

Going Exponential and Quality Management

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Abstract: - Exponential growth is defined as non-linear development characterized by accelerating rates of change. The most impacted fields by the prevalent exponential growth include politics, economy, social dynamics, culture, sports, law, environment, artificial intelligence, and quality management. This paper discusses several aspects of exponential trends in the identified fields, the consequences of the developed trends due to exponential growth, and possible directions for future research. This research study will attempt to review some of the key exponential phenomena, and their impact, based on an analysis of selected literature and data.

But the very concept of exponential growth and accelerating increases reflections upon profound implications in many directions. In quality management, the exponential growth of technologies and data availability is promoting transformative changes. This article discusses how improvements in AI, big data analytics, and automation are changing the face of quality management today. These exponential technologies will enable one to monitor in real-time, get predictive analytics, and better decision-making methodologies leading to effective and efficient quality management systems.

AI and machine learning technological innovations are driving advanced quality control features, enabling organizations to dive deep into root cause analysis with unprecedented velocity and accuracy. The power of big data lies in valuable information that enhances quality assessments and supports continuous improvement initiatives. Automation streamlines the processes, reduces the margin of human error, and ensures consistency in adherence to quality standards.

However, the integration of these advantages is once again fraught with scalability problems, ethical issues relating to data privacy and algorithmic bias, and sustainability. The review further indicates some future research directions, including the potential exploration of emerging technologies around blockchain and IoT in quality management and the need for adaptable and ethical frameworks to guide technological integration. This research has pointed out the existing practices of organizations and the influence of exponential growth in managing quality to show how organizations could capitalize on these improvements in pursuit of better quality, greater efficiency, and innovation. It is deduced that rapid adaptation is somewhat urgent and that strategy development would be needed to face issues linked to exponential growth in the management of quality.

Key-Words: - Exponential Growth, Quality Management, AI, Automation, IoT, Technological Advancement.

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1 Introduction

Exponential growth is a process wherein the rate of increase continually accelerates over time, bringing about a dramatic change in the order of many things. Whereas most discussions of exponential growth are couched in mathematical terms, the concept has real-world applications.

This paper will discuss trends related to exponential growth in the areas of politics, economy, social dynamics, culture, sports, law,

environment, artificial intelligence, and quality management. An understanding of these different trends is critical in the development of various strategies through which their respective impacts can be managed and their potential benefits maximized.

During recent decades, exponential growth has stopped being an abstract scientific theme but started materializing as one of the decisive driving forces behind change and innovation in business. Exponential growth is, in essence, a

process that undergoes acceleration of its rate of change which surges over time. One such sphere significantly influenced by this effect is quality management—a scientific discipline invested in the realization of standards of excellence in the process, product, or service of the organization.

Traditional quality management typically employs certain systematic approaches concerned with maintaining and improving quality using established procedures, metrics, and continuous feedback loops. The increased adoption of these exponential technologies (AI included), big data analytics, and automation altered this dynamic and reshaped the landscape. Such technologies today assist businesses in operating with unprecedented intelligence to monitor, analyze, and improve quality, thereby making quality management much more effective and accurate.

For instance, AI and machine learning algorithms analyze vast volumes of data in real time to detect anomalies, forecast potential issues, and optimize processes at an unprecedented level of detail. Big data provides a helicopter overview of organizational performance; decisions are thus made from an informed standpoint regarding strategic improvements. Automation reduces repetitive human work and minimizes the element of human error, hence guaranteeing the same quality levels consistently.

While these developments are occurring, additional challenges also arise in the integration of exponential technologies into quality management: issues on scalability, data privacy, and ethical considerations including algorithmic bias and sustainability. Besides, adaptable frameworks and strategies to overcome these challenges are increasingly demanding to be developed while technology is further evolving.

Exponential growth is shaping quality management as changes in technology influence not only the quality control processes but also continuous improvement. This could be an attempt to better understand the opportunities and challenges accompanying these technologies in an in-depth analysis of the state of future research. In this study, a

review of current and emerging best practices serves as a means of illustrating how exponential growth will continue to shape the quality management system for organizational success.

2 Problem Formulation

2.1 Going exponential in all areas

Politics - Under politics, it is patent that exponential growth occurs in the development of digital platforms and how these affect the mobilization of politics. Smith (2020) digitizes the thought that social media platforms amplify political campaigns and the sharing of information by citizens to cause rapid changes in political landscapes. This thought of an exponential increase in data analytics to consolidate political strategies and outreach to voters is further expounded by Johnson (2019).

