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Editor

Dr. Daniel Gordy

Journal Profile

The *Journal of Research in Business Information Systems* (JRBIS) is a national blind-reviewed, refereed publication published annually by the Association of Business Information Systems. This refereed journal includes articles from fields associated with business information systems focusing on theory, problems associated with information systems and information resources in education, business and industry, government, and the professions.

Manuscripts are selected using a blind review process. The first issue of the Journal was available Spring 2008. The Journal is listed in the ERIC Database and Cabell's Directory of Publishing Opportunities in Accounting, Computer Information Systems, Education, Instructional Technology, and Management.

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The readership is comprised of college and university faculty, administrators, staff, practitioners, and students engaged in business information systems or preparing for careers in fields related to information resources. The journal is distributed electronically annually to all Association of Business Information Systems members as part of conference registration or membership. The journal is also available online at http://www.abis-fbd.org.

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Call for Manuscripts
Deadline: July 31, 2025

We invite you to submit manuscripts for publication consideration in the 2025 issue of the *Journal of Research in Business Information Systems (JRBIS)*, a national blind-reviewed, refereed journal published annually by the Association of Business Information Systems (ABIS). According to the Constitution and Bylaws of ABIS, the published articles of *JRBIS* are limited to the papers presented at the previous ABIS Annual Conference or published in the *ABIS Proceedings*.

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Submissions of manuscripts relating to topics, along with research findings, theoretical and practical applications, discussions of issues and methods for teaching and assessing instructional technology, and reviews of textbooks are encouraged. Manuscripts will be selected using a blind review process. Manuscripts should not have been published or be under current consideration for publication by another journal.

Submission and Formatting Guidelines

Submit abstracts electronically in Microsoft Word format. Manuscripts, citations, and references must use the **APA 7th edition** style format.

Submissions should include a <u>separate file attachment</u> for the title page that contains the following information in this exact order:

- Title of the manuscript
- Each author's full name; position/title; institutional affiliation, including address, city, state, zip code; home, office, and cell phone numbers; and e-mail addresses (identify the main author who should receive all correspondence).
- Number of words in the article (including all parts–everything)
- Biographical paragraph (50-60 words) for each author
- Any acknowledgments or information about manuscript history (e.g., based on a conference presentation)

The second <u>separate file attachment</u> should be the manuscript file that begins with the title of the article, a 50-100 word abstract, 3-5 keywords or phrases describing the focus of the article, and the body of the manuscript. **Do not include any personal or institutional affiliation information in this file.**

The manuscript body must adhere to the following guidelines:

- 10-25 double-spaced pages (3,000-6,000 words)
- 1" margins all around
- Times New Roman, 12 pt. font-size text within the article
- Bold and center primary headings, with major words capitalized
- Bold and left-align secondary headings, with major words capitalized
- No footnotes or endnotes
- No page numbers or headers or footers

Tables and figures may have varying font sizes (but must adhere to APA Style). Include tables or figures formatted and placed correctly within the manuscript.

Include the References page at the end of the manuscript, followed by appendix information, if necessary.

All submissions will be reviewed by the editor and at least two reviewers, using a blind review process. Authors will receive feedback 6-8 weeks after the initial peer review. Manuscripts will be "accepted," "accepted with minor revisions," "possibly accepted after major revision and resubmission for further peer review," or "rejected."

The editor reserves the right to edit selected/accepted manuscripts for publication as deemed appropriate and necessary to optimize journal publication and format. The manuscript's author retains responsibility for the accuracy of a manuscript published in the *Journal of Research in Business Information Systems*.

To ensure your manuscript is considered for publication in the *2025 Journal of Research in Business Information Systems*, submit the manuscript by July 31, 2025, to the JRBIS journal editor.

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Technology Scouting and the Role of Social Media: Leveraging Online Platforms for Innovation and Market Insights

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Abstract

This paper explores how social media platforms serve as crucial tools for technology scouting, enabling organizations to identify emerging innovations and market trends. Technology scouting, a strategic process of discovering and assessing new technologies, has been significantly enhanced by social media's vast data resources and real-time interactions. Platforms such as Twitter, LinkedIn, and Reddit facilitate trend monitoring, professional insights, and grassroots discussions, offering companies valuable intelligence on technological advancements.

The study highlights successful case studies where organizations have leveraged social media for technology scouting. Examples include IBM Watson Health's use of Twitter to track AI applications in healthcare, Ford's reliance on LinkedIn to assess electric vehicle trends, and Amazon's analysis of Reddit discussions to refine its drone delivery strategy. These cases demonstrate the tangible benefits of integrating social media insights into innovation and investment decisions.

Furthermore, the paper discusses strategies for effective technology communication and dissemination through social media. Key tactics include using clear and engaging content, leveraging influencer marketing, and fostering online communities for collaborative knowledge-sharing. Social media influencers play an increasing role in shaping technological adoption, driving engagement, and enhancing brand credibility.

Challenges such as information overload, ensuring data credibility, and navigating privacy concerns are also addressed. The paper suggests that organizations employ advanced analytics, AI-driven monitoring tools, and ethical frameworks to mitigate these risks while maximizing social media's potential.

In conclusion, social media has transformed technology scouting, making it a dynamic and essential tool for staying competitive in a rapidly evolving digital landscape. Organizations that effectively harness social media insights can accelerate innovation, improve strategic decision-making, and strengthen market positioning.

I. Introduction (Nafisa)

Technology scouting refers to the systematic pursuit of discovering new and emerging technologies, practices, and methodologies that can be harnessed to achieve organizational goals and stimulate innovation. This process involves identifying, analyzing, and utilizing technological advancements to maintain a competitive advantage in the marketplace. Social media platforms have become essential tools in this effort due to their ability to collect vast amounts of user-generated content and real-time discussions. These platforms provide insights into emerging trends, innovations, and user feedback, making them invaluable for organizations aiming to stay ahead in the technology landscape (Wamba & Carter, 2016). The main objectives of this paper are to explore how social media can be leveraged for technology scouting, to highlight successful case studies across various industries, and to discuss strategies for effectively utilizing these platforms. Additionally, the paper will address the challenges associated with using social media for technology scouting and offer recommendations for organizations.

As digital transformation progresses rapidly across various sectors, the importance of technology scouting has grown significantly. Organizations that can quickly identify and adapt to technological changes are better equipped to seize new opportunities and manage risks. Social media platforms, with their extensive reach and immediate nature, are crucial for spreading and acquiring technological knowledge. These platforms allow organizations to access a global pool of information and expertise, promoting a more agile and informed approach to innovation. Moreover, the interactive nature of social media facilitates real-time feedback and collaborative problem-solving, accelerating the development and refinement of new technologies. In this

context, understanding how to effectively utilize social media for technology scouting is vital for maintaining a competitive edge in today's rapidly changing market.

II. Utilizing Social Media to Identify Emerging Technologies(Nafisa)

Monitoring Social Media Discussions and Trends

In today's digital age, social media platforms have become essential tools for identifying emerging technologies. Twitter, LinkedIn, and Reddit are particularly influential in this regard, serving as hubs for real-time discussions, professional insights, and niche community conversations respectively. Twitter, with its dynamic and instantaneous nature, allows for the rapid spread of information and trends. Technological innovations often trend on Twitter, providing early signals about emerging technologies (Wamba & Carter, 2016). LinkedIn, on the other hand, offers a more professional environment where industry leaders and professionals discuss the latest technological advancements, share insights, and provide expert opinions. This platform is invaluable for understanding the professional landscape and the potential impacts of new technologies on various industries. Reddit, with its diverse range of communities, provides in-depth discussions and grassroots insights into emerging technologies. Subreddits dedicated to specific technologies or industries can reveal trends and innovations long before they become mainstream (He, Zha, & Li, 2013).

Effective monitoring of these platforms requires specialized tools and techniques. Tools such as Brandwatch, Hootsuite, and Sprout Social are designed to track and analyze social media conversations. These tools can identify trending topics, perform sentiment analysis, and pinpoint key influencers within specific technological domains. By using these tools, organizations can stay ahead of the curve, gaining insights into emerging technologies as they develop.

Brandwatch, for instance, offers deep analytics on social media trends and conversations, allowing companies to understand the context and sentiment behind emerging technologies. Hootsuite provides comprehensive social media management capabilities, enabling organizations to monitor multiple platforms simultaneously and gather actionable insights. Sprout Social combines social media monitoring with powerful analytics, helping organizations track relevant conversations and measure the impact of their social media strategies (He, Zha, & Li, 2013).

Case Studies of Successful Technology Identification

Several industries have successfully leveraged social media to identify emerging technologies, leading to significant advancements and strategic decisions. For instance, in the healthcare sector, IBM Watson Health utilized Twitter and other social media to identify growing discussions around artificial intelligence applications in healthcare. By monitoring these conversations, IBM was able to recognize the increasing interest and potential of AI in medical diagnostics and treatment planning. This insight led to the development of new AI-driven health solutions that have since improved patient outcomes and streamlined healthcare processes (Yang et al, 2020).

In the automotive industry, Ford Motor Company employed LinkedIn to monitor trends related to electric vehicle technology. By engaging with industry experts and following professional discussions on LinkedIn, Ford identified key technological advancements and market shifts towards electric vehicles. This strategic use of social media insights guided Ford's investment in electric vehicle startups, positioning the company as a leader in the sustainable automotive market. Ford's proactive approach to technology scouting through LinkedIn has not only

enhanced its innovation capabilities but also solidified its competitive edge in the rapidly evolving automotive industry (Ford, 2020).

The retail giant Amazon provides another compelling example of successful technology identification through social media. Amazon monitored Reddit to understand consumer sentiment and discussions about drone delivery services. By analyzing conversations in relevant subreddits, Amazon gained valuable insights into consumer perceptions, expectations, and potential challenges associated with drone delivery. This information informed Amazon's development and deployment strategies, ensuring that their drone delivery service addressed consumer needs and concerns effectively. The feedback gathered from Reddit discussions allowed Amazon to refine their technology and implementation plans, ultimately enhancing the overall customer experience (Amazon, 2019).

Outcomes and Implementations

The successful identification of emerging technologies through social media monitoring has led to tangible outcomes and implementations across various industries. IBM's use of AI in healthcare, driven by insights from Twitter, has resulted in the creation of innovative solutions that improve diagnostic accuracy and patient care. These AI-driven tools assist healthcare professionals in making more informed decisions, ultimately enhancing the quality of healthcare services. IBM's proactive approach to technology scouting through social media has positioned the company as a pioneer in AI healthcare applications, attracting partnerships and investments that further fuel innovation (Yang et al, 2020).

Ford's strategic investments in electric vehicle technology, guided by insights from LinkedIn, have not only expanded their product offerings but also strengthened their market position. By

staying ahead of technological trends and understanding industry dynamics, Ford has been able to develop electric vehicles that meet consumer demands and regulatory requirements. This foresight has enabled Ford to capture a significant share of the growing electric vehicle market, driving sales and enhancing brand reputation. The insights gained from LinkedIn have also informed Ford's long-term innovation strategies, ensuring that the company remains at the forefront of automotive technology advancements (Ford, 2020).

Amazon's use of Reddit to gather consumer feedback on drone delivery has led to the development of a more refined and consumer-centric service. By addressing concerns and incorporating consumer suggestions, Amazon has been able to create a drone delivery system that is efficient, reliable, and well-received by customers. The insights from Reddit discussions have also helped Amazon navigate regulatory challenges and optimize their operational processes. As a result, Amazon's drone delivery service has become a key component of their logistics strategy, enhancing delivery speed and customer satisfaction (Amazon, 2019).

III. Spreading Awareness of Current Technologies to Improve Organizational Processes (Azarria)

Role of Social Media in Disseminating Technological Innovations

On average, 11.5 million hours are spent viewing and indulging in the use of social media, per The University of Maine. (Nyst , 2023). Social media acts as a vibrant hub for swiftly circulating technological advancements, enabling ideas to traverse the globe in mere moments. Within social networks, creators can exhibit their innovations, solicit input, and entice potential partners or financiers. Additionally, social media plays a pivotal role in democratizing information, granting

individuals from various backgrounds access to and interaction with emerging technologies, thereby nurturing innovation and societal advancement.

One significant way social media contributes to spreading technological innovations is through its ability to connect people from different parts of the world. Platforms like Twitter, Facebook, and LinkedIn allow innovators, researchers, and enthusiasts to share their discoveries and breakthroughs quickly and efficiently. This means that a new invention or technological advancement can gain attention and traction within moments of being announced, leading to faster adoption and implementation.

Moreover, social media enhances the visibility of technological innovations. Innovators can use platforms to showcase their products or ideas through videos, images, and detailed posts. This visual and interactive approach not only makes the information more accessible but also engages the audience in a way that traditional media cannot.

Another crucial role of social media in disseminating technological innovations is its role in building communities of interest. Platforms enable users to join groups, follow specific topics, and participate in discussions related to technology. This fosters collaboration, feedback, and further development of ideas, creating a dynamic environment where innovations can evolve rapidly.

Furthermore, social media serves as a platform for education and awareness about technological advancements. Experts and organizations often use these platforms to explain complex concepts in simple terms, conduct live demonstrations, or host Q&A sessions. This accessibility democratizes knowledge, allowing even those with limited technical expertise to understand and appreciate innovations (Yang et al., 2023).

Strategies for Effective Technology Communication

Effective technology communication hinges on several key strategies. Firstly, clarity is paramount; conveying complex ideas in simple terms ensures understanding across diverse audiences. Secondly, tailoring the message to the audience's expertise level and interests enhances engagement and comprehension. Additionally, incorporating visuals, demonstrations, or interactive elements can elucidate technical concepts and facilitate retention. Lastly, fostering open dialogue and providing opportunities for questions and feedback promotes a collaborative and inclusive communication environment, fostering deeper understanding and driving technological adoption.

A fundamental principle of effective communication is understanding the audience. Tailoring the message to align with the audience's knowledge level, interests, and concerns is essential. For technical audiences, providing detailed data and technical specifications is crucial, while for non-technical audiences, simplifying complex concepts and highlighting practical benefits is more effective.

Using clear and simple language is another critical strategy. Avoiding jargon and technical terms that might confuse or alienate the audience helps ensure that the message is accessible to everyone. Explaining technical terms when necessary and using real-world examples to illustrate key points can significantly enhance understanding and engagement.

Crafting a compelling narrative around the technology can captivate audiences both intellectually and emotionally. Describing the problem the technology solves, its development journey, and its potential impact on users or society helps create a connection with the audience. Utilizing storytelling techniques makes the information more memorable and relatable.

Visual aids such as charts, diagrams, infographics, and videos are powerful tools for enhancing understanding and retention of information. These visuals simplify complex concepts, illustrate processes, and highlight key benefits in a clear and visually appealing manner.

Emphasizing the practical benefits and real-world applications of the technology is crucial for gaining buy-in and support. Explaining how the technology improves efficiency, solves problems, reduces costs, or enhances quality of life helps stakeholders see its value. Case studies, testimonials, or success stories can further illustrate tangible outcomes and potential advantages (Kirk, 2024).

Building trust through transparency and honesty is essential in technology communication. Providing clear information about the technology, including its limitations, risks, and challenges, helps manage expectations and foster credibility. Addressing concerns openly and clarifying misconceptions encourages informed decision-making among stakeholders.

Engaging stakeholders early in the communication process promotes collaboration and ensures alignment. Tailoring communication strategies to different stakeholders such as investors, employees, regulators, and the public helps align messaging with their interests and priorities, increasing the likelihood of acceptance and support.

Utilizing multiple communication channels is essential for reaching diverse audiences effectively. Beyond traditional methods like presentations and reports, leveraging digital platforms such as social media, blogs, webinars, and podcasts allows organizations to engage with a broader audience and amplify their message.

Providing opportunities for interaction and feedback deepens understanding and fosters engagement. Organizing Q&A sessions, workshops, or demonstrations where stakeholders can ask questions, provide feedback, and participate actively in discussions about the technology encourages dialogue and collaboration.

Monitoring the effectiveness of communication efforts through metrics such as audience engagement, feedback, and adoption rates is crucial. Continuously evaluating and adjusting communication strategies based on insights gained helps improve clarity, relevance, and impact over time. (NeilPatel)

Content Creation and Sharing

Content creation and sharing have been revolutionized by technological innovation, enabling creators to produce high-quality content with greater efficiency. Advanced tools and platforms facilitate the seamless distribution of this content to a global audience, enhancing reach and engagement. Additionally, technologies like AI and analytics provide valuable insights, allowing creators to tailor their content to audience preferences and trends, driving more effective and impactful communication.

One of the primary roles of content creation is to amplify awareness. Through a myriad of mediums such as blogs, articles, white papers, and social media posts, innovators and organizations bring attention to their technological breakthroughs. These platforms serve as digital stages where complex concepts are demystified and potential benefits are highlighted. By making information accessible and understandable, content creators bridge the gap between technical expertise and broader public understanding, sparking interest and generating support.

Beyond mere promotion, content creation serves an educational function. Detailed explanations, tutorials, and case studies not only inform but also empower stakeholders from policymakers to consumers, to make informed decisions about adopting and investing in new technologies. This educational aspect is critical in dispelling misconceptions, addressing concerns, and illustrating the practical applications of innovations in real-world scenarios.

Credibility and trust are foundational elements cultivated through well-crafted content. By sharing authoritative research, expert opinions, and success stories, content creators establish the reliability and tangible impact of technological innovations. Transparent discussions about challenges, risks, and ethical considerations further contribute to building trust among stakeholders, encouraging responsible adoption and development.

Moreover, content sharing fosters collaboration and feedback loops among a global community of innovators, researchers, and practitioners. Platforms dedicated to research papers, online forums, and collaborative tools facilitate the exchange of ideas, insights, and improvements. This collaborative environment accelerates innovation cycles, enabling rapid development and refinement of technologies through collective knowledge and expertise.

Communities of interest are also nurtured through content creation. Online forums, social media groups, and specialized websites bring together enthusiasts, early adopters, industry professionals, and researchers who share a passion for advancing specific technologies. These communities serve as hubs for dialogue, networking, and knowledge-sharing, fostering a supportive ecosystem that drives continuous innovation and adoption.

The impact and applications of technological innovations are effectively showcased through multimedia formats such as videos, infographics, and interactive presentations. These visual

tools illustrate how innovations solve challenges, improve efficiencies, and enhance quality of life across various domains. Case studies and testimonials from users provide compelling evidence of the transformative potential of new technologies, influencing perceptions and encouraging widespread adoption.

As communication channels continue to evolve with advancements in digital platforms and technologies, content creators must adapt to these changes. Embracing emerging channels such as live streaming, virtual reality, and augmented reality enhances engagement by offering more immersive and interactive experiences. This adaptability ensures that technological innovations remain accessible and relevant in a rapidly changing digital environment.

Content creation also wields influence over policy and regulatory frameworks. Thoughtful analysis, expert insights, and data-driven discussions presented in policy briefs, thought leadership articles, and public consultations contribute to informed decision-making by policymakers and regulatory bodies. This advocacy helps shape policies that support innovation, ensure safety, and address societal concerns related to emerging technologies.

Metrics such as audience engagement, reach, and conversion rates provide valuable insights into the impact and effectiveness of content creation efforts. Analyzing these metrics allows content creators to refine strategies, optimize content formats, and tailor messages to resonate more effectively with target audiences. This data-driven approach enhances the overall effectiveness of communication efforts, driving greater adoption and acceptance of technological innovations.

Ethical considerations and responsible innovation practices are also promoted through content creation. Discussions around data privacy, security, inclusivity, and sustainability are integral to guiding the development and deployment of new technologies. Content creators have a

responsibility to raise awareness, facilitate dialogue, and advocate for ethical standards that prioritize societal benefit while mitigating risks and unintended consequences (Sembra Media).

Engaging with Online Communities

Engaging with online communities can be a powerful catalyst for innovation. By participating in these communities, individuals and organizations can tap into a diverse pool of ideas, feedback, and expertise. This collaborative environment fosters creativity and accelerates problem-solving, leading to the development of innovative solutions. Additionally, online communities provide valuable insights into emerging trends and customer needs, enabling more effective and responsive innovation strategies.

