

Leadership and Sustainability in the Manufacturing Industry: A Progressive Model

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Abstract

South African manufacturing continues to operate under sustained economic, social, political and organisational pressure. Against this backdrop, this paper presents a progressive model for advancing the manufacturing industry by

linking leadership, radical transformation and sustainability. The study draws on an extensive literature review and a quantitative survey administered across major South African manufacturing centres. Structural equation modelling was used to test the relationships among antecedent, intervening and outcome variables. The results indicate that leadership, economic conditions, organisational learning and technological factors have important relationships with radical transformation, while political, economic, technological and legal factors show meaningful relationships with sustainability. The paper argues that manufacturing renewal cannot rely on productivity improvement alone. Rather, it requires an integrated management logic that combines human development, ethical leadership, institutional reform and long-term sustainability. The resulting model offers a practical decision framework for leaders seeking to strengthen competitiveness while addressing unemployment, inequality and social inclusion within the South African manufacturing context.

Keywords

Advanced manufacturing industry, leadership, radical transformation, sustainability, organisational learning, South Africa.

1. Introduction

Manufacturing remains one of the most important contributors to employment creation, productivity growth and gross domestic product in both developed and developing economies. In South Africa, however, the sector has experienced persistent decline, with falling contribution to GDP, weak employment growth, import pressure, capital intensification and ongoing concerns about inequality, poverty and social exclusion. The paper positions these concerns within a broader global context in which trade disruption, technological change and institutional uncertainty continue to reshape industrial systems (Lin 2011; Thompson 2014; Lilenstein et al. 2016).

The South African debate on radical economic transformation has intensified these concerns. Radical transformation is presented in the source literature as a structural shift in production relations, workplace equity, inclusion and the distribution of economic benefits (Davies 2014). Yet transformation in isolation is insufficient. Without sustainability, short-term changes may fail to generate enduring organisational, social and environmental value. Corporate sustainability therefore becomes central to any viable manufacturing reform agenda because it links business performance to societal wellbeing and environmental stewardship (Kaczmarek and Saniuk 2015).

This paper reframes the original thesis-style discussion into a conference paper that focuses on the core argument: the manufacturing industry can be strengthened through a progressive model that integrates leadership, sustainability and transformation. The paper also tightens the empirical narrative by concentrating on the constructs that were statistically supported in the survey-based analysis.

2. South African Manufacturing Context

The South African manufacturing sector has faced heightened exposure to global competition, shorter lead times, rising quality expectations and cost pressures. These conditions have required firms to pursue greater flexibility, responsiveness and learning capacity while still preserving productivity and quality performance (Leitao 2009). At the same time, the sector remains relatively capital and energy intensive, which has weakened its labour-absorptive capacity in an already fragile economy (Black et al. 2017).

The environmental burden of manufacturing adds another dimension. Industrial activity consumes materials, water and energy, while simultaneously generating waste streams that contribute to environmental deterioration. As a result, manufacturing strategy can no longer be judged only by output and efficiency measures; it must increasingly address broader environmental and societal outcomes (Duflo et al. 2012).

Within the South African context, the sector's decline since the democratic transition has been accompanied by deindustrialisation, uneven policy outcomes, labour-market tensions and substantial import competition, especially from China (Edwards and Jenkins 2015; Nattrass 2014). These realities make manufacturing a useful site for examining how leadership, learning, ethics, political influence and sustainability interact within a turbulent industrial system.

3. Research Aim and Objectives

The primary aim of the study was to develop a model for advancing the manufacturing industry within the South African context. The model proposes a human-based management orientation rather than a narrowly power-based or purely profit-centred one. In practical terms, the study sought to show that an integrated emphasis on transformation and sustainability could improve the long-term trajectory of manufacturing organisations and the broader industrial system.

The secondary aim was to test the model empirically across the South African manufacturing sector. This included the development of hypotheses, the design of a survey instrument and the statistical testing of relationships among antecedent, intervening and dependent variables (Leedy and Ormrod 2014).

