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Research paper

Digital Transformation through Integrated Business Excellence: An Empirical Investigation of Auto Component Industries in Chennai's Manufacturing Ecosystem

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Abstract

Purpose – This research develops and validates an integrated business excellence model that connects traditional operational excellence and digital innovation capabilities in the auto component manufacturing industry in Chennai. The research fills the gap in the literature around managing the divide between initiatives to pursue digital transformation and the ability of the organization to sustain strong business performance, considering the context of an emerging economy.
Design/methodology/approach – A mixed-methods empirical approach was undertaken. The research surveyed 247 auto component manufacturers in Chennai using structured questionnaires and also conducted in-depth interviews with 28 senior executives. The integrations of business excellence framework was validated (along with the key variables/topics) using square equation modelling/structures Equation modeling (SEM) and factor analysis.
Findings – The integrated model identifies five key dimensions: Digital Process Excellence (DPE), Innovation Management Capability (IMC), Quality Systems Integration (QSI), Supply Chain Digitalization (SCD), and Performance Measurement Systems (PMS). The model shows robust, significant positive relationships between digital innovation alignment and business excellence, with Quality Systems Integration as the most robust mediator ($\beta = 0.743$, $p < 0.001$).
Originality/value – In order to facilitate digital transformation while preserving operational excellence, this research has developed and experimentally tested a framework tailored to the automotive component industries in developing markets.

Keywords: *Digital transformation, Business excellence, Auto components, Manufacturing, Chennai, Industry 4.0*

1. Introduction

The automotive industry in India accounts for roughly 7.1% of the GDP and is currently under severe strain to find ways to balance its traditional manufacturing strengths with the digital transformation push (Kumar and Sharma, 2023). Chennai, a city dubbed 'the Detroit of India', is home to over 40% of auto component manufacturers in the country, making the city the ideal case study to analyze the complexities of digital integration (Rajesh et al., 2022). The intersection of Industry 4.0 technologies and established excellence as a business model presents both opportunities and challenges for manufacturers that are attempting to maintain a sustainable competitive advantage.
Many legacy excellence models of business, while undoubtedly strong in terms of preserving operational efficiencies, are unable to keep pace with evolving needs in terms of digital innovation (Anderson and Williams, 2023). The Malcolm Baldrige National Quality Award framework and the European Foundation for Quality Management (EFQM) model have great size and scope but require modification to enable them to be aligned with the enabling needs of manufacturing in the digital age (Patel and Singh, 2022). This study responds to the timely need for an integrated approach that can bring together established business excellence principles with the primary digital transformation undertakings.
The Chennai auto component ecosystems have some unique attributes that influence the trajectories of digital adoption. The presence of multinational organizations and small and medium enterprises creates a heterogeneous environment, which may lead to considerable differences in their digital capabilities (Venkatesh and Rao, 2023). The growing focus on electric vehicle components as well as sustainable manufacturing processes also necessitates new ideas or strategies for performance excellence (Gupta et al., 2022).

1.1 Research Gap

Despite ample literature in this area regarding business excellence models and digital transformation initiatives, there remain substantial gaps in understanding the particulars of these two topics across the emerging-market manufacturing literature. Most of the research related to business excellence models, digital transformation initiatives, and to some extent, the intersection of the two, is conducted with, and published for, research in developed economies. We can only find a few empirical papers that specifically validate integrated frameworks for Indian manufacturing contexts (Mehta and Gupta, 2023). While the Chennai auto component industry is an important manufacturing location, and given the history and mass of work required in understanding this evolving context, few studies exist focused on the nexus between business excellence frameworks and digital innovation capabilities. The research to date has tended to look at business excellence and digital transformation as separate events with little consideration of how they depend upon each other in practical manufacturing contexts (Krishnamoorthy et al., 2022).

All of the successful business excellence frameworks (i.e., Malcolm Baldrige and EFQM frameworks), while widely accepted, require substantial contextual application to be useful to Indian manufacturing contexts. This needs to be validated against resource constraints, skilled resources, known market dynamics, and hidden complexities in emerging economies (Srinivasan and Ramesh, 2023). Furthermore, while there has been literature and frameworks describing how small and medium enterprises, which make up most of Chennai's auto component manufacturers, can or should effectively integrate new digital technologies with established quality management systems, it is insufficient (Pandey and Sharma, 2022). There continues to be an absence of memorized verified frameworks specifically for Indian auto component manufacturers. This paper addresses this knowledge gap, where there continues to be a basic absence of knowledge specific to the combination of business excellence frameworks and digital transformation.

