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A REFERENCE MODEL FOR BUSINESS ANALYTICS-BASED DECISION-MAKING PROCESSES IN RAIL TRANSPORT MANUFACTURING COMPANIES IN SOUTH AFRICA

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Abstract
In addition to digital transformation, businesses have reviewed their business strategies and decision-making techniques to develop a competitive advantage in the transport manufacturing sector. It happens that innovative business approaches face some limitations compromising business survival in the long term. This study investigates the importance of adopting a reference model for business analytics-based decision-making processes in rail transport manufacturing companies. This study follows a qualitative research design using secondary data published in various annual reports to define the thematic analysis around descriptive, prescriptive, and predictive analytics for enhanced business analytics-based decision-making solutions. Results indicate that improved business decisions should be based on the combination of company strategies, technology innovation and business analytics techniques for goals alignment, innovative solutions and data visualisation. Additionally, descriptive, prescriptive, and predictive analytics are generated in a predefined format to suit business, socioeconomic and environmental requirements like product localisation, company equity, financial support of black businesses, skills development, local community empowerment, and environmental protection. Business analytics-based decisions enable cost control, differentiated business decisions for competitive advantage, and strategy upgrades in addition to customer satisfaction, profitability growth and long-term sustainability. The proposed reference model shows the link between company strategies, data analysis, and technology impact in generating enhanced analytics powering the decision-making process in transport manufacturing to ensure the revitalisation of future transport in South Africa. Recommendations highlight that the South African government should improve technology infrastructure and skills development to limit resistance to digital transformation enabling business analytics.

Keywords: Reference model, Business analytics, Decision-making process, Transport manufacturing, South Africa.
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1. INTRODUCTION

Being at the edge of revolution, future transport manufacturing requires smart technologies for improved business analytics enabling effective decision-making processes. The use of artificial intelligence, satellite, radio frequencies and sensors has increased the volume of data to be analysed for business sustainability and customer satisfaction. To minimise the adverse effect of globalization and digital transformation, railway companies should apply business analytics to remain market leaders and not followers to optimize market positioning and profitability. As one of the smart manufacturing pillars, big data analytics enable real-time decision-making based on the rules, policies, and regulations applied to the organisation strategy (Bălănescu, Soare, Beliciu & Alpopi, 2013). Analytics and business intelligence provide valuable insights into operations and strategic management for predictive and prescriptive analytics. From traditional to digital, business operations management has changed its methods and techniques to adapt to new demands associated with improved technology and continuous innovations. In so doing, businesses can have better control over management at several levels namely, supply chain, inventory levels, manufacturing, and customer satisfaction. The successful shift from traditional business approaches to the adoption of e-business highlights the benefits of using web-based applications for operations optimisation (Davenport & Dyche, 2013). Observations showed that the performance of modern companies have increased since the adoption of business intelligence, big data management and business analytics (Bayrack, 2015). Furthermore, business managers affirmed that such initiatives have augmented their business capabilities through intelligent decisions based on data analysis. Initially, business performance was based on customers' loyalty, period, product quality, and stock availability. It happens that with globalisation and digital progress, customer experience has considerably improved leading to a very demanding clientele. Therefore, companies and organisations that want to survive must change their business processes using innovative technologies for competitive advantage and market positioning. Nowadays, free movement of goods and people has forced businesses to strengthen their core activities and incessantly develop new strategies for sustainability purposes compared to the old approach of improving marketing to increase sales (Parks, & Thambusamy, 2017). In modern economies, customers are educated via social media and are aware of the product and service description of what they want in addition to requesting continuous upgrades. This justifies the fact that businesses must define appropriate and flexible strategies based on smart technologies and innovative changes. Besides, the use of e-business immediately upgraded business intelligence tools like online analytical processing (OLAP) to data mining to meet effective management of data high in volume and velocity (Zeljko, 2012). Considering the rapid change in the manufacturing industry caused by digital disruption, multisource data analysis remains a challenge for traditionally orientated managers in an environment where digital implementation is still

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picking up the pace. In compliance with globalisation requirements, people and goods are free of movement within the globe leading to the exchange of information from multiple sources. Fortunately, digital transformation has facilitated the management of big data through web computing and business analytics.