One of the primary benefits of engaging with online communities lies in the opportunity to tap into diverse perspectives and expertise. Whether through specialized forums, social media groups, or virtual conferences, participants can share insights, discuss challenges, and brainstorm solutions in real-time. This collaborative environment not only fuels creativity but also enhances problem-solving capabilities by leveraging the collective wisdom of a global network.

Moreover, online communities serve as incubators for innovation. They provide a fertile ground for testing new ideas, receiving feedback, and iterating on prototypes. Innovators can showcase their inventions, demonstrate proof of concept, and attract potential collaborators or investors who share a passion for advancing technology. This iterative process of refinement is crucial in bridging the gap between concept and market-ready product.

Beyond technical development, online communities play a pivotal role in shaping the narrative and perception of technological innovations. Through curated content, discussions, and thought

leadership, participants can influence public discourse, address misconceptions, and highlight the societal benefits of new technologies. This proactive engagement helps build trust and foster acceptance among a broader audience, including policymakers, regulators, and the general public.

Furthermore, online communities facilitate continuous learning and professional development. Members have access to a wealth of educational resources, ranging from tutorials and webinars to research papers and case studies. This knowledge-sharing environment not only keeps participants abreast of cutting-edge developments but also empowers them to stay competitive in their respective fields (Hafeez, 2024).

IV. Influencer Engagement and Technology Promotion (Neilequelette)

The emergence of social media influencers as pivotal players in the digital marketing landscape has transformed the way companies approach technology scouting and promotion. This study explores the multifaceted role of social media influencers in showcasing products and innovations, gathering market insights, and enhancing brand visibility within relevant tech communities. By analyzing various collaboration models between companies and influencers, this paper aims to elucidate the strategic benefits and challenges associated with influencer partnerships in the tech industry.

In the digital age, the proliferation of social media platforms has given rise to a new breed of opinion leaders known as influencers. These individuals, with their substantial follower base and high engagement rates, possess the power to sway consumer behavior and shape industry trends. Influencers are not merely content creators; they have become vital intermediaries between

brands and consumers, particularly in the tech industry, characterized by rapid innovation and fierce competition.

Social media influencers serve as essential conduits for technology companies aiming to boost product visibility and drive innovation adoption. Their roles in technology scouting and promotion can be categorized into three primary functions. First, influencers create content that highlights the features, benefits, and applications of new technologies. Through unboxing videos, product reviews, tutorials, and live demonstrations, influencers provide authentic and relatable insights that resonate with their followers. This content often reaches a wider audience than traditional advertising methods, making it a powerful tool for tech companies (Khamis, Ang, & Welling, 2017).

Second, influencers act as a conduit for real-time feedback from the tech-savvy community. By engaging with their audience through comments, polls, and direct messages, influencers gather valuable data on consumer preferences, pain points, and emerging trends. Companies can leverage these insights to refine their products and marketing strategies, staying ahead of competitors and meeting market demands (Freberg et al., 2011).

Third, collaborations with influencers enable companies to tap into established online communities and amplify their brand presence. Influencers' endorsements can enhance brand credibility and attract a wider audience, particularly within niche tech segments. This strategy is crucial for building a loyal customer base and sustaining long-term growth (De Veirman, Cauberghe, & Hudders, 2017).

Successful partnerships between tech companies and influencers are built on strategic collaboration models that align with the objectives of both parties. Common approaches to

influencer engagement include sponsored content, where companies compensate influencers for creating and sharing content that features their products. Sponsored posts, videos, and stories are typically marked as advertisements but are designed to integrate seamlessly with the influencer's usual content. This model ensures that the influencer's audience perceives the content as genuine and trustworthy (Abidin, 2016).

Another approach is product seeding, where companies provide influencers with free products or early access to new technologies in exchange for honest reviews and feedback. This model is particularly effective for generating buzz around product launches and garnering authentic endorsements. Product seeding helps build credibility as influencers are seen using and discussing the products organically (Gretzel, 2018).

Affiliate marketing is also a prevalent model, where influencers earn commissions on sales generated through unique referral links or discount codes. This model incentivizes influencers to actively promote products and track the effectiveness of their campaigns. It also provides a measurable return on investment for companies, making it easier to assess the impact of influencer partnerships (Brown & Hayes, 2008).

Additionally, long-term partnerships with influencers who align closely with the company's values and target audience, known as brand ambassadors, participate in multiple promotional activities, including events, social media takeovers, and exclusive product collaborations. This deepens the influencer's connection to the brand and fosters a more genuine endorsement (Kapitan & Silvera, 2016).

To illustrate the impact of influencer collaborations in the tech industry, several case studies of successful partnerships are presented. Apple frequently collaborates with tech influencer

Marques Brownlee for product reviews and event coverage. His in-depth analyses and high production quality resonate with a tech-savvy audience, driving anticipation and adoption of Apple's latest innovations (Apple Inc., 2021). Similarly, drone manufacturer DJI partnered with filmmaker and influencer Casey Neistat to showcase their products' capabilities through creative and adventurous content. Neistat's storytelling and aerial cinematography highlighted DJI's technological advancements and practical applications, boosting brand visibility (DJI, 2021). Fitbit collaborates with health and fitness influencers to promote their wearable technology. By integrating Fitbit products into their fitness routines and sharing progress on social media, these influencers demonstrate the product's value in achieving health goals, attracting a health-conscious audience (Fitbit Inc., 2021).

While influencer partnerships offer numerous benefits, companies must navigate several challenges to maximize their impact. Maintaining authenticity is crucial for influencer marketing success. Consumers are wary of overly promotional content, and influencers must balance sponsored posts with genuine endorsements to retain trust. This requires careful selection of influencers whose values align with the brand (Campbell & Farrell, 2020). Regulatory compliance is another critical aspect. Regulatory guidelines require influencers to disclose sponsored content clearly, and companies must ensure compliance to avoid legal repercussions and maintain ethical standards. This transparency builds consumer trust and adheres to advertising laws (FTC, 2019).

Measuring the return on investment (ROI) from influencer campaigns can be complex. It requires robust analytics tools and clear KPIs to track engagement, conversion rates, and overall campaign effectiveness. Companies must invest in these tools to evaluate the true impact of influencer marketing (Hughes, Swaminathan, & Brooks, 2019).

The integration of social media influencers into technology scouting and promotion strategies has proven to be a game-changer for tech companies. By leveraging influencers' reach and credibility, companies can showcase their innovations, gain valuable market insights, and enhance their brand visibility. As the digital landscape continues to evolve, the role of influencers in technology promotion is likely to grow, necessitating more sophisticated collaboration models and measurement techniques. Companies that effectively navigate the benefits and challenges of influencer partnerships will be well-positioned to achieve sustained success in the competitive tech industry.

V. Challenges and Considerations (Azarria)

Managing Information Overload on Social Media

As a whole, managing information overload requires a proactive approach that involves prioritization, effective filtering techniques, and leveraging appropriate technologies. On social media, this phenomenon is exacerbated by the constant stream of updates, notifications, and the sheer diversity of content. The consequences include decreased productivity, decision fatigue, and increased stress levels. To address these issues, innovative technologies and mindful practices are essential.

Technological innovation has introduced sophisticated tools to manage information overload on social media, such as algorithms that filter and prioritize content based on user preferences. Advanced analytics and AI-driven recommendations help users focus on relevant information, reducing the noise and enhancing the overall experience. Additionally, customizable notification settings and content curation options empower users to control the flow of information, making social media engagement more manageable and efficient. (Franq, 2023).

Innovative time management tools such as RescueTime, StayFocusd, and Forest play a crucial role in helping users manage their social media consumption effectively. These applications track the time spent on various platforms and allow users to set usage limits, encouraging a more disciplined approach to social media. By providing insights and controls, these tools help users avoid the trap of endless scrolling and mitigate the effects of information overload.

Content aggregation platforms like Feedly and Flipboard further aid in managing information overload by compiling information from various sources into a single, streamlined interface. These platforms utilize algorithms to organize content by relevance and topic, enabling users to access information more efficiently. By consolidating information in one place, users can avoid the overwhelm associated with navigating multiple social media sites, making their information consumption more manageable.

Technological solutions are complemented by mindfulness and digital well-being practices, which help users maintain a healthy relationship with social media. Techniques such as digital detoxes, setting specific times for social media use, and mindfulness meditation can be highly effective. Additionally, digital well-being features integrated into smartphones and social media platforms, such as screen time trackers and reminders to take breaks, support these practices. Education and awareness about the pitfalls of information overload are also crucial. Social media platforms and educational institutions can provide resources and workshops on digital literacy, emphasizing critical thinking and mindful consumption, empowering users to take control of their digital environments. (Geels et al., 2024)

Ensuring Information Credibility and Reliability

Ensuring the credibility and reliability of information from social media requires a proactive and discerning approach. By verifying sources, cross-referencing information, checking author credentials, analyzing content, recognizing bias, utilizing fact-checking tools, and considering the date.

The first step in ensuring information credibility is to verify the source. Reputable sources are usually well-established media outlets, academic institutions, or organizations known for their expertise and reliability. When encountering information on social media, it is crucial to check the origin of the post. If the source is unknown or lacks a track record of reliability, it is wise to be skeptical.

One of the most effective ways to confirm the accuracy of information is by cross-referencing it with multiple sources. If the same information is reported by several credible outlets, it is more likely to be accurate. Discrepancies among sources should prompt further investigation. Cross-referencing helps in identifying consistent facts and eliminates the influence of potentially biased or erroneous information.

The credibility of information is significantly influenced by the author's expertise. Investigating the author's credentials, professional background, and previous work can provide insights into their reliability. Experts in the field are more likely to provide accurate and trustworthy information compared to unknown or unverified individuals.

Critical analysis of the content itself is essential. Reliable information is typically well-researched, balanced, and presented with evidence or citations. Look for data, statistics, or

references that support the claims made. Be wary of sensational language, unfounded assertions, or emotionally charged narratives, as these can be indicators of misinformation or biased content.

All sources have inherent biases, and recognizing these biases is crucial. Understanding the political, commercial, or ideological slant of a source helps in assessing the potential bias in the information presented. Consumers should seek out diverse perspectives to obtain a more balanced understanding of the topic.

There are numerous fact-checking organizations and tools available that specialize in verifying the accuracy of information. Websites such as Snopes, FactCheck.org, and PolitiFact are dedicated to debunking false information and providing factual analysis. Utilizing these resources can help users identify misinformation and confirm the credibility of the information they encounter.

The timeliness of information is also a critical factor. Outdated information can be misleading, especially in rapidly evolving situations such as natural disasters, political events, or scientific discoveries. Always check the date of the information and ensure it is current and relevant. (Boothby et al., 2021).

Navigating Privacy and Ethical Issues

Technology advancements have raised significant privacy and ethical concerns that require careful navigation. Addressing these issues is crucial to protect users' rights and maintain trust in digital platforms.

One of the primary privacy concerns in the realm of social media is data collection and usage. Social media platforms often collect vast amounts of personal data from users, including

location, browsing habits, and personal preferences. This data is invaluable for targeted advertising and improving user experience, but it also poses significant risks. Data breaches and unauthorized access to personal information can lead to identity theft, financial loss, and other forms of exploitation. To mitigate these risks, it is essential for platforms to implement robust security measures and for users to be vigilant about their privacy settings. (Kvalnes, 2020).

Ethical issues also arise from the way social media platforms handle user data and content. The use of algorithms to curate content can lead to the creation of echo chambers, where users are only exposed to information that reinforces their existing beliefs. This phenomenon can contribute to polarization and misinformation, challenging the ethical responsibility of platforms to provide balanced and accurate information. Moreover, the ethical implications of data usage extend to issues such as consent and transparency. Users often lack a clear understanding of how their data is being used, making informed consent difficult to achieve. Therefore, social media companies must strive for greater transparency and give users more control over their personal information. (IEEE).

Technological innovations such as artificial intelligence (AI) and machine learning further complicate privacy and ethical landscapes. AI-driven tools can analyze and predict user behavior with remarkable accuracy, leading to concerns about surveillance and autonomy. The ethical use of AI in social media requires establishing clear guidelines and regulations to prevent misuse and protect individual rights. Additionally, AI systems should be designed with fairness and accountability in mind, ensuring they do not perpetuate biases or discrimination. (Gates, 2024).

VI. Conclusion(Neilequelette)

In summary, the impact of social media on technology scouting and innovation dissemination has been profound, reshaping how organizations connect, engage, and innovate in today's digital age. Platforms like Twitter, LinkedIn, and Reddit have become vital hubs where technological advancements are shared and celebrated in real-time. They enable global connectivity, allowing innovators from diverse backgrounds to showcase their ideas to a vast audience instantly. This democratization of access not only accelerates the adoption of emerging technologies but also fosters collaborative efforts that transcend geographical boundaries.

Moreover, social media enhances the visibility of technological innovations through multimedia content, including videos, images, and detailed posts. Innovators leverage these formats to demonstrate the practical applications and benefits of their technologies, making complex concepts accessible to broader audiences. Educational opportunities on platforms such as Facebook and LinkedIn further bridge the gap between technical expertise and public understanding. Experts can simplify technical information, conduct live demonstrations, and engage in interactive sessions, thereby fostering informed decision-making and encouraging widespread adoption of innovations.

Effective communication strategies are pivotal in successful technology scouting and adoption. Clear, engaging communication that emphasizes audience understanding and utilizes visual aids like infographics and videos helps convey complex technological concepts effectively. Compelling storytelling with real-world examples enhances engagement and deepens stakeholders' understanding of the potential impact of new technologies.

The emergence of social media influencers has revolutionized how technological innovations are marketed and perceived. Influencers, with their substantial follower bases, wield significant influence over consumer behavior. Through collaboration models such as sponsored content, product seeding, and affiliate marketing, influencers play crucial roles in amplifying product visibility, gathering market insights, and enhancing brand credibility within niche tech communities. Successful partnerships with influencers, as demonstrated by case studies involving industry leaders like Apple, DJI, and Fitbit, underscore the effectiveness of influencer marketing in driving audience engagement and fostering long-term brand loyalty.

However, alongside its benefits, social media also presents challenges that organizations must navigate carefully. Maintaining authenticity in influencer partnerships is crucial to preserving consumer trust amidst sponsored content. Regulatory compliance, including adherence to disclosure guidelines and ethical practices, ensures transparency and accountability in marketing efforts. Measuring the return on investment from social media campaigns requires robust analytics tools and clear key performance indicators to track engagement, conversion rates, and overall campaign effectiveness.

In conclusion, social media has transformed the landscape of technology scouting and innovation dissemination, offering unprecedented opportunities for global connectivity, enhanced visibility, and effective communication. By embracing these opportunities, leveraging influencer partnerships strategically, and addressing challenges with diligence, organizations can position themselves for sustained success in the competitive tech landscape. As social media continues to evolve, its role in driving technological innovation and shaping public perception will only grow, necessitating continual adaptation and innovation in tandem with these digital advancements.

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Strategic Information Systems: Integrating Quality Management 4.0 with AI and Machine Learning

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Abstract

This manuscript develops a novel framework of integrating Quality 4.0 principles to strategic planning processes, based on the review and synthesis of recent literature on project quality management, Quality 4.0, and strategic planning. While strategic planning remains critical for shaping organizational objectives, there is limited research on leveraging quality management practices in this context. The methodology involves a qualitative literature review, outlining quality management evolution and discussing Quality 4.0's use of AI and machine learning. Gaps are identified regarding integrating quality with strategic planning processes. A novel framework is proposed for "Strategic Planning 4.0" that incorporates Quality 4.0 principles of automation, data analytics and machine learning into the strategic planning process. Implications for enhancing strategic planning through Quality 4.0, limitations, and areas for future research are discussed, positioning organizations for success in the Industry 4.0 era.

Introduction

Strategic planning is an important and prevailing process for shaping organizational strategic objectives (George, 2021) as it aligns vision, shares responsibility, and clarifies desired outcomes (Cote, 2020). Despite the critical role of strategic planning, there remains a lack of research on how quality management practices can effectively be integrated into this important process. Recently, there has been a growth in quality management literature that focuses on "Quality 4.0," which leverages new technologies such as artificial intelligence and machine learning with quality assurance (De Oliveira, Alvelos & Rosa, 2024). While there is a general consensus on best practices in producing a formal strategic plan (Cote, 2020) (Edwards et al., 2017) (El Zein Badawi, 2020), there is a gap in research on how to integrate modern quality management tools (i.e., Quality 4.0) in the process of strategic planning. Yet, in today's rapidly evolving business landscape, managers seek solutions to enhance strategic planning with data-driven decisions and continuous adaptation (George, 2021).

Strategic planning is an important management tool, however, if the process is done poorly, the plan can be ineffective and burdensome (Albon, 2016). Recent literature on quality management suggests the importance of integrating automation and machine learning with quality assurance to remain competitive in the fourth industrial age, also known as Industry 4.0, that is defined by these technological advancements (Alzahrani et al., 2021). However, Quality 4.0 is an emerging field of knowledge. This manuscript will examine recent literature that focuses on Quality 4.0, in addition to project quality management and strategic planning, and synthesize its finding to provide a novel framework for leveraging these new technologies and propel the evolution toward "Strategic Planning 4.0." Executives, managers, strategic planners, and quality management professionals actively engaged in the strategic planning process will

find this research compelling, as it provides insights into integrating these technologies, fostering innovation, and achieving success in the dynamic era of Industry 4.0 (Alzahrani et al., 2021).

This manuscript represents a significant and valuable contribution to project management research. Notably, it pioneers the application of quality management methods and "Quality 4.0" principles to the strategic planning process. By doing so, it provides essential insights for organizational leaders who aim to leverage emerging technology and streamline their strategic planning processes. As organizations navigate the complexities of Industry 4.0, the incorporation of Quality 4.0 principles becomes critical across all facets of organizational strategy, including strategic planning processes.

Methodology

The methodology of this manuscript consists of a qualitative literature review of research in the domains of project management, quality management, and strategic planning within the past four years. Additional background for the purposes of describing relevant theoretical frameworks and assumptions relies on some older literature. This qualitative literature review aims to explore and synthesize existing scholarly works, focusing on qualitative data and interpretations to gain a comprehensive understanding of the applications of quality management in strategic planning. The search strategy was mostly conducted through the online library offered by the University of Maryland Global Campus with the key phrases "strategic plan", "quality management", "TQM", and "Quality 4.0" and limited to the years 2020-2024. Some research was supplemented through search engines and prompt engineering with the same keywords. The process entailed many rounds of searching and screening to ensure a comprehensive coverage of research literature. Each identified source was screened through a review of the manuscript's research question and its relevance to the topic. Recurring themes and

concepts were extracted from the selected research to generate new insights and understandings. The findings of this qualitative literature review are documented and reported in accordance with the American Psychological Association – 7th edition citation style.

Literature Review

Quality management is frequently overlooked and undervalued, however, it plays a critical role in organizational excellence (Krivokuca, 2022). The literature review in this manuscript provides the historical context of quality management theory and strategic planning, and discusses emerging research on "Quality 4.0" from the past four years. Soltani (2022) highlights that in the current highly competitive global market, companies must prioritize both quality and innovation to ensure their survival. Amid the dynamic business landscape of the 2020s, business leaders must grasp the importance of a proactive, high-quality approach when formulating organizational strategies.

Overview of Project Quality Management

The PMBOK (2017) defines quality management as breaking down into three domains: planning, managing, and controlling. It is worth noting that developing a quality management plan is crucial because a structured approach ensures that high-quality deliverables are consistently produced throughout the project life cycle (PMBOK, 2017). The quality management plan defines the quality metrics and quality control activities so that the project deliverables meet the project requirements (PMBOK, 2017).

Lotich (2022) discussed the Total Quality Management (TQM) system and emphasized that organizations should clearly communicate their vision, mission, and values to stakeholders to foster alignment with strategic objectives. Customized Critical Success Factors (CSFs) are crucial for tracking progress, and relevant measurements and metrics should be established

(Lotich, 2022). Additionally, creating a customer-focused culture that prioritizes satisfaction and involving all employees in the quality management system contributes to successful TQM implementation (Lotich, 2022).

