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Operational Efficiency in the Age of Convergence: How Service Integration Drives Value in Digital-First Markets

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Abstract

Technological convergence among communication, computing, and control systems is expected to result in a wide range of novel industrial solutions with more intelligence, lower cost, and better sustainability traits that are difficult or even impossible to achieve using the three system types independently. This paper focuses on conveying the system-level reliability definition and quantification towards a ubiquitous convergence of the three practical systems. Related key arguments are made, together with research opportunities and hotspots. Technological convergence is defined as the integration of two or more distinct technologies into a unified system or product. By the universal convergence of communication, computing, and control, a wide range of novel Internet of Things (IoT) solutions is expected. The three systems would not only be packaged together, but all processed and communicated without boundaries. The convergence-enabled systems can be deployed more compactly, enable a wider range of applications, and respond to events even faster. The convergence offers many opportunities to facilitate the achievement of better intelligence, lower cost, and better sustainability traits, but also confronts many challenges. The next generation cellular communication systems have developed into research hotspots to support more complex and diversified applications with ultra-high reliability, high-density terminals, low-latency communication, reduced energy consumption, and full-spectrum coverage. With the rapid evolution of wireless technology, sensing and actuation devices have become lower-cost, smaller, more intelligent with artificial intelligence capacities, and hence readily integrated for development into compact cyber-physical systems (CPS). New applications of CPS such as autonomous driving and manufacturing are emerging. The unprecedented integration of terminals changes communication and control requirements. Multi-domain systems need to communicate, process, and control information from different types and dimensions. A cross-domain paradigm becomes necessary to effect a rapid performance response. It is expected that the convergence-nature behavior would bring novel automation and IoT solutions that are more intelligent, lower cost, and better sustainable. However, highly complex systems would preferably result in unpredictable and unreliable solutions that are hard to be tested, validated, and certified.

Keywords : Operational Efficiency, Service Integration, Digital-First Markets, Value Creation, Process Optimization, Convergence Technology, Workflow Automation, Customer Experience (CX),Resource Utilization, Cost Reduction, Agile Operations, Data-Driven Decision Making, Cross-Functional Collaboration, Performance Metrics, Scalability.

1. Introduction

As technology continues to evolve, companies must adapt to the changes in their environment in order to survive. The recent economic boom has resulted in rapid technological advances and convergence of once distinct technologies. The convergence of communication systems with computing and mass-media technologies has provided tremendous opportunities and challenges for organizations. Organizational alliances are now being formed for effective cooperation within business and technical ecosystems. A combinatorial digital ecosystem has arisen through interconnected and interoperable networks and applications. The convergence of voice communications with data telecommunications, wireless telecommunications with wired media, and the Internet with carrier and broadcast data services have blurred boundaries between distinct application domains. This is affecting business models, organizational structures, and processes from micro to macro levels.With the rapid advances in voice over IP technologies, organizations which previously owned a separate voice network are now able to build an additional data network.

Fig 1: Impacts of digitization on operational efficiency

Exploiting the synergies of previously separate networks requires not only technological but also procedural and behavioral changes. Businesses must take a more holistic and systemic view that shapes applications which are expected to continue to generate returns on the massive investments involved. Web portals, voice-mail-to-email systems and desktop/client integration applications for convergence are now emerging across the enterprise landscape. The convergence of data and telecommunications offers significant competitive advantages when carried out correctly. Firm-specific systems can replace the one-size-fits-all solutions currently available from traditional vendors and belligerents.

Standardized converged systems which span many industries and geographies are also emerging. The ideal systems will be open and easy to modify and integrate with other systems. They will ease transitions to new applications by utilizing context-sensitive automated configuration. Finally, they will employ advanced artificial intelligence (AI) techniques to assist the user in minimizing the system's complexity and maximizing productivity. Companies must choose from a multitude of converged systems under rapid development. A systematic and substantial research effort is required to develop methodologies, tools, specifications, and reference implementations that provide broad guidance for developing business-appropriate holistic converged systems.