Economy - Economic growth due to technological drive shows exponential characteristics. Comments by Schiller (2021) refer to how fast-paced sectors, such as artificial intelligence and blockchain, have redesigned economic models and created new market dynamics. Robinson (2022) comments on issues related to the management of economic growth to align with finite resources and environmental sustainability.

Social Dynamics - Technology brings an exponential growth rate that has increasingly affected social dynamics. According to Davis (2018), increases in the use of social media platforms have accelerated social changes in beliefs and behaviors. On the other hand, Thompson (2020) discusses the exponential rise globally in terms of interconnectivity, leading to more rapid exchanges of culture and society.

Culture - Cultural changes are also facing exponential acceleration. According to Green (2021) technological development and global media have induced rapid propagation and transformation in cultures. Such rapid exchange of culture presents opportunities and

challenges from the point of view of preserving cultural diversity.

Sports - This is attributed to exponential growth in the industry's viewership and revenues, which Lee (2019) attributes to technology and innovations in digital media. Green's work in 2021 considered what such growth has had on athlete performance and sports management, including the rising influence of data analytics.

Law - Exponential rates of technological change challenge the legal systems. Harris (2020) discusses the changing nature of laws to address issues of cybersecurity and digital privacy. Clark (2022) discusses the exponential growth in legal disputes arising out of new technologies and the consequences for practice.

Environment, health care, education - Exponential growth in impacts and challenges features environmental problems. According to Adams (2021) and Brown (2023), the speed at which some of the factors for global change visibly take place is marked by rising temperatures and increases in extreme weather, among other aspects of climate change. There is a pressing call for action to handle such issues, and a call for sustainable practices is sorely needed. Therefore, Artificial Intelligence (AI) stands out as a lucid example of exponential growth within the technology sphere. In this perspective, Kumar and Lee (2022) discuss how rapid advancement in AI transforms every sector, from healthcare to finance to education. With its exponential development comes ethical and practical considerations.

Quality Management - This exponential growth in quality management reflects the increased complexity of systems and processes. Quality management practices have now become increasingly sophisticated with technological and data analytics developments, according to Jones (2021). Along with the exponential growth in data availability, high-degree accuracy is possible in monitoring the

standards of quality, thus helping in its improvement. Jones (2021).

2.2 Quality Management and Exponential Growth

Quality management is essentially the process of supervising activities and tasks involved in maintaining a requisite level of excellence. It covers the formulation and implementation of quality policies and procedures, metrics of performance, and strategies for continuous improvement. The concepts and processes of quality management, too, are seeing exponential growth in this world of rapid technological changes and exponential access to data. This paper examines how the exponential trends affect quality management and what the consequences for organizations will be.

2.2.1 The Integration of Technologies for Quality Management

Artificial Intelligence - Arguably, one of the most profound drivers of exponential change for quality management is Artificial Intelligence. AI technologies, including machine learning and deep learning, provide advanced ways to drive and implement quality improvements. According to Kumar and Lee (2022), AI algorithms can interpret data on a large scale to notice patterns and anomalies in ways that are hardly achievable with traditional methods. This enables more accurate estimates of quality and interventions on time. For instance, AI-driven predictive maintenance systems forecast when a particular equipment failure might occur to minimize downtime by ensuring consistent product quality.

Big Data Analytics - Big data analytics is one of the most exponential evolutions faced in quality management. While its growing volume, variety, and velocity of data bring new opportunities, a significant number of challenges also occur. Davis (2018) noted that big data facilitates the power of going deeply into production process analysis and customers' feedback so that proper decisions

regarding quality improvement can be made. Companies can acquire deep knowledge about issues related to quality through big data emanating from different sources, which helps further in process optimization and making products meet customer expectations more effectively. These big datasets cannot be maintained and presented without advanced analytical tools and expertise, and may become tough for many organizations to manage.

Automation - Another major contributor toward exponential growth in quality management is automation. Automation technologies make repetitions less painful and leave no room for human errors besides confirming that quality standards are met consistently. According to Green (2021), automation of manufacturing processes, including the use of robotic systems as well as automated inspection equipment, helps in enhancing precision and efficiency. Something of real value in high-volume production environments is the capability of automatic systems for quality checks at very high speed and accuracy. Automation can also allow for real-time monitoring and control of the quality metrics with the possibility of immediately making adjustments and improvements. Smith (2022).

