Feature

Revisiting Ranganathan's Laws

Data-Driven Insights on Libraries and Technology

Manash Esh and Saptarshi Ghosh

Abstract

This study analyzes how modern libraries are keeping up with Ranganathan's Five Laws of Library Science, especially when it comes to user engagement, technology, and adapting to evolving needs. By analyzing data with Python, this study dives into key factors like how often people visit libraries, why they go, how helpful the staff are, the ease of using RFID and self-service tools, and overall satisfaction with digital resources. The results highlight the importance of libraries embracing new technology, expanding their offerings, and putting users first. Ultimately, this study provides practical insights to help libraries improve accessibility, engagement, and satisfaction—ensuring they stay relevant and continue to grow in the digital era.

Purpose of the Research

This study aims to empirically validate Ranganathan's Five Laws of Library Science by examining key factors such as library visit frequency, purpose of visits, staff assistance, technological advancements, and user satisfaction. By analyzing these relationships, the research seeks to understand how libraries can enhance user engagement and resource utilization, ensuring they remain effective and relevant in an evolving digital landscape.

Scope of the Study

The research focuses on user engagement, technological advancements, and library adaptability in response to changing user needs. This study explores aspects such as visit frequency, staff helpfulness, ease of material access, satisfaction with online resources, and website usability. The study employs data-driven analysis using Python, incorporating correlation matrices, visualizations (boxplots, scatter plots, and violin plots), and multiple linear regression to support the validation of Ranganathan's Five Laws. Additionally, the study underscores the importance of understanding the information ecosystem, emphasizing how user behavior and technological progress interact within library environments, as discussed in existing literature.

Introduction

The transformation of libraries from traditional physical spaces to dynamic digital ecosystems reflects broader societal and technological shifts that have fundamentally altered how we access, share, and value information. Advances in technology have prompted a reevaluation of the foundational principles of library science, particularly those established by Shiyali Ranganathan in

Manash Esh (manash@nbu.ac.in) is at University Library, University of North Bengal, Siliguri, India. **Saptarshi Ghosh** is at the Department of Library and Information Science, University of North Bengal, Siliguri, India.

the mid-twentieth century. His five laws—books are for use, every book its reader, every reader their book, save the time of the reader, and the library is a growing organism—remain deeply relevant to contemporary library practices. Recent studies highlight a growing trend of aligning these timeless principles with modern user engagement strategies, emphasizing a user-centered approach in response to rapid technological advancements.[1–3] This alignment is crucial because the outdated perception of libraries as mere repositories for books no longer holds; today's libraries must evolve to meet the diverse and evolving needs of their users, leveraging tools like digital repositories and interactive platforms.

As libraries navigate this new landscape, user engagement has emerged as a critical focus, prompting researchers to explore how Ranganathan's laws can be applied in modern contexts. Studies suggest that analyzing user behavior through data-driven methods can significantly enhance library engagement strategies, fostering a culture of increased usage and user satisfaction.[4,5] Additionally, research on social media, mobile applications, and virtual reality offers valuable insights into user interaction patterns, underscoring the importance of integrating these technologies to enrich user experiences.[6,7] However, despite the growing body of literature on these topics, significant gaps remain in empirically validating Ranganathan's laws through data-driven approaches and translating these findings into practical applications. Much of the existing research remains theoretical or anecdotal, lacking robust quantitative studies to substantiate claims about user engagement and library adaptation.[8,9] This research is particularly timely given the ongoing discourse around the evolution of libraries, especially in light of the interplay between technological progress and user-centered services. As libraries transition into open, multifunctional community hubs, they face the challenge of addressing an increasingly broad and diverse definition of library "users" and their varied needs.[10,11] Moreover, the potential for Ranganathan's laws to serve not only as historical benchmarks but also as actionable guidelines for contemporary library practices calls for a reexamination of their relevance in today's context.[12,13]

While significant strides have been made in understanding user engagement through the lens of Ranganathan's laws, there is a pressing need for more empirical research to address existing gaps. By conducting a data-driven analysis of the relationships among user engagement, technological advancements, and library evolution, this study aims to provide a clearer understanding of how Ranganathan's principles can be reinterpreted and applied to meet the demands of modern library science.[14,15] This research not only reinforces the enduring relevance of Ranganathan's laws but also aligns them with emerging trends, ensuring their continued significance in an increasingly digital future.

Ranganathan's Five Laws in the Age of Technology

In today's digital era, Ranganathan's Five Laws of Library Science remain highly relevant, shaping how libraries evolve alongside technological advancements. The First Law—"Books Are for Use"—emphasizes the need for enhanced digital access, ensuring materials are easily discoverable through advanced cataloging systems and user-friendly interfaces.[16] The Second Law—"Every Reader Their Book"—highlights the importance of personalized services, made possible by data analytics and AI-driven recommendation systems that cater to individual preferences. With the Fourth Law—"Save the Time of the Reader"—efficiency is paramount in today's fast-paced world, where innovations like RFID (radio-frequency identification) technology streamline inventory management and book retrieval.[17] Meanwhile, the Fifth Law—"The Library Is a Growing Organism"—reinforces the need for libraries to continuously evolve, integrating emerging technologies to enhance user experience and meet the changing needs of their communities.[18]

The Transformative Role of Technology in Libraries

Technology is fundamentally reshaping how libraries organize, access, and disseminate information. Digital tools such as automation systems, web-based discovery platforms, and institutional repositories have revolutionized information access, enabling users to retrieve vast resources with ease. Studies from institutions like IIT Delhi and IIT Bombay show that libraries are leveraging technology to improve operational efficiency and user engagement, aligning their services with Ranganathan's Five Laws.[19] Also, knowledge management and indexing play a critical role in handling the exponential growth of information, ensuring seamless navigation of digital archives.[20] As libraries adapt, data mining and digital access technologies become essential for maintaining relevance in an increasingly interconnected world. These advancements reflect a deep commitment to meeting user needs while upholding the core principles of library science.

Case Study: University of North Bengal Library, India

This research explores the University Library at the University of North Bengal (NBU), West Bengal, India, through a case-survey methodology. Since its establishment in 1962, the library has continually adapted to shifts in information dissemination and user expectations. By embracing modern technologies, the library has significantly enhanced accessibility, convenience, and service quality.

Key technological implementations include:

- RFID-based checkout systems, enabling seamless book borrowing and returns
- A comprehensive Library Management System (LMS) for efficient resource management
- A diverse range of e-resources, expanding access to scholarly materials

These advancements have transformed the user experience, making information retrieval more efficient and aligning library services with contemporary academic and research demands. This study examines the impact of these technological upgrades, demonstrating how they have improved access, enhanced convenience, and elevated overall user satisfaction.