Escobar (2021) offered a comprehensive history of changes in quality management philosophy. It began in manufacturing industries with the use of statistical tools (Pareto charts, histograms, etc.) to measure and control quality. This later evolved to TQM (plan, do, check, act) and Six Sigma (define, measure, analyze, improve, control). However, Escobar (2021) noted that recent advancements in technology now require a predictive element in quality management, which is based on quality curve theory, or Quality 4.0. While the definitive activities of Quality 4.0 are still in the theoretical stages of research, Escobar (2021) suggests a predictive framework of seven steps: identify, ascensorize (defined as deploying sensors and observe), discover, learn, predict, redesign, and relearn.

Quality philosophy				
(a) SQC	(b) TQM	(c) Six sigma	(d) DFSS	(e) Quality 4.0
Controlling	Managing	Reactive	Proactive	Predictive
Specification	Plan	Define	Define	Identify
Production	Do	Measure	Measure	Acsensorize
Inspection	Check	Analyze	Analyze	Discover
	Act	Improve	Design	Learn
		Control	Optimize	Predict
			Verify	Redesign
				Relearn

"Evolution of quality, problem-solving strategy by quality philosophy." From Escobar (2021).

Quality 4.0

According to research by Alzahrani et al. (2021), a fourth industrial revolution is transforming the world, also referred to as "Industry 4.0". The original Industrial Revolution (1.0) began in the late 1700s with the discovery of coal and steam power. Industry 2.0 began in

the late 1800s with the advancements of oil, electricity, and mass production. In the late 1900s, Industry 3.0 was sparked by nuclear energy and electronics. Finally, Industry 4.0 is defined by the advancements in digital technologies, machine learning, and artificial intelligence. These developments have led to the emergence of quality curve theory, or Quality 4.0, as quality management has changed as reflected by technological advancements (Alzahrani et al., 2021). Organizations must evaluate their readiness for Quality 4.0 adoption, considering enabling technologies, big data capabilities, skilled workers, collaboration, and leadership support (Alzahrani et al., 2021).

Liu et al. (2023) discussed Quality Curve Theory and suggested that Quality 4.0 activities fall into three categories: design, manufacturing, and service. It is important to note that the main premise of this theory is that the process design and service end contribute significantly more to quality than manufacturing (or production) quality in and of itself. In other words, organizations need to emphasize design and service activities, or the beginning and the end of the process, to thrive in the current climate (Liu et al., 2023).

Liu et al. (2023) also noted that the difference between TQM and Quality 4.0 is that while TQM focuses on the alignment of activities with customer requirements and expectations, Quality 4.0 emphasizes a predictive and proactive approach through automation, advanced data analysis, and result integration. In other words, TQM looks to improve upon past performance, while Quality 4.0 aims to reduce defects through technology and automation.

Maganga & Taifa (2023) describe Quality 4.0 as a modern quality management approach that leverages Industry 4.0 technologies, integration, and digitalization. They noted that publications on Quality 4.0 began in 2016 and surged in 2020 and 2021, with India leading in research output and little output from the United States. Maganga & Taifa (2023) suggest that the

framework of Quality 4.0 is based on four pillars: TQM principles, Industry 4.0 technologies, big data management, and real-time quality management. Finally, their research suggested that the top three motivating factors for adopting Quality 4.0 is for organizations to provide the required big data tools, assistance in decision-making, and incentives for continuous improvement.

Emblemsvåg (2020) emphasized the importance of replacing manual data collection with automated methods such as QR codes, barcodes, and RFID chips, which can enhance data quality, security, and centralization through cyber security and cloud computing technologies.

As noted earlier, Escobar et al. (2021) also stated that Quality 4.0 integrates Industry 4.0 technologies, defines digitalization, and emphasizes enablers like big data capabilities and leadership support. Furthermore, Emblemsvåg (2020) and Escobar et al. (2021) agreed on the unreliability of manual or visual inspections, which can be subject to bias, and the need to replace manual methods with automation to the extent possible.

A systematic literature review conducted by De Oliveira, Alvelos, and Rosa (2024) revealed a significant global increase in scholarly publications related to Quality 4.0 since 2020, underscoring its paramount importance in global quality management. De Oliveira et al. (2024) illustrated the evolution of quality management to align with Industry 4.0, highlighting the integrated approach involving new technologies and methodologies. De Oliveira et al. (2024) emphasized key aspects include motivations (customer satisfaction, productivity, and cost and time savings), barriers (initial costs, employee skills, lack of resources), and readiness factors (leadership, culture, data analytics, training, and scalability). Quality 4.0 professionals must possess a diverse skill set, including proficiency in technology utilization, big data analysis, effective communication, leadership, creative problem-solving, adaptability to change, knowledge of IT and production processes, and a commitment to continuous lifelong learning

(De Oliveira et al., 2024). These skills are essential for achieving success within a Quality 4.0 system, which combines automation and real-time data analysis while integrating traditional tools and methodologies (De Oliveira et al., 2024).

Overview of Strategic Planning.

Strategic planning continues to be the prevailing method for shaping strategies (George, 2021). Cote (2020) defined strategic planning as an ongoing organizational process that documents a business's goals and objectives by prioritizing efforts, allocating resources, aligning stakeholders with organizational goals, and ensuring data-backed reasoning. While a strategic plan is time-bound with a beginning and an end, the strategic planning process should be characterized by continuous learning and improvement. The benefits of strategic planning include a unified vision, enhanced responsibility and accountability, and improved business outcomes (Cote, 2020).

Edwards et al. (2017) offered a case study that exemplifies the traditional components of a successful strategic plan implementation. The study emphasized the strategic importance of strengthening partnership networks and the initial challenges faced in executing their strategy. Edwards et al. (2017) noted that strategy is a process, not an event, and that it is imperative to develop a common vision, "SMART" goals, and a cohesive decision-making process. Edwards et al. (2017) also recommended standardization, prioritization, collaboration, accountability, and the use of dashboards for initiatives, implementation status, and impact assessment.

George (2021) noted that effective implementation of strategic plans is shaped by the interplay of three key factors: people, process, and plan (often referred to as the 3Ps). George (2021) advised assembling a diverse team with creative thinking to drive strategic initiatives. Stakeholder involvement at all levels ensures alignment and commitment. Data-driven decisions,

continuous adaptation, risk mitigation, and high-quality plans are essential. Strategic planning is not one-size-fits-all. Variation in people, process, and plan impacts implementation success.

In a compelling case study, El Zein Badawi (2020) explored the successful integration of quality assurance and strategic planning within a Sudanese higher education institution (HEI). The study emphasized that these two critical aspects should not exist in isolation. By strategically aligning quality assurance efforts with the university's vision, mission, and objectives, the HEI achieved notable improvements in organizational performance and student outcomes. El Zein Badawi (2020) underscored the importance of clear, validated, benchmarked, and transparent key performance indicators (KPIs). Additionally, the study highlighted that while quality assurance provides insights into past performance, integrating it with strategic planning is essential for HEIs to thrive in a dynamic enterprise environment.

Gaps in literature

Existing research on the integration of quality management and strategic planning reveals several gaps that warrant further exploration. First, existing literature on strategic planning tends to emphasize development and implementation, often overlooking an assessment of the quality of the strategic planning process. Second, while the PMBOK (2017) offers valuable guidance on project quality management, empirical research on Quality 4.0 is an emerging field with limited established guidance or frameworks for successful implementation within organizations (De Oliveira et al., 2024). Third, although the potential advantages of incorporating Quality 4.0 into organizational management are recognized, empirical studies on its concrete impact or organizational performance remain limited, likely due to its status as an emerging research field. Lastly, despite a growing body of conceptual literature on Quality 4.0, empirical research examining its practical application and impact on strategic planning processes within

organizations remains elusive. This manuscript proposes a framework for organizations to enhance strategic planning by integrating Quality 4.0 principles, ensuring alignment with the dynamic Industry 4.0 context.

Proposed Process for Strategic Planning 4.0

The PMBOK (2021) highlights that quality activities aim to align delivered outcomes with customer and stakeholder objectives, minimizing resource waste, and increasing the likelihood of achieving desired results. The complexities arise from human behavior, system interdependencies, uncertainty, and technological innovation. Yet, Soltani (2022) noted that quality management is foundational for product and process innovation, and that organizations must prioritize best practices in quality management to drive innovation and performance.

Quality 4.0 activities, as highlighted by Krivokuca (2022), emphasize digital technologies, data-driven decision-making, smart manufacturing, risk management, collaboration, and continuous improvement to enhance quality. While strategic planning remains the dominant approach for shaping strategies (George, 2021), effective implementation hinges on the interplay of three key factors: people, process, and plan (often referred to as the 3Ps). Aligning "Strategic Planning 4.0" with Quality 4.0 is critical for organizational success in the Industry 4.0 era, yet a consensus on a practical framework remains elusive.

Escobar (2021) proposed a practical framework for Quality 4.0, termed "the evolution of problem-solving," which is currently in its early development stage. The objective is to enhance process quality by incorporating predictive analytics and automation, while minimizing reliance on manual updates and inspections. The below process for Strategic Planning 4.0 is modeled on "the evolution of problem-solving" (Escobar, 2021) and organized by the Quality 4.0 principles

of people-process-technology (Chiarini & Kumar, 2022) and the people-process-plan approach

by (George, 2021).

Proposed Process for Strategic Planning 4.0		
Stage	**Definition**	**Activity examples**
Identify	Recognize and classify data that can predict defects.	**People:** Identify communication to stakeholders that can be automated (such as reminders and alerts) **Process:** Create value with Quality 4.0 - Use dashboards with live updates on KPIs. Make it fun! This is not just for management; it is for everyone! **Technology:** Cybernetics – is there data that can be captured automatically? **Plan:** Continue traditional planning methods (resource allocation, milestones, etc.).
Ascensorize	Develop activities to monitor identified data and observes those activities.	**Process:** Monitoring data activity, metrics, KPIs, etc. **Technology:** Monitor with automation and machine learning **Plan:** Continue traditional management methods (meetings, updates).
Discover	Create reports from raw data that are indicators of success or failure.	**People:** create systems for individualized reports. **Technology:** Automated alerts to deviations from quality standards such as changed or missed milestones.
Learn	Use machine learning to classify data from discovery reports and look for patterns.	**People:** Be transparent about data to enhance trust and communication strategy. **Technology:** Real-time dashboards and other data analytics are key.
Predict	Optimize prediction based on patterns identified in discovery reports.	**Technology:** Leverage machine learning to be predictive, not reactive. What is resonating? What is working and what is not? What do people find confusing?
Redesign	Use relevant observational data to generate correlation.	**Process:** Experimental data and statistical analysis should be used to determine root causes of defects. In other words, use information from machine learning to evaluate quality and effectiveness. This redesign stage is not automated. **Plan:** Continue traditional control methods (change requests).
Relearn	Relearn data	**Process:** Repeat this process

Proposed Process for Strategic Planning 4.0 modeled on "The Evolution of Problem Solving"
Escobar (2021) by Leilani Uttenreither

Implications of Research

While traditional quality management focuses on continuous improvement through production feedback, Quality 4.0 prioritizes proactive design process through automation and machine learning (Liu et al., 2023). Escobar (2021) offered a problem-solving strategy that could provide a possible framework to apply automation to the strategic planning process. However, Escobar (2021) also noted challenges in adopting the tools including a lack of understanding and trust, a lack of applicability for all situations, machine learning is not appropriate for root-cause analysis, and practical complications with the final relearning component. Krivokuca (2022) cautioned that the involvement of people remains critical to processes, and it is imperative to emphasize that artificial intelligence will not replace people. Overall, while challenges persist in integrating big data and automation into strategic planning, the benefits of minimizing manual updates and leaning into automation are evident.

This manuscript contributes to the existing body of knowledge by introducing a novel framework that integrates Quality 4.0 principles with organizational strategic planning processes, laying the groundwork for Strategic Planning 4.0. These findings have the potential to guide future research, influence industry practices, and foster innovation and discovery, enabling organizations to thrive in the dynamic Industry 4.0 landscape.

Limitations of Research

While this manuscript contributes to research as it relates to quality management and strategic planning, it encountered limitations and areas that merit further investigation. First, this manuscript focuses exclusively on the integration of Quality 4.0 principles into the strategic planning process. Notably, it did not discuss in detail the broad value of strategic planning, the specific quality of an organization's strategic plan, or the intricacies of the implementation.

Instead, its primary objective is to optimize the strategic planning process by leveraging the transformative capabilities of Quality 4.0. Second, the framework design targets mid-size and large organizations with the necessary resources and complexities that demand a predictive and automated approach. Small operations with limited funds and resources may find it impractical. Finally, Escobar (2021) recognized that the 'evolution of problem-solving' framework remains in its early stages, while the field of practical applications for Quality 4.0 continues to expand (De Oliveira et al., 2024).

To comprehensively grasp the interplay between Quality 4.0 principles, the people-process-technology nexus, and their impact on business outcomes and customer satisfaction, future research should delve into both qualitative and quantitative investigations. Another valuable avenue for further research lies in investigating the integration of Quality 4.0 within strategic planning and its implementation.

Implications for Management

In the era of Industry 4.0, defined by digital technology, machine learning, and artificial intelligence, organizations must evaluate their readiness for Quality 4.0 adoption to thrive (Alzahrani et al., 2021). It is imperative for organizations to find ways to reduce manual data collection and leverage automation and machine learning (Emblemsvåg, 2020). While Escobar (2021) noted challenges in developing and adopting a concrete solution for monitoring and control that leverages Quality 4.0, modern quality management should be integrated in strategic planning processes to drive innovation and success in today's technological landscape (El Zein Badawi, 2020) (Soltani, 2022).

In summary, organizational management should prioritize leveraging automation and machine learning to streamline manual data collection and other monitoring and control activities as part of their strategic planning process to thrive in the modern business landscape.

Key Takeaways

Geroge (2021) introduced the people-process-plan framework serves as an additional tool in strategic planning, noting that it cannot replace the need for formality, comprehensiveness, and effective stakeholder management in the planning process. Chiarini & Kumar (2022) offered a simple Quality 4.0 framework, people-process-technology. The below key takeaways are thus organized as people-process-technology-plan for Strategic Planning 4.0.

People: Stakeholders are key in identifying and categorizing predictive defect data. To enhance strategic planning, create a roadmap that seamlessly integrates Quality 4.0 principles, ensuring alignment with organizational goals.

Process: Develop automated activities to monitor data, metrics, and KPIs, and create reports for interpretation. The systematic flow starts with identifying potential defects and emphasizes continuous learning. While embracing Quality 4.0 approaches, continue to incorporate traditional elements (e.g., timelines, resource allocation, and specific milestones).

Technology: Allocate resources for technology infrastructure (data analytics, automation, machine learning) and upskill workforce in data analysis and technology proficiency. Leverage automation and machine learning for deviations from quality standards and missed milestones, real-time monitoring, up-to-date dashboards, classifying data for discovery reports., and creating algorithms enhance efficiency and accuracy.

Plan: Continue traditional approaches to strategic planning, but cultivate an environment that values people and automated processes.

Conclusion

The next phase of quality management, Quality 4.0, leverages traditional quality management approaches with automation and machine learning. This manuscript discussed project quality management, Quality 4.0, and strategic planning, and offered a possible framework that integrates modern technology with organizational strategic planning processes, or Strategic Planning 4.0. This manuscript highlights the benefits of integrating modern technology with strategic planning processes, though limitations and challenges remain.

Quality 4.0 is a developing area of research and a definitive framework similar to traditional quality management approaches such as TQM has yet to emerge. This manuscript recommends a framework primarily geared for medium and large organizations with the budget and resources to invest in new technology. This manuscript focuses solely on integrating Quality 4.0 in the strategic planning process and does not delve into evaluating the quality of specific strategic plans or providing best practices for implementation. Further research is needed to refine a framework for Quality 4.0 and its application to all phases of strategic planning.

Strategic planning remains the bedrock of organizational strategies by cultivating a unified vision, reinforcing responsibility and accountability, and ultimately driving successful outcomes. In today's dynamic enterprise environment, aligning the strategic planning process with best practices is paramount. Through the deliberate integration of Quality 4.0 principles, forward-thinking managers can cultivate an organizational culture that values people, optimizes processes, and embraces technological advancements. This strategic alignment not only propels the organization toward "Strategic Planning 4.0," but also positions it at the forefront of innovation and sustainable growth.

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The Effects of Computer-Based Interruptions on Task Performance: Evidence from an Eye-Tracking Experiment

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Abstract

Interruptions are always occurring in the business working environment and can be annoying for workers. More importantly, interruptions can significantly delay task completion time, increase error rates, and create disruptions in the workflow. Our study investigates the effect of controlled computer-based interruptions on task completion time by utilizing an eye-tracking experimental study. Data analysis based on analysis of variance (ANOVA) on a sample of 76 participants provided significant evidence for the negative effect of computer-based interruption on task completion time.

Key Words: Computer-Based Interruptions, Eye Tracking, Behavioral IS Research, Experimental Study, and Working Efficiency.

Introduction

Interruptions are a common feature of modern work environments and can cause significant challenges across various business settings. Research has shown that they adversely affect task completion time, error rates, and overall workflow. Frequent disruptions often lead to delays, increased mistakes, and difficulty maintaining focus. Studies also reveal that interruptions raise cognitive load, making it harder to regain concentration and lowering both work quality and efficiency. However, while productive employees are expected to manage distractions, humans are generally poor at multitasking, and shifting attention between tasks can be inefficient. Therefore, understanding and managing interruptions effectively is essential to improving workplace performance.

Literature Review

Distraction

Distraction is defined as "something that diverts attention away from an ongoing" (Baron & Kenny, 1986, p.4). In this context, the "ongoing" activity refers to the primary task, while all other tasks are considered secondary. When a secondary task is unrelated to the primary task, it becomes a distraction. For instance, while using an information system, users may encounter additional information unrelated to their main objective. Processing this irrelevant information constitutes a distraction. Such distractions may arise from within the system itself—for example, receiving an unrelated email while composing one—or from external systems, such as pop-up notifications from social media during work.

According to some researchers, attention is considered a singular resource (Kahneman, 1973). Users switch their focus between the primary task and the distraction because only one stimulus can be attended to at any given moment (Jeong & Hwang, 2012). Dual-task interference

theory (DIT) indicates that the human brain faces difficulty in simultaneously handling multiple tasks without experiencing a significant decline in overall performance, even if the tasks are straightforward (Jenkins et al., 2016). The distraction effect can cause the user to put the primary tasks aside and instead engage in irrelevant activities. In this case, the user deals with the primary task and the distraction task consecutively. The users' attention is shifted away from the primary task to the distractive information, which results in the primary task's completion being delayed. Meanwhile, there are contrasting views from other researchers who propose that attention involves multiple resources that can be allocated simultaneously to different tasks. This perspective is elaborated upon by the multiple resource theory (Gupta & Irwin, 2016) and threaded cognition theory (TCT) (Salvucci & Taatgen, 2008).

Distractions are frequently linked to cognitive failures (Hadlington & Murphy, 2018; Magen, 2017). In the context of texting while driving, the distraction effect leads drivers to perceive lower levels of risk, which, in turn, prompts them to engage in more potentially hazardous behaviors (Gupta & Irwin, 2016). Also, research shows that the distraction can negatively impact working memory accuracy (Zickerick et al., 2020). Besides those negative influences, distractions can yield positive outcomes. Individuals may not realize that they are multitasking when they do. In some case, people enjoy multitasking (Czerwinski et al., 2004; Forsberg et al., 2015). Also, researchers have discovered beneficial effects of distraction, particularly in the context of background music (Blood & Zatorre, 2001; Gefen & Riedl, 2018). When individuals are exposed to background music that is unrelated to their main task, the music becomes a form of distraction. Background music do influence decision-making by enhancing people's pleasure (Blood & Zatorre, 2001)and reducing customer dissatisfaction during waiting periods(Peevers et al., 2009). Additionally, studies have shown that background music can

enhance the attention given to advertising messages (Gefen & Riedl, 2018). However, it is essential to note that most of these positive effects do not directly relate to the performance of the primary task.