2.2.2 Continuous Improvement and Exponential Technologies

Continuous Improvement - Continuous improvement is the most elementary principle of quality management, meant to bring about enhancing processes and products over time. What exponential technologies do is help provide tools and methodologies for the continuous refinement of that principle. For Thompson, advanced analytics and real-time feedback loops provided by AI and big data analytics contribute to continuous improvement initiatives. This takes in new forms made possible by such technologies as those affording organizations the ability to identify the need for improvement, quickly and easily, make the changes, and measure the effect of those changes on quality, as Parker &

Reed found (2021). AI-driven insight integrated into continuous improvement processes can deliver huge gains in both efficiency and effectiveness.

Quality Control - Exponential technologies play an ever-increasing role in quality control. More sophisticated quality control using AI and big data is made possible, with advanced insight into product quality and process performance. AI-powered vision systems, for example, can detect product defects that are invisible to the naked human eye; this should raise quality control standards. Big data analytics can highlight trends and correlations to ensure the implementation of quality improvement policies and avoid problems long before they occur. Overall, improved accuracy and reliability in quality control processes spawned by these enhancements result in better product quality.

2.2.3 Challenges and Considerations

Scalability - Scalability is one of the important challenges arising from or associated with the development of exponential technologies in quality management. This simply means that while the organization scales up by adopting new technologies, the quality management system should equally be scalable to handle the volume of data increase and complexities arising in production. For instance, Jones (2021) says, the scalability of technologies being implemented for the various sizes and types of organizations. Such solutions include developing scalable technology architecture and investing in infrastructure that will accommodate growing data and automation capabilities, among others, as Adams & White wrote (2023).

Data Privacy and Security - Data privacy and security are among the major concerns in this exponential growth context. Big data and artificial intelligence in quality management engagement will be driven and mainly based on gathering and analysing volumes of sensitive information. Harris (2020) raises the ante by adding that this information needs

protection to prevent leakage and misuse. Of course, information security does need good data protection, encryption, controls on information access, and compliance with relevant regulations on data privacy. Clark et al. (2022) show that the appropriate implementation of these steps will enable the process of gaining customer confidence through protecting private information. About exponential technologies being used on issues concerning quality management, this is a matter that needs deliberation with an emphasis on ethics and responsibility. The following paragraph develops this matter further.

Ethical Considerations - Ethical considerations form another scope of key importance in the integration of exponential technologies into quality management. For example, the use of AI and analytics intrinsically raises a different set of concerns regarding algorithmic bias and fairness. Kumar and Lee assert that algorithms must be transparent and unbiased so as not to unconsciously perpetuate certain biases or inequities in quality management. Organizations should have a set code of ethics or a body of governance in AI system development and deployment in service of the responsible and equitable utilization of these technologies. Brown & Green (2023) assert, sustainability has become one of the swelling concerns in quality management, especially as organizations continue to work out a balance between technological advancement and environmental cum social responsibilities. It is also very important in integrating exponential technologies that they are compatible with the goals of sustainability, such as reduction of wastes, less use of resources, and being eco-friendly. According to Adams (2021), leveraging AI and automation can help promote sustainable quality management by optimizing resource utilization and reducing the footprint in the environmental impact of production processes. Future studies may explore the potential role of exponential technologies in enhancing sustainable development and offering solutions to various environmental challenges.

2.2.4 Future Directions

Emerging Technologies - Research in the future should pursue the position and potential contribution of emerging technologies, like blockchain and IoT, toward better quality management. Specifically, the blockchain might enable advances in supply chain transparency and traceability that enhance quality and compliance assurance, as Smith & Roberts (2023) found. IoT enables real-time monitoring and control, thus allowing for much finer quality management and process optimization. Application and advantages-focused studies of such technologies can lead to insights into how they enable the continuous pursuit of improvements in quality management practices more achievable.

Agile Frameworks - To this end, exponential technologies are constantly and rapidly evolving, and so the development of adaptable frameworks in quality management is called for. Organizations require flexible and scalable quality management systems that will adapt to these new technologies and emerging needs. The studies that support this must develop a framework that reflects the dynamic nature of rapid technology development and enable organizations to meet high standards of quality that correspond to the latest innovations, as White & Black (2023) discovered.

Ethical and Sustainable Practices - Future studies should try to address a list of issues that include ethical and sustainability concerns. The development of guidelines and best practices on how to use AI and big data in the management of quality in ethical ways, together with strategies for promoting sustainability, goes fundamentally through the issues of responsibility and effectiveness in technology integration. Collaboration among researchers, practitioners, and policymakers will help define standards and practices that support ethics and sustainability in the management of quality.