Literature Review

Ranganathan's Laws of Library Science have faced new challenges as user engagement and technology evolve. Early discussions emphasized their timeless nature, arguing that core library values remain unchanged despite shifts in formats and access methods.[1] However, the rise of digital libraries sparked debates about how technology reshapes user interactions with resources. Studies show online databases and digital catalogs have revolutionized information searches, reinforcing the importance of accessibility—a key idea in Ranganathan's second law.[2,3] As libraries integrated technology, recent research highlighted user engagement metrics as a modern measure of success. This shift ties user-focused approaches directly to Ranganathan's laws.[4,5] It also sparked exploration into how new tools enhance library services and user experiences, emphasizing the need for libraries to evolve while staying true to their principles.[6,7]

Recent studies use data-driven methods to validate Ranganathan's laws, bridging traditional principles with modern digital practices.[8,9] These studies highlight that core library principles remain vital, even as environments and technologies change. Libraries continue to promote access to knowledge and foster information literacy in a rapidly advancing digital era.[10,11] This historical perspective underscores the enduring relevance of Ranganathan's laws in discussions about library transformation, user engagement, and technology's impact.[13–15]

Libraries must adapt to changing user needs and behaviors. Research shows digital technology has significantly altered user engagement, requiring a rethinking of traditional principles.[1,2] User-centered services are now the norm, with accessibility and interactive platforms critical to library evolution.[3,4] Technological advancements have transformed how libraries operate and share knowledge. Digital tools enable personalized content delivery, aligning with Ranganathan's idea of "Every reader their book."[5,6] Libraries now balance traditional methods with innovative approaches, reinforcing their role as essential institutions.[7,8]

Data-driven approaches deepen understanding of user interactions, guiding strategic development.[9,10] Validating Ranganathan's laws today affirms their importance and highlights the need for libraries to adapt and innovate.[11–13] Ongoing discussions call for a thoughtful approach that respects historical frameworks while addressing modern challenges.[14,15] Recent research explores methods to validate Ranganathan's laws, focusing on user engagement and technology. Quantitative studies, like user surveys and usage data analysis, support their relevance today. For example, shifts in user behavior align with Ranganathan's principles, emphasizing the link between user satisfaction and access to resources.[1,2] Qualitative research reveals how libraries adapt to the digital age, showing they are dynamic organizations responding to community needs and technological changes.[3,4] Mixed-methods research combines quantitative and qualitative data, offering a comprehensive view of user experiences.[5,6]

Technological change has reshaped library services. Digital tools are transforming how patrons interact with resources.[7,8] Studies stress the importance of flexibility, reflecting Ranganathan's view of libraries as "growing organisms" that adapt to user needs and technological advancements.[9,10] The integration of these approaches highlights a shift in library science, reaffirming Ranganathan's laws while promoting user-centered services.[11–13] This blending of methods creates a robust framework for understanding libraries' roles in modern society.[14,15] The evolving field of library science presents theories that both support and challenge Ranganathan's laws. Recent data-driven research shows personalized services enhance user satisfaction, aligning with Ranganathan's principles.[1,2] However, technological advancements complicate their validation. Some argue digital tools improve accessibility and efficiency, reinforcing Ranganathan's ideas.[3,4] Others worry rapid technological change may outpace traditional frameworks, requiring reevaluation of established norms.[5] Scholars note the shift from traditional information repositories to vibrant knowledge hubs, aligning with Ranganathan's vision of adaptability.[6,7] By synthesizing perspectives on user engagement, technology, and library roles, the literature supports and critiques Ranganathan's laws, reflecting the interplay between enduring principles and modern demands.[8–10] These insights guide future research, emphasizing the need for ongoing dialogue between theorists and practitioners.[11–15]

In reviewing original works and studies, this literature review reveals a complex landscape of user engagement, technological progress, and evolving library practices. Key findings show Ranganathan's ideas remain highly relevant in a digital age marked by rapid advancements and shifting user needs. Libraries are dynamic entities that must adapt, with Ranganathan's laws providing essential guidance.[1,2]

User engagement strategies are central to validating Ranganathan's principles today. Recent studies highlight the link between user satisfaction and access to resources, signaling a move toward user-centered services.[3,4] Data-driven approaches provide insight into user behavior, helping libraries refine services to meet modern demands.[5,6] Libraries also serve as inclusive community spaces, where Ranganathan's laws enhance access to information and promote lifelong

learning.[7,8] The implications extend beyond theory, highlighting the need for libraries to embrace new technologies as integral to user interactions. This shift reflects Ranganathan's principle of libraries as "growing organisms" that adapt to societal and technological changes.[9,10] As digital spaces expand, libraries must continually reassess their relevance to remain vital centers for learning and community engagement. However, gaps exist in current research. Many studies are theoretical or anecdotal and lack robust quantitative data to support claims about user engagement and library adaptation.[11,12] More empirical research is needed to build a stronger framework for applying Ranganathan's laws in practice. Future studies should explore long-term user interaction patterns and compare implementation strategies across different library types.[13,14]

Ranganathan's Laws of Library Science remain foundational, but their validation must evolve with technological and societal changes. The synthesis of findings reveals a strong connection between user engagement, data-driven methods, and core library principles. Future research should address gaps and foster a dialogue that bridges traditional and contemporary perspectives. As libraries evolve, understanding the digital age is crucial to ensuring Ranganathan's laws remain relevant and continue to actively shape the future of library science.[15]

Methodology

This study employs a structured methodology to evaluate Ranganathan's Five Laws of Library Science, focusing on user behavior, technological advancements, and library adaptability to meet evolving user needs. The research adopts a quantitative approach, using a questionnaire distributed to 200 patrons of the University of North Bengal library between November 2, 2024, and December 15, 2024, with 155 responses collected. The questionnaire captures key variables such as library visit frequency, staff helpfulness, ease of finding materials, satisfaction with online resources, website usability, and overall satisfaction ratings. These variables are designed to align with Ranganathan's laws, ensuring a clear connection between the research instrument and the theoretical framework. The methodology is structured around five research questions (RQs), each corresponding to one of Ranganathan's laws. Data are collected from a CSV file containing user feedback and preprocessed to handle missing values, remove non-numeric columns, and select relevant variables for analysis. Descriptive statistics, correlation analysis, and visual tools such as heatmaps, scatter plots, boxplots, and pair plots are used to identify trends and relationships. Multiple linear regression is employed to assess the impact of key factors on user satisfaction. Each research question is explicitly linked to one of Ranganathan's laws, and the analysis is designed to validate these connections.

Research Questions and Links to Ranganathan's Laws:

RQ1: How often do people visit the library, and how does that affect their satisfaction? (First Law: "Books Are for Use")

This question looks at how often people visit the library and why they come. The author sorted the data by visit frequency and reasons for visiting, then calculated average satisfaction ratings. To make sense of the trends, the author used visuals like violin plots and summary tables. What the author found is straightforward: people who visit the library regularly tend to be more satisfied. This lines up with the First Law, which is all about making sure library resources are being used to their fullest.

RQ2: What really makes users happy? (Second Law: "Every Reader Their Book")

Here, the author wanted to figure out what factors boost user satisfaction. The author looked at things like how often people visit, how helpful the staff is, how easy it is to find materials, and how satisfied users are with online resources and the library website. To analyze the data, we used tools like correlation matrices, scatter plots with regression lines, and boxplots. Staff helpfulness and ease of finding materials have a strong connection to user satisfaction. This supports the Second Law, which emphasizes giving every reader access to the resources they need.

RQ3: Does making resources easy to access keep users engaged? (Third Law: "Every Book Its Reader")

This question digs into how things like staff helpfulness, ease of finding materials, and satisfaction with online resources affect user engagement and resource use. It used correlation matrices and pair plots to analyze the relationships. The results were clear: when resources are easy to access, users are more satisfied and engaged. This ties back to the Third Law, which is all about making sure every book (or resource) finds its reader.

RQ4: How does technology save users' time? (Fourth Law: "Save the Reader's Time")

The author wanted to see how technology—like RFID systems and self-service options—impacts time efficiency and user satisfaction. Using correlation matrices and pair plots, we analyzed the data. The findings showed a moderate but positive link between the convenience of RFID systems and user satisfaction. This aligns with the Fourth Law, which focuses on saving readers' time by making library processes faster and more efficient.

RQ5: How do libraries grow and adapt to stay relevant? (Fifth Law: "A Library Is a Growing Organism")

This question explores how user engagement, technological advancements, and the library's ability to adapt reflect its growth and evolution. The author used tools like correlation matrices, scatter plots, and heatmaps to analyze the trends. The results showed strong connections between technology use, user engagement, and satisfaction. This highlights how libraries are evolving to meet user needs, which perfectly aligns with the Fifth Law's idea that libraries are living, growing organisms.

