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The impact of Digital Control Towers on 3PLs and their customers

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ABSTRACT

Purpose of the study: Contemporary business thinking requires organisations to consider the interconnectedness of their supply chains and the successful integration and synchronisation of the upstream and downstream processes. A key enabler for such integration is the deployment of technology, such as a Digital Control Tower (DCT). This study aims to examine the veracity of benefits and challenges associated with the implementation of DCTs.

Design/methodology/approach: A qualitative research approach was used to explore the experiences of 3PLs with DCT implementations. Data was collected by conducting interviews with the operations and business development executives of 3PLs.

Findings: A key finding was that DCT implementation projects deliver significant improvements in full supply chain visibility, collaboration, and performance. The results indicate that the key DCT implementation challenges are project complexity, systems integration, team selection and change management.

Recommendations/value: A key finding was that DCT implementation projects deliver significant improvements in full supply chain visibility, supply chain collaboration and supply chain performance. The results indicate that the key DCT implementation challenges are project complexity, systems integration, team selection and change management.

Managerial implications: The study highlights the benefits and challenges of DCT solutions. A DCT implementation framework is presented that guides management in considering the technical, financial, commercial, and operational requirements needed for DCT implementation projects.

Keywords

Digital control towers (DCT); supply chain collaboration; supply chain integration; supply chain visibility; third-party logistics (3PL)

JEL Classification: L20; L91; M00

1. INTRODUCTION

Contemporary businesses have multiple divisions and departments - each responsible for specific business activities that contribute to the overall organisational strategy and purpose. According to Min (2015), past business activities saw firms focus on how best to operate their separate business functions, such as sales and marketing, production, purchasing, finance and logistics. They believe a lack of connectivity has resulted in sub-optimal performance for the organisation. According to Cooke (2014), contemporary businesses reversed that trend because they achieved better synchronisation among their business functions. This new way of business thinking has forced organisations to pay attention to the interconnectedness of their business activities, commonly referred to as supply chains.

The Council of Supply Chain Management Professionals (CSCMP) defines supply chain management as "*the planning and management of all activities involved in sourcing, procurement, conversion, and logistics management activities*" (CSCMP, 2019). The CSCMP includes collaboration and coordination among partners as a key success factor in supply chain management. Khan and Yuce (2019) postulate that supply chains consist of complex and widely dispersed processes involving different stakeholders. They state that such complexities have led to operational efficiency and quality challenges. Chopra and Meindl (2004) identify the synchronisation of these activities and the ability of supply chain partners to share real-time information as two of the success factors of supply chain management. According to Kwon *et al*. (2007), such synchronisation or integration yields high levels of value for all supply chain participants. Minagawa (2018) finds that synchronising supply chain activities gives companies a competitive advantage, and Rautenbach (2008) finds that it increases customer value. This integrative approach leads to supply chains where partners work together to deliver greater value for each participant and not only the end customer. Each supply chain partner becomes aware of the contribution made by others, beyond their immediate first-tier supplier or customer.

Successful integration up and down the supply chain can have substantial benefits, such as manufacturing alignment with sales, improved customer service, better returns on capital expenditure, better asset utilisation and higher profits to the supply chain (One Network, 2019; Resolve, 2019; Nucleus Research, 2017). Until recently, the lack of appropriate technologies has been a key impediment to achieving supply chain strategy execution, end-to-end collaboration, synchronisation and agility (Bleda *et al*., 2014), thus ensuring that supply chains remain reactive to disruptions and inflating issues, such as excess inventory and sub-optimal logistics processes.

According to Bleda *et al*. (2014), this impediment can be addressed through advances in the critical mass of supply chain technologies, cloud-based computing and big data analytics. Technologies have the potential to address integration challenges by providing the ability to control, trace and give visibility (Gia *et al*., 2015). Alias *et al*. (2014) recommend the deployment of a Digital Control Tower (DCT) as a technology tool to ensure such synchronisation.

2. LITERATURE REVIEW

2.1 Digital Control Towers defined

The German Institute for Standardisation (2009) describes DCTs as decision support systems which merge divergent data streams from various sub-operational levels and display them in a consolidated format for monitoring, controlling and decision-making. Solvanni (2019) defines a DCT as a centralised hub where data is captured and integrated for the use of business intelligence and decision-making across the networks of single or multiple supply chains. Nucleus Research (2017) defines DCTs as enablers that deliver visibility, provide collaboration capability and enable supply chain participants to automate their processes and controls. According to Nof (2009), in the automation hierarchy, DCTs are connected to the most basic level of devices, such as sensors and actuators. Such objects with minute processors and embedded computer technology are commonly referred to as components of the Internet of Things (IoT). Large numbers of connected objects generate vast amounts of data which require processing, classification and analysis (Botta *et al.,* 2016). Bleda *et al*. (2014) expand that a control tower is not a replacement for any transactional and data management systems. They state that control towers use standard operating procedures to augment the analytical capabilities to perform overall supply chain diagnostics.