1.1. Background and Significance

As technological innovations continue to proliferate and information is increasingly shared between previously disparate systems, the significance of operational efficiency in the age of convergence, a front-of-mind concern among both technology and business specialists, becomes apparent. The methods of analysis that shed light on the implications of a converged IT and OT environment are numerous. However, little study has been conducted so far on how to quantitatively examine the IT/OT convergence implications across various technologies. Thus, this effort aims to establish a novel simulation-based model of a converged IT/OT environment and systematically study operational efficiency considerations across several industrial practices. The performance measures of IT/OT convergence are derived from a mathematical conversion between discrete-event simulation and queuing theory, given a common key metric of operational efficiency for systems composed of generalized queuing networks under specific parametric stochastic assumptions.

The proposed model is validated by a solid performance comparison against established smaller systems. Its applicability is illustrated with case studies of both information systems and operation systems widely found in practice. Simulation experiments using the novel simulation-based model across representative stochastically driven environments uncover qualitative insights about handling the situation when the IT and OT systems tend to be in convergence. These findings can serve as guiding principles for corporate-level IT/OT convergence concerns. Managerial insights about operational efficiency considerations in the age of convergence are summarized and possible avenues for future research are discussed. More importantly, a framework of methods to quantitatively analyze and evaluate operational efficiency considerations across different technologies is developed. The framework can be adapted to shed light on other business/IT areas of study not restricted to the industrial practice of convergence, competing, and co-opetition.

The large lighting systems/network industries perpetuated by the pandemic development of solid-state light-emitting diode (LED) technologies underscore the potential of IT and OT convergence to fundamentally change existing systems, structures, and industries. Current technological advancements allow lighting systems to develop capabilities far beyond their original functions, thus providing fertile ground for innovation and opportunities to enhance operational efficiency. Given this co-location of operational feasibility and competition/resource considerations, the backdrop of the study may hold true for a plethora of industrial practices across industries, with considerable scope for follow-up research to explicate the opportunities and considerations for operational efficiency across generically converged environments.

Equ 1: Operational Efficiency (OE) as a Function of Service Integration (SI)

$$OE = f(SI, R, C)$$

Where:

- OE = Operational Efficiency
- SI = Degree of Service Integration
- R = Resource Utilization Efficiency
- C = Cost Management Effectiveness

2. Understanding Convergence

A continual movement towards fewer, more powerful, integrated technologies is called convergence. Convergence is a key factor in many industries today, giving rise to such popular phrases as “media convergence” (supply) and “cross-channel behavior” (demand). A set of industries may be said to converge when they share a set of competitive dimensions or face the same set of competitors. This paper outlines conditions under which industries converge, tests this hypothesis with a number of examples, and evaluates the limitations of the theory.

Convergence occurs when previously recognized industries begin to fall outside the limits of their original definitions. This suggests a broader body of conceptual and empirical work through non-standard perspectives, such as the resource-based view of the firm or network approaches. According to the resource-based view, convergence occurs simply because of the sharing of resources in the services offered . As with similar treatment of concepts such as externalities and the cooperative firm, these views can reveal certain aspects of convergent industries, but they are neither sufficiently general nor well-supported to shed real light on either the causes or the broader implications of convergence.

When a firm operates in a convergence environment, the competition it faces includes the offerings of the converging industries and the founded industries.

This affects those competitive dimensions on which they compete, such as performance, features, bundled services, product cost, switching costs, or branding issues. In the process, the competitive logic or roles of the industries must be reconsidered. Some competitive dimensions may nonetheless emerge, while new roles may arise.

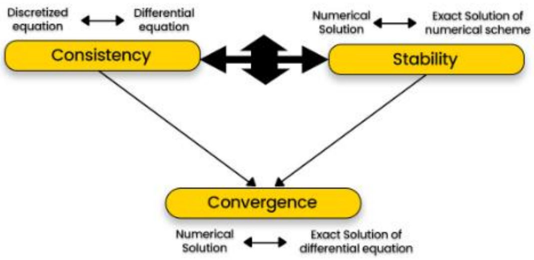

Fig 2: Understanding Convergence

2.1. Definition and Scope

Operational efficiency, synonymously used with operational effectiveness, operational performance, operational productivity and operational quality, is the quality of a process output due to the relationship between its established objective and its evaluated performance. Process objectives correspond to process measures that provide a high level view of the operating gains and shortfalls associated with the realization of operational activities. These measures are typically aggregated in effectiveness categories. Quality, productivity and efficiency are commonly agreed operational effectiveness measures. Production system throughput and cycle time measures are mutually exclusive with these measures.