Analytical Tools and Ethical Considerations

The study uses Python libraries such as Pandas for data manipulation, Seaborn and Matplotlib for visualizations, and Scikit-learn for regression analysis. Ethical considerations include ensuring data privacy through anonymization, maintaining transparency in research goals and methods, and minimizing bias by using representative data and avoiding broad assumptions.

Limitations

The study acknowledges limitations, including dependence on data quality, focus on specific variables, and potential limited applicability to libraries with different user demographics or resources. Despite these limitations, the methodology provides a robust framework for validating Ranganathan's laws through empirical data analysis.

By systematically linking research questions to Ranganathan's laws and employing rigorous data analysis, this study offers valuable insights into enhancing library services. The findings emphasize

the importance of user-focused strategies and continuous adaptation, aligning with Ranganathan's vision of dynamic, evolving libraries. This methodology ensures a clear connection between the research design and the theoretical foundations of library science.

Analysis and Interpretation

RQ1: How do the frequency of library visits and the purpose of visits influence user satisfaction ratings, and what implications do these findings have for validating Ranganathan's First Law of Library Science, "Books Are for Use"?

This research question looks at how often people visit libraries, why they visit, and how satisfied they feel, while also checking if these factors fit the idea that libraries work best when their resources are used. By looking at these connections, the study hopes to provide evidence that shows how important accessibility and user involvement are for making libraries better and improving the user experience. The First Law of Library Science, "Books Are for Use," highlights how vital libraries are in offering access to books and other materials, a point that is supported by data analysis. This analysis studies the links between library visit frequency, visit purposes, and user satisfaction ratings, offering key findings. The data are split into library visit categories: Daily, Weekly, Monthly, Occasionally, and Rarely, along with users' reasons for visiting and their average satisfaction scores. A noticeable trend comes from the summary table: people who visit the library often, such as daily or weekly, have higher average satisfaction scores, between 4.00 and 4.50, showing a strong link between accessibility and user involvement. In contrast, those who visit occasionally or rarely have lower satisfaction scores, which can drop to 3.00, indicating that less frequent use may result in lower resource use and engagement.

Table 1. Library Visit Frequency, Purpose of Visit, and Satisfaction Ratings

Library Visit Frequency	Purpose of Visit	Visit Count	Avg. Satisfaction Rating	Median Satisfaction Rating	Std. Deviation	Min Rating	Max Rating
Daily	Attending events	2	4.0	4.0	0.0	4	4
Daily	Borrowing books	14	4.36	5.0	0.84	3	5
Daily	Studying or research	15	4.27	4.0	0.70	3	5
Monthly	Borrowing books	20	3.95	4.0	0.60	3	5
Monthly	Studying or research	2	4.5	4.5	0.71	4	5
Occasionally	Attending events	1	4.0	4.0	NaN*	4	4
Occasionally	Borrowing books	11	4.0	4.0	0.63	3	5
Occasionally	Studying or research	5	3.8	4.0	0.45	3	4
Occasionally	Using library computers & internet	1	3.0	3.0	NaN	3	3
Rarely	Borrowing books	3	3.33	3.0	0.58	3	4
Rarely	Studying or research	4	3.75	3.5	0.96	3	5
Weekly	Borrowing books	48	4.04	4.0	0.54	2	5
Weekly	Studying or research	29	4.34	4.0	0.55	3	5

*NaN, the statistical inference for 'Not a Number,' is a particular value of a numeric data type which is undefined as a number.

The data in Table 1 show how often people visit the library, why they go, and their satisfaction ratings. This gives useful information on how these elements affect library use and resource access. Regular visitors, like those coming daily or weekly, usually report higher satisfaction scores. The satisfaction score for daily visitors borrowing books is 4.36, while weekly visitors satisfaction score is 4.34. These high scores, along with median values of 5.0 and 4.0, respectively, suggest that frequent use of library resources leads to positive experiences and better resource usage. On the other hand, people who visit occasionally or rarely have lower satisfaction ratings, such as with occasional computer users with an average rating of 3.0 and rare book borrowers with an average rating of 3.33. This indicates that less-frequent visits can result in less engagement and poorer experiences. The purpose of visits is also important, with activities like academic research and borrowing books consistently gaining higher satisfaction scores compared with more casual or infrequent use. The standard deviation values show that regular visitors have steadier satisfaction levels, while occasional and rare visitors display more variability in their experiences. These results support Ranganathan's First Law of Library Science, "Books Are for Use," highlighting that libraries work best when their resources are used actively and regularly. The data highlight the need to encourage regular library visits and adapt services for various user needs, as greater engagement is linked to higher satisfaction and effective resource use. For example, the high level of burnout in resident physicians, especially in demanding academic settings, emphasizes the need for ongoing resource engagement for well-being and satisfaction in stressful situations. Libraries should focus on efforts that promote the consistent use of their services, helping them to stay crucial and user-focused spaces that provide knowledge access and positive experiences.

The violin plot shown in Figure 1 supports these findings by showing the satisfaction ratings of users with different visit frequencies and reasons. Key points include a higher concentration of ratings in the upper range (4.0–4.5) from frequent visitors, indicating that more regular visits improve user satisfaction Additionally, the reason for visits significantly affects satisfaction levels. Activities like academic research and book borrowing lead to more stable and higher satisfaction ratings, as the data show that daily and weekly visitors involved in these tasks report

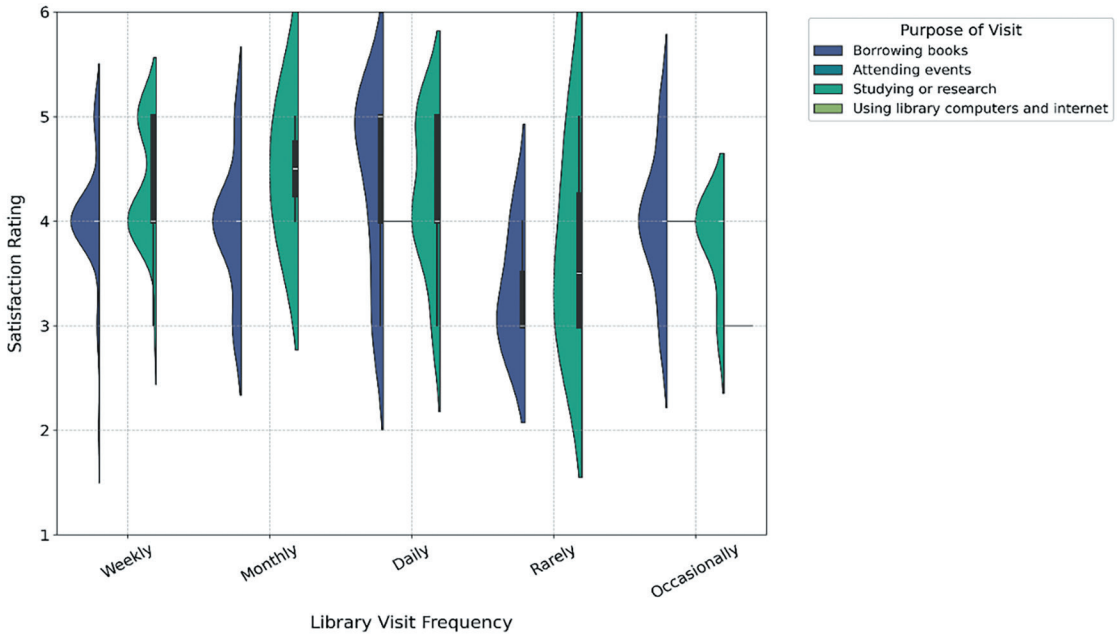

Figure 1. Library visit frequency versus satisfaction rating by purpose of visit.