The impact of distractions varies from person to person, as individuals differ in their susceptibility to them. Certain individuals are less prone to reactance than others (Drews & Musters, 2015). These individuals are likely to restrict their ability for rational reasoning and perceive threat to the feeling of freedom. When they are confronted with distraction, they may view it as an attempt to manipulate or control them, leading them to disregard it.

Interruption

Interruption is a specific type of distraction. An interruption is an externally generated, random event that disrupts the cognitive focus on the primary task (Coraggio, 1990, p.19). These interruptions typically demand immediate attention and action (Covey, 1989, pp. 150–152). Interruptions have two key characteristics: 1, these are unexpected. 2, these lead to the immediate suspension of the current task. In the area of human computer interaction, interruption is defined as "the process of coordinating abrupt changes in people's activities" (McFarlane & Latorella, 2002) In this definition, four elements are involved, including "(P) the people involved in the interruption; (T) the task(s) the person is attempting; (In) the interruption itself; and (C) the working context or environment" (McFarlane, 1997, p. 4).

The interruption involves unexpected events occurring during the primary task, like receiving an email (Addas & Pinsonneault, 2018), a systems alert notification (Jenkins et al., 2016), a security warning (Vance et al., 2018), or other notifications (Paul et al., 2015). Additionally, interruptions can also arise when the system experiences lag (Altmann & Trafton, 2015)or becomes temporarily unusable (Hodgetts et al., 2015). When interruption diverts a user's

attention, it causes delays in completing the primary task, increasing the overall cognitive processing load, and potentially influencing the quality of the primary task.

Studies proposed a model to describe the process of interruptions, which unfolds in a sequential manner (Trafton et al., 2003; Weng et al., 2017). According to the model, the interruption occurs in a time sequence comprising three stages. First, a distractor triggers the interruption, diverting the person's attention away from the primary task. Subsequently, the individual attends to the interruption, addressing or processing it. Finally, after the interruption has been handled, the person resumes the primary task. Within this process, two distinct lags are identified. The first is the interruption lag, which refers to the duration between the initial occurrence of the interruption and the moment when the person begins to deal with it. The second is the resumption lag, representing the time span between the conclusion of the interruption and the recommencement of the primary task (Weng et al., 2017). In 2015, Addas and Pinsonneault conducted a study on IT interruption, focusing on the relevance of content to primary tasks (i.e., whether it is relevant or irrelevant) and the content structure (i.e., whether it is informational, actionable, or system-related). In a subsequent study, they further classified 36 interruptions into two groups: congruent and incongruent (Addas & Pinsonneault, 2018). The term "congruent" indicates that the distractor is related to the primary task but does not directly impact its execution. On the other hand, "incongruent" refers to a distractor that is unrelated to the primary task. The study revealed that when the distractor is relevant to the primary task, it indirectly influences mindfulness in a positive manner. However, if the distractor is irrelevant to the primary task, it negatively affects the workload (Addas & Pinsonneault, 2018).

Attentional and working memory are crucial to efficiently handle interruption. Working memory run control functions, by inhibiting irrelevant information and maintaining relevant

information for a task (Baddeley, 2012). However, the process of filtering information not only supports this control but also diverts attention (Gazzaley & Nobre, 2012; Sawaki et al., 2012). In multitasking situations, it can be difficult to distinguish between secondary tasks that support the primary task and those that merely serve as distractions (Baethge et al., 2015). This effect have been studied and described as bottom-up or stimulus-driven attention (Desimone, R., & Duncan, J., 1995).

Influence of Interruption

Prior research has revealed that interruptions lead to adverse effects, including reduced accuracy (Altmann & Trafton, 2015; Trafton et al., 2003), prolonged task completion time (Addas & Pinsonneault, 2018; Carayon et al., 2007; Hodgetts et al., 2015), and diminished performance quality in handling complex tasks (Paul et al., 2015; Speier et al., 1999). Since Interruption impairs the ability to process relevant information in working memory, the time for task completion is extended and the corresponding accuracy reduced (Sakai et al., 2002). When a task is interrupted, its completion time is prolonged by two transition time intervals: 1, interruption lag, which refers to the time taken to switch from the primary task to the secondary task, 2, resumption lag, which is the time required to return from the interruption task back to the primary task (Altmann & Trafton, 2002). As a result, the completion time overall is delayed. Other streams of research show that interruption is associated with an increasing error rate. For example, Interruption is commonly seen in the daily activities of doctors in the medical field. Those distractions increased the errors rate and make it harder for doctors to back to their primary tasks (Mobeen et al., 2022).

Interruption could have harmful effect on the performance and well-being of individuals (Baethge et al., 2015). Literature shows that poorly timed notifications can have negative impacts

on workers' task performance and delay task completion. Additionally, recent smartphone use research point out that users perceive notification alerts as an interruption, which diverts their attention from their current task of driving an automobile (Caird et al., 2014; Törnros & Bolling, 2005). An early study demonstrated that receiving notifications with ringtone alerts may lead to symptoms of inattention and hyperactivity (Kushlev et al., 2016). Researchers have provided explanations for these detrimental effects of interruptions. For instance, Addas and Pinsonneault (2015) highlighted that interruptions from information technology (IT) sources can lead to information overload, burdening individuals with excessive data to process. Moreover, the time and effort required to handle interruptions have negative consequences on overall productivity (Addas & Pinsonneault, 2018).

In the workplace, individuals employ various strategies to cope with interruptions (Weng et al., 2017), which often results in the interruption being only partially addressed when they return to their primary activities (Addas & Pinsonneault, 2018). Due to our limited information processing capability, when the volume of information input surpasses our processing limitation, we experience information overload (Miller, 1956; Milord & Perry, 1977). Add high time pressure to a task can also lead to information overload (Speier, Valacich, & Vessey, 1999). Information overload can be caused by two mechanisms (Speier et al., 1999). The first mechanism involves time pressure. Interruptions consume time intended for the primary task, increasing time pressure and the risk of information overload. When users address distractions sequentially, additional time is required to refocus, further intensifying time constraints. The second mechanism concerns rising cognitive demands. Handling interruptions requires mental effort, leading to more complex cognitive processing, which can also contribute to information overload.

Many studies have identified the negative effects of interruptions on primary tasks. However, not all impacts are detrimental—some research suggests that interruptions can also enhance work performance. Although they may delay the current task, interruptions can provide opportunities to address urgent issues that might become more problematic if left unattended. (Hudson et al., n.d.) Interruptions themselves may contain valuable information that can aid primary tasks or activities. Especially when working as a team, team members collaborating in activities with shared goals, resources, deadlines, to-do items, social roles, and work practices can benefit from interruptions that provide updates and changes, as these interruptions help them respond to the changes and effectively integrate them into their work (Carroll et al., 2003). Interruption also acts as a short break from the primary tasks. Those small breaks during work are also considered as a positive practice to enhance focus and foster creativity (Abdullah et al., 2016). A qualitative study of motivation and usage of smartphone found that the use of smartphone frequently interrupted the primary task of the user (Chang et al., 2023). However, the users perceived the smartphone as a tool for improving task performance and promoting their personal well-being rather than only a distraction to primary task (Chang et al., 2023). Additionally, interruptions have the potential to offer valuable information that can aid users in accomplishing their main tasks more effectively (Addas & Pinsonneault, 2015). For example, system-generated alerts may prove to be beneficial for users, even such alerts can be considered interruptions, as security messages frequently obstruct users from completing their primary tasks (Jenkins et al., 2016). Also, according to the study conducted by Addas and Pinsonneault (2018), congruent interruptions are linked to increased subjective workload and are positively correlated with performance effectiveness, leading to better decision-making performance, higher perceived performance, and improved learning.

Some other studies find that the influence of interruption is dependent on context. Distraction confluence theory proposes that the conflict in attention between primary and secondary tasks can be induced by unexpected events. This attentional conflict heightens arousal, thereby enhancing performance on simple tasks. However, it also results in cognitive load, impairing performance on complex tasks (Addas & Pinsonneault, 2018; R. S. Baron, 1986; Speier et al., 1999). Several studies in the healthcare industry find that interruptions may have both positive and adverse effects on performance such as nurses' perceived efficiency and job satisfaction (Forsberg et al., 2015). The evidence that the interruption is associated with medical errors is still weak (Grundgeiger & Sanderson, 2009), frequent work interruption is associated with increased workload in doctors, while the interruption may provide valuable information for the primary tasks, such as a warring for error (Weigl et al., 2012). In another study, data shows that when email interruptions are related to the main task at hand, they exhibit a positive influence on performance. However, when the email interruptions are unrelated to the primary task, they lead to a negative impact on performance (Gefen & Riedl, 2018).

Research Questions

Research shows that interruption increase the task completion time (Carayon et al., 2007) Notifications have been widely regarded as interruption, particularly when they come during a primary activity. The harmful effects of interruption can last long after the interruption has ceased. The main goal of this study is to quantify the influence of interruption on the main task. We want to know how much time could be wasted because of a simple error message in a computer program.

Research questions: How do task-irrelevant computer-based interruptions affect task performance as measured by eye-tracking technology?

Methodology

Experimental Design

To investigate the influence of computer-based interruption on task performance, a traditional between-subjects experimental design was utilized. Each participant was assigned to one of two groups: the control group or treatment group. In the experiment, participants completed data analysis questions in the "Milo" system, which recorded their eye movement, and performance; after which they answered a brief survey about anxiety and cognitive load.

Experimental Procedure

All participants were undergraduate students recruited from a large research university in the United States. They received extra credit for participating, with alternative credit opportunities also provided. A total of 86 students were recruited and randomly assigned to either a control or treatment group (43 students each) to minimize selection bias. However, eye-tracking data from 10 participants could not be collected due to system failure, resulting in a final sample of 36 students in the control group and 40 in the treatment group.

Participants completed a series of data analysis tasks and a brief survey using the Milo system in a lab setting. The tasks involved selecting answers based on information presented in graphs. Afterward, participants completed a survey measuring anxiety and cognitive load. Performance was assessed by total response time and answer accuracy. The survey was developed in Qualtrics and integrated into the Milo system. To reduce external distractions and social influences, each participant completed the experiment individually.

The experiment was conducted in a 5×5-meter lab equipped with three computer stations. To prevent participant influence, only the middle station was used for data collection. Each participant sat at a desktop computer monitored by an attached camera.

Before the experiment, participants read and signed an informed consent form and received standardized verbal instructions on using the Milo system and completing the analysis questions. During the task, participants answered each question based on a data graph (see Figure 1), with each question shown only once. They were given up to 15 minutes to complete the entire session.

Figure 1:

Data graph example

Experimental Manipulation

A designed interruption served as experimental manipulation for the treatment group. In this condition, participants encountered a pop-up message (see Figure 2) that acted as an external stimulus, requiring a passive response before continuing the task. Ten seconds after viewing a question, the pop-up automatically appeared, blocking the screen. Participants were instructed to press Shift + Space to dismiss the window and resume the task. iMotions facial recording

software captured participants' responses to the interruption. The control group did not receive any interruption during the experiment.

Figure 2:

Pop-up message
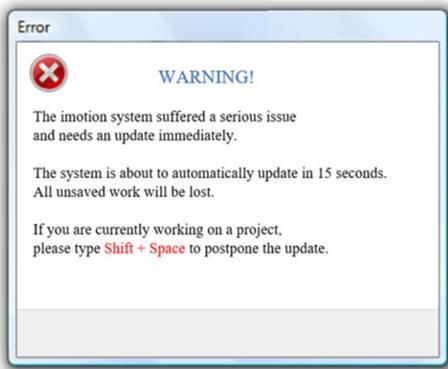
Tools for Measurement

During the experiment, participants answered data analytics-type questions using a system named Milo, which is an eye movement and facial expression-capture system. It uses eye tracking hardware (Tobii X60) and iMotions software (version#) to assess visual attention measured by gaze and fixation characteristics.

Measurement

To examine the impact of distraction on user behavior, this study drew upon several theoretical frameworks, including memory for goals theory, processing efficiency theory, attentional control theory, cognitive load theory, working memory theory, distraction conflict theory, and resource matching theory. Four constructs were used: distraction, anxiety, cognitive load, and task performance. Anxiety and cognitive load were treated as physiological measures, while distraction and task performance were measured behaviorally.

The study compared performance between the control group (0) and the distraction group (1), with performance assessed by the time participants spent answering data analysis questions immediately following each distraction.

Performance

In this study, less time spent on a task was interpreted as better performance. The iMotions system recorded the time each participant took to complete each question, with data captured to the millisecond. For analysis, the time was converted to seconds to enhance practical interpretation.

Task time measured only the duration spent answering the analysis questions, beginning from the participant's first fixation on the question. It excluded time spent on distractions or responding to the distraction message. Facial expression recordings were also used to verify when and whether participants engaged in the secondary task.

Considerations of the Design

One key design consideration is the potential learning effect. Since the tasks involve graphical analysis, participants were asked to interpret graphs and answer related questions. Given varying levels of skill in this area, the first 12 questions—presented before the distraction—served as a learning phase, familiarizing participants with all questions and graph types used in the study. After completing these questions, participants were expected to competently handle the remaining questions following the distraction.

The experimental manipulation targeted participants' attention. If a participant read the distractive material and shifted focus from the primary task, the manipulation was considered

successful. The iMotions system recorded participant behavior to support this manipulation check.

<p style="text-align:center">Data Analysis and Results</p>

SPSS version 28.0.1.1 (IBM Corp., 2012) was used for hypothesis testing and preliminary and post-hoc data analyses. Several one-way analyses of variance (ANOVAs) were conducted to test the influence of distractions on user performance. Fixation and gazed points are also additionally measured using the metrics recorded by the iMotions.

ANOVA was carried out to test the hypothesis that there is a significant difference in participants' task completion time followed by interruption. The results of a one-way ANOVA showed there was a significant effect of interruption on time spent on task ($F\ [1, 84] = 13.74$, $p <.001$). Participants in the control condition ($n = 43$, $M = 38.802$, $SD = 17.986$) spent less time on the primary task than participants in the treatment group ($n = 43$, $M = 53.516$, $SD = 18.819$). Furthermore, the assumption of homogeneity of variances was tested and satisfied based on Levene's F test ($F\ [1,84] = .03$, $p = .863$). The data supported our hypothesis.

We use dummy code for accuracy of the task, "1" means correct and "0" means incorrect. The results of a one-way ANOVA showed that there is no statistically significant difference in the effect of distraction on the accuracy with which participants performed the task ($F\ [1, 84] = .058$, $p = .810$). Participants in the control condition ($n = 43$, $M = .72$, $SD = .45$) showed a similar accuracy rate for the primary task as those in the interruption condition ($n = 43$, $M = .72$, $SD = .40$).

Saccades are quick, simultaneous movements of both eyes between two or more phases of fixation. In this experiment, the saccade rate refers to the frequency of rapid eye movements made by a person during a task. iMotions record also shows that distracted individuals would have a higher saccade rate and a lower fixation rate than undistracted individuals. The fixation rate was collected by iMotions, with a data set of 76 eye tracking measurements successfully collected. The results of a one-way ANOVA showed that there was no statistically significant effect of distraction on saccade rate (F [1, 74] = .48, p = .49). Participants in the control condition (n = 36, M = 37.22, SD = 15.05) had a lower saccade rate than those in the interruption condition (n = 40, M = 39.62, SD = 15.21).

iMotion record shows that the distraction group would spend more time on fixation. The results of a one-way ANOVA showed that there was a significant effect of distraction on fixation time spent on task (F [1, 74] = 4.013, p = .01). Participants in the undistracted group (n = 36, M = 24.14, SD = 11.58) spent less time on fixation than those in the interruption condition (n = 40, M = 31.86, SD = 13.56). Furthermore, the assumption of homogeneity of variances was tested and satisfied based on Levene's F test (F [1,74] = .214, p = .65). Apendix A shows the output pages from SPSS.

Discussion of the Result

The hypothesis examined the relationship between interruptions and task completion time. The results supported the prediction that individuals interrupted by computer-based distractions would take longer to complete tasks than those who were not interrupted. Specifically, the study found that interruptions temporarily reduced task efficiency. Participants in the distraction group spent more time on the primary task, although their answer accuracy was

comparable to that of the control group. According to process efficiency theory, individuals can adjust the time spent on a task and its effectiveness while keeping efficiency constant (Eysenck & Calvo, 1992). When distracted, individuals face reduced efficiency and must choose between spending more time or accepting lower output quality. In this study, participants opted to invest additional time to maintain accuracy. On average, those in the computer-based interruption condition spent 14.71 more seconds completing the same questions with similar accuracy. These findings further support our hypothesis.

The findings show an increase in saccade rate after distraction. One of the explanations proposed by previous research is that the saccade rate consistently reflects individuals' anxiety level (Tichon, Wallis, Riek, & Mavin, 2014). Attentional control theory suggests that distraction increases anxiety because it influences the function of the attentional control system (Eysenck & Derakshan, 2011). Eye movement data in this study confirmed an increase in saccade rates following distraction. Participants in the computer-based interruption group exhibited higher saccade rates than those who were not interrupted, suggesting elevated levels of anxiety.

The findings show an increase in Fixation time after distraction. Research has found that an increase in fixation is associated with cognitive load increase (Gould, 1973). Cognitive load theory posits three types of cognitive load: intrinsic, extraneous, and germane (Paas et al., 2003). Distraction increases both intrinsic and extraneous loads, placing greater demands on working memory resources. The data reveal that distracted participants spent more time fixating on the area of interest, which previous research has shown to be an indicator of cognitive load (Behroozi et al., 2018; Marandi, Madeleine, Omland, Vuillerme, & Samani, 2018). These findings support the idea that distraction indeed increases cognitive load.

Implications for Research

This research contributes significantly to the field of information systems (IS) scholarship in several ways. Firstly, it delves into the impact of distractions on individual task performance by combining distraction-conflict theory (R. S. Baron, 1986) and cognitive load theory (Paas et al., 2003). These two theoretical frameworks were integrated to provide a comprehensive explanation of how interruptions caused by computer systems affect the completion of primary tasks.

Secondly, this study adopts a novel approach by using a physiological tool—rather than relying solely on self-reported perceptions—to measure cognition and task performance. Addressing a gap in recent IS research, it employs the iMotions eye-tracking system to capture key behavioral metrics such as task duration and cognitive load.

Third, the study investigates the effect of a single computer-based interruption on task performance. While prior research has explored distraction frequency and timing, few studies have focused on one-time system-generated interruptions. This study addresses that gap, emphasizing the importance of precise measurement in detecting subtle performance changes. With performance differences measured in mere seconds, the iMotions system's millisecond-level accuracy makes it well-suited for capturing individual behavioral responses.

Implications for Practice

This research provides valuable practical insights by offering empirical evidence that computer-based interruptions not only extend task completion time but also increase the cognitive effort required to resume the primary task. The study demonstrates that even brief, one-time interruptions can negatively affect performance.

From a managerial perspective, these findings highlight the need for organizations to accurately assess the lasting impact of system-related disruptions. The extended effects stem not

only from the time spent on the secondary task but also from its influence on employees'
cognitive processes.

Additionally, the study shows that distractions elevate both anxiety and cognitive load.
As anxiety can significantly impair productivity, emotional regulation becomes a vital
component of effective organizational management, especially in multitasking environments.
Managers can apply these insights by implementing strategies to minimize interruptions and
support employees' emotional well-being, thereby reducing the negative impact on performance.

Conclusion

This research offers significant contributions to our understanding of how distractions
affect task performance. Specifically, it addresses the research question: How do task-irrelevant
computer-based interruptions influence task performance as measured by eye-tracking
technology? By employing an eye-tracking system, the study monitored user behavior across
undistracted, mandatory interruption, and multitasking conditions, enabling direct comparison of
behavioral outcomes.

The findings clearly indicate that task-irrelevant computer-based interruptions have
detrimental effects, increasing anxiety and cognitive load while reducing task efficiency. The
results also show that both primary and secondary task durations are extended when interruptions
disrupt the flow of the primary task.