Operational efficiency refers to the output per unit time cost slack, and is estimated by process performance measures. The maximization of product quality (minimization of defects quantity and/or severity) is intended to eliminate held up work (increased inventory) and/or reprocessing delays as well as avoidance of malfunctioning products for the manufacturing stage, and product returns or service rescues for the post-manufacturing phase. The operational asset utilization measure assesses whether a process is effectively utilized, motivated on usage criteria related to utilization level (excessive resource idle time) or unit purchases (excessive stocks). Efficiency consideration is on the one hand a function of measurable and valence quantitative process performance parameters, on the other hand more vague variables that quantifies automated output precision and accuracy relative to their established specification limits and distribution type, multi-dimensional definitions of output variables and fault mechanism analysis.

An operational efficiency improvement precedence is with regards to introducing a separation of the production process into interdependent process units. Sequential operational unit decomposition creates composite production units, with associated performance measures and effectiveness categories as in a flat production system. Composite performance measures are jointly defined, chainwise or crosswise, for operational unit decomposition implementation. Chainwise measures are characteristic of large systems wherein some operational random unit events have an unavoidable domino effect on subsequent units and generate production corresponding delays in processing.

2.2. Historical Context

The quest for operational efficiency is as old as the Industrial Revolution; however, the pervasive convergence of the last decade has completely changed it. Convergence refers to the intermingling of previously distinct industries, business models, and competitive landscapes that, nevertheless, share common underlying processes and operation. The intermingling is often facilitated by the emergence of domain-agnostic technologies, which in turn was only possible because outsized strategic investments were made in their predecessors. As a result, even erstwhile fully distinct industries or sectors have found themselves competing in each other’s markets, often with overlap in business model. In addition to the strategic implications, the most daunting operational efficiency challenges arise in this context of convergence.

Notably, in its connotation of profoundly interconnectedness of previously distinct domains, convergence is set apart from mere technological progress, particularly Digital Transformation. The speed and scope of the resultant social effects are also of a different order of magnitude as exceedingly more interdependent industries are subjected to slower-than-expected remedial processes. A year is a long time in the age of social media, but a generation is an eternity in the finance and energy industries. Much of the work observed in the wake of earlier convergence waves were for more systemic, less anoxic issues. Hence, they did not require the kind of changes that could roil development historically thought of as stable.

A need to assess operational efficiency arises on many levels in the context of convergence. First, changes in resource and end-user markets can drastically alter the relative attractiveness of business models, re-ranking incumbents and entrants alike. Individual firms, industries, and places all have their own take on why this is happening. However, they could all benefit from the fundamentals being laid out for competitive analysis at a time at which many of the metrics on which historical analysis relied would appear to be nebulous at best.

3. The Role of Service Integration

Service integration is a comprehensive service provision for delivering converged voice, data and video services to businesses and their customers. The integration of telecommunications with information technology is leading to the converged world. The Unified Communication Space (UCS) is an intuitive suite of applications that provide enterprise users with a single point of access for the management of converged voice, video and data services. A new generation of collaborative applications is being developed for a variety of business environments ranging from teleworking to tele-consulting. Service integration is a closed architecture that facilitates the unified communication service provisioning using SIP. Ongoing research work is aimed to extend the scope of services covered by SIPS to include the delivery of new converged services to business enterprise users such as tele-holding or tele-presentation services. A web service-based approach embracing the global service architecture view of SIPS is also being investigated for SDM3 to facilitate sharing of services amongst third party developers and procurement of disparate external services.

The current telecommunication service landscape has evolved from a traditional proprietary and clustered systems environment to one that is much more heterogeneous in nature. The latter architecture has emerged due to the proliferation of a multitude of proprietary and vendor-specific systems and devices from various telecommunication and data systems vendors. These were acquired by service providers in a bid to be competitive in the marketplace with little regard to modularization, scalability, interoperability, and upgrade path. Considered inadequate, costly, and limiting, this vendor lock-in problem is further exacerbated by the convergence trend where voice, data and image communication systems will no longer operate in isolation but will all need to be integrated together to deliver more complex converged media services.