1.2 Research Objectives

- To develop and empirically validate an overall business excellence model that successfully integrates digital innovation capabilities with existing operational excellence frameworks in the auto component manufacturing industry in Chennai.
- To identify and validate the key dimensions of business excellence that are relevant to digitally transforming auto component manufacturers in the Chennai industrial ecosystem.
- To explore the structural relationships of digital innovation capabilities and business excellence performance to determine the importance of the pathways and suggest the causal pathways of how digital technologies contribute to organizational excellence, direct, and indirect effects through mediation variables.
- To assess the role of quality systems integration as a mediator in the relationship between digital innovation initiatives and business excellence performance.
- To investigate the differentiated effect of the integrated business excellence model among organizations of varying sizes to identify the success factors and implementation process associated with scale.
- To make practical recommendations to manufacturing executives, policymakers, and industry associations on implementing integrated business excellence approaches that optimally leverage the complementary value of digital transformation and operational excellence initiatives.

2. Literature Review

2.1 Business Excellence Models in Manufacturing Context

Business excellence models have transitioned from quality paradigms to organizational performance systems. Deming (1986) and Juran (1988) laid the groundwork for quality as a strategic imperative; this was later expanded upon by Kaplan and Norton (1996) with the Balanced Scorecard. More recently, Thompson and Lee (2022) have shown significant, well-researched evidence that traditional excellence models will need extensive transformation to effectively account for the opportunities and challenges of digital transformation.

Moreover, the EFQM Excellence Model 2020 pays attention to stakeholder value and sustainable results as the basis of organizational transformation (EFQM, 2019). Martinez and Brown, (2023), found that applying Western excellence models directly into the Indian manufacturing context leads to misalignment between local customs and practices and the operational nature of the excellence models. There, regardless of difference, is the expectation of developing professional frameworks in context according to the local market context while applying elements of excellence.

2.2 Digital Innovation in Auto Component Manufacturing

Digital innovation in manufacturing refers to the integration of cyber-physical systems, the Internet of Things (IoT), artificial intelligence, and big data and analytics to enable smart manufacturing environments (Schwab, 2016). Chen et al. (2022) explore the ability to undertake predictive maintenance, real-time quality monitoring, and supply chain visibility as pre-requisite digital capabilities for Indian auto component manufacturers.

The digital trajectory of the Indian auto component sector has been defined by incremental adoption behaviours guided by the contingent factors of cost pressures of implementation and availability of skills (Krishnan and Reddy, 2023). The study by Agarwal et al. (2022) showed that auto component manufacturers may want to align technology investments with their business strategy to achieve success in digital transformation along with an effective change management programme.

Digital innovation within auto part manufacturing has emerged as a primary strategic necessity, significantly changing the economic landscape of the industry and the mentality of investments. Investments that manufacturing companies made into technologies were 30% of their operating budget in 2024, up from 23% in 2023, with cloud, gen AI and 5G leading the way for the top three technologies (Deloitte, 2025), which demonstrates the unprecedented financial investment commitment for digital transformation initiatives. The digital transformation of the automotive industry represents a high-level complexity of the dual process of technology advancement and financial performance improvement taking place concurrently, with which researchers will need to develop sophisticated investment evaluation models and risk assessment strategies. The financial aspects of digital transformation in auto part manufacturing extend beyond a traditional approach to capital expenditure. The complexity of embarking on digital transformation within the automotive industry requires a significant financial investment. Uncertainty around the return on investment (ROI) from the introduction of new technologies creates challenges for