4. Theoretical Model

The theoretical model incorporated ten antecedent constructs: political impact, leadership, economic impact, organisational learning, societal impact, business ethics, technological impact, productivity, environmental impact and legal impact. These constructs were hypothesised to influence the intervening variables of radical transformation and sustainability, which in turn were linked to the outcome variable described as an advanced manufacturing industry.

In conceptual terms, radical transformation refers to a substantial shift in productive structures, participation, inclusion, benefit-sharing and the reduction of conflict and inequality (Davies 2014). Sustainability, by contrast, is framed as the balance of economic growth, social wellbeing, technological progress and environmental responsibility (Esmaeilian et al. 2016). The model therefore treats manufacturing advancement not simply as productivity growth, but as the combined achievement of institutional change, human development and durable industrial performance.

5. Research Design and Methodology

A quantitative research design was used. The study adopted a positivist paradigm and employed survey questionnaires to gather perception-based data from respondents across the South African manufacturing industry (Creswell 2009; Cilliers et al. 2014). The survey drew responses from major manufacturing centres including Cape Town, Johannesburg, Durban and Port Elizabeth, thereby providing broad geographic representation across the sector.

Structural equation modelling (SEM) was used as the principal analytical technique. SEM was selected because it supports the testing of hypothesised relationships among both observed and latent variables and allows the researcher to assess the overall fitness of the conceptual model (Hox and Bechger 1998; Iacobucci 2010). A total of 417 responses were received, of which 410 were retained for analysis after incomplete returns were removed. Given the scale and complexity of the model, this sample size was adequate for the analysis undertaken (Iacobucci 2010).

Purposive non-probability sampling was used because the full South African manufacturing population was not practically accessible. The questionnaire was administered manually to improve participation among respondents with limited access to computers or the internet. This decision aligned the data-collection method with the realities of the target population and improved completion rates.

6. Results

The retained measurement items indicated broad coverage of the model constructs, with the strongest retained scales observed in societal, business ethics, technological and productivity variables (see Table 1). The final model demonstrated acceptable overall fit on several commonly cited indices, including RMSEA, CFI and the normed chi-square ratio. While selected indices such as GFI and NFI were below ideal thresholds, the model was interpreted as sufficiently acceptable for theory testing because multiple fit criteria were met concurrently (Hox and Bechger 1995; Hair et al. 2010; Iacobucci 2010).

Table 1. Selected Model Fit Indices

Fit Index	Recommended Value	Observed Value
p-value	As close to 1.0	.998
Root Mean Square Error of approximation (RMSEA)	< 0.05	.000

Fit Index	Recommended Value	Observed Value
Normal Fit Index (NFI)	0.0-1.0	.516
Non-conformed Fit Index (NNFI)	> 0.95	1.133
Comparative Fit Index (CFI)	0.0-1.0	1.000
Incremental Fit Index (IFI)	> 0.90	1.084
Relative Fit index (RFI)	> 0.90	.413
Goodness of Fit Index (GFI)	> 0.90	.849
Minimum Discrepancy Function/Degrees of freedom (Cmin/DF)	< 3.0	.924

Source: adapted from the original CFA/SEM output summarised in the submitted manuscript.

The hypothesis testing results showed that leadership, economic impact, organisational learning and technological impact had significant positive relationships with radical transformation. Political and environmental impacts showed notable but weaker relationships. With respect to sustainability, political, economic, business ethics, technological and legal impacts were supported, while societal impact was notable but not statistically strong in the model. Taken together, the results suggest that transformation and sustainability are not driven by a single variable; rather, they arise through the cumulative influence of leadership quality, institutional conditions, learning capacity and enabling systems.

7. Discussion

The most important contribution of the results is that they reposition leadership from a background managerial factor to a central industrial lever. Leadership in the study is not limited to authority or control. Instead, it is associated with creativity, appreciation, future leader development, employee inclusion and a more participative organisational orientation. This is consistent with prior arguments that leadership behaviour can enhance team, organisational and system-level performance when aligned to contextual demands (Yukl 2012; Nelson et al. 2014).