2. LITERARURE REVIEW

2.1. Strategic management

Besides the need to be technologically updated, smart innovation requires the application of suitable management strategies to ensure effective change management (Mahmood, Amir, Javied, & Zafar, 2013). They argued that defining and executing strategies in the context of using new technology is essential when strategies are aligned with the corporate vision and goals to improve the efficiency and competitiveness of the company in the long run. Strategic management definition requires the association of corporate social responsibility (CSR) in the organisational processes for efficiency improvement and social development (Rusu, 2022). According to Bayrack (2015), organisations can identify business opportunities and make informed and relevant business decisions leading to performance improvement based on integrated data sources. Although data from various sources involves management of their volume, velocity, variety and veracity, analytics systems synthetised them to achieve descriptive, predictive, and prescriptive analyses as indicated by Davenport and Dyche (2013). For Parks & Thambusamy (2017), strategic management do not only involve value creation, business techniques formulation and competitive methods but considers technological analysis for intelligent business opportunities meeting the organisational vision and mission. In the objective of achieving market demands and customer needs, marketing analytics provide techniques and methods for customer profiling, behavior, retention and satisfaction for productivity optimization, increased market positioning and sustainability maintenance (Kaur, Singh, Gehlot, Priyadarshi, & Twala, 2022). Ramadan, Shuqqo, Qtaishat, Asmar & Salah (2020) argued that the capabilities of big data depend on data availability and innovative capacities like new products, technologies, and management approaches to ensure sustainable competitive edges and not only data analytics. Effective risk management for long-term survival in the manufacturing supply chain contributes to organizational leverage through the identification and mitigation of supply chain limitations such as traffic violations, condition of vehicles, fuel consumption monitoring, workforce safety and unethical practices using big data analytics (Mani, Delgado, Hazen & Patel, 2017). Emphasis on business values is aligned with customer experience compared to BI which requires BI infrastructure, data

quality, management support and skilled human resources to provide expected results (Paradza & Daramola, 2021). On the corporate behaviour side, the adoption of business analytics faces challenges related to a data-driven culture, data importance, BA awareness and opportunities compromising efficiency management (Pugna, Dutescu, & Stănilă, 2019). BA uses specific systems for big data processing like Apache Tez for workflow definition, Flink for streaming operations, YARN for resource allocation and job scheduling, Storm for real-time data provision, Chukwa for big distributed systems monitoring, Avro for big data queries and Zookeeper for data synchronization (Ajah & Nweke 2019).

2.2. Technological innovation

Constant innovation applied to technologies is the main characteristic of business intelligence that enhances business decision-making process using knowledge-based support systems (Zeljko, 2012). He further argued that thanks to the upgrade in business intelligence, the appearance of e-business, using web analytics and web mining, professional businesses started using dashboard technologies involving big data management. According to Mahmood et al. (2013), some factors impact the adoption of technology and innovation such as socio-technical system design, system engineering activities, decision-making process, top management limitations, new operations procedures and ultimately staff resistance behaviour. Companies and organisations implement smart technologies to have visibility on operations, well-managed inventory, increase customers' values and optimise productibility and profitability (Mahmood et al., 2013). Using applications for big data analytics in rail transportation, Land, Buus, & Platt (2020) stated that railroad sustainability is ensured through the Internet of Things and network operators like sensors, hardware platforms and video recorders. Thanks to IoT communication platforms provided by mobile network operators, data traffic flow triggered by multisource sensors generates data analytics. Business intelligence and analytics required big data management coupled with AI-based solutions supported by the 5g networks to provide enhanced administrative and strategic outputs (Chen, Li, & Wang, 2022). The combination of BI and AI platforms deploys augmented analytics assisted by machine learning and convenient language definition to achieve data transformation, modeling, visualization, and insights without delays (Alghamdi & Al-Baity, 2022). Žigiene, Rybakovas, Vaitkiene, & Gaidelys (2022) indicated that the use of business and artificial intelligence in BA enables effective risk management in the supply chain process through risk events factors, data analytics and algorithms, analytical methods, risk evaluation and risk forecasting leading to increased objectivity, reduced mistakes, impartially and inefficiencies. Specific technological and data-defined infrastructures are the supportive platforms for enterprise applications generating BA outputs at an effective rhythm (Mohammad, Al-Okaily, Al-Majali, & Masa'deh, 2022). In the banking industry, machine learning using Artificial Neural Networks (ANN) was