Fig 3: Service Integration

3.1. Concept of Service Integration

In the context of a media convergence centre (MC2), service integration refers to a model that incorporates media convergence technology into a centralised management framework to support the integration of broadcast, telecommunications and Internet multi-channel services or networks throughout the entire service lifecycle within a modular service architecture. The model comprises three levels of service integration: service development management that integrates modelling and formal specification of service-based equipment while accounting implementation and service composition and deployment management; service operations management that integrates convergence service supervision and management with equipment maintenance and fault diagnostic information; and service monitoring that handles monitoring and situational awareness and evolves service and operational models for customer relationship management .

A media convergence centre is a unified platform for the management and provision of broadcast, telecommunications and Internet convergence services. An MC2 can develop various convergence services combining audio/video, voice, text, and graphics processing. Operations of complex media services require the collaboration of diverse, rich and heterogeneous equipment/service systems. With service-based network equipment/services, the key tasks of service-oriented management are the monitoring of complex service execution and fault diagnosis or service restoration. A media convergence centre (MC2) is a concept of a centralised management framework that regulates service resource and context information execution, on which various multi-channel and multi-domain convergence services are constructed. An objective is to develop a generic model that supports the adaptation of diverse equipment-service resources and integrates their development and operation management. As the first essential step, service development management is explored. A media centre is a service-oriented architecture composed of various equipment/service systems interconnected by IP networks. Media convergence centres are customised for diverse applications and domain-specific embodiments with different emphasis, covering architecture design, specification and implementation issues, and equipment integration.

3.2. Benefits of Service Integration

A media convergence centre (McC), powered by a media convergence architecture, enables telecommunication companies and information technologies to provide unified and user-friendly media convergence services to its customers. With the opportunity to take advantage of the rapid developments in VoIP technology and possibilities for integrating other networked media types, the McC can provide a plethora of media-rich collaboration and interaction services from a common point of entry, easy access and an intuitive user interface.

Convergence, or the integration of previously distinct media has been happening for centuries. Today, with the rapid advances in broadband telecommunications, digital media technologies and growing numbers of people with good access to services it will be possible to deliver previously unfeasible services to individuals and businesses using a plethora of media amplification and alteration types. Converged services in a single session in a broadband environment would enable users to interact in a media-rich virtual collaboration environment. A media convergence centre (McC) solution would provide all industries and consumers with a new, innovative and powerful means for data-rich collaboration and interaction.

Commercially, it is expected that a myriad of broadband telephony, television/video and fax services will be available when the fourth generation of terrestrial broadcasting services become available. It is important to note that telecommunication means a networked transmission media type used to send messages between points and that historically many ways of sending messages have existed. Over time, new transmission media and types emerged, for example, radio waves and voice/sound, electricity and text/number, light and picture/television, and data packets containing unstructured data.

Equ 2: Service Integration Level (SI) as a Composite Index

$$SI = w_1 \times I_c + w_2 \times I_t + w_3 \times I_d$$

Where:

- I_c = Integration of Customer Channels
- I_t = Integration of Technology Platforms
- I_d = Integration of Data Streams
- w_1, w_2, w_3 = Weight coefficients summing

4. Operational Efficiency Explained

In brief, operational efficiency refers to a benchmark metric of organizational processes—a relative concept where some processes are more efficient than others, but not all processes are efficient. All organizations are made up of processes, which are in themselves complex collections of behavioral rules operating in dynamics through time. At one level, all organizational processes perform their intended tasks recognizing that some processes perform their tasks better than others. Consequently, processes differ in operational efficiency: some can perform (either more responsible tasks, level of completeness, time taking and/or less resource consuming) and some cannot. Process efficiency is a relative metric of benchmarked accomplishment (efficiency is defined as the ratio of the times a process has performed its intended task in the time it has to perform it). The need for efficiency metrics varies depending on the scope of their information.

Fig 4: Operational Efficiency

A process functionally responsive to such claims will be slower and will consume more resources, etc. It will not be efficient regardless of that fact; those will be more costly measures taken at the social level to compensate for that efficiency loss. There is thus a reluctance to accept that process efficiency metrics exist. Instead, it is said that all processes are efficient on their own operating on individual time scales and quality heuristics known only to those within the process. Attempts at rationalizing across processes are futile, as managers cannot possibly know what those heuristics are (knowledge being too local). Buying and selling resources across organizations is all there is.A system responds to information about later events, one hopes in order to improve future performance. It would be possible to examine what is needed to foster a better organization, the purpose of efficiency metrics.