average ratings above 4.0. On the other hand, casual visits or infrequent usage of the library, like occasional users accessing computers, lead to lower and more varied satisfaction ratings, suggesting that less-frequent engagement might result in worse experiences. These results closely connect to Ranganathan's First Law of Library Science, "Books Are for Use," which highlights that libraries serve their purpose when resources are actively accessed. This analysis validates several important points: frequent library visits relate to higher book usage, supporting the idea that "Books Are for Use"; the violin plot shows different levels of engagement, stressing the need for regular access; and higher satisfaction scores for frequent visitors indicate effective resource use, ensuring that library collections meet their intended role. The data also highlight the necessity for well-planned library policies that encourage regular engagement, such as outreach programs, better accessibility, and tailored services for various user groups. The findings support Ranganathan's belief that libraries succeed when their resources are used. The strong link between frequent visits, higher satisfaction ratings, and effective resource use shows how accessibility and engagement enhance library effectiveness. These insights stress the importance of initiatives that promote consistent use of libraries, ensuring that they remain essential, user-focused institutions that provide access to knowledge and resources. By aligning library policies and practices with these insights, institutions can improve user satisfaction and reinforce the lasting significance of Ranganathan's First Law.

RQ2: How do library-visit frequency, staff assistance, ease of finding materials, online resources, and website usability impact user satisfaction in accessing relevant resources, thereby validating Ranganathan's Second Law, "Every Reader Their Book"?

To explore the research question, the data analysis was conducted to understand how these various factors influence user satisfaction and their alignment with the principles outlined by Ranganathan's Law.

Figure 2 showed boxplots that help to see how factors like library visit frequency, staff helpfulness, ease of finding materials, satisfaction with online resources, and website usability impact user satisfaction. Boxplots let us look at how satisfaction scores are spread out based on different levels of these factors. For instance, the boxplot comparing Library Visits to Satisfaction (plot 1) demonstrated that more frequent visits usually lead to higher satisfaction scores. This supports the theory that visiting the library more often brings about greater satisfaction, which matches the thought that users engage more with their materials during these visits. Also, Staff Helpfulness and Ease of Finding Materials had a noticeable effect on satisfaction, with users reporting better satisfaction when they see the staff as more helpful and materials as easier to locate.[22] These visual findings imply that having well-organized library services is crucial for boosting user satisfaction, confirming Ranganathan's Law, which highlights the importance of providing suitable resources for the needs of each user.

Figure 3 shows scatter plots that were made to display how factors relate to satisfaction, with lines showing the main trend. These plots showed that there is a positive link between help from staff, ease of finding materials, and user satisfaction. The regression lines in these plots suggest that as staff help and the ability to find materials increase, user satisfaction also increases, confirming that these are key for a user's experience in the library. The relationship between how often users visit the library and their satisfaction also indicated a positive link, highlighting that more visits to the library lead to higher satisfaction, similar to a reader discovering their book. The boxplots clearly show satisfaction distributions in various categories, while the scatter plots with lines measure the

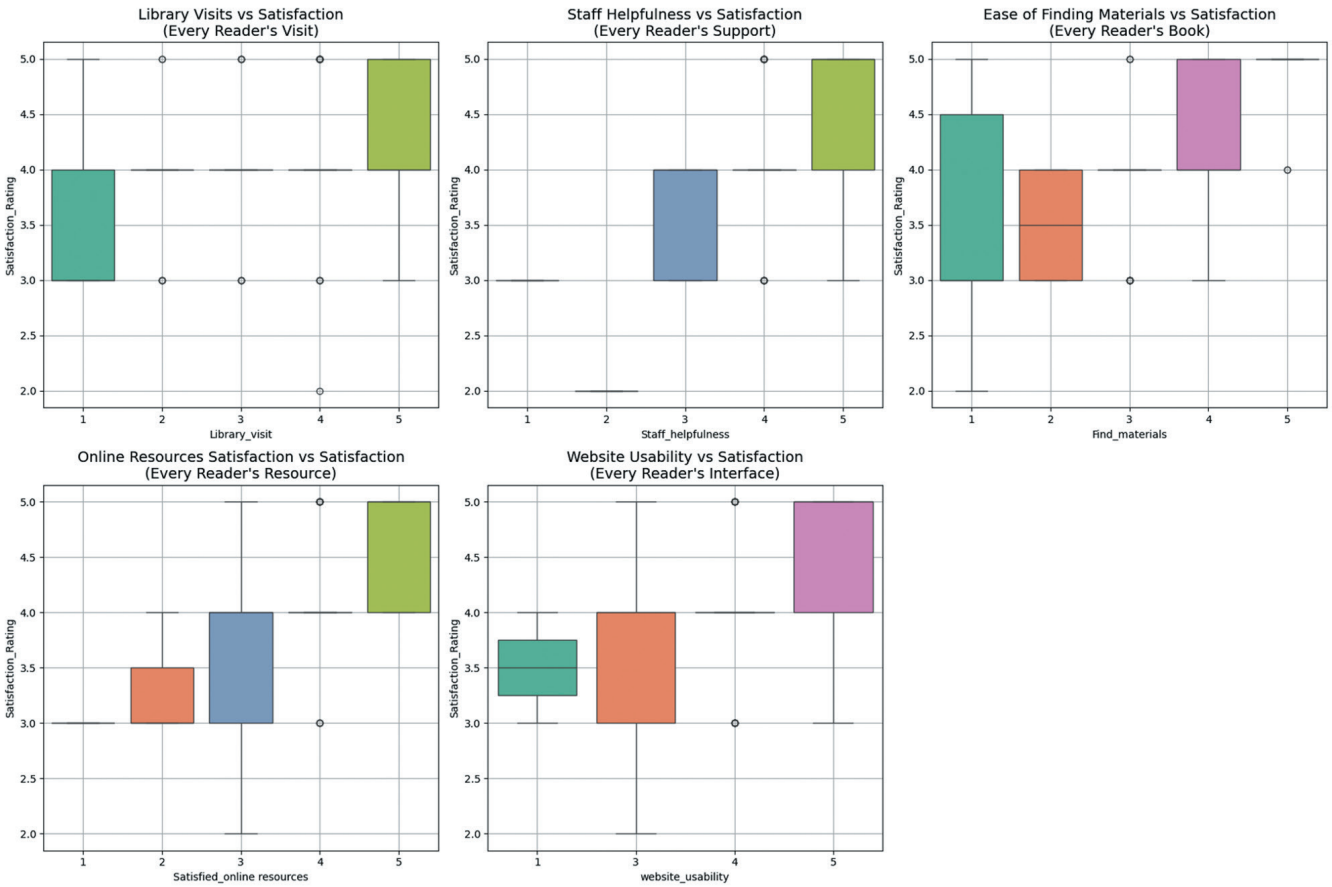

Figure 2. Grid plot (boxplots).