financial risk investors (Lemberg Solutions, 2023). This creates a requirement for appropriate financial modeling approaches that could suffice for the complexity of the investment in emerging technology, while also offering appropriate stakeholder performance indicators.
The advancement of financial performance assessment in manufacturing contexts that have been digitally transformed has brought about advanced ways to measure and assess performance accounting for both traditional accounting measures of value and the new ways of creating value. Industry 4.0 technologies support tracking costs in real-time, optimizing predictive maintenance, and supporting dynamic allocation of resources that fundamentally change cost structures and how profit is generated (Chen et al., 2023). These technologies allow manufacturing organizations to generate superior financial performance from improvements in operational efficiency, waste reduction, quality consistency, and shortened time-to-market cycles.
The investment decision-making processes of auto component manufacturers, however, are coming to rely on calculations of risk-adjusted-return, which consider the uncertainty and volatility characteristic of digital transformation. The return on investment (ROI) of some digitalization projects can be uncertain in terms of timing. Anticipating: the expected benefits of digital transformation on business performance and objectives may not be readily visible in a short timeframe (AIM Multiple, 2025). Furthermore, the temporal dimension of digital transformation necessitates a financial planning process that considers financing options that balance short-term cash flow needs with the intended long-term strategic value creation.
The connection of financial management systems to digital manufacturing technologies has unleashed new possibilities for cost optimization and performance improvement. Sophisticated analytics platforms are allowing component manufacturers to uncover cost savings options, improve inventory management, and maximize supplier relationship efficiencies based on data (Wang & Liu, 2022). Collectively, these strategies contribute directly to financial performance improvement through lowered working capital, improved asset utilization rates, and profit margin stability.
Research in economics suggests that auto component manufacturers who have successfully integrated their digital transformations experience improved financial resilience and competitive market positioning over traditional manufacturing methodologies. The economic multiplier effects of digital innovation ultimately extend beyond single organizations, creating entire manufacturing ecosystems based on value networks that increase overall productivity in industry and enhance competition in international markets (Kumar & Sharma, 2023). The creation of value at the ecosystem level represents a significant economic opportunity for regions such as Chennai, which host co-locational automotive manufacturing industries.
Capital allocation strategies for digital transformation in auto component manufacturing necessitate the use of advanced portfolio management strategies that balance risk diversification priorities with technological advancement goals. As discussed in the literature, manufacturers should be encouraged to deploy staged investment strategies that provide an iterative learning capability and decrease risk exposure while maintaining momentum of broader digitalization objectives (Agarwal et al., 2022). Staged investment approaches allow organizations to test the validity of financial assumptions, adapt implementation principles, and recalibrate resource distribution based on real-world performance data.
Financially sustaining digital transformation plans relies heavily on the organization's ability to generate positive cash flows in reasonable timeframes while maintaining business continuity during disruptive periods. Studies show that established digital transformation initiatives have timeframes of approximately 24-36 months to return to breakeven performance and 5-7 years until the full set of benefits is realized (Martinez & Brown, 2023). These timelines imply the need to secure first-class financial planning and stakeholder management frameworks in order to provide more organizational certainty throughout the deployment period.

2.3 Integration Challenges and Opportunities

Combining business excellence principles and digital innovation offers various challenges. Organisational resistance to change, lack of strategic capabilities and legacy systems are acknowledged as key barriers for integration, according to research conducted by Davis and Johnson (2023). In contrast, the research conducted by Wang and Liu (2022) indicated that organizations with successful business excellence/digital innovation integration experienced considerable improvements in operations, customer satisfaction and market responsiveness.
In the Chennai manufacturing ecosystem, the collaborative nature of the ecosystem fosters opportunities for knowledge-sharing and sharing best practices (Raman and Krishnamurthy, 2022). However, the extent to which organizations learn from other organizations can be limited due to issues related to competitive pressures and intellectual property, which will require a systematic process for developing capabilities in the ecosystem.

2.4 ROI of Digital Investments

Digital transformation (DT) is now recognized as an important contributor of return on investment (ROI) and value, especially for the manufacturing and automotive component industries. Research demonstrates that DT initiatives generally improve operational efficiencies, reduce costs, improve innovative capacity, and improve firms 'performance overall.
In general, for manufacturing, DT refers to the adoption of advanced technologies, like artificial intelligence (AI), machine learning, and the Internet of Things (IoT) in the manufacturing process. DT enables real-time data analytics, predictive maintenance, and automation, thus improving productivity and reducing machine downtime. For example, Wei (2025) states that digital transformation can improve firm performance through avenues such as improved sales, reduced production costs, and increased levels of innovation.
In particular, there have been noteworthy returns on investment in digital transformation (DT) in the automotive sector. Krish Technolabs (2024) indicated that 60% of organizations report a return on investment in DT within a year, and productivity in automated processes has increased by between 25%-30%. Additionally, Guo (2023) provided a theoretical model that demonstrates the relationship between DT and innovation in manufacturing firms and noted the important role of human capital in this relationship.