The empirical support (see Table 2) for organisational learning is equally significant. In manufacturing systems under pressure, learning acts as a bridge between current capability and future adaptability. Training, employee development and learning culture are therefore not peripheral human-resource activities; they are structural conditions for transformation. Likewise, the significance of technological impact suggests that advanced equipment, improved methods and productivity-enhancing technologies remain necessary for competitiveness, but they are most effective when combined with human and institutional development rather than implemented in isolation.

Table 2. Retained Variable Items

Variable	Initial Items	Items Retained
Political	8	3
Leadership	12	7
Economic	8	6
Organisational Learning	7	6
Societal	12	11
Business Ethics	8	8

Variable	Initial Items	Items Retained
Technological	8	8
Productivity	10	10
Environmental	11	6
Legal	12	6
Radical Transformation	6	5
Sustainability	6	6

Source: adapted from the original study dataset reported in the submitted manuscript.

The sustainability findings broaden the discussion from firm-level efficiency to longer-term industrial resilience. Political and legal factors matter because they shape the policy and regulatory environment in which manufacturing operates. Economic conditions matter because sustainability is difficult to achieve in a stagnant or contracting industrial economy. The marginal result for business ethics is especially important in the South African context, where the distinction between formal compliance and genuinely ethical organisational conduct remains highly consequential.

8. Contributions, Limitations and Future Research

This study contributes in three ways. First, it integrates radical transformation and sustainability into a single manufacturing framework, which is relatively uncommon in the cited literature. Second, it offers an empirically tested measurement structure that can be refined and reused in later studies. Third, it extends management discussion in manufacturing beyond efficiency and productivity to include leadership, ethics, social participation and institutional development.

The study is also subject to limitations. The model was developed and tested within the South African manufacturing context and may therefore require contextual adaptation before application in other countries. The study relied on perception-based survey data rather than longitudinal operational performance data. In addition, some fit indices and path strengths suggest that the model can still be refined.

Future research should examine the causal relationship between radical transformation and sustainability more directly and should test the model in specific manufacturing subsectors. Comparative studies between regions, ownership structures or labour-absorbing versus capital-intensive industries would also strengthen the external validity of the framework.

9. Conclusion

South African manufacturing cannot be renewed through cost reduction, technology adoption or productivity improvement alone. The evidence presented in this paper supports a broader progressive model in which leadership, learning, economic conditions, enabling institutions and sustainability-oriented thinking interact to shape industrial advancement. The study therefore argues for a manufacturing agenda that is simultaneously competitive, socially responsive and ethically grounded. For practitioners, the model provides a structured way to think about industrial renewal. For researchers, it offers a basis for further empirical refinement and theoretical development.

References

- Black, A., Craig, C. and Dunne, P., “*Capital intensity, employment and sustainability in the South African manufacturing industry*”, University of Cape Town, Cape Town, pp. 1–31, 2017.
- Cilliers, F., Davis, C. and Bezuidenhout, R., *Research Methodology for the Economic and Management Sciences*, Juta, Cape Town, 2014.
- Creswell, J.W., *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage, Thousand Oaks, CA, 2009.
- Davies, R., “*What we mean by radical economic transformation*”, available from Politicsweb, 2014.