4.1. Key Performance Indicators

Operational efficiency how-to, principles of execution, and metrics for success. Concepts that are table stakes for the modern enterprise operating today in a world of convergence; where multiple volatile trends force an evolving playbook and contract between companies and their suppliers, partners, logistics providers, and customers. A world where predictable lead times on raw materials, production capability, and service delivery are increasingly complex with multiple moving parts and fractal sub-patterns. And a world where user preferences from configuration to arrival time frame and environmental impacts multiply in ways difficult to coordinate without an internal compass adaptable to the misalignment of decentralised stakeholders and market principles. Operational efficiency must be both articulated and executed to avoid added slack fixed costs, variable failure costs, and declining competitiveness feedback. Said another way, for a company to limit exposure, allow for rapid evolution of the service catalogue, and protect pricing power, it's critical to have a transparent yet flexible governance mechanism for trades between costs and service at all stocked-to-order based business processes on the end-to-end supply chain. Competitors compete on hard-to-copy complementary offerings, but effectiveness is severely limited when propensities to deliver or experience fail to match user expectations.

Key Performance Indicators form the backbone of operational efficiency, providing the foundations of a holistic strategic efficiency model and the company's ability to govern the local decisions through a performance trade-off and risk assessment. A universally applicable trigger-roadmap of convergent trends to operational efficiency. Each convergence-lever moves a number of parameters and visualizes measures of success to reach a new equilibrium stock of products along categories and/or pipe-pipes. However, a roadmap's approach limits its ability to extract additional value added from a non-linear trajectory around its outline and occasionally questions on the assessment of equilibrium reached and new potentials, both short- and long-term.

4.2. Measuring Operational Efficiency

Wage dispersion may be calculated as a time-invariant exogenous underlying factor of firm-wide efficiency. To see this, express the dynamic wage ratio as , where the second term is a time-specific unobserved factor. Accordingly, productivity gains may be evaluated in terms of changes in the average underlying factor of firm-wide efficiency. Empirically, observe that fine-tuning helped to smooth productivity fluctuations and rendered a closer fit to the distribution. To take out the microeconomic influences of wages and inefficiency, a pseudo-Prussian path was disentangled for the size distribution. Arranging firms by time-average firm-wide efficiency and taking groups of 253 firms, the resulting 18-month reallocation ranges (percentiles at 5, 25, 75, and 95) equal to (2.01, 27.38, 66.68, 94.75) for the time. Accordingly, treatment effects of a 1-unit cut in categorical patent drift on productivity, and a 1.98-factor across-the-board cut in technology drift were computed. Productivity retook higher values and bandwidths against the placebo path. Static responses of gains in log productivity to state-dependent standard deviations show little drifts following the exogenous cuts. To clarify why effluent loads did not diminish after co-implementation, cabe-shaped responses of productivity to time-specific technology drift shocks were traced. The failure to remodel the industry with upfront outlays in capitalization was interpreted with respect to two moments: the distribution-following transition on the burgeoning firm size and the fresh-engine market concentration. Captured with unobserved factors, the Schneider effect conjectured an industry-wide co-existence of technology drifts in asymptotic open-economy equilibrium.

5. Digital-First Markets

Widespread availability of smartphone connected digital devices and mobile subscriptions per capita is driving rapid digitization. Digital technology convergence is taking place on application and device levels. Given the rapid digitization of both markets and enterprises, a strong and sustainable operational efficiency is needed in the digital-first age. The paradigm of operational excellence in traditional markets is not enough in terms of both customer experience and efficiency. It is imperative for incumbent enterprises to establish next-generation digital-first operations. It is equally challenging for newcomers to get to the same efficiency level as incumbents. Several factors shape operating actors and actions.

The nine grounding principles of digitized operations are new rules to build operational excellence in the digital-first era, and they must be applied together. To start digitizing operations, one must first rethink the scope of operations. Under the new paradigm, the scope of operations becomes a mesh network of interconnected digital twins that span across product, services, machine, workforce, supply chain and market dimensions. The operational meshes can be virtually endless in terms of dimensions and the uniqueness of data and algorithms. Through such a mesh network, a twin ecosystem is formed to digitally connect all actors from different enterprises and markets, including customer, IT and OT stakeholders. The twin ecosystem is animated by advanced modelling, simulation and AI based designs.