2.2 Reasons for DCT implementation

According to Van Doesburg and Tholhuijsen (2018), a key function of DCTs is providing supply chain visibility for short-, medium- and long-term decision-making aligned with an organisation's strategic objectives. Such visibility enables the combination of people, systems and processes within the supply chain to act as partners and enablers throughout the entire supply chain. JDA and Ernst & Young (2019) stated that the purpose of DCTs is to deliver real-time visibility, offer predictive insights for prescriptive decision-making, and provide operational dashboards which enable the orchestration of processes in the supply chain. Myerson (2019) adds that DCTs create an overview of the performance of every element in a supply chain. DCTs can translate and display such performances into a dashboard that outlines key performance indicators (KPIs). It gives management visibility and provides capabilities for collaboration with trading partners through an automated platform for processes and controls.

The key drivers for adopting a cloud-based DCT platform are cost, outsourcing, specialisation, uniformity in business models, competition and digitisation (DHL, 2019). DCTs create end-to-end visibility, collaborative information sharing, support for predictive and descriptive decision support, and autonomy for decision-making and early warnings (One Network, 2019; Nucleus Research, 2017). Crandall (2019) stated that DCTs can enable organisations, through dashboards for visibility, to generate early warnings. This can be achieved by providing analytics from root cause analyses, scenario planning and simulations; and disseminating information for decision-making and monitoring outcomes.

Van Doesburg and Tholhuijsen (2018) stated that DCTs enable better planning, decision-making, proactive event management, improvement of the performance of supply chain partners, and more sophisticated supply chain analytics. This type of enablement ultimately results in savings in logistics costs, inventory reduction and service level improvements, such as shorter cycle times.

According to Lippincott (2019), a key feature of DCTs is that software has expanded to encompass data modelling of multi-tier suppliers and consumers in a supply chain. It has moved from not only giving visibility but also providing the ability to orchestrate data and activities throughout the supply chain. DCTs provide crucial, real-time records for successful supply chain decision-making. This platform provides end-to-end supply chain visibility beyond the traditional data warehouse dashboards.

A key element distinguishing DCTs from legacy logistics systems is using interconnected devices at the most elementary levels of an operation, process or system. In harnessing the capabilities embedded in the IoT and cloud-based computing, the correct deployment of DCTs can yield cost and efficiency advantages for all supply chain participants. Table 1 summarises these benefits.

Table 1: Benefits of DCTs

BENEFITS	REFERENCE
Visibility	Crandall (2019), JDA and Ernest & Young (2019), One Network (2019), Nucleus Research (2017)
Integration and collaboration	DSV (2019), Lippincott (2019), One Network (2019), Solvanni (2019), Hugo (2018), Nucleus Research (2017)
Process improvements	DSV (2019), Van Doesburg and Tholhuijsen (2018), Nucleus Research (2017), Alias *et al.* (2014)
Reporting and analytics	Crandall (2019), DSV (2019), Myerson (2019), Solvanni (2019), Van Doesburg and Tholhuijsen (2018)

2.3 Challenges associated with DCTs

Despite numerous advantages, DCTs are not exempt from challenges. According to Yoders (2014), cloud-based collaboration will require powerful operating systems, file-sharing platforms and hardware. Due to the high cost of information technology infrastructure related to hardware and software, many organisations find themselves without the necessary investment funds to acquire DCT-related technology (Benotmane *et al.,* 2017).

As a result of the IoT, these connected devices generate large amounts of data, which require codification, analysis, and processing for decision-making and commercial viability (Botta *et al*., 2016). Big data has intensified recently as more IoT sources come online. Zaslavsky *et al*. (2012) state that big data is characterised by velocity, volume and variety. DCTs require technology that requires massive storage ability and high-speed processing (Lee & Lee, 2015; Gubbi *et al*., 2013) collected from data from various sources.

Sanchez-Morcilio and Quiles (2016) highlight that the strategic value of having the correct human resources skills for information technology in a business directly influences the cost, quality and customer satisfaction. Wong and Karia (2010) argue that besides having a skilled information technology workforce, their competencies and knowledge are often considered unique to the business. It is often difficult for companies to secure the correctly skilled resources.

Atlam *et al*. (2017) posit that systems integration may be hampered by the heterogeneity of linked IoT devices, operating systems and other platforms. Suciu *et al.* (2013) argue that cloud-based platforms face similar heterogeneity issues in that they are generally proprietary interfaces which allow integration based on specific service provider profiles.