Moreover, the study demonstrates the effectiveness of eye tracking as a method for
behavioral data collection and analysis, reinforcing its value in research on distractions and
cognitive performance.

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**Identifying the Effectiveness of Training Program in the Workplace:
A Meta-Analysis of Relationships among Training Evaluation Criteria**

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Abstract

This study aims to identify the positive relations among training criteria including reaction, learning, job performance, and organizational impact based on Kirkpatrick's four-level training evaluation model. This study collected the previous studies associated with evaluations and effectiveness of training programs in organizations and conducted a meta-analysis. A summary of the searching and screening process based on a PRISMA flow diagram is demonstrated. This study contributes to theories in the field of employee training development and corporate teaching evaluations. Methodologically, this study serves as an example of how meta-analysis can be used to synthesize previous studies of business information system topics.

Keywords: training evaluation criteria, Kirkpatrick model, meta-analysis

Identifying the Effectiveness of Training Program in the Workplace:

A Meta-Analysis of Relationships among Training Evaluation Criteria

Since Donald Kirkpatrick published four articles triggered by his doctoral dissertation in the late 1950s addressing a four-level training evaluation model (Kirkpatrick, 1959a, 1959b, 1960a, 1960b), the model has been easily understood and become the most influential and prevalent one in the field of human resource (HR) (Alliger & Janak, 1989; Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997). Kirkpatrick argues that training can be evaluated using four criteria or levels of evaluation: reaction, learning, job performance, and organizational impact (Kirkpatrick & Kirkpatrick, 2006).

At level 1, originally, to evaluate reactions was to ask trainees how they liked and felt about training (Alliger & Janak, 1989). The instruments on level 1 require opinions about the training content, materials, instructors, environment, and delivery methods (Kirkpatrick, 1959a; Kirkpatrick & Kirkpatrick, 2006). Learning as level 2 training criterion is identified by results from the examination of what trainees learned from the training program. Learning is referred to "as the extent to which participants change attitudes, improve knowledge, and/or increase skill as a result of attending the program (Kirkpatrick & Kirkpatrick, 2006, p. 22)." Level 3, job performance, is applied to highlight the on-the-job nature of a criterion, which is associated with learning transfer. The instruments on level 3 assess how trainees apply their attained knowledge and skills on the job. (Kirkpatrick, 1960a). Lastly, organizational impact at level 4 measures business results from the training program including organizational change or monetary and/or numerical value. In general, both HR and business information (BI) scholars and practitioners are likely to consider organizational impact the most significant and challenging level to assess (Werner & DeSimone, 2005; Kirkpatrick, 1960b; Kirkpatrick, 1998; Phillips, 1996).

Rationale and Research Questions

One of the questionable assumptions about training criteria of a four-level training evaluation model is that they are causally linked and positively intercorrelated (Alliger & Janak, 1989). Following the assumption, many HR scholars assume that positive reactions encourage effective learning, and this learning can contribute to behavioral changes and ultimately improve organizational results (Alliger & Janak, 1989; Hilbert, Preskill & Russ-Eft, 1997; Kirkpatrick & Kirkpatrick, 2006). In other words, as long as the significance of the positive relations among criteria is demonstrated, researchers and professionals can estimate the effectiveness of job and organizational performance only with results from level 1 and 2. Indeed, the most commonly gathered training criteria are trainee reactions (Bassi, Benson, & Cheney, 1996; Saari, Johnson, McLaughlin, & Zimmerle, 1988) because they are easier to collect than the other levels. In addition, previous research has addressed that level 2 is the most popular level adopted to measure training programs (Bersin, 2003) even though some studies do not advocate equivalence between learning and job performance (Strunk, 1999).

Despite the significance of the relations among the training criteria, there have been few synthetic studies on identifying the relations. At first, many previous studies on training evaluation have likely examined training programs' contribution to enhancing organizational performance such as productivity, innovation, customer satisfaction, and financial performance (Aguinis & Kraiger, 2009; Kim & Ployhart, 2014; Noe, Clarke, & Klein, 2014). These studies may yield a serious mistake to bypass level 1 and 2 because this would result in inappropriate conclusions about the effectiveness of the training program (Kirkpatrick 1959a; Kirkpatrick & Kirkpatrick, 2006). Next, many scholars in HR and BI have adopted the alternative evaluation models that are similar to and different from a four-level training evaluation model, including

input, process, output (IPO) model (Bushnell, 1990), Phillips' five levels of evaluation (Phillips, 1999, 2003), performance improvement evaluation model (Swanson, 1994), and three level evaluation and research model (Holton, 1996). Although the relations among criteria may be identified through comparative analysis with these analogous models, there is a limit to the lack of empirical evidence on them. Most importantly, to date, there have been few meta-analyses on the relations among training criteria published that have synthesized findings of each criterion from individual studies. Although Alliger and his colleagues (1997) and Nawaz and Khushnood (2022) conducted a meta-analysis on the relations among training criteria, the studies have a limitation in that there were few or no correlations since there were very few studies on level 4 criteria. Accordingly, a new meta-analysis on the relations among training criteria needs to be conducted.

With the rationale, this study aims to identify the positive relations among training criteria including reaction, learning, job performance, and organizational impact, based on Kirkpatrick's four-level training evaluation model. Thus, the research question for this study is: *What is the correlation between reaction and learning, and job and organizational performance? How do participants' positions and types of interventions (training contents) moderate these relationships?* To answer this question, I collected the previous studies associated with training evaluation in business and conducted a meta-analysis.

Universe of Generalization

A central aspect of statistical inference should make a generalization from an observed sample to a larger population or universe of generalization. The result of this analysis can be generalized to organizations that are similar to those that are represented in the sample, with participants who are similar to those represented in the sample. Thus, this study will enable

researchers to reinterpret the concept of the meanings of the four criteria and provide justification to adhere to a four-level training evaluation model. In addition, through the validation of relations among criteria, HR practitioners would provide results of level 1 and 2 as evidence on the necessity of training programs to stakeholders and policymakers in an organization who are more interested in organizational and financial effectiveness from training interventions that is a more challenging level to assess.

Method

Searching Strategy

In order to search primary research and avoid missing a valuable paper related to the topic of this study, four search strategies were adopted in order: consultation, searches in subject indexes, browsing, and citation search. First of all, I asked an expert who is well known for evaluation and assessment in the field of HR. Through consultation with her, I was able to conceptualize trends and main arguments on the topic. In addition, she provided significant search terms and journals associated with the evaluation model in HR and BI. To confirm the validity of the search terms and limits, I also asked colleagues and faculty members at the Academy of Human Resource Development Conference on February 22, 2024.

Next, I found primary studies through a computer search of abstract databases, using EBSCOhost (Education Source), EBSCOhost (ERIC), Ovid (PsycInfo), and EBSCO (Business Source Premier). The first search was conducted in databases on October 15, 2024, and the last search was conducted on November 15, 2024. The keywords with Boolean operators can be classified into three categories, given that this study aims to identify the positive relations among training criteria including reaction, learning, job performance, and organizational impact, based on Kirkpatrick's four-level training evaluation model. First, since I fundamentally focused on

Kirkpatrick's model, I adopted "Kirkpatrick*", or "Kirkpatrick four-level training evaluation model" OR "Kirkpatrick evaluation" OR "Kirkpatrick training" OR "four-level training evaluation" OR "four-level assessment". In addition, considering that some studies utilized similar models or frameworks that includes four different evaluation criteria in HR, I searched evaluation or assessment studies on training and development, by using these terms such as "evaluation training and development" OR "assessment training and development" OR "measurement training and development" OR "evaluation HR" OR "assessment HR" OR "measurement HR". Lastly, given that evaluation criteria should be included in primary studies to be analyzed, I used these terms including "reaction AND learning AND job performance AND organizational impact", or "reaction AND learning AND learning transfer AND business performance", or "reaction AND learning AND job transfer AND business outcome".

The limits that were placed on the research are language, year, and journals. First, the search limited to studies that are only in English. In addition, studies after 1959 were searched because Kirkpatrick announced a four-level training evaluation model in 1959 and papers published before 1959 may not be relevant to the model. Moreover, I narrowed down the search to journals related to training research, recommended from consultation: (1) human resource development and training and development such as *Human Resource Development Quarterly, Human Resource Development Review, Human Resource Development International, Advances in Developing Human Resources, Training and Development Journal, Training and Education, European Journal of Training and Development,* (2) Psychology such as *Journal of Applied Psychology, Journal of Applied Behavioral Science, Personnel Psychology, International Journal of Psychology,* and (3) Management such as *Academy of Management Journal, Academy of Management Review, Personnel, Group and Organizational Studies, Human Factors, Human*

Relations, Journal of Management, Journal of Organizational Behavior, Public Personnel

Management Journal. On the other hand, I did not limit any geographic region since the

evaluation of training and development in HR should be considered all around the world.

To maximize the amount of relevant primary research included, several other search

strategies were employed. In terms of browsing, I searched Google Scholar on October 15, 2024,

with the search terms such as "Kirkpatrick four-level training evaluation model", "evaluation

training and development", and "evaluation HR". In this strategy, based on the model level search

terms rather than the criteria level terms, this search was repeated to find relevant resources.

Additionally, in order to avoid missing any unpublished studies, I searched ProQuest Digital

Theses/Dissertations and OSF Preprints on October 16, 2024, by using the same search terms in

searching Google Scholar. Finally, I searched the websites related to the four-level training

evaluation model in HR including "Kirkpatrick Partners" and "ROI Institute". Since they also issue

their reports, I found additional resources through the websites.

Lastly, after completing a search for primary studies associated with the topic and research

questions and removing duplicates, I conducted a backward and forward citation search to examine

other relevant sources by using Zotero. Backward citation searches were conducted for journals

that appeared more than three times in the included study dataset by searching the reference lists

of included articles for new possible studies. Newly identified studies were screened for

eligibility criteria. In addition, a forward citation search was conducted for all included studies

after duplicates removed, and any new articles were screened for inclusion/exclusion. When new

articles were included, reference lists were reviewed at the end.

Eligibility Criteria

In order to acquire transparency and replicability of this study, I establish eligibility

criteria for seven dimensions: (1) language, (2) year of publication, (3) population, (4) research

methodology, (5) learning type, (6) evaluation criteria, and (7) research model with the statistical result.

First, the resources were limited to studies that were only in English. In addition, studies after 1959 were included because Kirkpatrick announced a four-level training evaluation model in 1959 and papers published before 1959 may not be relevant to the model. Next, in terms of population, I excluded any studies that are not related to adults since the four-level evaluation model is based on the training and development of adults in an organization. Thus, I excluded any training evaluation model research employing children, adolescents, and college or graduate students. Since the age of trainees can vary, I did not consider age as an exclusion criterion. Also, since this model is appropriate for individual-level training, any studies with collective subjects such as an organization, group, or team were excluded. Next, as for research methodology, only quantitative research was included, and qualitative and non-empirical studies, such as conceptual studies and integrative review studies, were excluded. In addition, about learning type, I excluded any studies focused on informal or incidental learning because the evaluation model is fitted with formal training and development. Therefore, I excluded any studies on evaluation related to informal learning, action learning, and facilitated learning such as mentoring or coaching in HR. Moreover, among evaluation criteria including reaction, learning, job performance, and organizational impact, studies that did not have any criteria at all were excluded. Since the purpose of this study is to identify the relations among four criteria, four criteria should be constituted to be classified into the final inclusive resources. Finally, in a similar vein, studies that did not mention relations or associations between criteria at all were excluded. Since all of the relations did not have to be mentioned, studies should have demonstrated at least the partial relations among the criteria.

Coding Process and Interrater Reliability

In order to acquire interrater reliability (IRR), the coder's reliability was considered. As depicted in Figure 1, the coding was conducted by the general process. Before coding variables, the primary coder created the coding manual as a draft at first and asked the second coder after considering an appropriate candidate. The second rater was a fourth-year doctoral student in the field of HR. The primary and the second rater had an initial meeting to share the purpose of the study, and the inclusion and exclusion criteria. After the primary author completed the initial search, the second rater conducted the subsequent screening such as title and abstract screening, and full text review. In this stage, the coders excluded irrelevant studies based on eligibility criteria.

Figure 1

Coding Process
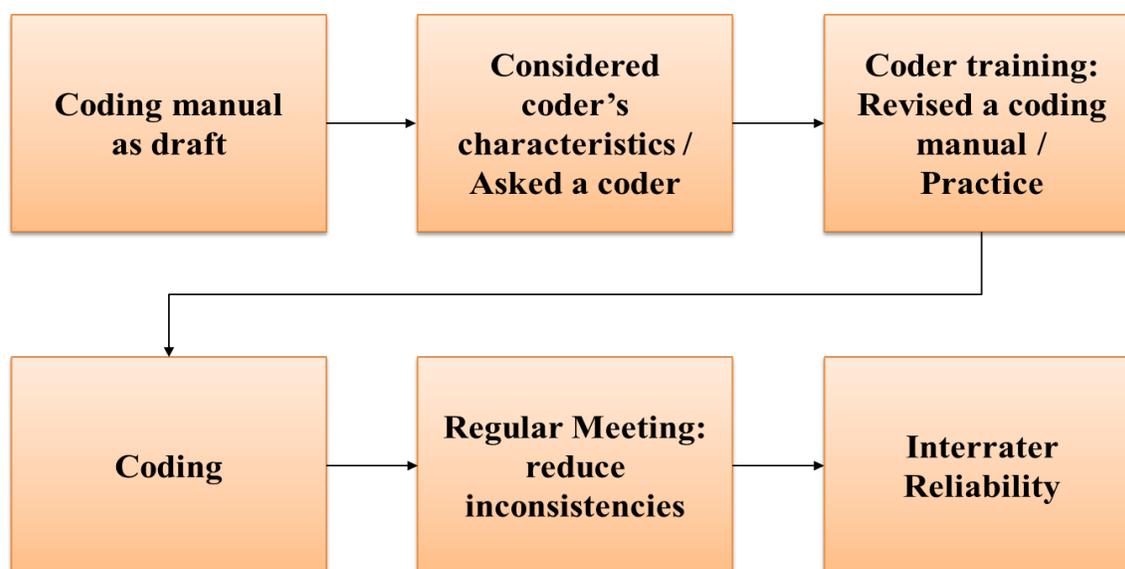
Next, in the stage of coding variables, for gaining the consistency and accuracy of the information from primary studies, both coders had a training session after the primary coder developed the coding manual as a draft. During the first meeting, the coders reviewed all of the

variables and adjusted the coding manual by practicing to code values from three primary studies at the same time. A set of articles was double-coded by two coders since the search results included a small sample. During coding values, the coders had a consensus meeting to discuss unclear information and arguable criteria, and resolved disagreements so that the coders had reduced inconsistencies and coder drift that may be reflected in the coding process. Finally, in order to assess IRR, Cohen's kappa was used for categorical variables and continuous variables. The values of Cohen's kappa were 1 for every variable except 2 variables including type of intervention (0.6) and intensity of intervention (0.4). After a discussion with the secondary rater, it became apparent that this was a problem in operationalization, and it was corrected in the final coding.

Coded Variables

In the coding manual, information was classified into six parts: report identification, study setting, participants, methodology, treatment or experimental manipulations, and measure and effect size. In order to increase coding efficiencies and accuracy, the two coders classified six types of information into four variable levels: study-level, sample-level, intervention, and outcome. Each database related to variable levels was exported in a Microsoft Excel spreadsheet.

Study-Level Variables

All values related to study-level variables were coded including report identification, study setting, and methodology. The following variables were included: (1) study ID, (2) author's name, (3) journal name, (4) year of publication, (5) type of publication, (6) type of research methodology, and (7) level of analysis. Most variables within the study-level dataset were treated as categorical variables except for the author's and journal name as free entry, and year of publication as a continuous variable. Regarding research methodology, the type of

research methodology was classified into five categories including quantitative research, qualitative research, conceptual study, integrative review study, and other. In addition, the values of the level of analysis were coded as individual, group/team, department, firm, and other.

Sample-Level Variables

All values related to sample-level variables were associated with information about participants among six types of information. The following variables were included: (1) study ID, (2) group ID, (3) adult or not, (4) type of organization, (5) gender, and (6) position. All of the variables within the sample-level dataset were treated as categorical variables and missing data was coded as nine. To be more specific, adult or not was coded as either adult or non-adult including children, adolescents, college, and graduate students. Since the type of organization and position may have the potential to influence training contents, the coders classified them into each categorical variable: business, government, army, school, and other, and position with employee, manager/supervisor, executive and C-level, and overall employee.

Intervention Variables

The data extracted from the primary studies were consistent with treatment or experimental manipulations including (1) study ID, (2) group ID, (3) type of intervention, (4) intensity of intervention, and (5) role of evaluator. All of the variables in the intervention dataset were treated as categorical variables and missing data was coded as nine. Since the type of intervention is likely to be associated with training contents, it was included in the intervention variable, which was coded as vocational training, leadership training, and organizational training. Intensity of intervention was also coded since it may be regarded as a moderator: less than 8 hours, 8 hours (1 day), 1 week, 2 weeks to 4 weeks, 5 weeks to 8 weeks, 8 weeks to 6 months, 7 months to 1 year, and longer than 1 year. In addition, the role of evaluators was classified into

five values: 'evaluator delivers intervention', 'evaluator is designer of program', 'evaluator is influential in service setting but has no direct role in delivering, controlling, or supervision', 'evaluator is independent of service setting and intervention.'

Outcome Variables

All values associated with outcome variables stemmed from the information of the measure and effect size. The following variables were included: (1) study ID, (2) group ID, (3) evaluation model, (4) sample size, (5) correlation, and (6) standard deviation. Study and group ID, and evaluation model were treated as categorical variables, whereas sample size, correlation, and effect size were regarded as continuous variables. In terms of the evaluation model, the coders tried to clarify whether Kirkpatrick's four-level training evaluation model was adopted or not, coded as Kirkpatrick's model, a model including four-level criteria, a model including partial criteria, and others. In addition, as for the correlation between two continuous criteria, the coders recorded values of covariance between reaction and job performance, reaction and organizational impact, learning and job performance, and learning and organizational impact. Since the primary studies were not likely to address effect sizes, the coders coded values required for computing effect sizes for examining correlation between two continuous criteria including sample size, standard deviation of the predictor (reaction and learning) and outcome (job performance and organizational impact) variables, and the above-mentioned covariance between two variables (four in total).

Statistical Analyses

Missing Data Analysis and Calculation of Effect Size

The dataset was examined for missing data. Calculating or gaining correlations between evaluation criteria is the most significant for the main argument of this study and the effect sizes.

When I encountered any studies that had missing information related to covariance, I contacted the primary authors for information that would make it possible or found information in another report of the same study. When I did not gain information related to covariance, these studies that still had missing information were only included in the descriptive results.

In terms of categorical missing moderators, I searched other publications on the same study to gain the missing information. In addition, I inferred and created a missing value based on the other information from the primary study; for example, organizational types were inferred from the names and characteristics of organizations. When moderators were not inferred, listwise deletion was used.

Since no primary study provided effect sizes, I calculated effect sizes from other information provided in the primary studies. At first, I computed Pearson r by using the covariance between two criteria, sample size, a standard deviation of the predictor (reaction and learning) and outcome (job performance and organizational impact) variables. Next, Fisher's Z-transformed correlation effect size was addressed since the transformation can contribute to improved comparisons of both the statistic and variances by normalizing the estimate and variance. The transformation to Fisher's z is shown here:

$$z = 0.5 \ \ X \ \ ln \left(\frac{1 + r}{1 - r} \right)$$

Examining Outliers and Identifying Publication Bias

Among various approaches to the detection of outliers, visual inspection methods were utilized to identify potential outliers. Particularly, a box plot was adopted, which can allow researchers to discover potential outliers easily by providing a visual distribution of numerical summaries including the central location, how spread out the data are, and the shape of the distribution.