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applied not only to predict customer behaviour but to also solve the challenge associated with an imbalance in customer data while preserving the core banking data (Ghatasheh, Faris, AlTaharwa, Harb, & Harb, 2020). Analytics applications use OLAP, queries, reporting and data mining to generate BA (Raghupathi & Raghupathi, 2021). For BI to enhance company performance through BA, the bridge is maintained by blockchain technology using a monitoring system and standards compliance (Panci´c, Cu´ci´c, & Serdaruši´, 2023) and blockchain-based collaborative models (Pucheanu, Bugheanu, & Dinulescu, 2020). Examples of AI and machine learning techniques applied in predictive BA include deep learning, decision tree, artificial neural network, nearest neighbour, and the support vector machine compared to charts, excel and Microsoft BI for data visualization in descriptive analytics and simplex algorithms in perspective analytics (Liu, Liu & Chen, 2023). In supply chain management, PRANAS is a process Analytics System that employs process warehouses and cubes to support data and process-orientated analysis for optimal manufacturing decisions (Kim, Obregon, & Jung, 2020).

2.3. Business analytics

By applying Internet of Things (IoT) technology, e-business enabled the use of the balance scorecards that provide on-time information on operations, capacities, and results as argued by Keivanpour (2021). Business analytics is a statistical tool integrated into management information systems to automatically generate report analysis at descriptive, prescriptive, and predictive levels. It involves data sourcing, descriptive, prescriptive, and predictive analyses allowing us to measure business value and efficiency. Considering that the organisation is fully digitalised, business reports are put together to generate past, descriptive and predictive business analyses (Parks & Thambusamy, 2017). This implies that business analytics represent a solution for the decision-making process since it allows detailed visibility of the operations at every functional unit. However, analytics should integrate information, data, and knowledge analysis with decision-making and action implementation for effectiveness purposes (Liu, Han, & Debello, 2018). Besides problem-solving using data analysis, business analytics is concerned with evidence-based problems and their recognition using a transformational process and systematic reasoning embedding field practices and technologies (Holsapple, Lee-Post, & Pakath, 2014). Business analytics domains vary from different fields like project analytics, customer analytics, risks analytics and even knowledge analytics all orientated to predictive, descriptive, and prescriptive approaches following quantitative, qualitative or hybrid techniques in addition to data collection techniques like data mining, dashboard and query-based analysis (Holsapple, Lee-Post, & Pakath, 2014). Whatever the case might be, constructs of business analytics involve management and business process enhancement capabilities, producer and consumer expertise with technical infrastructure quality on data and systems (Torres, Sidiriva, & Jones, 2018). Such information should be tested in a prototype dashboard that displays business capabilities measures,

existing capabilities, recent values, and controls (Rivera & Shanks, 2015) before their application on real-time business.

Many studies have been conducted in the fields of big data, business intelligence, data analytics, artificial intelligence and decision making including the keywords of data mining intelligent systems, data visualization, enterprise resource planning, business analytics and competitive intelligence and advantage (Chen, Li, & Wang, 2022). Evidence showed that the adoption of Business intelligence and analytics is affected by organizational and environmental in addition to the technological factors where C-suite management capabilities, technological infrastructure and data are inevitable (Mohammad, Al-Okaily, Al-Majali, & Masa'deh, 2022). They added that intelligent management considers the impact of external local and global markets and adherence to regulatory requirements. Including time dimension in business analytics through time series forecasting, casual time relationship and time variability improves BA insights especially when lean and agile techniques like Kano, Kanban and value stream mapping are applied (Mach-Król, 2022). From business to talent analytics, companies are aware of their workforce insights and thus ameliorate their HR performance using scrutinised data governance and ethical considerations as decision-making tools (Nocker, & Sena, 2019). Bustamante, Sebastia & Onaindia (2020) highlighted that using a BI platform especially the ones embedding collaborative data sources like OpenStreetMap for geolocalisation, Airbnb and TripAdvisor enables data mining and processing of tourists' movements and their analysis and visualization for tourism differentiation. According to Potanˇcok, Pour & Ip (2021), BA is impacted by specific factors defined at company level such as IT infrastructure, application and the existing BA stage; at business level like organizational culture, legislation and stakeholders; and at market levels such as quality, products, services and cloud computing following internal and external classification. Other research indicated that BA abilities and Knowledge orientation enable business innovation models through knowledge engagement, organizational vision, and continuous upgrading (Daradkeh, 2022). The main purpose of data analytics in rail transportation manufacturing is to improve productivity through effective operations, maintenance and safety based on descriptive, prescriptive and predictive analytics as mentioned by Ghofrani, He, Goverde & Liu (2018). For Ghofrani et al. (2018), big data analytics involve orientated technologies in alignment with descriptive (History), diagnostics (Reasons), predictive (Expectations) and prescriptive (Solutions) analytics. In alignment with the sustainability dimensions, manufacturing companies strive for profit increase, people development and planet preservation that are achieved with the combination of numerous integrated information obtained in real-time following specific communication plans (Ngcobo, Roya, 2023). In Romania, railway companies defined a transforming business intelligence structural design for performance enhancement using data-based decision processes and automated business analytics attached to specific systems (Dinulescu, Bugheanu, &