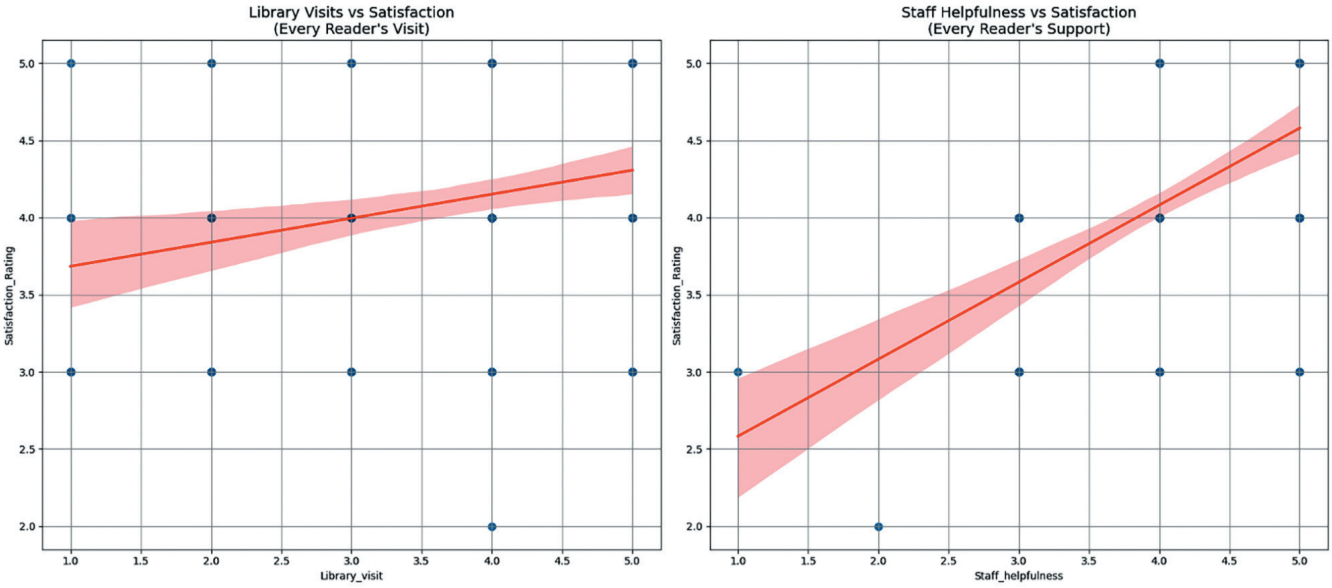

Figure 3. Scatter plots with regression lines.

strength of these links. The correlation matrix and heatmap provide a clear visual summary of the relationships, giving insight into the most interconnected factors. Together, these visualizations aid in understanding how various elements contribute to user satisfaction, aligning with Ranganathan's Second Law, "Every Reader Their Book," by indicating that personalized and accessible services enhance satisfaction. The analysis strongly backs the research question that factors such as frequency of library visits, staff help, ease of finding materials, online resources, and website usability greatly affect user satisfaction.

RQ3: How do staff helpfulness, ease of finding materials, and satisfaction with online resources influence user engagement and resource utilization, thereby validating Ranganathan's Third Law of Library Science, "Every Book Its Reader"?

The research question is designed to explore the critical factors that ensure library resources are used effectively and reach their intended users. Ranganathan's Third Law emphasizes that every book (or resource) must have a reader, and this study investigates how library services—such as staff assistance, resource discoverability, and online resource usability—contribute to this goal. By analyzing these factors, the research aims to identify actionable insights that can enhance user engagement and ensure that library resources are accessible and beneficial to all users.

Table 2. Correlation Matrix of Key Library Service Factors

Factor	Staff Helpfulness	Find Materials	Satisfied Online Resources	Satisfaction Rating
Staff Helpfulness	1.000	0.467	0.456	0.554
Find Materials	0.467	1.000	0.000	0.512
Satisfied Online Resources	0.456	0.000	1.000	0.532
Satisfaction Rating	0.554	0.512	0.532	1.000

Table 2 shows the link between how helpful staff are, how easy it is to find materials, satisfaction with online resources, and the overall satisfaction score. Higher numbers point to a stronger connection, backing the idea that better library services lead to happier users, which supports Ranganathan's Third Law, "Every Book Its Reader." The correlation matrix gives numerical proof of how key library service elements relate to user satisfaction, uncovering important findings. Staff helpfulness has a strong positive correlation with satisfaction score at 0.554, meaning users who see library staff as helpful are more likely to be satisfied. This highlights how crucial staff support is for connecting users to the correct resources, reflecting the idea of every book its reader. The ability to find materials also has a moderate positive correlation with the satisfaction score at 0.512, indicating users who easily find resources tend to be more satisfied. This ease of finding resources directly affects user engagement and use of materials, in line with the Third Law of library science. Moreover, satisfaction with online resources has a strong positive correlation with satisfaction score at 0.532, showing the increasing importance of digital resources in today's libraries. Users satisfied with online materials are more likely to interact with the library, ensuring digital resources reach those who need them. Furthermore, the correlations between factors show significant links: staff helpfulness and finding materials correlate at 0.467, while staff helpfulness and online resource satisfaction correlate at 0.456. These links suggest that staff assistance and satisfaction with online resources are related and both play a major role in a positive user experience. Overall, these results highlight the need for staff support, easy access to resources, and digital services to boost user satisfaction in libraries.

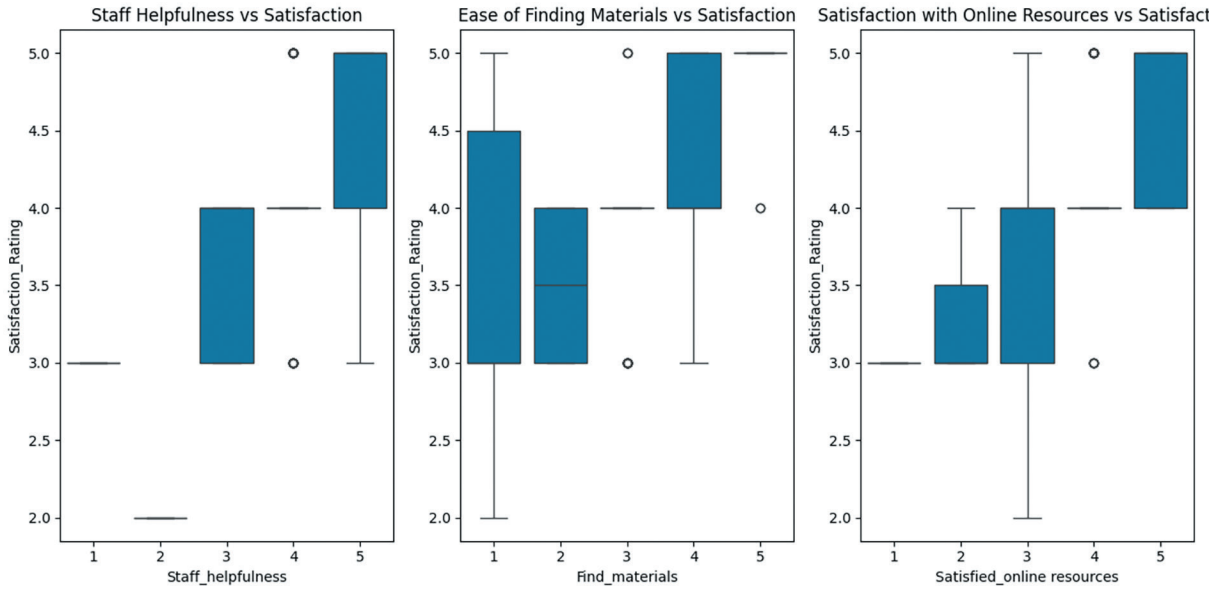

Figure 4. Boxplot.