Subashini and Kavitha (2010) assert that security concerning privacy and data protection are major issues that plague organisations. The prolific use of information technology in supply chains increases the chances of cybercrimes, such as hijacking, phishing and solicitation (Khan & Varma, 2014). According to Fan and Bifet (2013), cyber security threats directly affect the robustness and availability of systems, which extends to the control that organisations can exercise over their technology.

In terms of cloud-enabled DCTs, some of the most significant security risks for a business would be placing their critical data on remote servers (Sehgal & Bhatt, 2018), ensuring user authenticity and maintaining secure data transmission and storage capabilities (Cachin *et al.,* 2009). In addition, factors such as shared resources, remote access, distributed computing, multi-tenancy, and third-party hosting further increase security risks.

The relatively short lifecycles of technology solutions present organisations with the risk of potential obsolescence and irrelevance of their technology platforms. Thus, businesses must be constantly aware and able to enumerate such potential risks (Tazehzadeh 2014). Rajesh and Ravi (2017) contend that obsolescence results in system risks that can cause significant disruptions, such as a loss of information.

Shahbaz *et al.* (2019:201) identify the concept of “collaboration side risk” in the supply chain. This poses a significant challenge to the supply chain if one or more of the supply chain partners do not cooperate (Shahbaz *et al.,* 2018). Such risk occurs when there is a lack of information accuracy, disruption in information security, unavailability of information infrastructure or a breakdown in external or internal IT infrastructure (Basole *et al.,* 2016; Wang *et al*., 2014). Table 2 gives a summary of each of these challenges.

Table 2: Challenges of DCT

CHALLENGE	DESCRIPTION	REFERENCE
Investment	Capital intensive infrastructure	Chugh (2018), Benotmane *et al.* (2017)
Storage and processing capabilities	Big data and IOT generate large amounts of data.	Lee and Lee (2015), Yoders (2014), Gubbi *et al*. (2013)
Integration	Heterogenic systems with multiple service providers; Legacy systems with limited capability	Nowicka (2019), Atlam *et al*. (2017), Benotmane *et al*. (2017)
Skills	Insufficient resource pool; Insufficient expertise	Benotmane *et al*. (2017), Sanchez-Morcilio and Quiles (2016), Wong and Karia (2010), Karia and Razak (2007),
Security	Cybercrime; Data protection	Sehgal and Bhatt (2018), Fan and Bifet (2013), Cachin *et al*. (2009)
Collaboration	Commitment from supply chain partners	Shahbaz *et al,* (2019), Shahbazm *et al,* (2018), Basole *et al.* (2016)
Rapid changes in technology	Obsolescence of infrastructure	Rajesh and Ravi (2017), Tazehzadeh (2014)

2.4 Elements for successful DCT implementation

Setting up a DCT is a journey that must be informed by understanding where the real opportunities are to create value. The decision for a DCT should be driven by an organisation's strategic objective and tactical and operational capabilities (Hugo, 2018; Alias *et al*., 2014)

Businesses must use the correct technologies to build robust DCTs (Mena *et al*., 2014). Data feeds into the DCTs via activity recorders and is transmitted through various components of IoTs (Shou-Wen, 2013). The logistics sector is one of the industry domains that is an early adopter of IoT for real-time operational execution.

A key prerequisite for a successful DCT deployment project is the selection of teams with the correct skills and expertise (Mena *et al*., 2014) to identify the correct processes or business signals to ensure optimal process interfaces. These interfaces are necessary because DCTs use existing transactional data to generate the required functionalities across the supply chain (Greene & Caragher, 2015).

DCTs make use of standard operating procedures (SOPs) (Trzuskawska-Grzesińsk, 2017), which are ideal for organisations that operate over different geographies (Büyüközkan & Göçer, 2018; Green & Caragher, 2015). The advantage of standardised SOPs is that systems and processes are managed uniformly within the supply chain. A typical DCT offers KPI dashboards as one of its functionalities (Manning, 2016) and requires identifying the correct matrices to be measured in such dashboards (Mena *et al*., 2014). The dashboards serve as business tools for problem detection, solutions and crisis management (Cooke, 2014). Dhaneshwar *et al*. (2018) mention that KPIs are must-haves for effective DCTs because they provide analytics and processing abilities to meaningfully take action that impacts decision-making. The elements needed for the successful deployment of a DCT solution are summarised in Table 3.