Secondly, one must conceive the mesh-to-ecosystem tooling architecture in tandem with the mesh network of operational twins. Overall, the tooling architecture consists of cloud computing for global digital twins, a digital marketplace for procuring digital twins, a grid computing network for co-evolving digital twins, and core AI engines as the mineral processing factories to obtain valuable knowledge from the digital twins. Thirdly, one must build a mesh of digital threads. These digital threads form the logic of the mesh network, define the orientations of operations and tackle issues of scalability of operations at different levels. Each digital thread must be coupled with a relevant operation domain by completing at least a diamond mesh.

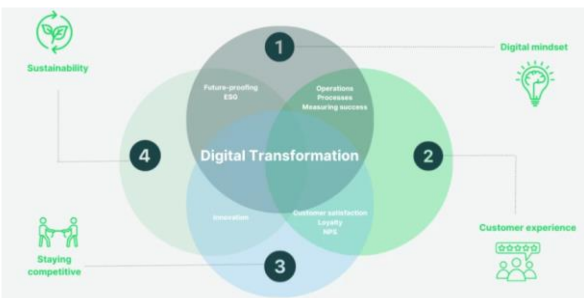

Fig 5: Corporate Digital First Strategy

5.1. Characteristics of Digital-First Markets

The emergence of digital convergence has significant implications for products developed or delivered by firms from different incumbent industries going digital. Digital convergence enhances functionalities and efficiencies of products across diverse and sometimes unrelated industries through the incorporation of digital technologies in product development or delivery. New categories of digital products that are capable of performing functionalities traditionally supported by disparate products emerge. As different industries grow hostile to their erstwhile complements, the rival product offerings introduced by digitally converged entrants give rise to intense competitive battles. At the same time, a greater learning curve and higher inherent costs backload the digital transition, resulting in diverse technology market structures - equilibrium configurations of asymmetric product differentiation - before the eventual competitive takeovers in (multi-dimensional) product spaces. This observation classifies markets of diverse industries undergoing digital convergence into digital-first and digital-late markets, and operational strategies consistent with the class of product spaces.

Digital-first industries disappointed by guard-banded competitive edge are at the mercy of disturbing competitive imitations from product entrants with no prior stakes in the industry. Information flow induced by digital technologies generates enormous opportunities and risks unknown to erstwhile incumbents who are confronted with new market configurations. Likewise, competition brings with it numerous learning opportunities for digital-late firms who might eventually act upon their newfound characteristics. Implications of such strategic investment choices for competitive dynamics in both digital-first and digital-late environments are explored. Through a detailed case analysis across a range of industries, key characterizations of digital-first industries, examined mainly through the lens of choice of product scope, are illustrated. It argues that the choice of strategic scope is however inevitably confounded with pre-existing product scope of the firms, and competitive dynamics themselves are shaped by varying nuances of product substitution logics at the edges of product spaces, e.g. with text messaging services distinguishing rather than competing with chat services. Hence, it advocates for a framework of action-oriented distillate events, recovering micro-simulations, that provide a nuanced understanding of firm strategies and outcomes in the age of convergence.

5.2. Consumer Behavior Trends

According to a study, consumers now spend 8 hours and 14 minutes each day across a plethora of media and devices. Increased media consumption and ownership of devices is translating into greater consumer attention to marketing efforts. Combined with increased adoption of virtual assistants, advertising through natural language queries made on a digital assistant-enabled device will continue increasing in popularity. As digital voice assistants continue their rise, many consumer questions will be asked through a self-selected service rather than a search engine. In response, marketers will shift tactics from search engines to package leagues within filters such as business listings instead of search results.

A growing percentage of consumer transactions are being carried out across multiple channels – laptops, phones, stores, social media, and applications. The government, led by the US, pressured by governments worldwide strived to protect privacy. Marketers completed the leap from managing one customer in one day to managing all customers, many of whom traversed multiple points of engagement. Increased digital commoditization made the cost of entry to offer a product of a given demand curve infinitely lower. Marketers also rushed to adapt their timing, site ranking, and offering trigger optimization to a state of fluid parallelism with these vast, complex demand functions, thus losing some of the nominal return on investment advantage which communication media had before convergence.