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Prioteasa, 2020). For Singh and Bhardwaj (2019), the Hadoop framework is a reliable, flexible, and scalable analytic system that runs multiple applications like Pig, Chukwa, and Hive to analyse voluminous data from different sources by mapping, shuffling and reducing them using Java-based programming techniques. According to Bogdan (2015), reliable decisions depend on tailored business analytics systems associated with precise business activities as indicated in the competitive business intelligence (CBI) architecture where Atlas, Mecur, Cronos, Argos, and Focus systems ensure automatic schedules for rail transportation, load management supervision, railway traffic regulation, operating activities and train traffic monitoring respectively. 16 applications such as Bessy, Rufus, Lupp, Optram, Agresso and RWIS among others forming the Swedish railway infrastructure generate business analytics in specific railway transportation operations for better decisions on transport operations activities such as delay statistics, maintenance, asset management, traffic analysis, safety measures, weather, financial situation, planning and scheduling (Thaduri, Galar & Kumar, 2015). In Europe and America, multinationals apply analytics to enhance logistics and total quality management and built-to-order supply chain operations (Sazu & Jahan, 2022) compared to the aerospace sector using DiagnoSE analytics tool for critical and activities ranking to support cognitive and emotional behaviour of decision makers (Vizitiu, Văleanu, Tanţău, Vizitiu, Marin, & Nistorescu, 2014). Defining capabilities of transport manufacturing analytics allows to conceptualise of transformational processes from evidence to insights and actions and to materialise them using system analytics (Holsapple, Lee-Post, & Pakath, 2014). For Torres, Sidiriva & Jones (2018), business analytics and intelligence in transport manufacturing enable business process reengineering and functional performance through effective management of operational cost, product quality, efficiency, cost of adequate decision and productivity. Given the volume, variety, velocity, and veracity characterising big data, good data governance depends on time conception, mapping of business activities to time and allocation of time actors to ensure the provision of real-time data analytics (Conboy, Dennehy, & O'Connor, 2020). Big data analytics should reflect laws and regulations applied in the sector like the ecological, social and regulatory impacts, besides business requirements like asset management, digital operations and corporate governance (Deloitte, 2023). They indicated that future transport manufacturing models should consider strategic collaborations, people and culture, vision, and strategy in addition to technology and processes. Analytics require mobility technology and solutions based on reliable data whether humanly monitored or automated-based driving and most importantly on the decision-making abilities of policymakers (Leskaj, Kume, & Zyka, 2015).

3. METHODOLOGY

This paper uses a case study of Gibela as a manufacturing company in the transportation sector in South Africa because it represents one of the major trains rolling stock manufacturers supplying state-owned players namely Passenger Rail Agency of South Africa (PRASA) and it uses various technologies provided by its Consortium formed by Alstom and Ubumbano Rail (Railways Africa, 2020). This study follows a qualitative research design using secondary data published by the Gibela company in its various annual reports and websites to investigate the adoption of business analytics in the decision-making process in manufacturing companies using technology strategies. The thematic analysis uses descriptive, prescriptive and predictive analytics techniques to determine the use of nosiness analytics to solidify the decision-making process for future transport manufacturing in the country. This paper uses the combination of business strategies, technology innovation and business analytics to design a reference model for business analytics-based decision-making processes in manufacturing companies using descriptive, prescriptive and predictive analytics techniques.