In order to avoid a file drawer issue, the publication bias should be identified and assessed. One criticism of the meta-analytic approach is that results may largely be biased due to a failure to include both published and unpublished literature (Greenhouse & Iyengar, 2009). Unpublished literature may be systematically different and only statistically significant results are published. A funnel plot was used to identify publication bias in the dataset. In addition, an Eggers test was conducted to examine the symmetry of the funnel plot as well as test the hypothesis of publication bias. Lastly, Trim and Fill method (Duval & Tweedie, 2000) was utilized to assess the impact of publication bias when I interpreted that publication bias exists in the dataset.

Meta-Regression

In order to identify and adjust the effect size estimates of outliers, average effect sizes were calculated through an intercept-only random-effects meta-regression model. To avoid artificially reducing variance estimates and inflating Type I error because of effect size dependencies (Borenstein, Hedges, Higgins, & Rothstein, 2009), I employed the robust variance estimation (RVE) procedure developed by Hedges, Tipton, and Johnson (2010).

To determine if a moderator analysis would be warranted, the effect size estimates were evaluated through the I^2 statistic proposed by Higgins and Thompson (2002), which is calculated as follows:

$$I^2 = (\frac{Q - K}{Q}) \text{ X } 100\%$$

I^2 can provide a practical interpretation of heterogeneity in which $I^2 < 50\%$ is representative of small heterogeneity, $50\% \leq I^2 < 75\%$ is representative of medium heterogeneity, and large heterogeneity is represented by an $I^2 \geq 75\%$ (Higgins & Thompson, 2002).

Results

Study Selection and Description of Sample

Figure 2

PRISMA Flow Diagram Examining the Search and Screening Process of the Meta-Analysis
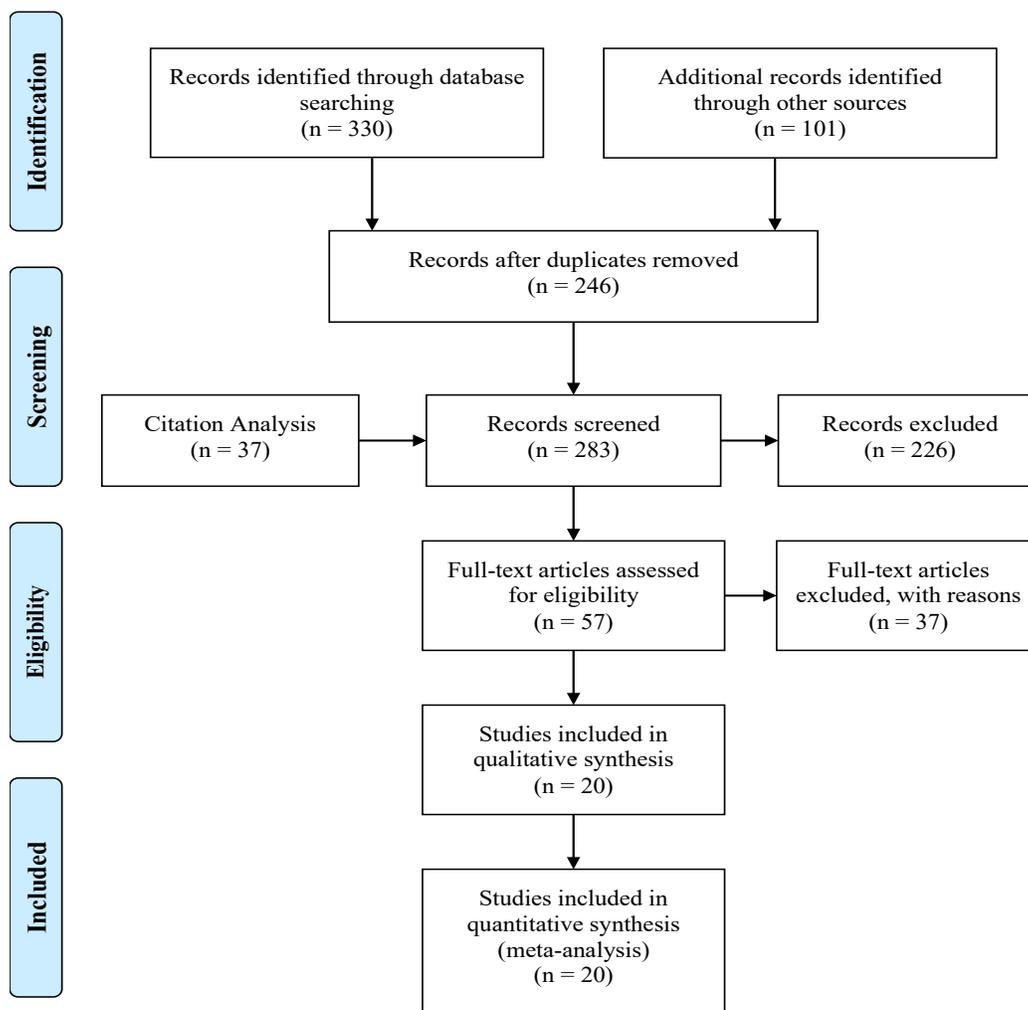
In total, 283 studies were examined based on a consultation, database search, internet browsing, and backward and forward citation. A summary of the searching and screening process based on a PRISMA flow diagram can be shown in Figure 2. While the search of EBSCOhost (Education Source), EBSCOhost (ERIC), Ovid (PsycInfo), and EBSCO (Business Source Premier) yielded 330 studies, 101 studies were searched through other sources including Google Scholar, ProQuest Digital Theses/Dissertations, OSF Preprints, Kirkpatrick Partners, and

ROI Institute. Additionally, backwards and forwards citations searches yielded 37 studies after duplicates were removed. A total of 283 studies were subsequently narrowed down to 57 studies that were qualified for the inclusion criteria. Final full text screening resulted in a sample of 20 studies, only including published journal articles since 7 unpublished dissertations were not allowed to be accessed.

The final sample of 20 was retained following the eligibility criteria outlined earlier in this paper. These 20 studies produced 46 effect sizes of correlations coefficient between evaluation criteria based on 3,134 participants. Table 1 presents the description of studies for author, year, sample size, features of intervention and participants, ranging from the year 1982 to the year 2013. Trends in publication year suggest primary studies have gradually decreased since 2000 as only 15% of studies (3 out of 20) were published. In contrast, particularly in the 1990s, 55% of primary studies (11 out of 20) had been conducted. Among 20 studies, two first authors such as Gist and Mathieu were involved in two different studies, while the other 16 studies were conducted by various authors. In addition, in regard to sample nationality, most studies were conducted in the U.S. while only four studies were conducted outside of the U.S.

Table 1

Description of Studies Included in Meta-Analysis

Author	Year	Journal Name	N	Organization
Baldwin	1992	Journal of Applied Psychology	72	School
Clement	1982	Public Personnel Management	50	Government
Eden & Shani	1982	Journal of Applied Psychology	105	Army
Frayne & Latham	1987	Journal of Applied Psychology	40	Government
Gist	1989	Personnel Psychology	59	Government
Gist et al.	1989	Journal of Applied Psychology	108	School
Harrison	1992	Journal of Applied Psychology	65	Government
Hutchins et al.	2013	International Journal of Selection and Assessment	235	School
Leach & Liu	2003	Journal of Personal Selling & Sales Management	445	Business
Mathieu et al.	1993	Personnel Psychology	215	School
Mathieu et al.	1992	Academy of Management Journal	106	School
Noe & Schmitt	1986	Personnel Psychology	60	School

Author	Year	Journal	N	Type
Quinones	1995	Journal of Applied Psychology	69	School
Saks & Burke	2012	International Journal of Training and Development	150	Business
Tannenbaum et al.	1991	Journal of Applied Psychology	666	Army
Tracey et al.	1995	Journal of Applied Psychology	104	Business
Tziner & Falbe	1993	International Journal of Psychology	73	Army
Warr & Bunce	1995	Personnel Psychology	106	Business
Werner et al.	1994	Human Resource Development Quarterly	150	School
Wexley & Baldwin	1986	Academy of Management Journal	256	School

| Author	Domestic or International	Position	Type of intervention	Intensity of Intervention	Evaluation Model
Baldwin	Domestic	Employee	Leadership	2.5 hours	Kirkpatrick
Clement	Domestic	Employee	Leadership	5 days	Kirkpatrick
Eden & Shani	International	Manager	Leadership	15 weeks	Others
Frayne & Latham	Domestic	Manager	Leadership	8 hours	Kirkpatrick
Gist	Domestic	Manager	Leadership	3 hours	Others
Gist et al.	Domestic	Manager	Leadership	3 hours	Others
Harrison	Domestic	Manager	Leadership	24 hours	Kirkpatrick
Hutchins et al.	Domestic	Employee	Leadership	1 day	Others
Leach & Liu	Domestic	Employee	Vocational	1 year	Kirkpatrick
Mathieu et al.	Domestic	Employee	Vocational	8 weeks	Kirkpatrick
Mathieu et al.	Domestic	Employee	Vocational	8 hours	Kirkpatrick
Noe & Schmitt	Domestic	Manager	Vocational	16 hours	Kirkpatrick
Quinones	Domestic	Employee	Vocational	1 hours	Kirkpatrick
Saks & Burke	International	Employee	Leadership	6 months	Kirkpatrick
Tannenbaum et al.	Domestic	Employee	Vocational	8 weeks	Kirkpatrick
Tracey et al.	Domestic	Employee	Vocational	3 days	Others
Tziner & Falbe	International	Employee	Vocational	8 hours	Others
Warr & Bunce	International	Employee	Leadership	4 months	Kirkpatrick
Werner et al.	Domestic	Employee	Vocational	2 weeks	Kirkpatrick
Wexley & Baldwin	Domestic	Employee	Leadership	3 hours	Kirkpatrick

Diagnostic Analyses

Missing Data and Effect Sizes

Overall, although I gained 46 effect sizes of correlations coefficient between evaluation criteria. While 36 effect sizes of the correlations were obtained about the correlations between reaction and job performance with the 4 missing covariances between reaction and job performance, 15 studies of 20 studies did not provide any covariances between reaction and organizational impact, and learning and organization outcome. In terms of categorical missing moderators, all of the values were discovered and inferred as presented in Table 1.
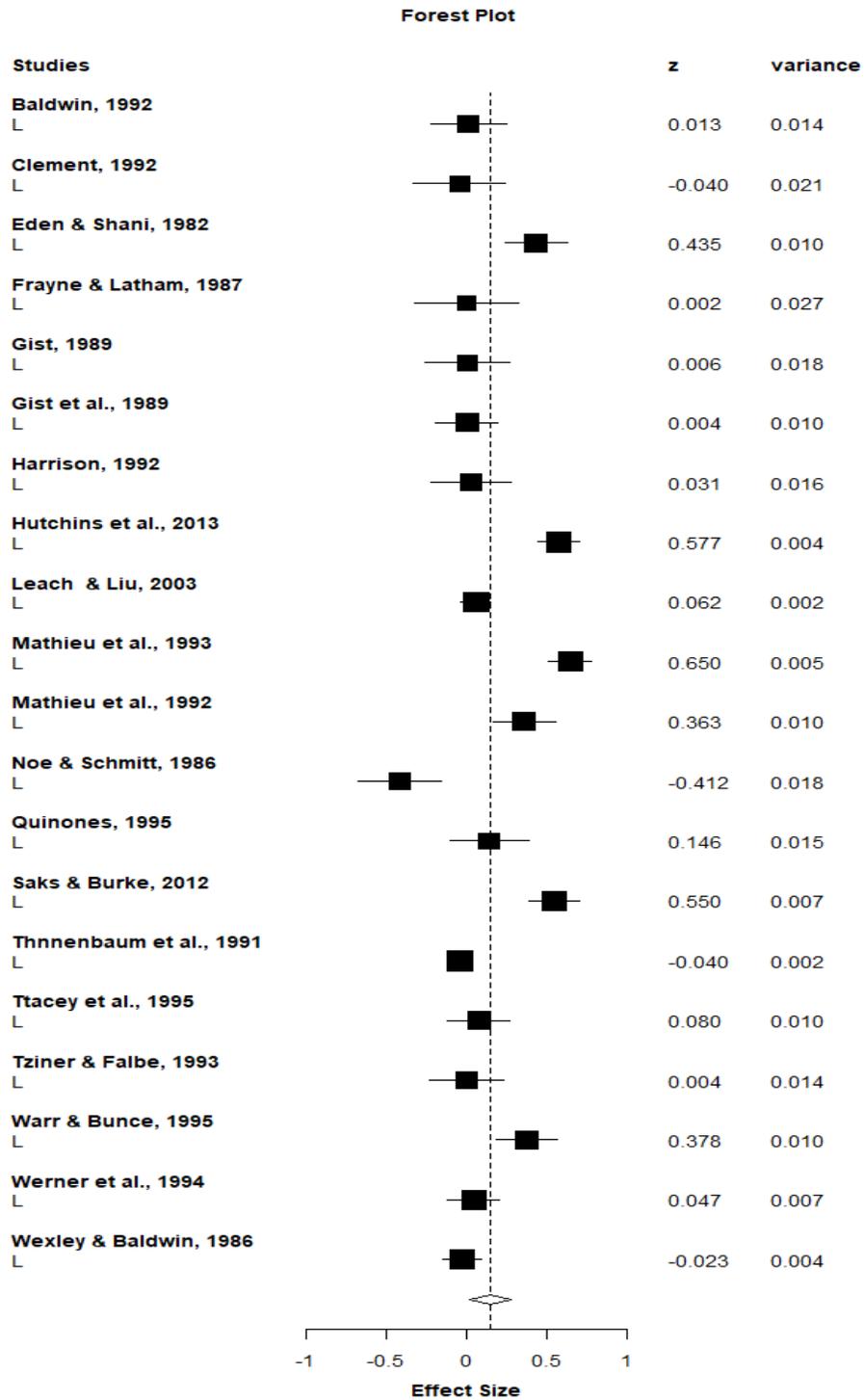
Figure 3

A Forest Plot Displaying 16 Effect Sizes of Correlations between Reaction and Job Performance
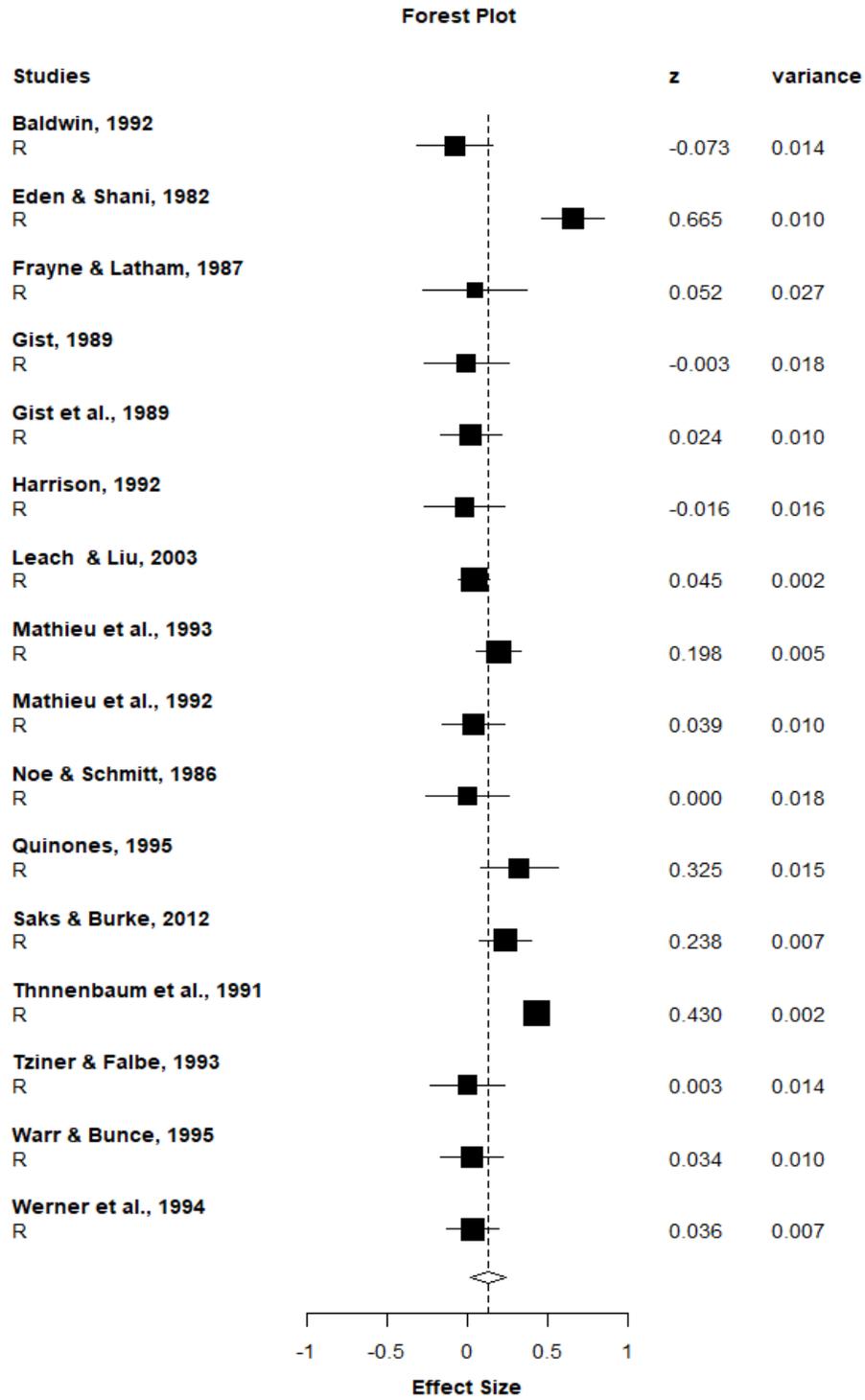
Note. The dotted line represents the weighted mean effect size determined from the null model; the point size is determined by the sample size of the effect.

Figure 4

*Forest Plot Displaying 20 Effect Sizes of Correlations between Learning and Job Performance*

Note. The dotted line represents the weighted mean effect size determined from the null model; the point size is determined by the sample size of the effect.

Finally, I focused on analyzing 36 effect sizes of the correlations between reaction and job performance (16), and learning and job performance (20). The 10 correlations between reaction and organizational performance (5), and learning and organizational performance (5) were excluded for analysis because of a lack of effect sizes. As presented in Figure 3, 4, forest plots show effect sizes of correlations between reaction and job performance, and learning and job performance.

Publication Bias

Figure 5

Funnel Plots for Effect Sizes of Correlations between Reaction and Job Performance
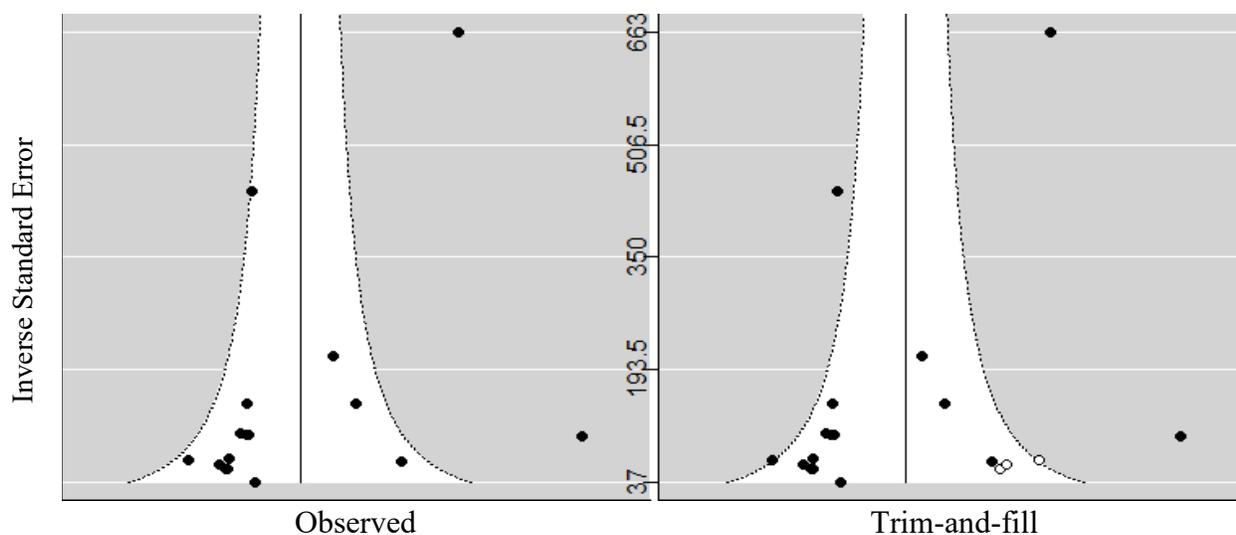
Note. Funnel plots for the observed and trims-and-fill effect sizes of correlations between reaction and job performance, plotted against inverse standard error; the dotted line represents the weighted mean effect size assuming effect sizes are all independent.