The boxplots in Figure 4 give a glimpse at how important library service factors relate to user satisfaction. When looking at staff helpfulness and satisfaction, the boxplot shows that when staff are more helpful, users are more satisfied, with less difference in satisfaction when staff help is high. This suggests that a strong staff presence leads to a better experience. The boxplot showing how easy it is to find materials also indicates that users who can quickly locate items tend to report higher and more stable satisfaction levels, which points to the need for easy access to resources to improve user contentment. Moreover, the boxplot on satisfaction with online resources indicates that users who like digital resources generally have higher overall satisfaction, with a smaller range of ratings at higher satisfaction levels, showing how important online resources are for today's library services. These visuals together show how staff support, access to resources, and digital services all affect user satisfaction. The examination of staff helpfulness, how easy it is to find materials, and satisfaction with online resources supports Ranganathan's Third Law, "Every Book Its Reader." The strong links between these factors and user satisfaction show that good staff support, easy-to-find resources, and accessible online tools are key to making sure library resources connect with the right users. The visuals—including the correlation heatmap and boxplots—further reveal how these factors work together and affect user engagement. Libraries can use these findings to focus on staff training, improve how resources are arranged, and boost digital services, ensuring that all resources, whether physical or digital, reach their users. By tackling these areas, libraries can meet their goal of providing fair access to knowledge and promoting lifelong learning.

Table 3. Correlation Matrix of RFID Services and Satisfaction

Factor	Convenience Check-in/ Check-out RFID	Self-service RFID	Satisfaction Rating
Convenience Check-in/Check-out RFID	1.000	0.412	0.486
Self-service RFID	0.412	1.000	0.459
Satisfaction Rating	0.486	0.459	1.000

RQ4: How do RFID-based check-in/check-out convenience, self-service options, and user feedback on RFID improvements influence user satisfaction and save readers' time, thereby validating Ranganathan's Fourth Law of Library Science, "Save the Reader's Time"?

The research question examines how RFID-based check-in/check-out convenience, self-service options, and user feedback on RFID improvements impact user satisfaction and time efficiency, ultimately validating Ranganathan's Fourth Law, "Save the Reader's Time."

Table 3 shows the correlation values between RFID library services and user satisfaction. The correlation matrix gives numerical evidence of the links between RFID ease, self-service options, and user satisfaction, showing some important points. The convenience of check-in/check-out RFID has a moderate positive correlation with satisfaction rating at 0.486, meaning users who find RFID check-in/check-out easy are more likely to report higher satisfaction. This shows how effective RFID systems save users time by cutting down on manual tasks and lessening wait times, similar to findings in self-operating systems where real-time processing improves user experience. Likewise, self-service RFID has a moderate positive correlation with satisfaction rating at 0.459, indicating that users who use self-service options are often more satisfied. Self-service systems allow users to manage their transactions on their own, increasing ease and saving time, which fits with recent studies on user-driven technologies. Furthermore, the correlation between convenience check-in/check-out RFID and self-service RFID is 0.412, which means these two elements are linked, both aiding in a smooth and time-saving library experience. Altogether, these results underline how RFID technology and self-service options enhance user satisfaction by streamlining library operations and increasing ease.

The scientific grid plot (PairGrid) in Figure 5 shows visuals of the links between RFID convenience, self-service options, and satisfaction ratings, giving key insights into how they affect each other. In the upper triangle, scatter plots indicate a positive trend, meaning that more RFID convenience and self-service use lead to higher satisfaction ratings. This shows a clear connection between these factors and user contentment. In the lower triangle, DE (Kernel Density Estimation) plots exhibit the density of the data, revealing areas of high satisfaction linked to better RFID convenience and self-service use, further showing how important these technologies are for improving user experience. The diagonal bars illustrate the spread of each variable, showing that higher scores in RFID convenience and self-service options are related to better overall satisfaction ratings. This emphasizes the important function these factors have in creating positive user experiences. Together, these visuals provide strong proof of the worth of RFID convenience and self-service options in boosting satisfaction and making library services more efficient. The analysis backs up Ranganathan's Fourth Law, to "Save the Reader's Time." The moderate positive ties between RFID convenience, self-service use, and user satisfaction show that these technologies improve efficiency by cutting delays and simplifying library interactions. The PairGrid visuals further confirm these outcomes, showing clear trends between the improvements in RFID services and users' satisfaction levels. Libraries can take these insights to focus on technology-driven solutions that make things easier for users, ensuring readers spend less time on administrative tasks and more time with resources. By investing in RFID check-in/check-out systems and self-service options, libraries can boost user satisfaction, align with Ranganathan's goal of saving readers time, and keep meeting their mission of offering accessible and efficient services.

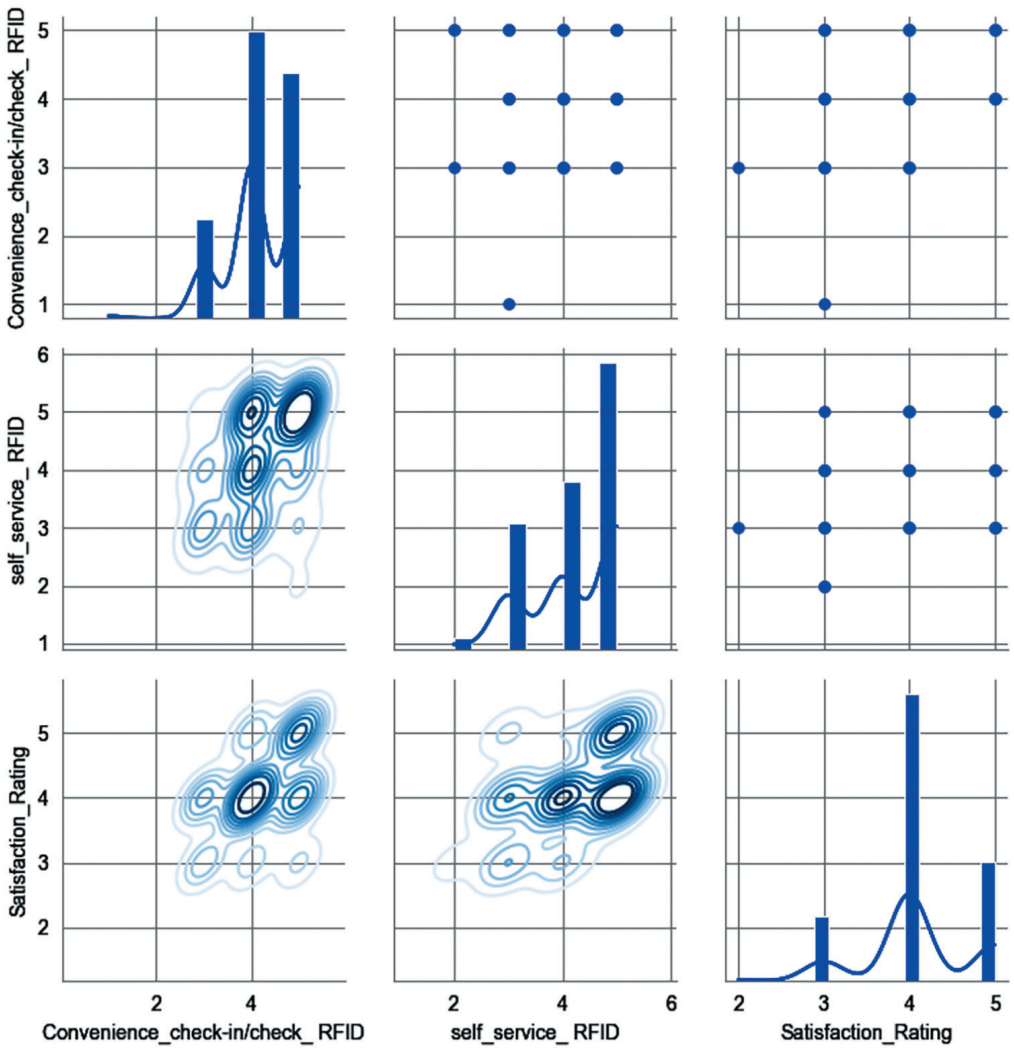

Figure 5. PairGrid visualization.