4. RESULTS AND DISCUSSIONS

4.1. Analytics-based decision making

Figure 1 indicates that relevant business decisions are made based on the business analytics generated by the technological innovations and tailored to the predefined business strategies. Company strategies encompass the vision, mission and future transport goals, Key Business Development (KBDs) and Key Performance Indicators (KPIs) driving daily business activities and railway operations optimisation. IT projects' implementation follows business strategies and can be readjusted if further system requirements, transport requirements and other technological challenges are encountered. Integrated IT systems and platforms enhance BA following the provision of structured and quality data in addition to data correction when required. Data visualisation is obtained in the form of dashboards or standard reporting following specific formats defined at the managerial level besides graphical representation and interactive reports with ad hoc interpretation. Improved analytics automatically display existing problems, metrics and gap analysis to power prescriptive and predictive decisions. Analytics revision for strategic alignment and vice versa are required to ensure regulations and policy compliance. Effective business analytics starts with collecting, cleansing, storing, and processing data from multiple sources and integrating them for embedded analysis. Data Analytics depend on both input data and business targets that can defined at the company and environmental levels for the overall organisational efficiency. Business analytics provide

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synthetised information from those different sources as well as their interpretation through machine learning mechanisms supported by technological platforms. Technological system capabilities improve business analytics over time through effective business datasets stored in cloud system architecture. Business analytics then use web-based analytical processing systems that generate real-time business metrics for on-time business decisions with risk reduction.

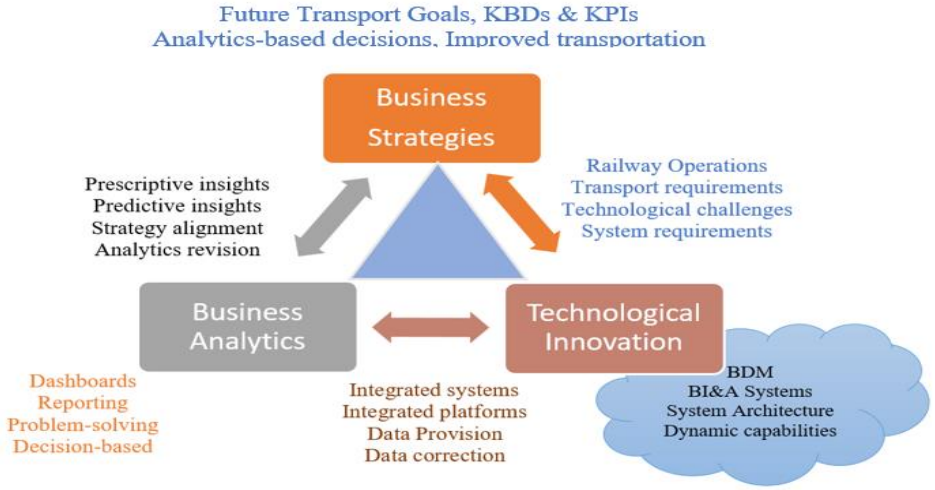

FIGURE 1. BUSINESS ANALYTICS-BASED DECISION-MAKING ENABLERS
Source: Researchers' results

The Gibela rail company manufacturing trains in South Africa has a vision and mission of leading the revitalization of the industrial development in the railway sector in South Africa through commuter rail improvement regarding availability, reliability, safety and comfort of rail transport (Railways Africa, 2020). Since 2013, its manufacturing objectives are to deliver a set of 600 X'trapolis Mega world-class trains to the SA rail network and provide fleet maintenance support in national depots besides complying with the 2030 National Development Plan (NDP) and economic development policies (Railways Africa, 2020). To achieve these goals, Gibela has built a state-of-the-art factory (Readiness of depot, infrastructure, maintainer, signaling, driver and technology upgrades using MMIS) for optimal production of trains, investing in energy-saving technology, ensuring safety by design, skills development (rail-related training) and job creation in addition to observing environmental standards (natural draining, restore wetlands, flora and fauna around the factory). The Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis in strategy allows for the identification and early management of internal bottlenecks and external challenges that can compromise the achievement of the company objectives.

