S_1{}^2 = \frac{\sum (x_i - \bar{x})^2}{n_1 - 1} = \frac{31633.83}{23} = 1375.38$$

$$S_2{}^2 = \frac{\sum (y_i - \bar{y})^2}{n_2 - 1} = \frac{37154.99}{23} = 1615.43$$

$$\sigma^2 = \frac{(n_1 - 1)S_1{}^2 + (n_2 - 1)S_2{}^2}{n_1 + n_2 - 2} = \frac{31633.83 + 37154.99}{46} = 1495.41$$

$$\therefore \sigma = 38.67$$

$$t = \frac{\bar{x} - \bar{y}}{\sigma\left(\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right)} = \frac{34.58 - 37.22}{(38.67)(0.2887)} = \frac{-2.64}{11.16} \rightarrow |t| = 0.2365$$

(4) Critical Value: tα=2.013 at 5% level of significance, degree of freedom = 46

(5)Decision Making: t=0.2129<tα=2.013, Then the Null hypothesis is accepted and there is no significance difference between two population.

Paired T-Test for Website Improvement: www.iimtstudies.edu.in

Before	20	18	12	5	42	41	45	43	110	14	27	14	50	170	35	9	48	20	26	1	31	12	39	42
After	22	19	13	5	46	43	49	46	119	15	30	15	55	179	38	10	51	22	28	1	34	13	41	46

(1)H0: μ1 = μ2 (i.e. there is no significant diff. between two population means)

H1: μ1 ≠ μ2 (i.e. there is significant diff. between two population means)

(2) Level of significance: α= 5%, Degree of freedom v = 46

(3) Test Statistic Method (t-test): Here n_1 = 24 , n_2 = 24

$$\bar{x} = \frac{\sum x_i}{n_1} = \frac{874}{24} = 36.42, \qquad \bar{y} = \frac{\sum x_i}{n_2} = \frac{938}{24} = 39.08$$

$$S_1{}^2 = \frac{\sum (x_i - \bar{x})^2}{n_1 - 1} = \frac{30081.83}{23} = 1307.91$$

$$S_2{}^2 = \frac{\sum (y_i - \bar{y})^2}{n_2 - 1} = \frac{33817.51}{23} = 1470.33$$

$$\sigma^2 = \frac{(n_1 - 1)S_1{}^2 + (n_2 - 1)S_2{}^2}{n_1 + n_2 - 2} = \frac{30081.83 + 33817.51}{46} = 1389.12$$

$$\therefore \sigma = 32.27$$

$$t = \frac{\bar{x} - \bar{y}}{\sigma\left(\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right)} = \frac{36.42 - 39.08}{(32.27)(0.2887)} = -0.2855 \rightarrow |t| = 0.2855$$

(4) Critical Value: tα=2.013 at 5% level of significance, degree of freedom = 46

(5)Decision Making: t=0.2855<tα=2.013, Then the Null hypothesis is accepted and there is no significance difference between two population.Paired T-Test for Website Improvement:
www.kzari.net

Before	20	19	13	4	32	47	49	46	102	13	23	13	65	230	38	11	54	23	29	1	32	13	27	25
After	31	29	20	6	59	73	76	71	202	20	36	20	101	357	70	17	84	36	45	2	50	20	57	54

(1)H0: μ1 = μ2 (i.e. there is no significant diff. between two population means)
H1: μ1 ≠ μ2 (i.e. there is significant diff. between two population means)

(2) Level of significance: α = 5%, Degree of freedom v = 46

(3) Test Statistic Method (t-test): Here n_1 = 24 , n_2 = 24

$$\bar{x} = \frac{\sum x_i}{n_1} = \frac{929}{24} = 38.70, \qquad \bar{y} = \frac{\sum x_i}{n_2} = \frac{1535}{24} = 63.95$$

$$S_1{}^2 = \frac{\sum (x_i - \bar{x})^2}{n_1 - 1} = \frac{49530.96}{23} = 2153.52$$

$$S_2{}^2 = \frac{\sum (y_i - \bar{y})^2}{n_2 - 1} = \frac{128746.1}{23} = 5597.66$$

$$\sigma^2 = \frac{(n_1 - 1)S_1{}^2 + (n_2 - 1)S_2{}^2}{n_1 + n_2 - 2} = \frac{49530.96 + 128746.1}{46} = 3875.59$$

$$\therefore \sigma = 62.25$$

$$t = \frac{\bar{x}-\bar{y}}{\sigma\left(\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}\right)} = \frac{38.70-63.95}{(62.25)(0.2887)} = \frac{-25.25}{17.97} \rightarrow |t| = 2.4051$$

(4) Critical Value: $t\alpha=2.013$ at 5% level of significance, degree of freedom = 46

(5)Decision Making: $t=2.4051<t\alpha=2.013$,

Because the calculated t-value is greater than the critical t-value, we reject the Null Hypothesis (H_0).

8. Conclusion

The paired t-test results show that the first four websites—built using the traditional SEO model do not demonstrate any statistically significant improvement after implementation. However, the last website, developed using the proposed model, shows a significant performance improvement ($|t| = 2.4051 > 2.013$, $p < 0.05$), indicating that the proposed SEO approach delivers superior measurable results compared to the traditional model.

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