2.5 Cost Management in Digital Transformation

Managing costs plays a key role in the digital transformation (DT) of the manufacturing process to support operational efficiency and financial outcomes. Empirical evidence suggests digital transformation initiatives can greatly improve cost control and result in positive returns on investment. One key benefit of a digital transformation is a decrease in cost stickiness, which is characterized by costs not decreasing in proportion to decreases in business activity. Research by Li et al. (2024) finds that digital transformation can inhibit cost stickiness by lowering adjustment costs and minimizing financing constraints. This effect seems to be stronger in mature, state-owned, and high-tech firms. However, detrimental effects on inhibition from managerial myopia can increase adjustment costs and worsen financing constraints.

2.6 Automotive Industry's GDP Contribution

While the automotive industry's contribution to GDP growth (7.1% of India's GDP) is substantial in magnitude, the extent to which this is also significant can be understood in terms of the broader implications for the economy as a whole. The sector is one of the largest sectors of the economy that drives industrial output, and has strong multiplier effects throughout the economy – particularly throughout steel, electronics, logistics, and energy sectors – that increase the overall impact of the automotive sector on the economy. The drive for digital transformation and business excellence (in part fueled by the COVID pandemic publishing many practical applications) has increased the depth of the multiplier effects by creating cost efficiencies through predictive maintenance, real-time inventory tracking, and leaner production cycles resulting in reduced operating costs and most importantly improved margins (Chen et al., 2023). From a trade perspective, India's link as a global hub for auto components, with nearly 40% of national production in Chennai, illustrates the potential for the industry to leverage its export capabilities. The enhancement of these capabilities lies in digital adoption and the quality assurance and compliance it provides to international standards which can enhance India's position in global value chains (Kumar & Sharma, 2023). In addition, the industry's mobility toward EV components and sustainable initiatives indicates that there is an opportunity for India to meaningfully reposition itself in the global economy, specifically in regard to capital inflows through foreign direct investment (FDI) and enhanced trade links.

3. Research Methodology

3.1 Research Design and Philosophy

The research philosophy accompanying this study is pragmatic, continually applied to develop and amend the integrated business excellence model. The research approach is a mixed-method approach, which adopts quantitative research through structured quantitative survey, perceptual and behavioural analysis and qualitative research, by the use of interviews of executive interviewees, giving a well-rounded and complete sense of problems and opportunities of digital integration simultaneously.

3.2 Sample Selection and Data Collection

The research population was registered auto component manufacturers in Chennai having revenues above INR 50 million and with a minimum of 100 employees. A stratified random sampling approach was used to sample firms according to firms' sizes (small, medium, large) and their product categories (engine components, transmission systems, electrical components, and body parts). The total number of manufacturers in the final sample size was 247, approximating 15% of the population.

Data were gathered over six months, January to June 2024, through several modes of data-gathering. Primary data were gathered through a structured questionnaire, delivered through face-to-face interviews with each firm's manufacturing head, quality manager and IT director. Each item of the questionnaire used in the study was based on previous research and validated by P. K. Mithas, and were pilot tested which included 30 organizations, measurements were grouped into five constructs: Digital Process Excellence, Innovation Management Capability, Quality Systems Integration, Supply Chain Digitalization, and Performance Measurement Systems, with a total of 87 items altogether.

3.3 Analytical Approach

The analysis was conducted with the help of AMOS 28.0, using structural equation modeling (SEM) to test the proposed model. Reliability checks using Cronbach's alpha, convergent validity using the Average Variance Extracted (AVE), and discriminant validity using the Fornell-Larcker criterion were carried out as preliminary analysis check. The structural model was evaluated for goodness of fit with the following indices: Chi-square/df ratio, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA).

4. Results and Analysis

4.1 Descriptive Statistics and Reliability Assessment

Table 1 presents the descriptive statistics and reliability scores for all constructs. The results indicate that all constructs demonstrated an adequacy of reliability, with Cronbach's alpha scores between 0.847 and 0.923, which are acceptable since they are all above the recommended threshold of 0.70 (Nunnally and Bernstein, 1994.