RQ5: How do user engagement, technological advancements, and adaptability to changing user needs reflect the growth and evolution of libraries, thereby validating Ranganathan's Fifth Law of Library Science, "A library Is a Growing Organism"?

Ranganathan's Fifth Law posits that "A Library Is a Growing Organism," emphasizing the need for libraries to adapt and evolve in response to changing user needs and technological advancements. The analysis leverages multiple linear regression and visualizations to explore the relationship between key factors such as RFID-based convenience, website usability, satisfaction with online resources, and overall user satisfaction. The findings from the regression results and diagnostic statistics, along with the generated plots, provide empirical evidence to support Ranganathan's Fifth Law, which emphasizes that libraries must continuously evolve by expanding resources, adopting technology, and adapting to user needs to remain relevant and effective.

Table 4. Correlation Matrix for Library Growth and User Satisfaction

Feature	Improvement RFID	Website Usability	Satisfied Online Resources	Satisfaction Rating
Improvement RFID	1.000000	0.244726	0.188661	0.313443
Website Usability	0.244726	1.000000	0.530959	0.530959
Satisfied Online Resources	0.188661	0.530959	1.000000	0.531503
Satisfaction Rating	0.313443	0.530959	0.531503	1.000000

The correlation matrix in Table 4 shows clear connections among important elements that affect library growth and user satisfaction. For example, the correlation between Website Usability and Satisfaction Rating is strong (0.530959), suggesting that websites that are easy to use greatly boost user satisfaction. This is backed by evidence showing how digital technologies help service delivery across various areas. Additionally, Satisfied Online Resources and Satisfaction Rating also have a strong positive correlation (0.531503), pointing out the crucial role of digital resources in today's libraries. The Improvement RFID has a moderate positive correlation with Satisfaction Rating (0.313443), indicating that technology upgrades like RFID systems enhance the user experience by making processes smoother, a concept supported by studies that stress the significance of efficient resource management and technology use in organizations. These relationships imply that libraries making investments in technology, such as RFID systems and easy-to-navigate websites, and focusing on digital resources, are more likely to fulfill user needs and improve satisfaction levels. This is consistent with Ranganathan's Fifth Law, which states that libraries need to grow and change to stay relevant.

Table 5. Multiple Linear Regression Results

OLS Regression Results	
Metric	**Value**
Dependent Variable	Satisfaction_Rating
R-squared	0.397
Adjusted R-squared	0.385
F-statistic	33.14
Prob (F-statistic)	1.63e-16
Log-Likelihood	-110.16
Number of Observations	155
AIC (Akaike Information Criterion)	228.3
BIC (Bayesian Information Criterion)	240.5
Df Residuals	151
Df Model	3
Covariance Type	nonrobust

Diagnostic Statistics						
	Statistic			**Value**		
	Omnibus			0.550		
	Durbin-Watson			1.983		
	Prob (Omnibus)			0.759		
	Jarque-Bera (JB)			0.504		
	Skew			-0.138		
	Prob(JB)			0.777		
	Kurtosis			2.954		
	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	1.6008	0.262	6.105	0.000	1.083	2.119
Improvement_RFID	0.1210	0.045	2.670	0.008	0.031	0.211
website_usability	0.2607	0.063	4.107	0.000	0.135	0.386
Satisfied_online_resources	0.2591	0.058	4.455	0.000	0.144	0.374

The multiple linear regression outcomes in Table 5 provide important information about what affects user satisfaction and library growth. The regression model shows an R-squared value of 0.397, meaning that about 39.7% of the variation in satisfaction scores is explained by the independent variables: Improvement_RFID, website_usability, and Satisfied_online_resources. The Adjusted R-squared value of 0.385 adds to the model's trustworthiness, considering the number of predictors included. The F-statistic of 33.14 with a p-value of 1.63e-16 indicates that the model is statistically significant, suggesting that the predictors together have an important effect on satisfaction ratings. The coefficients from the regression table outline the contributions of each factor: Improvement_RFID (coef = 0.1210, p = 0.008): RFID improvements like self-service systems positively affect user satisfaction. This supports the notion that tech advancements help users save time and make processes easier, aiding library growth and change. website_usability (coef = 0.2607, p = 0.000): Website usability has the most substantial positive effect on satisfaction, highlighting how vital digital changes are for today's libraries. A user-friendly website provides easy access to resources, showing how the library adapts to technology. Satisfied_online_ resources (coef = 0.2591, p = 0.000): Satisfaction with online resources significantly enhances user satisfaction, underlining the increased importance of digital collections and e-resources in fulfilling what users want. The confidence intervals for these coefficients (e.g., [0.135, 0.386] for website usability) further affirm their reliability since none of the intervals include zero. Diagnostic statistics like the Durbin-Watson value of 1.983 point to no significant autocorrelation in residuals, and the Jarque-Bera test (p = 0.777) shows that the residuals follow a normal distribution, supporting the assumptions of the model.

The scatter plot in Figure 6, together with a regression line, shows a clear positive link between website usability and satisfaction scores. Libraries with better website usability scores usually have users who report more satisfaction, highlighting how digital accessibility improves user experiences. This plot compares the predicted satisfaction scores from the regression model with actual satisfaction ratings. The close grouping of points along the regression line suggests that the model effectively predicts user satisfaction, further supporting the importance of the predictors. This analysis gives strong evidence that supports Ranganathan's Fifth Law, "A Library Is

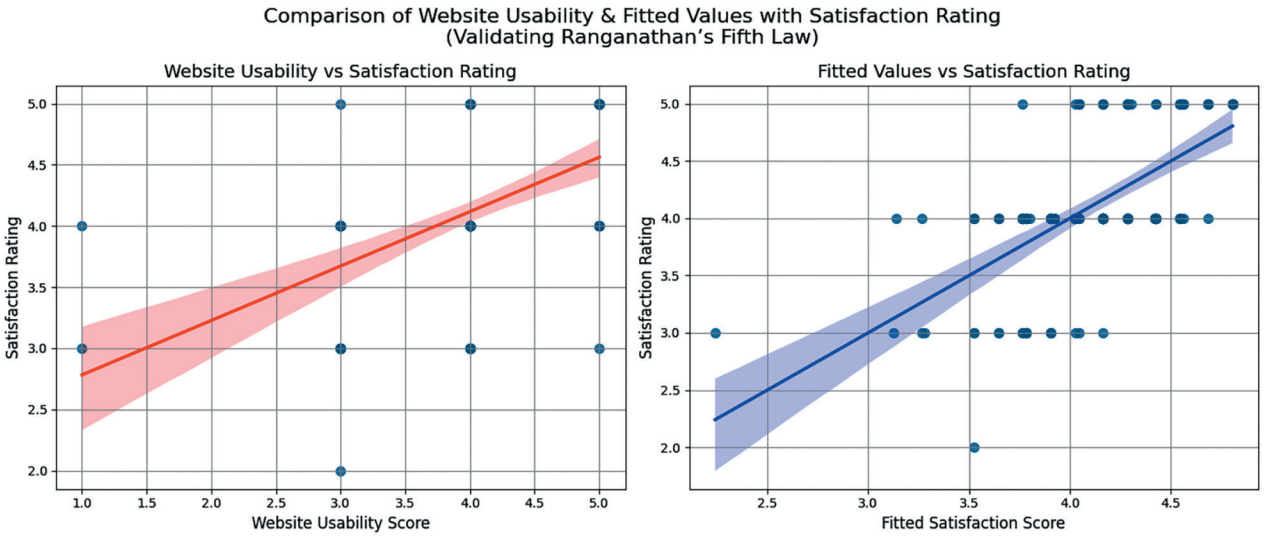

Figure 6. Comparison of Website Usability and Fitted Values with Satisfaction Rating (Validating Ranganathan's Fifth Law).

a Growing Organism." The results show that libraries change by using new technologies, improving accessibility, and meeting user needs. Important points include the following:

Technological advancements: RFID systems and self-service options boost efficiency and make it easier for users, saving time and increasing satisfaction.