5. DESCRIPTIVE, PRESCRIPTIVE AND PREDICTIVE MANUFACTURING ANALYSIS

5.1. Descriptive analysis

Private and public entities must foster economic development considering the challenges associated with slow economic development, education, unemployment, and the transport industry to combat poverty and inequality. According to the quarterly Labour Force Survey, the unemployment rate not including people who are economically inactive reached 31.9% in September 2023 from 24.34% in 2020 (OECD, 2023). The OECD indicated in 2022 that over half of South Africans have completed secondary education as the highest qualification (OECD, 2023). South Africa has experienced an economic recession and is still struggling with a real GDP growth of around 4% (OECD, 2023). The NDP regarding the transport sector prescribes the leveraging of commuter rail as the preferable mode of public transport, revitalization of the SA rail transport, community empowerment and inclusive growth (NDP, 2019). Transportation should support economic development, ensure efficiency and geographical accessibility while reducing challenges and costs related to social environmental, and economic activities. The Gibela rail manufacturing company adheres to the economic mandate prescribed by the National Development Plan which includes the following: Nurturing the railway industry, building state-of-the-art trains, building facilities for manufacturing, and training, ensuring localisation, creating employment, developing modern skills, encouraging black economy expansion, and uplifting communities.

5.2. Prescriptive analytics at Gibela

To achieve prescriptive analytics over time, Gibela currently applies prescriptive analytics to improve decision-making towards the preset targets through the revitalisation of the rail sector, job creation, economic participation, localization, community development and environmental protection. **Revitalising the rail sector**: The upgrading of customer requirements through bigger cabin sizes, faster trains, air conditioning improved reliability, and improved disabled person access and most importantly the production of 168 trains in 2023 shared across provinces (Railways Africa, 2020). Gibela has offered or sponsored training for 432 employees and youth in the communities in industrial fields like Bussmart 21%, apprentices 19%, entrepreneurship 14%, electrical wiring 10%, welding 10%, tiling and so on 26% (Railways Africa, 2020). **Environmental footprint**: Trains components are 90% recyclable. Trains use lightweight structures ensuring less energy consumption compared to standard trains. Trains embed energy-saving features like regenerative braking. Brakes generated a 30% reduction in energy consumption through trains' power network and thus reduced carbon emissions and costs. **Environmental and health safety**: Gibela cleaned the wetland, rescued 11 928 endangered species and

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obtained environmental licenses where 80% of the waste is recovered through recycling and reuse materials. **Job Creation and Economic Participation**: Out of the 8209 new jobs, Gibela has created 20% of direct jobs in construction and around 30% of direct and indirect jobs in both construction and manufacturing. Gibela contributes R1.9bn to the country GDP (Railways Africa, 2020). **Localisation**: Gibela has achieved 44% corresponding to R6.4 billion of the local content, boosting suppliers' capabilities. **Community skills development**: Gibela has spent R156 million to socially invest in the Ekurhuleni local community for employability increase.

5.3. Predictive analytics at Gibela

Based on descriptive and diagnostic analytics, predictive analytics are important to prevent future negative impacts while improving positive impacts but mostly to define the prescriptive analytics. Following the National Development Plan (NDP), specific focus areas including the reliability, affordability, improved quality, safety and sustainability of transport are observed at Gibela to improve future transport manufacturing (Railways Africa, 2020). In the transport sector, the future perspective remains aligned with the NDP regarding, affordability, reliability, safety, better quality, and sustainability of transport in the country. Socioeconomic aspirations continue to emphasis on product and services localisation, substantial change in company equity, financial support of black business, employee development and local community empowerment. **Affordability of Transport:** given the economic recession in South Africa, rail transportation represents the common mode of transport and Gibela ensures affordable trains around the country, especially for the underprivileged people. **Better Quality Public Transport:** Gibela continuously renews the existing fleet using newly manufactured trains of the highest quality and improved maintenance analytics based on gauges, sensors, and meters to improve transport quality. The quality of public transport is equally assured by automated rail inspection involving asset efficiency (no failure and accidents), locomotive scheduling efficiency, engine performance, aerodynamic locomotive and train derailment prevention (Speed and direction control). **Reliability of Transport:** Continued fleet maintenance at Gibela ensures reliability in combination with the introduction and implementation of the TSSSA (servicing) for the trains and the preventative maintenance undertaken every 20000km/ 2 months. Tailored detectors and sensors (Wheels, bearings, brakes, rail, thermal and pressure) together with drones with sensors and cameras stating asset conditions, power outages prevention and, oil and gas control to enhance train\rail performance monitoring. **Sustainability of Transport:** Gibela adheres to the environmental protection standards applied in the manufacturing industry by producing trains with a 93% component recyclability rate and consuming 15% less net energy. **Safety of Transport:** Gibela trains are aligned to worldwide safety and security standards through the execution of state-of-art technologies like automated rail inspection systems, noise monitoring systems, alert systems and condition monitoring