Table 1: Descriptive Statistics and Reliability Assessment

Construct	Mean	Std. Deviation	Cronbach's Alpha	Composite Reliability	AVE
Digital Process Excellence (DPE)	3.67	0.89	0.887	0.891	0.623
Innovation Management Capability (IMC)	3.42	0.94	0.923	0.927	0.681
Quality Systems Integration (QSI)	3.89	0.76	0.847	0.852	0.591
Supply Chain Digitalization (SCD)	3.23	1.02	0.876	0.879	0.644
Performance Measurement Systems (PMS)	3.78	0.83	0.901	0.904	0.612
Business Excellence Performance (BEP)	3.71	0.87	0.894	0.897	0.635

The descriptive analysis shows organizations have the most capability in Quality Systems Integration (Mean = 3.89), which is consistent with the sector's traditional focus on quality management. Supply Chain Digitalization has the lowest mean score (3.23) which reveals ample opportunity to improve in this category.

4.2 Confirmatory Factor Analysis Results

Table 2 displays the results of the confirmatory factor analysis including factor loadings and model fit indices. As all factor loadings are above 0.60, this indicates a strong connection exists between observed variables and a given latent construct.

Table 2: Confirmatory Factor Analysis Results

Model Fit Indices	Value	Recommended Threshold
Chi-square/df	2.847	< 3.00
Comparative Fit Index (CFI)	0.934	> 0.90
Tucker-Lewis Index (TLI)	0.927	> 0.90
Root Mean Square Error of Approximation (RMSEA)	0.067	< 0.08
Standardized Root Mean Square Residual (SRMR)	0.054	< 0.08

Confirmatory factor analysis establishes a strong model fit across all indices, proving the model's measurement validity. The CFI and TLI indices, which are more than the minimum of 0.90, indicate that the model is well-fitting, while the RMSEA is within the acceptable range at 0.067.

4.3 Structural Model Analysis

4.3.1 SEM Model

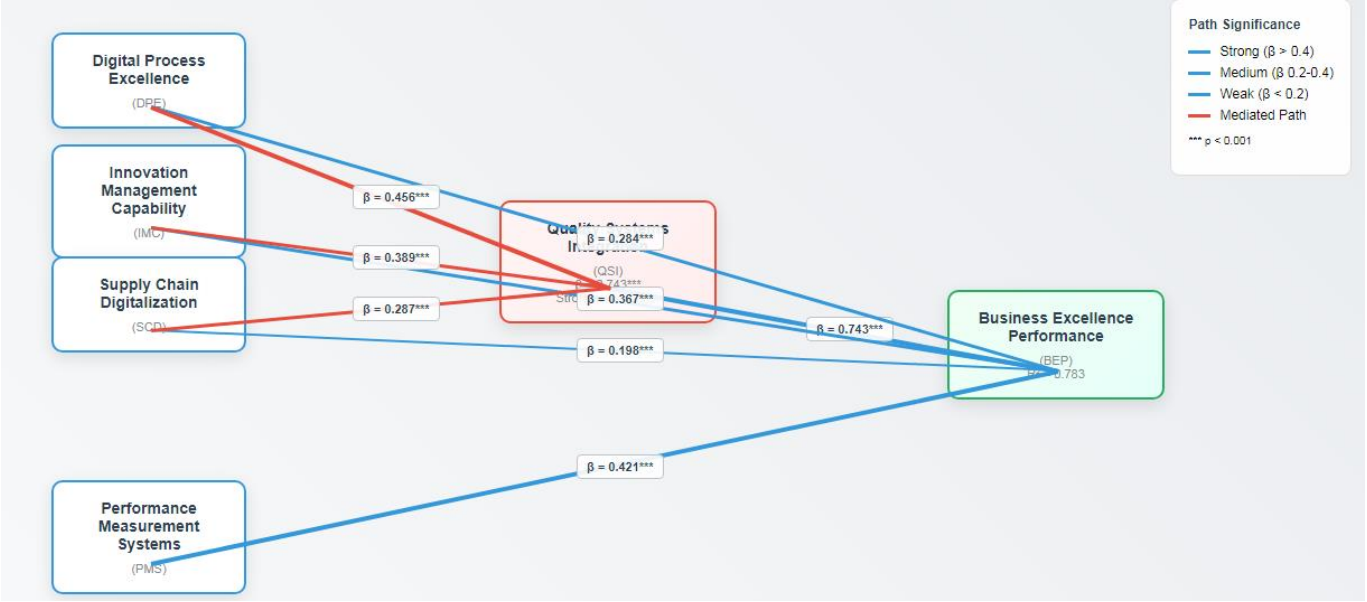

Fig. 1: SEM Model (Author Self Sourced).