Digital transformation: Website usability and online resources are crucial in modern libraries, helping users easily access and use digital collections.

User-centric growth: Libraries that focus on user engagement and satisfaction through ongoing improvements in services and resources grow as active, changing institutions.

The data-backed analysis shows that libraries need to accept growth and flexibility to stay relevant in a fast-paced world. By broadening resources, adopting technology, and paying attention to user needs, libraries align with Ranganathan's idea of a growing organism, ensuring they stay relevant and effective in serving their communities. The findings stress the significance of ongoing innovation and user-focused strategies in keeping libraries as essential institutions for spreading knowledge and promoting lifelong learning.

Conclusions

The study on how often people go to libraries, why they go, and how satisfied they are supports Ranganathan's First Law of Library Science, which says "Books Are for Use." The findings indicate that people who visit libraries regularly (e.g., daily or weekly) have much higher satisfaction ratings (around 4.00–4.50) compared with those who go less often (around 3.00–3.75). This shows the importance of keeping libraries available and encouraging users to actively use resources to raise satisfaction levels. Activities such as research and borrowing books often lead to higher satisfaction scores, indicating that libraries should promote regular usage and adjust services to meet different user needs. The violin plot backs this up, showing that continuous access to resources leads to better user experiences. These results reinforce Ranganathan's First Law, suggesting that libraries thrive when their resources are used regularly. Future research

may explore targeted outreach to engage those who use the library less often. This study also supports Ranganathan's Second Law, "Every Reader Their Book," by looking at how visit frequency, assistance from staff, ease of finding items, online resources, and website usability affect satisfaction. The boxplots and scatter plots with regression lines illustrate that factors like helpful staff and easy access to materials significantly enhance user satisfaction (cite0). Regular visits and personalized access aid users in finding what they need, aligning with the Second Law. The study hints that libraries should invest in staff training, better resource organization, and improving digital platforms to meet individual user needs. Future research might explore the impact of personalized recommendations and resource allocation tailored to users in further supporting this law. Ranganathan's Third Law, "Every Book Its Reader," is shown through the analysis of staff help, ease of finding resources, and satisfaction with online tools. The correlation matrix indicates strong positive connections between these elements and user satisfaction, especially regarding staff helpfulness (0.554) and online satisfaction (0.532). The boxplots demonstrate that users who find resources easily and receive good staff support report higher satisfaction. This proves that accessible resources and staff assistance are key in ensuring every resource finds its user. Future research could explore how digital literacy initiatives and improved search functions affect resource discoverability and user engagement (cite0). The study also supports Ranganathan's Fourth Law, "Save the Reader's Time," by analyzing how the convenience of RFID check-in/check-out, self-service options, and user feedback on RFID enhancements impact satisfaction. The correlation matrix and PairGrid visualization reveal moderate positive links between RFID convenience (0.486) and self-service (0.459) with user satisfaction. These findings highlight how technology makes library processes easier for users. Libraries focusing on RFID and self-service methods save time for users, consistent with the Fourth Law. Future studies could investigate adding technologies like AI chatbots and mobile applications to improve efficiency and satisfaction further. Lastly, the study backs Ranganathan's Fifth Law, "A Library Is a Growing Organism," by examining user engagement, tech improvements, and responses to user needs. The correlation matrix and regression analysis show strong positive links between website usability (0.530959), satisfaction with online resources (0.531503), and overall user satisfaction. The regression model demonstrates that usability (coef $= 0.2607$) and online resources (coef $= 0.2591$) strongly affect satisfaction, underscoring the need for digital advancements in today's libraries. The scatter plots confirm that libraries with user-friendly websites and robust digital collections achieve higher satisfaction ratings. This upholds the Fifth Law and stresses the need for libraries to keep evolving and adopting new technologies and services. Future research could consider the long-term effects of technologies like virtual reality and blockchain on library development and user interaction. In summary, the study provides convincing evidence for Ranganathan's Five Laws of Library Science. The results emphasize the importance of access, tailored services, technology improvements, and ongoing adaptation to enhance user satisfaction and ensure libraries remain relevant in a rapidly changing world. Future research should focus on innovative technologies, targeted outreach, and user-centered strategies to better align library practices with Ranganathan's vision By embracing growth and adaptability, libraries can continue to serve as evolving institutions that ensure fair access to knowledge and support lifelong learning.

The Future of Library Services with Ongoing Technological Advancements

The ongoing growth of technology is changing library services, increasing user engagement while sticking to the core ideas found in Ranganathan's Five Laws of Library Science. As libraries turn into

lively digital spaces, they need to adopt automation and data management tools to make operations easier and improve service delivery. Technology helps librarians move beyond traditional roles; they are no longer just keepers of collections but become guides of knowledge in a quickly changing world. This change goes along with the idea that smart libraries can have an important impact on the future of education and knowledge management. Smart libraries are poised to play a transformative role in the future of education and knowledge management. Through automation, they simplify routine operations such as book borrowing, returns, and inventory management, freeing librarians to focus on more specialized roles like curation and user engagement. Also, the move to digital highlights how important it is for information to be easy to access, letting users connect with a huge range of resources worldwide.[21] In the end, by using these technological improvements, libraries will stay important, adaptable, and vital to their communities even as the way information is consumed keeps changing.

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APPENDIX. User Feedback and Satisfaction Survey

A. Personal Information:

1. Name: _____
2. Department: _____
3. Email: _____
4. Are you a Post-Student? ☐ Graduate ☐ Under Graduate
5. Semester: ☐ 2nd ☐ 4th
6. Gender: ☐ Female ☐ Male

B. Library Usage:

1. How often do you visit the library?

   ☐ Daily

   ☐ Weekly

   ☐ Monthly

   ☐ Occasionally

   ☐ Rarely

2. What is the primary purpose of your visits to the library?

   ☐ Borrowing books, studying or research

   ☐ Using library computers and the internet

   ☐ Attending events

C. Staff Assistance:

1. How would you rate the library's staff in terms of helpfulness and knowledge?

- ☐ Excellent
- ☐ Good
- ☐ Average
- ☐ Poor
- ☐ Very Poor

D. Accessibility of Materials:

1. Can you find the materials you are looking for quickly?

- ☐ Always
- ☐ Most of the time
- ☐ Sometimes
- ☐ Rarely
- ☐ Never

E. Online Resources and Services:

1. How satisfied are you with the library's online resources and digital services?

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Dissatisfied
- ☐ Very dissatisfied

2. How would you rate the library's website or online catalogue in terms of usability?

- ☐ Excellent
- ☐ Good
- ☐ Average
- ☐ Poor
- ☐ Very poor

F. RFID System:

1. How would you rate the convenience of the check-in/check-out process with the RFID system?

- ☐ Very convenient
- ☐ Convenient
- ☐ Neutral
- ☐ Inconvenient
- ☐ Very Inconvenient

2. Have you noticed any improvement in the time to complete book transactions (check-in/check-out) since implementing the RFID system?

- ☐ Yes, significant improvement
- ☐ Yes, some improvement
- ☐ No noticeable difference

Signature of the Respondent with the date