Since all of the publication types in this study were published literature, publication bias should be examined in order to ensure that it is not present. Evaluation of publication bias

through both the funnel plot procedure and trim-and-fill method demonstrated that most effect

size estimates were scattered somehow asymmetrically across the median effect size across most

studies for correlations between reaction and job performance (See Figure 5). Although a few

small groupings of outliers were demonstrated on the right sides of the plot, the result from an

Eggers test for correlations between reaction and job performance was significant (z = 2.62, p =

0.01).

Figure 6

Funnel Plots for Effect Sizes of Correlations between Learning and Job Performance
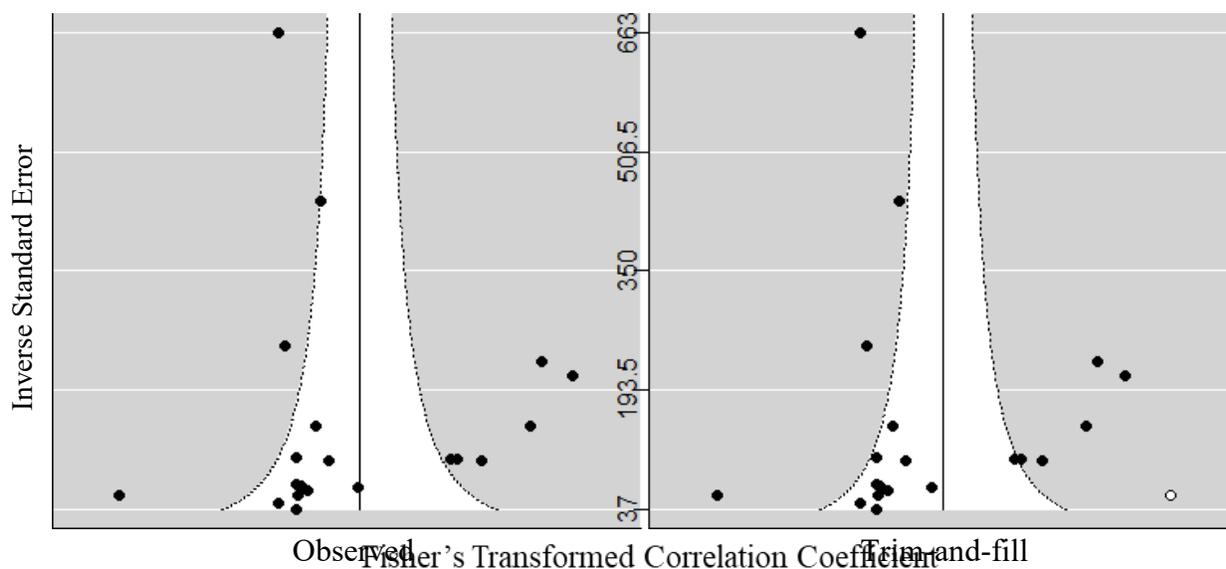

Note. Funnel plots for the observed and trims-and-fill effect sizes of correlations between
learning and job performance, plotted against inverse standard error; the dotted line represents
the weighted mean effect size assuming effect sizes are all independent.

On the other hand, in the case of correlations between learning and job performance,

although an Eggers test were significant (learning and job performance, z = 2.51, p = 0.01), it is

doubtful that there may be publication bias because the funnel plot procedure and trim-and-fill

method demonstrated small groupings of outliers on the right sides of the plots(See Figure 6), which is caused by the small sample size. Therefore, the following quantitative results should be interpreted with caution.

Outliers

Analysis of outliers through effect size boxplots for correlation between reaction and job performance and learning and job performance demonstrated one effect size estimate for correlation between reaction and job performance that was found to be greater than 75 percentile. However, from winzorized visual inspection of a boxplot within 5th and 95th percentile, there was no outlier. Thus, an additional sensitivity analysis comparing the adjustment of the effect size estimates to making no adjustments was not required.

Meta-Regression

In terms of correlation between reaction and job performance, the average effect size is 0.133 ($SE = 0.05$, 95% CI [0.024, 0.243], p = 0.02), which was based on 16 effect sizes obtained from 16 studies as shown in Figure 3. As for the correlation between learning and job performance, the average effect size is 0.151 ($SE = 0.06$, 95% CI [0.025, 0.277], p = 0.02), which was based on 20 effect sizes obtained from 20 studies as presented in Figure 4. A large degree of heterogeneity was observed across these effect sizes ($I^2 = 84.68\%$ for reaction and job performance; $I^2 = 90.58\%$ for reaction and job performance), suggesting the need for moderator analyses to explain the variance.

Accordingly, moderator analyses were conducted separately for two variables using an RVE random effect model: 1) if participants were leaders or employees, and 2) if the type of intervention was related to leadership training or vocational training. Although other variables may be regarded as moderators such as domestic or international, type of organization, and

intensity of intervention, the information was only included in the descriptive results as shown in

Table 1 because of a lack of sample sizes and unrelatedness to the research question.

Table 2

Results of Null Model and Moderator Analysis for Meta-Regression

Moderator	Reaction and Job Performance				Learning and Job Performance			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Position: Leaders		-0.001 (0.131)		0.011 (0.132)		-0.184 (0.132)		-0.253 (0.145)
Type of Intervention: Leadership			-0.016 (0.108)	-0.022 (0.103)			0.080 (0.124)	0.165 (0.138)
Constant	0.133* (0.051)	0.133* (0.052)	0.141 (0.061)	0.139* (0.064)	0.151* (0.060)	0.202* (0.069)	0.107 (0.095)	0.133 (0.084)
Effect sizes (n)	16	16	16	16	20	20	20	20
Number of studies (k)	16	16	16	16	20	20	20	20
I^2	84.679	85.643	85.478	86.462	90.584	90.874	90.318	90.016

Note. Significant (p < .05) findings are marked with an asterisk.

I conducted moderator analyses for both correlations between reaction and job

performance, and learning and job performance as shown in Table 2. All of the 6 models

including moderator are not statistically significant because of a small number of studies. While

I^2 values of moderator models for correlations between reaction and job performance are a little

higher than one of the null model, the values of moderator models for correlations between

learning and job performance are a little lower than one of the null model. However, there are

not significantly different values between the null model and the moderator models. Thus,

although the null model still has a large degree of heterogeneity and implies further moderator

analysis should be conducted, the null model can be selected.

Discussion

The results of this meta-analysis reveal that there are positive associations between reaction and job performance, and learning and job performance from the evaluations of training programs in organizations based on Kirkpatrick's four-level training evaluation model. Since the relationships are slightly weak (reaction and job performance, $r = 0.133$, $p = 0.02$; learning and job performance, $r = 0.151$, $p = 0.02$), these results support that the value based on criteria such as reaction and learning partially predicts the success in job performance. Therefore, the assumption from HR and BI scholars and practitioners can be partially validated that positive reactions and learning improve behavioral changes (Alliger & Janak, 1989; Hilbert et al., 1997; Kirkpatrick & Kirkpatrick, 2006).

When comparing the correlations between reaction and job performance with the correlations between learning and job performance, the former is a little lower than the latter. Although there is not a great difference from each other, it is assumed that the assessment by a learning criterion can predict behavioral change based on a job performance criterion better than the evaluation by a reaction criterion. Thus, given the limited resources and time within an organization, HR practitioners need to pay more attention to the measurement of learning achievement than reactions to training programs in order to estimate behavioral changes influenced by training.

Limitations and Future Directions

There are several limitations related to this study. First, it is doubtful that there may be publication bias because the funnel plot procedure and trim-and-fill method demonstrated small groupings of outliers on the right sides of the plots. The issue is likely to be caused by a small sample of studies. Although 20 studies were collected after final full-text screening, the primary

studies were peer-reviewed journal articles. In order to avoid missing any unpublished studies, I

found 7 unpublished dissertations that seemed to include the values based on four-level

evaluation criteria, but finally, they were excluded from the analysis because they were not

allowed to be accessed. For future research, grey literature should be discovered and included to

overcome the issue of the file drawer.

In terms of moderator analyses, there was a weakness caused by small sample sizes.

Although I considered all moderators of interest before coding data, I should have excluded

possible moderators such as the type of organization and the intensity of intervention. The

information related to these variables was only included in the descriptive results because of a

lack of sample sizes. In addition, all of the moderator models for correlations between reaction

and job performance, learning and job performance but there were not significantly different

values between the null model and moderator models. The issue may be caused by the lack of

sample size. Since the null model still has a large degree of heterogeneity, further moderator

analysis should be conducted in the next study.

Implications

Although the results of this study support that the values based on criteria such as

reaction and learning are positively related to the success in job performance, this study failed to

identify the correlations between reaction and organizational impact, and learning and

organizational impact because of a lack of covariances between them. According to the survey

by Strunk (1999), about 1,100 HR practitioners responded that over 50% evaluate level 4 such as

organizational impact after providing employees with training programs. Contrary to the result of

the survey, there are very few published studies based on organizational impact including

organizational or financial performance influenced by training programs. The previous studies

did not seem to pay attention to data that can be obtained by HR practitioners. In order to examine the legitimacy of correlations among four-level training evaluation criteria in the field of HR, scholars and researchers need to conduct primary studies with archival data from the organizations.

For practice, this study may contribute to providing HR and BI practitioners with evidence to utilize the criterion of reaction and learning instead of producing the effectiveness of behavioral change. However, given a lack of correlations between reaction and organizational impact, learning and organizational impact, HR and BI practitioners should interpret the effectiveness of a training program on organizational and business performance with caution when they highlight the necessity of training programs to stakeholders and policymakers in an organization who are more interested in organizational and financial effectiveness from training interventions. Accordingly, HR and BI practitioners need to continue their efforts to identify the effectiveness of training programs with management information within an organization.

Conclusion

Despite the significance of identifying the relations among training criteria based on Kirkpatrick's four-level training evaluation model, there have been few synthetic studies on identifying the relations. From the results of this meta-analysis study, there are positive associations between reaction and job performance, and learning and job performance from the evaluations of training programs in organizations. This study may encourage researchers to reinterpret the concept of the meanings of four criteria as well as HR practitioners to feel free to use the criterion of reaction and learning to estimate job performance. It is believed that if more data and samples are obtained, more meaningful and reasonable results will be produced.

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*Note: Studies marked with a * were included in the quantitative analysis*

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Teaching Soft Skills in Information Systems

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Abstract

Although technical skills are the predominant skills needed for Information Systems professionals, soft skills are in demand and are the differentiators of continued success in the field. Developing effective soft skills may help students secure a job and advance in their fields. This paper presents six practical exercises for educators to add to their courses to help develop these skills.

Keywords: soft skills, emotional intelligence, communication, career success

A recent job ad called for the "ability to articulate both business and technical needs as functional and non-functional user stories" and "excellent listening, communication (verbal and written), influencing, and presentation skills." This ad seems to be looking for a salesperson; however, it is a posting for an entry-level systems analyst. Employers are expecting more communication-related skills from new hires as the value of soft skills in technical careers continues to rise.

The need for more soft skills has increased with the prevalence of artificial intelligence (AI), which has been one of the most discussed topics in schools, academic conferences, and the newsroom since the introduction of ChatGPT to the public in 2022. People worry about how it will affect both education and the workplace. While those arguments are ongoing, it is obvious that although AI will change the way we do things, it will never completely replace humans. Human skills may well become one of the most sought-after skills in the workforce (Bartoli, 2025). Feedback from employers indicates that younger workers lack the needed soft skills, such as communication and emotional intelligence, that help them to understand when AI is appropriate.

This concern is of particular interest in information systems (IS) fields. Although considered a technical skills-based career, IS professionals need soft skills to be successful. Many data analytics job postings include communication as a required skill (Booker et al., 2024), IS professionals identified soft skills needed by new graduates, and there is a shortage of people with these skills (Dubey et al., 2022). In fact, Marshall (2024) found that "while technical skills and experience remain essential, soft skills – communication, emotional intelligence, adaptability, and collaboration – are becoming the differentiators of success."

Hard skills are teachable skill sets that are usually specific to a job and are easy to measure. They include skills such as foreign language proficiency, a degree or certificate, knowledge of a computer program, and typing speed. Soft skills cannot be quantified, but they are transferable to different jobs. Once somebody has learned this soft skill, they can then use it in a variety of positions. They include skills such as communication, leadership, teamwork, time management, and critical thinking. In-demand soft skills for tech positions include communication, collaboration, time management, networking, self-awareness, and customer service (Bender, 2023; Wells, 2024).

A search on Google identifies a variety of business-related positions available for students who major in information systems: business analyst, data analyst, IT consultant, systems analyst, project management, and IS manager. Using these position titles, a review of recent job postings listed on Indeed.com in the Dallas, Texas, area revealed several entry-level positions in the field. These open positions identified both hard and soft skills in their job descriptions and qualifications. To illustrate this, below are selected soft skills identified for each of these positions:

- Business analyst – self-starter, excellent communication skills, ability to translate large amounts of data into actionable insights, ability to tell a story with this data, strong stakeholder engagement skills

- Data analyst – ability to communicate findings clearly to both technical and non-technical audiences

- Entry-level consultant – strong verbal communication skills and excellent writing skills

- Systems analyst – ability to articulate business and technical needs, excellent listening skills, communication, influencing, and presentation skills

- Entry-level project manager - strong organizational and time management skills, excellent verbal and written communication skills, leadership, and presentation skills

- Information security associate manager – influencing skills; ability to motivate and direct diverse teams; ability to take an active role in the education, mentoring, and training of less experienced team members.

This list demonstrates the consistent demand for softs skills across many IS-related fields.

Soft skills are difficult to teach because they are tied to personality traits, and these skills can weaken over time. It is important to use these skills regularly to keep them sharp (Rockwood, 2021). Additionally, Bartoli reminds us that "soft skills aren't built in a vacuum – they're forged in real-world interactions" (2025, para. 5); therefore, instructors need to find ways to help students practice these skills in multiple situations. Because students need these soft skills to be successful and hired into their fields, how can educators help their students develop them?

This paper presents the importance of improving the soft skills of students who will enter information systems fields and provides practical classroom exercises to incorporate into our classes. As employers continue to emphasize communication and interpersonal skills in technical roles, IS educators must be intentional about embedding soft-skills development into coursework. The following assignments provide practical, classroom-ready approaches that mirror real workplace expectations and help students gain a competitive advantage.

Assignments to Teach Soft Skills in IS Classes

Assignment ideas will be provided to help develop students' communication, collaboration, time management, networking, self-awareness, and customer service skills. These exercises replicate workplace scenarios and provide structured practice to build soft skills.

Communication

While technical skills are essential for success in IS fields, the ability to communicate clearly can be a deciding factor for career success. The following assignment helps students develop their persuasive communication skills by emulating a real-world situation.

Communication skills include written and oral modes, and these skills can be practiced to develop other soft skills. Persuasion is a skill needed in many professions, and an IS professional can practice preparing a sales pitch for an emerging technology that he/she would like to adopt in the company. Steps to complete:

- Choose an emerging technology (AI, quantum computing, blockchain, etc.) and research its purpose, benefits, and potential impact on the company.

- Write a script for a 2-minute pitch as if presenting it to a non-technical executive to persuade him/her to adopt this technology for the business. The script should contain an attention-getting opening, a description of the key benefits of the technology in the business, and a request for a specific action

- Deliver this pitch in person in the class or through a pre-recorded video.

This activity can be extended by recording the presentation and asking the students to critique their own performance. Students could also write a reflection about how they adapted their language for a non-technical audience.

Collaboration

Communication is a foundation for a successful team as many IS professionals need to collaborate in cross-functional teams. Working as a team can be challenging in any situation, and many business projects require effective collaboration for success. This next assignment,

planning an IT project as a group, challenges students to communicate, negotiate, organize, and motivate. Steps to complete:

- Separate into teams of 3-5 students

- Identify a small IT project (creating a troubleshooting guide, a basic app design, or a network layout)

- Assign the team to create a communication plan to help them manage the project. The plan should include tools (email, Slack, etc.), meeting schedules (frequency and duration), roles and responsibilities for each member, and a plan to handle disagreements or delays in progress

- Students submit a written, one-page document that includes the communication plan to implement the project.

Extend the activity by having the student orally present the project to the class and ask class members to troubleshoot potential problems with the plan. A follow-up assignment includes peer evaluation or self-reflection on challenges that the team encountered.

Time Management

Teamwork and project success are influenced by the ability to manage one's time well. With multiple responsibilities in life, ensuring that each item is completed on time can be challenging. A new employee may struggle with managing the many deadlines of the position. Teaching students how to manage their time can begin with having them analyze how their time is spent. The following Start/Stop/Continue activity helps students to reflect on their own time management skills. Steps to complete:

- Distribute three sheets of paper to each student

- On each paper, students trace their hands. Inside the palm of one hand, write "Start"; on the next hand, write "Stop;" and on the third hand, write "Continue"

- On the Start hand - write one thing on each digit of things they should START doing that will help them be more organized

- On the Stop hand - write one thing on each digit of things to STOP doing that get in the way of being organized and punctual

- On the Continue hand - write one thing on each digit of things to CONTINUE doing that will help them be organized

- A week later, students revisit their plan and write a reflection of how well they managed their time.

This activity can be repeated in a subsequent week to assess the long-term effect of the activity.

A variation of this activity is to require students to write a detailed schedule for the upcoming week that includes upcoming deadlines. The schedule will include activities that help the student complete daily tasks to meet the deadlines. After following the schedule for the week, students reflect on how well they stayed on schedule, how well they spent their time, and how they can improve.

Networking

Expanding one's communication and collaboration skills will help build internal and external relationships. Developing one's network of professional connections is essential for lifelong career success, especially in technology-based fields that rely on referrals and vendor relationships. An effective elevator speech can help students make connections, land a job, and be promoted later. This next assignment helps students develop and practice a confident and

professional introduction in the form of an elevator speech. The script for the speech should follow this model:

- Introduction: "Hi, my name is <u>INSERT</u>, and I'm a <u>INSERT</u> major from <u>INSERT</u> University.

- Content: Insert some recent relevant experience (work, academic, or extracurricular) that displays a major accomplishment related to the future career.

- Close: Identify an action – future job opportunity, internship, etc. such as "I was hoping today to discuss with you opportunities in which my <u>INSERT</u> skills could be used to help <u>INSERT COMPANY</u>'s ongoing success."

After finishing the script, students should practice it one-on-one with other students, including practicing an effective handshake and maintaining eye contact.

This exercise can be extended by asking business professionals or professors to join the class to act as company recruiters and give students more practice for their speeches.

Self-Awareness

Building connections is important, but understanding oneself is just as critical. Self-awareness, the ability to understand one's strengths and weaknesses, is a component of emotional intelligence that is an indicator of career success. Reflective practice also supports leadership development. Students need to be aware of how their behavior impacts others, and this next assignment asks students create a personal SWOT analysis to develop this skill. Steps to complete:

- Assign students to create a personal SWOT Analysis with a four-quadrant grid that includes strengths, weaknesses, opportunities, and threats to their future career.

- Pair up with a classmate (or use a trusted friend or relative) to discuss the analysis, asking questions such as, "Do you see any strengths I overlooked?" or "Do you know of any other weaknesses I should work on?"

- Revise the SWOT based on feedback

- Create a growth plan based on the revised SWOT analysis that includes 3-5 specific goals for personal or professional improvement. Each goal should include an action step, a deadline or timeframe, and a resource to help (e.g., online course, mentor, book)

- Write a reflection to address the following questions:

  1. What was the most surprising insight from your SWOT analysis?

  2. How does your self-awareness impact your career readiness?

  3. How will you stay accountable for your growth plan?

To extend this exercise, students can use the reflection questions to create a personal development plan with a follow-up at the end of the semester to check on their progress on the action items.