systems besides automatic doors, fire sensors, CCTV and smoke detectors. **Supplier chain:** Gibela's suppliers comply with the B-BBEE legal requirements in their business relations with all stakeholders to ensure technology transfer, social improvement and skills developments in addition to local market opportunities, openness to global markets, job creation and business efficiency. **Socioeconomic and environmental development:** Gibela has defined annual purchasing goals to empower local businesses and transform the SA businesses in addition to achieving global green mobility, emission reduction and remarkable economic development contribution. **Future Manufacturing** expectations will be to comply with upgraded corporate social responsibility as prescribed in the South African regulations for manufacturing companies through modernised jobs, economic participation, green manufacturing, environmental Health, and Safety.

6. REFERENCE MODEL OF BUSINESS ANALYTICS FOR FUTURE TRANSPORT MANUFACTURING

Figure 2 represents the reference model for business analytics-based decisions for future transport manufacturing in South Africa. It shows that BA&I systems in railway manufacturing companies should include the parameters of data mining, quality and data-driven solutions while implementing train manufacturing processes that comprise procurement of raw materials, production, car assembly, testing, maintenance and disposal/sales to provide supply chain, production and disposal analytics. Data collection from different functional units is integrated to generate integrated BA using AI&BI systems embedded in the Manufacturing Management Information System (MMIS) as integrated Enterprise Resource Planning (ERP) systems. Following preset reporting setup in MMIS using databases like SQL, Java, and Python, descriptive, prescriptive and predictive analytics are generated in a specific format to suit business and legislative requirements. Well-designed analytics enable cost control, differentiated business decisions for competitive advantage, and strategy upgrades in addition to customer satisfaction, profitability growth and long-term sustainability.

Diagnostics Analytics: From the industrial revolution to the smart city, transport manufacturing technologies are required to guarantee mobility through automation and sector improvement. However, the existing operational modeling approach adopted in automotive industries tends to compromise the mobility adaptation matching vibrant market turbulences due to unviable information. Consequently, the product-centric process has moved to data-centric consideration using customer-centric approaches for enhanced business models. Diagnostic analytics highlight the participation of the transport industry regarding low

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education and employment rates and economic recession occurring in South Africa besides requirements from the transport manufacturing operations.