3 Problem Solution

3.1 Methodology and methods

The approach for this study is qualitative and quantitative. The method of data collection and analysis for existing research on exponential growth in different fields and industries is based on a wide-ranging literature review, while the exponential growth of quality management systems is based on a correlative analysis. Sources of data include academic journals, industry reports, and expert interviews, as well as the ISO 2022 Report on ISO standards issued worldwide. Key methods will involve:

1. Literature Review: The researcher will conduct a critical literature review of available academic and industry literature on the trends and impact of exponential growth in the areas identified.
2. Case Studies: Investigations into specific cases where exponential growth has elicited phenomenal effects.
3. Expert Interviews: Perceptions from experts in those fields of relevance add to contextualization and future perception.

While in studying the effect of exponential growth on quality management, this work has adopted a qualitative and qualitative research design. The approach entailed the following:

1. Literature Review: A critical review of related academic and industry literature to comprehend emerging trends and practices in quality management occasioned by exponential growth.
2. Case Studies: Investigations into organizations that successfully integrate exponential technologies into their quality management systems. This also covers assessments of how they address automation, data analytics, and continuous improvement.
3. Expert Interviews: A set of interviews with professionals in quality management and technology experts to gain insight from them

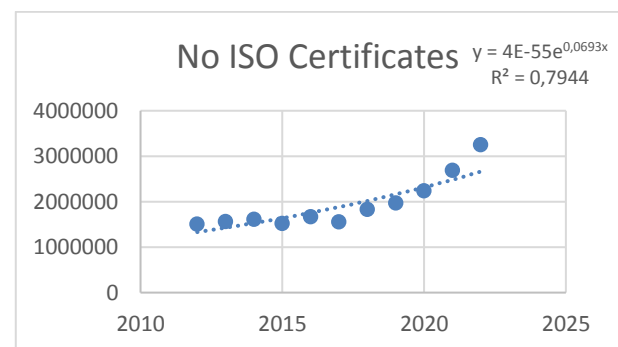
concerning the practical implications of adopting exponential technologies and the challenges that come with this adoption.

4. Correlative analysis

Table 1: Number of ISO standards certificates issued between 2012 – 2022 worldwide (ISO 2022)

Year	No ISO Certificates
2012	1.504.213
2013	1.564.448
2014	1.609.294
2015	1.519.952
2016	1.664.357
2017	1.556.758
2018	1.826.253
2019	1.970.029
2020	2.237.791
2021	2.689.972
2022	3.249.383

Graphic 1. Correlation between time and ISO standards certificates (graphic drawn from the author in this paper, using data from ISO 2022), where it shows exponential; growth of ISO standards worldwide, with $R^2 = 0.7944$, in a $y = 4E-55e^{0.0693x}$.



3.2 Future Avenues

The following areas need to be addressed in future research:

1. Integration of Exponential Technologies: Future review in the domain must integrate newer technologies such as blockchain and the Internet of Things for better efficiency in

quality management. For example, blockchain can be engaged to avail a quality enterprise with enhanced supply chain visibility and traceability, while IoT has the potential to monitor and control quality metrics in real-time.

2. Cross-D-domain Analysis: Analyze how exponential trends in one domain influence others and create strategies that can help manage influences of such effects.

3. Ethical Implications: Looking into ethical considerations for rapid technological advancement and ensuring responsible innovation in this regard. In this vein, the ethical impacts of deploying AI and Big Data would need consideration. Further, such issues would involve data privacy, algorithmic bias, and potential employment impact.

4. Sustainability: The study of the long-term effects of exponential growth on environmental sustainability and social equity, while finding solutions to minimize negative impacts. Research in this regard should also cover the application of exponential technologies in the encouragement of sustainable quality management practices. It would include, among other things, the environmental impact caused by technological solutions and how waste and resource consumption can be reduced to a minimum.

5. Scalability and Adaptability: The investigation into how organizations can scale up and adapt their quality management systems to exponential growth is another core agenda. This will involve examining the challenges and strategies relating to implementing advanced technologies in organizations of varying sizes and across different industries.