Customer Service

Finally, IS professionals will need to interact with various people within an organization and combine their skills in communication, collaboration, and listening, to provide helpful and user-friendly support to internal and external customers. This last assignment uses a role-play exercise to practice adapting a message to develop a customer-focused message that incorporates empathetic phrasing and active listening. Steps to complete:

- Assign students to paired roles – one student is the IT professional and the other is the customer

- Choose an issue that the IT professional must solve for the customer. You can allow the student to choose the issue, or you can assign it (i.e., long wait times for the help desk, defective products, software crashes, slow service).

- Have the IT professional ask questions to diagnose the issue, explain the solution in non-technical terms, and offer proactive tips for preventing future problems

- Following the first round, switch roles and repeat the exercise with a different issue.

Extend the learning by asking students to write a short reflection on what they learned about communicating with non-technical people.

As IS professionals begin to take on customer-facing roles, their ability to interact with professionalism and empathy becomes a critical asset in career success. Integrating variations of these activities into coursework helps students bridge learning between their academic and professional lives.

Conclusion and Implications

The rapidly changing job market will change the in-demand skills required of new graduates. While technical skills are still vital, the candidate who can demonstrate effective soft skills will be in-demand. The candidate who has the ability to communicate, collaborate, self-manage, and adapt will thrive and excel in an IS career. As business educators, we should be preparing our students for the new demands in this field by proactively embedding soft-skills to develop activities in our courses to help students be not just employable, but promotable as well.

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Leveraging LMS for Improved Student Retention:
A Pedagogical Perspective

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Abstract

The use and integration of technology into course frameworks have been identified as a potential way to boost student retention rates. This research examines the role of Learning Management Systems (LMS) in improving student retention by identifying best practices, uncovering pedagogical gaps, and evaluating the less effective aspects of current LMS implementations in course development. It proposes a framework for using LMS as a dynamic course design tool that not only promotes academic success but also creates an inclusive and supportive learning environment.

Problem Statement

Student retention remains a persistent challenge for higher education, with institutions seeking effective strategies to support diverse student populations, including regular, face-to-face, online, and nontraditional learners. Universities and their faculty are continuously tasked with finding ways to help increase student enrollment numbers and retain students through graduation. Retention and graduation rates serve as key performance metrics for institutions and accreditation bodies.

Student retention remains a significant challenge in higher education, particularly in accommodating diverse learning needs across regular, face-to-face, online, and non-traditional student populations. While Learning Management Systems (LMS) are widely adopted as a tool to enhance student engagement and learning outcomes, there remains a lack of clarity regarding their effectiveness in promoting retention from a pedagogical perspective. Instructors often struggle to identify the best practices for leveraging LMS features and to be knowledgeable about what is missing or less effective in current implementations. A great need exists for a systematic and adaptive approach to utilizing LMS in an engaging and impactful way for all types of learners. This research addresses these gaps by proposing an adaptive framework for utilizing LMS from a pedagogical aspect to support and improve student retention.

Literature Review

A comprehensive literature review and analysis highlights the need for a systematic approach to maintaining LMS that are adaptive, engaging, and impactful for all types of students.

The integration of Learning Management Systems (LMS) in higher education has been widely studied for its potential to enhance student retention and engagement. Ilgaz and Gülbahar

(2015) highlighted that online learners' e-readiness and e-satisfaction significantly impact their engagement with LMS, which in turn affects retention rates. They emphasize the importance of understanding student characteristics when designing LMS features to meet diverse learning needs.

Kent (2015) pointed out challenges faced by students with disabilities in accessing online resources, suggesting that LMS design should be more inclusive to improve retention for all students (Kent, 2015). Similarly, Wladis et al. (2015) found that minority groups, particularly Hispanic and Black STEM majors, were less likely to enroll in online courses, which may affect retention rates among these groups (Wladis et al., 2015). This highlights the need for LMS systems to prioritize accessibility and inclusivity, ensuring equitable outcomes.

According to Lambert (2020), Massive Open Online Courses (MOOCs) show promise in contributing to student equity and social inclusion. However, there is still a gap in understanding how LMS can be adapted for different student populations (Lambert, 2020). This aligns with findings by Kift et al. (2010), who emphasize a "third generation" approach to pedagogy that fosters student transition and engagement in higher education, suggesting that LMS should be tailored to support this transition effectively.

Tight (2020) conducted a systematic review and found that student engagement has become a more recent focus of research, overtaking student retention in importance. He suggests that LMS should not only support retention but also foster active participation, making it a shared responsibility between students and higher education institutions.

Research also underscores the value of proactive instructor involvement. Johnson (2014) found that instructor interventions such as timely feedback, personalized communication, and

presence significantly reduced dropout rates in online STEM courses. These results support the idea that LMS design should embed tools that facilitate and encourage instructor-student interactions. Martin and Bolliger (2018) further corroborate that students perceive instructor engagement as one of the most critical factors for success in online learning.

Learning analytics has been identified as a promising tool for enhancing retention rates in STEM disciplines, as demonstrated in a study by Li et al. (2022), who analyzed 59 key publications and categorized seven factors contributing to retention using learning analytics. Muljana and Luo (2019) also emphasize that early alert systems, consistent communication, and institutional support play essential roles in maintaining engagement and retention. Furthermore, AI-driven adaptive learning technologies have been shown to enhance student engagement and retention in e-learning environments significantly (Gligorea et al., 2023). Adaptive systems can personalize learning experiences in real-time by analyzing student performance data and providing tailored content to improve learning outcomes.

The role of blended learning in higher education is another critical area explored by Means et al. (2013). They found modest positive effects when blended learning was used compared to fully online or traditional face-to-face environments. This finding aligns with Dziuban et al. (2015), who suggest that LMS should incorporate elements of blended learning to create more engaging and effective learning experiences (Dziuban et al., 2015).

The flipped classroom model has emerged as an innovative approach that leverages LMS to facilitate active learning, as discussed by Steen-Utheim and Foldnes (2017). Their research suggests that incorporating video screencasts into an LMS can enhance retention and engagement, making it a valuable strategy for higher education institutions. Meta-analytic work by Richardson et al. (2017) has shown that social presence, a key aspect of the Community of

Inquiry framework, is significantly associated with student satisfaction and learning outcomes in online environments. Their findings underscore the importance of LMS features that facilitate peer-to-peer interaction, collaborative activities, and instructor visibility.

Lastly, in a similarly related study, Chilvers (2025) outlines a structured peer-to-peer model that enhances retention by embedding curricular and co-curricular peer support, reinforcing the importance of community and collaboration within LMS environments. These findings highlight the importance of incorporating tools such as discussion boards, collaborative projects, and real-time chat features to cultivate a sense of community among students.

Proposed Methodology

The methodology for this study is grounded in a qualitative, exploratory design informed by extensive teaching experience, institutional feedback, student input, and recent technological advancements. The authors, who collectively bring more than 70 years of teaching experience across diverse disciplines, have drawn upon their pedagogical expertise in both traditional and innovative instructional methods. This collective experience encompasses teaching both regular and non-traditional learners, as well as managing transitions in pedagogical practices during the COVID-19 pandemic, which presented new challenges and learning opportunities.

To gain a holistic understanding of the context and the challenges of student retention and engagement, the authors conducted structured interviews with key stakeholders within the academic institution. These stakeholders included department heads, unit heads, student advising office staff, recruiting and admission directors, deans, and other relevant faculty members. The objective of these interviews was to gather insights on institutional practices, challenges in

student retention, and successful engagement strategies that have been implemented across different academic units.

Additionally, student feedback from recently taught courses played a critical role in shaping the methodology. The feedback provided firsthand insights into how students engage with various pedagogical strategies, how they navigated challenges during the pandemic, and their experiences with online and hybrid learning environments. This student input enabled the authors to refine their approach, ensuring that the proposed framework addresses the real-world needs of students.

Furthermore, the authors reviewed the recent advancements in AI technology, focusing on how AI-powered tools have been integrated into digital resources and courses by educational publishers. The integration of AI assistants into LMS platforms and course content has enhanced adaptive learning, allowing for more personalized learning experiences for students. By analyzing how these AI tools are being utilized, the authors could better understand the potential for AI to enhance student retention and engagement.

By triangulating teaching experience, institutional feedback, and student perspectives, combined with current technological advancements in the AI arena, this methodology provides a robust foundation for developing an adaptive, engaging, and inclusive framework to improve student retention. The use of real-world feedback and technological integration ensures that the proposed approach is both data-driven and responsive to current educational challenges.

Results

This proposed framework is based on the structured approach of the Continuous Improvement Process (CIP). CIP is founded on the premise that positive change, efficiency, and

customer satisfaction can be realized when an organization focuses on incremental and ongoing improvements to its processes over time. In business management, the steps are referred to as the Plan-Do-Check-Act (PDCA) cycle. This continuous improvement cycle is a problem-solving system that includes research and planning for more minor incremental changes, executing these modifications, monitoring and evaluating their effectiveness, and proceeding forward toward continuous improvement in the process or system along the way. Feedback and learning are essential features of the process.

The PDCA cycle is an effective procedure when implementing any change. The cycle begins with the first phase, the "PLAN". The `Plan` phase includes data collection and analysis, during which student performance and engagement data are gathered. Based on this data, a stage of Reevaluation and Adjustment to refine the LMS strategies occurs. The next step, the "DO" Phase, is the Implementation of Changes that result from the reevaluation process. After implementation, the system undergoes a "CHECK" for Effectiveness, ensuring the changes lead to the desired outcome. The "ACT" cycle then repeats, supporting the goal of Enhanced Student Retention and Engagement through ongoing improvement.

The proposed continuous improvement framework is illustrated in **Figure 1**, which shows how the PDCA cycle supports the integration of LMS tools and strategies to enhance student retention. The authors' proposed framework aims to support diverse student populations, including regular, online, and nontraditional students, by enhancing retention through robust, personalized, and adaptive Learning Management Systems (LMS) that integrate advanced technology, engaging content, and inclusive pedagogy. This framework proposes three core pillars: 1) Technology, 2) Engagement, and 3) Inclusive Pedagogy at the center, and these three

pillars drive the process of creating more adaptive and effective Learning Management Systems
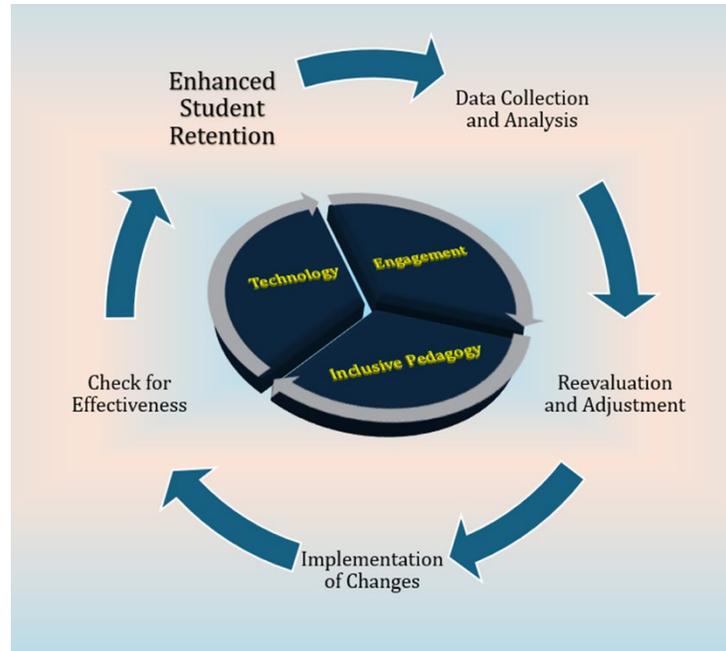
(LMS).

Figure 1. A continuous improvement cycle for enhancing student retention using the proposed

methodology.

The Core Pillars

Pillar 1: Technology (AI-Driven Personalization and Other Tools)

The Technology pillar encompasses a range of digital tools and systems that can support

personalized and adaptive learning, not just limited to AI. Research indicates that AI-based

adaptive learning systems significantly enhance student engagement and retention by providing

personalized learning paths and real-time feedback (Gligorea et al., 2023). AI plays a central role

by analyzing student performance data to offer personalized learning paths, reinforcement

exercises, and predictive analytics that can anticipate student challenges. However, several other technologies significantly enhance the learning process. For example, learning analytics track a student's interaction with the LMS, identifying patterns in behavior, engagement, and performance, which can be used to provide targeted support or early interventions for at-risk students.

Virtual and Augmented Reality (VR/AR) bring complex concepts to life, enabling students to immerse themselves in simulated environments, such as a virtual lab for science students or a 3D reconstruction of historical events for history courses. Natural language processing (NLP) tools, such as chatbots and virtual tutors, offer students real-time assistance by answering common questions, guiding them through complex topics, and providing 24/7 support. Additionally, automated grading systems instantly evaluate assignments and quizzes, providing immediate feedback to students and freeing up instructors to focus on higher-order teaching tasks. For instance, adaptive learning systems continuously adjust the difficulty of assignments based on student progress, ensuring that students are always appropriately challenged and supported.

Innovation in teaching through the use of technology enables teachers to push the boundaries of traditional education, offering immersive and flexible learning environments where students engage in ways that suit their individual preferences and needs. These technologies work together to create a dynamic, student-centered learning environment that adapts to individual needs, tracks progress, and enhances both learning and retention. By incorporating a range of technological tools—such as AI, VR/AR, NLP, and learning analytics— LMS platforms can become highly responsive, ensuring that students receive the personalized attention they need to succeed.

Pillar 2: Engagement (Gamification, Peer Interaction, and Collaborative Tools)

The Engagement pillar focuses on keeping students actively involved in their learning by integrating interactive and collaborative technologies into the LMS. Gamification is one of the most effective ways to motivate students, incorporating elements like points, badges, leaderboards, and rewards. These elements transform learning tasks into engaging challenges, encouraging consistent participation and fostering a sense of achievement. Gamification techniques can also involve time-bound competitions, quizzes, and milestone tracking to maintain student motivation and engagement. For example, a student might earn badges for completing assignments on time or achieving high scores on quizzes, leading to improved engagement with the course content.

Peer interaction is another key component of engagement, allowing students to connect and collaborate through discussion forums, group projects, and peer review systems. Online collaborative tools such as shared documents, whiteboards, and breakout rooms in virtual classrooms enable students to work together in real-time, regardless of their location. This collaboration fosters a community atmosphere where students learn from one another, exchange ideas, and form social connections—an important factor in student retention, particularly for online or non-traditional learners. Studies have shown that interactive content and collaborative environments within an LMS can significantly increase student engagement and improve overall learning outcomes (Tight, 2020). Additionally, interactive content, such as simulations, polls, and embedded quizzes within videos, further enhances engagement by making learning more dynamic and hands-on. For example, students might participate in a live poll during a lecture or work together in a virtual simulation of a real-world scenario, reinforcing the relevance of course material.

Together, these technologies ensure that students remain engaged, whether through individual motivation via gamification or social learning through peer collaboration. The goal is to make learning an active, enjoyable, and interactive experience, which can significantly improve both student performance and retention.

Pillar 3: Inclusive Pedagogy (Student-Centered Design, Accessibility, and Flexibility)

The inclusive pedagogy pillar is grounded in designing courses that accommodate diverse student needs and learning styles. Research highlights the importance of inclusivity in LMS design, emphasizing the need for real-world applications and transparent expectations to keep students engaged and on track (Lambert, 2020). Inclusivity is even more important for nontraditional and online students, who often face additional barriers in accessing education and most likely need flexible learning modalities.

Student-centered design offers multiple modes of content delivery, including text, video, audio, and interactive activities, to ensure that visual, auditory, and kinesthetic learners can all thrive. Course shells should be designed for ease of navigation and student engagement.

Further, the use of adaptive learning paths can accommodate students at different levels of understanding, ensuring that faster learners can progress at their own pace, while students who need more time receive additional support.

Accessibility is another crucial aspect of inclusive pedagogy. LMS platforms can integrate tools such as screen readers, closed captions, and alternative text for images, making course content more accessible to students with disabilities. Furthermore, ensuring compatibility with mobile devices and offering offline access to materials can benefit students in different circumstances, particularly nontraditional learners who may have other responsibilities, such as

work or caregiving. The goal is to create a flexible and adaptable learning environment where every student feels supported and empowered to succeed.

Feedback mechanisms and community building are integral features of Pillar 3. Classroom discussion forums, focus groups, in-class polls, and student surveys can serve as effective vehicles for gathering student feedback and promoting engagement. The results of these feedback interactions can also provide valuable insights into preferred teaching methods and favored student-centered learning experiences, assisting in the design of courses to enhance the student learning environment. Feedback loops create ongoing, continuous improvement opportunities and community building among LMS course designers, faculty, and students.

FAQs play a crucial role in Inclusive Pedagogy by offering students clarity on course expectations, procedures, and everyday challenges. Having a well-designed FAQ document provides transparency and removes confusion, ensuring that all students—whether traditional, online, or nontraditional—can easily navigate the course. This is especially beneficial for students who may be new to online learning or require additional support. It also aligns to create an accessible, student-centered learning environment, where resources are readily available to accommodate different needs.

Being open to trying new ideas aligns with both the Inclusive Pedagogy and Engagement pillars. In Inclusive Pedagogy, this openness manifests in the incorporation of diverse teaching methods to cater to different learning styles, adjusting the course structure based on feedback, and integrating new assessment techniques that allow students to demonstrate mastery in varied ways. This flexibility makes learning more accessible and relevant to all students.

Trying new ideas can lead to the introduction of innovative tools, such as gamified learning activities, peer-reviewed assignments, or new forms of collaborative work, which can significantly enhance student interaction and motivation. Being willing to adapt the learning environment based on emerging trends or student feedback ensures that the LMS stays engaging and fresh, reducing student disengagement.

Innovation in teaching is deeply rooted in both Inclusive Pedagogy and Technology pillars. In Inclusive Pedagogy, innovation can involve experimenting with new instructional designs, such as flipped classrooms, project-based learning, or inquiry-based approaches, which make learning more interactive and student-centered. It also includes integrating real-world applications or using case studies in novel ways to make theoretical content more engaging and relevant.

Ultimately, flexibility in assessments and learning schedules is crucial for an inclusive pedagogy. Students should have clear, transparent expectations, as well as options for demonstrating their learning in ways that align with their strengths. For instance, assessments can range from traditional exams to project-based work or creative assignments, allowing students to showcase their understanding in different ways. Real-world applications of course content, such as case studies or problem-solving exercises, further support inclusion by connecting theoretical knowledge with practical, relatable scenarios that enhance the relevance of learning.

By combining accessibility, flexibility, and a student-centered approach, inclusive pedagogy ensures that all students—whether traditional, online, or non-traditional learners—can engage meaningfully with the course content and succeed in their educational journey. The proposed methodology serves as a guide for university educators and administrators on how to

utilize LMS to enhance student retention effectively. By integrating adaptive technologies, engaging content, and inclusive pedagogical practices, LMS platforms can become vital tools for fostering academic success and addressing the diverse needs of students. This roadmap can be a central component in a wide range of educational strategies designed to improve retention, engagement, and learning outcomes across various educational settings.

Conclusion

This research demonstrates that adaptive, engaging, and inclusive Learning Management Systems (LMSs) can significantly enhance student retention among diverse learner groups, including traditional, online, and non-traditional students. By utilizing technology such as AI-driven personalization, gamification, peer collaboration, and innovative teaching methods, educators can create flexible and dynamic learning environments that cater to individual needs. The findings provide a guide for university educators and administrators to utilize LMS effectively, ensuring it remains a key component of student retention strategies in various educational settings. The ongoing cycle of improvement, driven by data-driven reevaluation and adjustments, helps keep LMS responsive to changing student needs. Ultimately, this framework provides a comprehensive approach to enhancing retention by fostering personalized, interactive, and inclusive learning experiences.

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