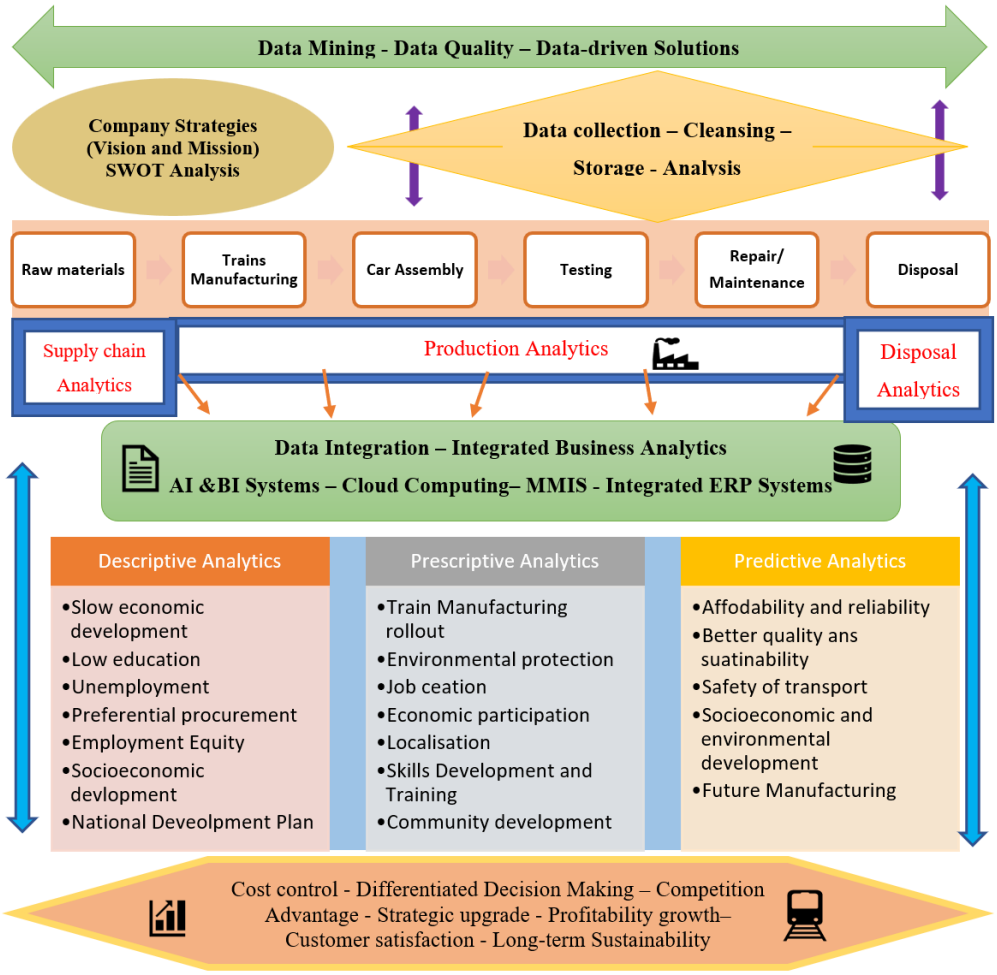

FIGURE 2. A REFERENCE MODEL FOR BUSINESS ANALYTICS-BASED DECISION-MAKING PROCESS
Source: Researchers' results

Prescriptive Analytics: Given the dynamic style of management imposed by unprecedented events and digital adoption, decision-making techniques have evolved to meet the data-driven business systems where big data comes from several sources and in different formats. Nowadays, ensuring business sustainability depends not only on business productivity but also on data management capabilities besides analytics generation and analysis. Prescriptive analytics involve participation in socio-economic development projects, enterprise development, supplier development, company equity, environmental sustainability, global green mobility and economic development, especially in the South Africa context.

Predictive Analytics: Dominated by customer behavioural change and the quest for business performance, forecasting analysis and future statistics based on simulation analytics enable present

decisions considering future impacts. Predictive modeling equally drives operational change designed by the dynamic environment and customer experience. Improved decision-making relies on leveraged analytics to ensure productivity increase, customer retention and future market positioning through the application of reliability and safety in transport together with the adherence to socioeconomic and environmental development requirements.

7. CONCLUSION

Following the vision of railway sector revitalization and the mission of improving manufactured trains and reliable railway transport in South Africa, data, As the primary enabler, are translated into intelligence affairs to unpack unrevealed business insights. Business analytics should be seen as an ecosystem of business systems tailored to specific business operations in a well-conceptualised and scalable system architecture where integrated information allows to make improved decisions. In comparison with conventional reports, evidence revealed that big data analytics provide unprecedented insights using sophisticated analytic systems enabling improved business strategies, market differentiation and productivity through the generation of descriptive, prescriptive and predictive analytics. Advanced analytics offers differentiated value across future transport manufacturing based on the system capacities to integrate business data, IT solutions and business statistics for exponential customer satisfaction, cost and profit control. Business analytics constitute a solid foundation for strategic and forward-thinking decision-making processes ensuring automotive market positioning through real-time data availability, upgraded transport services, and improved customer loyalty. Although automation through artificial intelligence and machine learning remains the target of manufacturing companies, evidence shows that investment in new technologies is very expensive for businesses with a very long-term return on investment besides the cost of research and development for market positioning. Therefore, data analytics for competitive advantage still applies to big companies for sustainability and long-term survival. From business intelligence to big data analysis, ICT transformation has disrupted traditional business approaches with the introduction of data mining. Business analytics provide on-time data through dashboards displaying key performance indicators that help businesses to make efficient decisions. Also, projected analytics are compared to business foundations to not lose track of the mission and values followed by the organisation but to enhance strategic performance initiatives. Although business analytics adoption is still at an emerging stage due to data management issues, lack of analytical skills and resistance to change, it remains an essential business platform for the improvement of business decisions and expansion. Considering the importance of being fully digitalised using local data quality, integrity and consistency in BA systems,

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businesses should embrace web-based analytics for improved decisions, productivity, and profitability enhancement.

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