4 Conclusion

This growth, from an exponential point of view, touches on the very basics of political, economic, social dynamics, cultural, sporting, legal, and environmental perspectives, among

others, coupled with artificial intelligence to quality management. To understand such kinds of trends, it is adequately necessary in the formulation of strategies on how to manage their impacts for harnessing potential benefits. Further studies in this area shall focus more on ways through which responding to integration challenges of technologies, cross-domain interactions, ethical implications, and sustainability can be used to address complexities attributed to exponential growth. Where earlier exponential growth in technologies and data availability enables the practice of quality management to progress toward real-time monitoring, advanced analytics, and automation. These emerging trends provide huge opportunities for improvement in quality and efficiency but also bring challenges regarding scalability, ethics, and sustainability. Further research should, therefore, focus on these challenges and the development of a framework that integrates emerging technologies into quality management systems to drive continuous improvement and innovation.

Conclusion 1: Technological Development for Better Quality Management

- Conclusion: Exponential technologies, including AI, big data analytics, and automation, have given a whole new dimension to quality management practices. These are capable of offering real-time monitoring, predictive insights, and smoother processes that help enhance the quality of products and services at better efficiency.
- Recommendation: Organizations should invest more in the use and implementation of AI and big data analytics tools, which would greatly enhance the quality management system. The use of automation for routine checks within the quality control processes will ensure greater accuracy and eliminate human errors. Constant evaluation and adaptation of these technologies will assure continuous improvement in quality management practices.

Conclusion 2: Scalability Remains a Challenge

- Conclusion: Even though exponential technologies come with enormous benefits, scalability is one of the key challenges. The quality management system must scale with business growth and handle larger volumes of data and increased complexity related to processing.
- Recommendation: The development of scalable technology infrastructures should be done, which could handle increasing volumes of data and rising automation requirements. The organizations have to adopt modular and flexible systems that can be modified and changed according to changing business requirements. Strategies related to technology have to be reviewed and updated on a timely basis so that issues regarding scalability could be addressed.

Conclusion 3: Data Privacy and Security

- Conclusion: The escalating growth of big data and AI in managing quality has resulted in very valid concerns regarding privacy and the security of data. Indeed, any important and sensitive information is required to be kept confidential to maintain customer confidence and not violate any regulation.
- Recommendation: Elaborate on data protection, including encryption, access controls, and periodic audits on security. Ensure data privacy regulations are followed and add clear policies with regard to data handling and security. Train employees on best practices in data security

Conclusion 4: Ethics of AI and Data Usage

- Conclusion: This is a critical conclusion: ethics regarding the use of AI and data analytics in quality management surrounds issues relating to fairness and algorithmic bias. AI

systems need to be transparent and operate equitably.

- Recommendation: Develop and apply ethical policies for the use of AI and data analytics, audit algorithms periodically to eliminate recent bias. Additionally, cultivate practices that promote transparency and stakeholder diversity in the development and implementation of AI systems to ensure fair development and deployment.

Conclusion 5: Sustainability and Environmental Impact

- Conclusion: On issues of environmental and social responsibilities, it will be appropriate if exponential technologies are aligned with sustainability goals. Though these technologies bring about efficiency, their deployment should be done in such a way as to take into account environmental impact.
- Recommendation: Embed sustainability considerations across the technology adoption process. Study the environmental impact of new technologies and ways of reducing waste and resource consumption. Encourage sustainable practices within quality management and include environmental criteria in the selection and implementation of technologies.

Conclusion 6: Future Research and Emerging Technologies

- Conclusion: There is a prospect that emerging technologies, such as blockchain and the Internet of Things, might further improve quality management practices. However, their applications and benefits require further exploration.
- Recommendation: Investing in research using blockchain and the IoT in quality management. Run pilot projects to establish how it works while determining the best practices for integrating those technologies. Keep updating yourself regarding the

technological changes, and be ready to change your strategy for quality management accordingly.

Final thoughts:

- To conclude, rapid technological development is one of the major factors bringing extensive changes to quality management today, hence fostering improvement precepts that create efficiency, precision, and continuous improvement. Within this context, the integration of artificial intelligence, big data analytics, and automation offers, for the first time, unparalleled opportunities concerning quality control and decision-making. Conversely, such rapid technological evolution comes with problems regarding scalability, data privacy, and ethical concerns. Meeting these kinds of challenges while aligning technological advancement with the goals of sustainability will be decisive in harnessing their full potential. With such dynamism, organizations have to be open to change, invest in scalable solutions, and be committed to ethical practices for sustained improvement in quality management that will drive long-term success.

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Conflict of Interest

The author has no conflict of interest to declare that is relevant to the content of this article.

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