Equ 3: Operational Efficiency (OE) in Quantitative Terms

$$OE = \frac{Output}{Input} = \frac{V}{R + C + T}$$

Where:

- V = Value generated (e.g., revenue, customer satisfaction)
- R = Resources consumed (labor, capital)
- C = Costs (operational costs)
- T = Time to deliver service

6. Conclusion

In summary, operational efficiency is more important than ever for the medical firms in the convergence era. As consumers are showing a higher tendency to substitute one type of media or service for another, shifting to alternative outlets offering similar content, usage across media has become increasingly substitutive. Thus, pervasive multi-media usage not only increases competition in audiences and advertising revenues, but also establishes a common media consumption market for firms across distinct traditional media. In this context, in order to avoid a price war, the medical firms must either build higher competitive advantages or build a stronger cross-media revenue generation capacity. The stronger the average demand for advertisements is, the higher the cross-media revenue generation capacity could be obtained. Hence, firms obtaining a higher prime advertising channel diseconomy of scale can have a sharper ad price, higher profitability, and a muscled cross-media operational capacity. Based on this setting, the paper provides a theoretical framework exhibiting the operation in a simplified multi-media environment. The theoretical operational models are summarized for the widely differentiated media firms, homogeneous media firms, and using global operational equipment strengths. Using this theoretical model, several key operational features, suggestions, and implications of the convergence in the advertising-based media environment are drawn, including consistent under-pricing of advertisements across media, the decreasing diseconomies of production existing throughout the whole media production services, as well as the optimality of global agency firms in the convergence era. Conclude by discussing the limitations of this initial framework, and suggesting future research directions.

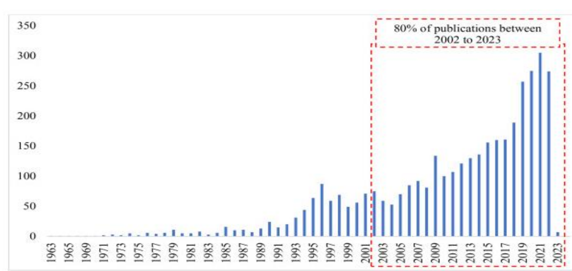

Fig : Operational efficiency in the age of convergence

6.1. Emerging Trends

Like any new technology, three phases of maturity can be identified: (1) Research: Thought of considerable interest, the technology is not yet deployed except in isolated cases and at significant effort and cost. Only a few companies may be profoundly affected. (2) Early Adoption: It is deployed extensively, with some going to great cost and effort to combine new methods and enable whole new ways of working. Some businesses disappear at this point. (3) Consolidation: It is deployed as a matter of course. A settled architecture emerges, decisions are arrived at in a routine way, and there is widespread acceptance of the cost-effectiveness. Originally disruptive technologies are effectively joined into the "business-class" of the company. Various aspects of the convergence that fall short of material and/or operating technology change will become obvious experiences in organizations. The four areas to be discussed here are: (1) service delivery, (2) platforms of voice service, (3) loyalty and service, and (4) application program interfaces and change management.

Perhaps ironically, while service delivery convergence is often taken for granted nowadays, among these four possible convergences, the biggest challenge and the toughest puzzle are here. In the mid-1990s, the birth of voice over Internet Protocol technology made the dream of delivering voice on the existing Internet network a commercial reality. However, this technology was not much more than a "technological" success because of many other challenges on ossified voice devices and differentiation against other voice services such as instant messaging and emails. In 1999, however, the convergence among delivery, format, platform, and the underlying devices was rapidly achieved, and the delivery of voice on the Internet using free software became the hottest trend. The overall analysis suggests that a lot of convergence long anticipated will come during the period when delivery, platforms, devices, and the milieu have all been relatively well settled.

Companies such as Skype are illustrative in the sense that they matured the email service in the previous decade and became the biggest in b-to-c companies in the changed milieu of WIMAX and wireless networks. Furthermore, what would happen in the case of convergence is quite complex and variable in part depending on the nature of the networks at hand. Would the delivery take the IP-based voice messaging over the ATM on top of dial-up telephone lines or dedicated, circuit-switched telecommunication networks underlying SMS and FAX? What platforms and operating systems would be used? Would they adopt a proprietary way of sharing across the borders or a more universal and open development? Would the main surviving companies be big shields against competitive inter-configuration or new comers leveraging wide areas with their distribution power? Would they heed loyalty, revenue, and loss prediction and retention analysis?

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