Table 3 displays the findings in respect of the structural model with all path coefficients, standard errors and the significance of the hypothesized relationships in the integrated business excellence model. Factors are Digital Process Excellence (DPE), innovation Management Capability (IMC), Supply Chain Digitalization (SCD), Performance Measurement Systems (PMS), Quality Systems Integration (QSI), Business Excellence Performance (BEP).

Table 3: Structural Model Path Coefficients

Hypothesized Path	Standardized Coefficient (β)	Standard Error	t-value	p-value	Hypothesis Support
DPE → BEP	0.284	0.057	4.982	< 0.001	Supported
IMC → BEP	0.367	0.062	5.919	< 0.001	Supported
QSI → BEP	0.743	0.048	15.479	< 0.001	Supported
SCD → BEP	0.198	0.054	3.667	< 0.001	Supported
PMS → BEP	0.421	0.059	7.136	< 0.001	Supported
DPE → QSI	0.456	0.063	7.238	< 0.001	Supported
IMC → QSI	0.389	0.067	5.806	< 0.001	Supported
SCD → QSI	0.287	0.061	4.705	< 0.001	Supported

In Figure 1, the results of the analysis with the structural model all demonstrate significant and positive results at the 0.001 level with all hypothesized relationships. The greatest direct effect on Business Excellence Performance was from Quality Systems Integration (β = 0.743). Next in order was Performance Measurement Systems (β = 0.421) and finally, Innovation Management Capability (β = 0.367). The model therefore explained 78.3% of the variance in Business Excellence Performance, indicating a strong level of explanatory strength.

4.4 Mediation Analysis Results

The outcomes of the mediation study for the indirect impacts of digital innovation factors on business excellence performance through quality systems integration are presented in Table 4.

Table 4: Mediation Analysis Results

Mediation Path	Direct Effect	Indirect Effect	Total Effect	Sobel Test	p-value
DPE → QSI → BEP	0.284	0.339	0.623	6.847	< 0.001
IMC → QSI → BEP	0.367	0.289	0.656	5.632	< 0.001
SCD → QSI → BEP	0.198	0.213	0.411	4.289	< 0.001

The mediation study results indicated that QSI plays a major mediating role in the relationships between digital innovation characteristics and business excellence performance. All three aspects of digital innovation have indirect effects that are statistically significant, but Digital Process Excellence has the largest indirect effect on quality systems integration at 0.339.

4.5 Multi-Group Analysis by Organization Size

The findings of the multi-group analysis are displayed in Table 5, which highlights how the model varies by organization size with respect to path coefficients.

Table 5: Multi-Group Analysis by Organization Size

Path	Small Companies (n=89)	Medium Companies (n=94)	Large Companies (n=64)	Chi-square Difference	p-value
DPE → BEP	0.198*	0.267**	0.342***	8.67	0.013
IMC → BEP	0.289**	0.378***	0.421***	5.43	0.066
QSI → BEP	0.687***	0.751***	0.789***	3.21	0.201
SCD → BEP	0.143	0.201*	0.256**	4.89	0.087
PMS → BEP	0.356**	0.434***	0.467***	2.98	0.225

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$*

The multi-group analysis indicates heterogeneous relationships across organization sizes. The relationships between Digital Process Excellence and Business Excellence Performance are stronger for large organizations, suggesting more ability to utilize and leverage digital technologies. All organization sizes have a similar approach to Quality Systems Integration and Business Excellence Performance. All organizations are equally invested in quality integration, regardless of size.

5. Discussion

Overall, the results in this study provide significant support for the integrated business excellence model in the auto component manufacturing industry in Chennai. With a good level of explanatory power ($R^2 = 0.783$), the results indicate that the five dimensions of the business excellence model combine to provide a sound framework for understanding business excellence in digitally transforming manufacturing contexts.

For instance, the finding that Quality Systems Integration is the most significant predictor of business excellence performance ($\beta = 0.743$) demonstrates the sector's development in quality management practices of the firm and the importance of quality within the automotive supply chains. This finding is consistent with previous academic literature about quality management within automotive industries, while extending our understanding of quality into digital integration contexts (Johnson and Smith, 2022). The notable mediation impacts through quality systems integration indicate that digital innovation programs were more beneficial when implemented in conjunction with quality management systems instead of as independent programs.