- Duflou, J.R., Sutherland, J.W., Dornfeld, D., Herrmann, C., Jeswiet, J., Kara, S. and Kellens, K., “Towards energy and resource efficient manufacturing: A processes and systems approach”, *CIRP Annals – Manufacturing Technology*, Vol. 61 No. 2, pp. 587–609, 2012.
- Edwards, L. and Jenkins, R., “The impact of Chinese import penetration on the South African manufacturing sector”, *The Journal of Development Studies*, Vol. 51 No. 4, pp. 447–463, 2015.
- Esmacilian, B., Behdad, S. and Wang, B., “The evolution and future of manufacturing: A review”, *Journal of Manufacturing Systems*, Vol. 39, pp. 79–100, 2016.
- Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E., *Multivariate Data Analysis*, 7th ed., Pearson, Upper Saddle River, NJ, 2010.
- Hox, J.J. and Bechger, T.M., “An introduction to structural equation modeling”, *Family Science Review*, Vol. 11, pp. 354–373, 1995.
- Hox, J.J. and Bechger, T.M., “An introduction to structural equation modeling”, *Family Science Review*, Vol. 11, pp. 354–373, 1998.
- Iacobucci, D., “Structural equation modelling: Fit indices, sample size, and advanced topics”, *Journal of Consumer Psychology*, Vol. 20 No. 1, pp. 90–98, 2010.
- Kaczmarek, B. and Saniuk, S., “Human factor in sustainable manufacturing”, *Universal Access in Human-Computer Interaction*, LNCS 9178, pp. 444–455, 2015.
- Leedy, P.D. and Ormrod, J.E., *Practical Research: Planning and Design*, 10th ed., Pearson, Harlow, 2014.
- Leitao, P., “Agent-based distributed manufacturing control: A state-of-the-art survey”, *Engineering Applications of Artificial Intelligence*, Vol. 22, pp. 979–991, 2009.
- Lilenstein, K., Woolard, I. and Leibbrandt, M., “In-work poverty in South Africa: The impact of income sharing in the presence of high unemployment”, *SALDRU Working Paper*, Vol. 193, pp. 1–26, 2016.
- Lin, J.Y., *From Flying Geese to Leading Dragons*, World Bank, Washington, DC, 2011.
- Nattrass, N., “A South African variety of capitalism”, *New Political Economy*, Vol. 19 No. 1, pp. 56–78, 2014.
- Nelson, T., Boudrias, J.-S., Brunet, L., Morin, D., De Civita, M., Savoie, A. and Alderson, M., “Does career maturity impact leadership behavior?”, *Journal of Leadership, Accountability and Ethics*, Vol. 11 No. 3, pp. 82–96, 2014.
- Thompson, C., “Can the employment impacts of manufacturing extension help counter inequality?”, EU/DSA/SA Government paper, Johannesburg, 2014.
- Yukl, G., “Effective leadership behavior: What we know and what questions need more attention”, *Academy of Management Perspectives*, pp. 66–84, 2012.

Biographies

Karl van der Merwe is an Associate Professor in the Department of Industrial Engineering within the Faculty of Engineering, Built Environment and Technology at Nelson Mandela University. He holds a Doctor of Technology in Operations Management and has served as Director of the School of Engineering as well as Head of Department. Prof. van der Merwe previously worked in the automotive sector for over 15 years as well as the FMCG sector. His interests include industrial engineering and operations management with particular emphasis on Lean and Six Sigma. He has been extensively involved with ECSA accreditations, participating in over 20 visits either as a team member or team leader for industrial engineering programmes.

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Richard Noor is a business leader, academic and community advocate with over four decades of manufacturing experience. He is Managing Director of W-Tech Manufacturing and Fibretek Manufacturing, and Group Managing Director of H&M Group. He holds a PhD from Nelson Mandela University and authored *Radical Transformation and Sustainability* in 2020. His leadership extends across business boards, higher education advisory roles, school governance, NGOs and community organisations. As Chairperson of the Community Chest of the Western Cape and recipient of the Man of Velour Award, he continues to champion human capital development, transformation and social upliftment.

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Bingwen Yan is a Professor and Head of the Department of Industrial and Systems Engineering within the Faculty of Engineering and the Built Environment at the Cape Peninsula University of Technology (CPUT). He holds a Doctor of Technology in Mechanical Engineering and has played a pivotal role in advancing education through his extensive involvement in teaching, learning, and curriculum development. Prof. Yan's research expertise spans a diverse range of fields, including industrial engineering, engineering management, operations management, and public administration. Throughout his academic career, Prof. Yan has made significant contributions to the academic community. He has successfully supervised eight doctoral candidates and approximately 30 master's students, fostering a culture of excellence in postgraduate research. His scholarly work is well-recognized, with numerous publications in ISI- and DHET-accredited journals, as well as presentations at esteemed international conferences. Additionally, Prof. Yan has contributed to academic quality as a member of organizing committees, a peer reviewer for leading journals and conferences, and an evaluator of NRF-funded research projects and grant applications. Prof. Yan is a registered member of the International Council on Systems Engineering (INCOSE) and is committed to bridging academia and industry through his active engagement in community projects and industrial collaborations. His dedication to education, research, and professional service underscores his commitment to driving innovation and excellence in the engineering field.