Overall, Innovation Management Capability appears as the second most significant aspect ($\beta = 0.367$), indicating that firms capable of managing innovation processes on a systematic basis have the best business performance. Our results confirm previous findings by Taylor et al. (2023) on innovation management in emerging markets and offer some specific validation in the Indian automotive context. In the present study, the positive connection between innovation capability and quality integration ($\beta = 0.389$) suggests, similarly to previous findings, that managing innovations with excellence enhances the effectiveness of the firms' quality systems overall, which together would deliver synergistic benefits for the firms' overall performance.

Performance Measurement Systems exhibited a quite significant influence on business excellence ($\beta = 0.421$) among SMEs sampled in the present study. The findings increase the understanding of data-based decision-making in firms' digital transformation efforts, in particular, SMEs. The modern manufacturer is increasingly reliant on quantitative metrics produced in real-time for optimizing their operations and responding to change in the marketplace (Brown and Davis, 2023). Performance measurement systems enable wider integrations of digital technologies together with evermore sophisticated analytics, and most importantly, they can respond, in their pursuit of business excellence overall.

Digital Process Excellence shows moderate direct effects ($\beta = 0.284$) but strong indirect effects through quality systems integration (0.339), demonstrating the connectors between digital and quality efforts. It reflects these findings, as digital processes can improve business performance through integrated quality management systems.

Supply Chain Digitalization has the weakest direct relationship with business excellence ($\beta = 0.198$). This may reflect lower maturity levels in supply chain digitalization relative to other quality and digital strategies. Supply Chain Digitalization has significant indirect effects through quality systems integration (0.213), suggesting that Supply Chain Digitalization leads to business excellence through quality management capabilities.

The multi-group analysis yields interesting information regarding organizational capabilities for digital and transformation readiness. Larger organizational sizes display stronger relationships between digital initiatives and business performance. These findings may reflect access to resources, such as how large organizations deploy technical resources. The consistent strength of quality systems integration across organization size suggests quality-focused approaches to digital integration may be lower cost and more seducingly attainable for smaller organizations with constrained resources.

The ideas generated from the mediation analysis are important learnings for practitioners, establishing that quality systems are key integration platforms for digital initiatives. In organizations using quality management systems to incorporate new technologies, practitioners should consider the integration of digital transformation technologies via the quality management system, and not as another separate initiative.

Digital technologies such as Industry 4.0 facilitate real-time cost management, optimize predictive maintenance, and enable dynamic resource allocation to fundamentally alter cost structures and profit generation. Enhanced analytics platforms for manufacturers make it possible to identify cost savings, improve inventory management, and enhance supply chain processes based on data. Implementing such actions will contribute directly to enhanced financial performance by lowering working capital, increasing asset utilization rates, and increasing the stability of profit margins. The economic benefits of digital innovation extend beyond singular organizations, but will create entire manufacturing ecosystems based on value networks, and produce increases in overall productivity for the industry and international competitiveness. This could lead to significant economic opportunity for the geographical example of Chennai due to the co-location of

automotive manufacturing industries. Allocating capital for organizations in digital transformation requires sophisticated portfolio management or risk management strategies to balance diversification and the organization's goals to advance technology. The approach of staged strategies for investment is suggested as this allows the organization to test financial assumptions, adjust implementation plans as needed, and recalibrate where future resources are spent based on real-world performance data from the investment outcomes to minimize risk of financial exposure. Where organizations integrate digital transformation quite well, they report directly experiencing increased financial resilience and competitive market position.

6. Implications and Contributions

6.1 Theoretical Contributions

This study has made several contributions to the body of knowledge on business excellence and digital transformation. To begin, it provides empirical support for an integrated framework that merges the traditional excellence model and the requisite factors of digital innovation while filling a significant gap in the current literature. The identification of Quality Systems Integration as a primary mediator that builds capacity around pre-existing organizational capabilities extends our understanding of how digital initiatives derive business benefits.
Second, the study contributes context-specific information for manufacturing within an emerging market, showing that global excellence frameworks must be adapted to reflect local market conditions. The validation of this model within the auto components manufacturing sector in Chennai should be considered a starting point for considering additional research on similar frameworks in other emerging market manufacturing clusters.
Third, by performing a multi-group analysis, our study added depth in revealing how organizational size has implications beyond understanding of effectiveness in terms of digital transformation, which has implications for theory and practice. The finding that quality systems integration is emergent consistently regurgitates across organization size will cause researchers to reconsider whether there are success factors linked to scale in digital transformation.

6.2 Practical Implications

The study presents practical insights for auto component manufacturers aiming for digital transformation while achieving business excellence. The validated model provides a structured mechanism for embedding digital initiatives in business excellence models and minimizing the risk of fragmented transformation efforts. Manufacturing executives can use the model as a decision-making blueprint to help prioritize investments in future initiatives relating to digital technologies, with a focus on quality system integration as a foundation for digital initiatives. The strong mediation effects suggest that in order to make more effective investments with digital technologies, organizations should focus on improving quality management capability before or at the same time as investing in digital technologies, if they are hoping to maximize returns on investment. The multi-group results offer unique insights for organizations based on size. It appears that for smaller organizations, they may experience better outcomes from future quality-integrated digital initiatives than by initiating comprehensive digital transformation programs, which may be beyond their reach in regard to maximizing their resource capacity.

6.3 Policy Implications

The findings have significance for the development of industry policy and support programs. Government programs supporting Industry 4.0 adoption should focus on quality system integration as a critically important element for success, and possibly offer direct support addressing quality management capabilities development and expenditures in technology adoption. Educational institutions and training providers could utilize the findings to develop a curriculum that articulates quality management and digital technology concepts, which would help prepare future manufacturing professionals for an integrated, excellence and innovation-focused approach. Industry associations could promote best practices sharing through a validated model, facilitating knowledge transfer and collaborative learning among member organizations.

7. Limitations and Future Research Directions

The study carries several limitations, which open avenues for further research. First, due to the cross-sectional nature of the study, which restricts the cause-and-effect conclusions drawn, longitudinal studies will be needed to investigate the development of integrated business excellence over time and how the relationships between the dimensions of the model change as organizations progress in their digital transformation journey. Secondly, whereas the context specificity provides richness for the study in terms of the insights gained into the auto component sector in Chennai, it also presents a limit to the potential generalizability to other geographic and industry contexts. Future research may be undertaken to validate the model in different types of manufacturing sectors and emerging market contexts to facilitate broader applicability. Third, the research adopts, generally, an organizational level of analysis and does not consider in detail individual-level capabilities or processes of change management. Future research may consider the influence of leadership capabilities, employee digital literacy, and organizational culture on the efficiency of integrated business excellence approaches. Fourthly, the research does not consider in any great detail the technological architecture and integration challenges of digital transformation. Future research may provide more comprehensive directions in terms of integration approaches that can support the business excellence objectives. Fifth, this study addresses internal organizational factors but does not thoroughly explore ecosystem factors, including supplier capabilities, customer needs, and regulatory landscape. Future research could take a broader ecosystem view to determine how external factors influence integrated business excellence.

8. Conclusion

This empirical study develops and then provides validation for an integrated business excellence model to support Chennai's auto component manufacturing sector. The study demonstrates that sustainable business excellence in manufacturing environments undergoing digital transformation involves a systematic integration of digital innovation capabilities and quality management practices. The validated model identifies five important dimensions that explain 78.3% of the variation in business excellence performance. Quality Systems Integration

is identified as the most important dimension and is at the same time a direct part, but also a key mediator of digital innovation interventions. This finding contradicts established practice, which assumes digital transformation will be a separate strategic path for organizations and instead supports an integrated approach that benefits from an understanding of established capabilities and performance drivers. Overall, the study provides important guidance and insight for manufacturing executives, policy makers, and researchers about how established industries like manufacturing can successfully engage in digital transformation and build sustainability and excellence into this process. The context-dependent nature of the findings with respect to emerging market manufacturing allows us to consider the particular characteristics of this type of manufacturing while offering a framework that balances global best practices with the lives and realities of the local market.

The impact of this research is not limited to its immediate context; it provides both a methodological approach and a theoretical framework that can be applied to similar research projects in other sectors and geographies. In other words, by highlighting quality systems integration as a basis of a digital transformation, organisations can use this as a practical means to ensure that their return on investment is maximized, while enabling operational excellence capabilities to be maintained. As the automotive sector transitions to connected electric vehicles and autonomous systems, and sustainable manufacturing processes, integrated means of business excellence will become more relevant. This research demonstrates how manufacturing organisations can better understand how to adapt to changing requirements while remaining operationally disciplined to sustain competitiveness and long-term viability. The validated model can be used as a diagnostic tool that examines where an organisation may stand in terms of readiness to create a roadmap for implementing integrated transformation initiatives. The framework will assist organisations in identifying capability gaps, prioritizing gaps for improvement, and designing transformation programs based on leveraging current strengths and capacity building for new capabilities in the future.

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