Table 3: Elements for DCT implementation

ELEMENT	REFERENCE
Alignment with the organisation's strategic objectives.	Hugo (2018), Bleda *et al.* (2014), Alias *et al.* (2014)
Identify and deploy correct technologies.	Jayaram (2016), Mena *et al*. (2014)
Select teams with appropriate skills and experience.	Mena *et al*. (2014), Hofman (2012)
Establish standard operating procedures throughout the supply chain.	Liotine (2019), Büyüközkan and Göçer (2018), Trzuskawska-Grzesińsk (2017), Green and Caragher (2015)
Define dashboards with relevant and manageable KPIs.	Manning (2016), Cooke (2014), Mena *et al.* (2014)
Establish strategic relationships/partnerships with supply chain participants.	Kim (2017), Min (2015)

3. RESEARCH OBJECTIVES

A comprehensive literature review was conducted, seeking information on DCT collaboration projects between 3PLs and their clients. Relevant articles yielded extensive discussions on cloud computing, big data and the need for logistics platforms as logistics enablers. Discussions extended to the integration of traditional business systems, such as enterprise resource planning, inventory management systems, warehouse management systems, transport management systems, and procurement systems into single technology platforms. Articles on DCT project implementation to enhance competitive advantage in organisations were also included. Some studies addressed the technological and commercial business cases for DCTs, but the academic literature did not account for actual DCT implementation projects. In South Africa, several 3PLs offer DCT solutions to their customers. However, details of benefit realisation and implementation success factors and challenges are limited to high-level statements about improvements and gains. In general, case studies on DCT implementation are not explicit about the details. The research objectives were, therefore, to identify the reasons for and the challenges associated with the implementation of DCTs, as well as to develop a practical framework for implementation.

4. MATERIALS AND METHODS

The topic under investigation represents real-world situations as broader perspectives or surveys were unobtainable. Leading South African 3PLs that deploy DCTs as a service to clients' supply chains were identified. The study sought to interrogate the impact of the service on the clients' supply chains. This required obtaining in-depth perspectives, information and experiences from customers and 3PLs. This exploratory research comprised semi-structured interviews with the representatives of selected 3PLs and their customers who had implemented DCT solutions. Operations and/or business development executives of 3PLs and customers were targeted as they are the key decision-makers for DCT projects in their organisations and, therefore, best suited to provide information on the topic and the appropriate level of validity and trustworthiness (Brough, 2018) to this research strategy. Insights were sought from two representatives from each of the five targeted 3PLs and three representatives of 3PL customers.

Fieldwork was conducted using semi-structured interviews. To seek clarity, allowances were made for follow-up questions and discussions. Responses were recorded on a standardised recording sheet to ensure uniformity and were supplemented with audio recordings for post-interview reference and follow-up. Data were analysed by categorising the responses into similar and/or different themes. Broadly, themes were derived from the specific benefits that DCTs deliver, and the challenges and requirements for implementation. Data were collated, and responses were paraphrased. This method of data analysis, codification and interpretation ensured that responses could be identified and clustered for a proper understanding of the issues.

To ensure the credibility of a study, the results must instil confidence that it is true and believable. In this study, credibility was established through verbal data collection (Schreier, 2012) and purposive sampling by selecting representatives with knowledge of the research topic (Creswell, 2013), as well as triangulation (Carter *et al*., 2014). In this instance, interviewees were selected to enable the collection of substantive and rich information about the practical experiences and perspectives. One-on-one interviews ensured that data were collected directly from the source, leaving little opportunity for distortion. Multiple data sources lead to enhanced corroboration and convergence of evidence (Moseholm & Fetters, 2017). Data collection continued until no further conclusions could be drawn, and data saturation was, therefore, achieved.

The following key principles for research ethics were used for this study - integrity, voluntary participation, objectivity, consent, privacy, data minimisation and adequacy. Ethics clearance was granted through the Research Ethics Committee of the Department of Transport and Supply Chain Management, University of Johannesburg.

5. RESULTS

This section presents the findings and analysis of the data collected from the 3PLs who implemented DCT solutions in their customer environments (User Group: 3PL) and those who embarked on projects to implement DCT platforms as a solution for their own in-house logistics activities (User Group: In-house). Data were solicited from participants to establish the status quo for their DCT solutions before implementation and to compare it with the post-implementation results.

5.1 Motivation for DCT implementation

Participants were asked to explain why they embarked on a DCT implementation project. Specific attention was given to key focus areas identified in the literature, namely visibility, integration and collaboration, performance management including KPAs and KPIs, and management reporting and analytical tools.

The responses from User Group: 3PL can be grouped into four themes, i.e. improving visibility, improving customer service, achieving better financial control and cost savings, and improving processes and productivity. The aspiration to improve productivity and processes included a need for better reporting, people empowerment and improved decision-making. Financial controls reflect a desire for cost reductions, better cash management and improved expense management. The need for improved visibility highlighted those participants who wanted complete visibility of their supply chains and sought a single view of the status of their supply chains. As the least expressed view, customer service highlighted the need for the enhancement of supply chain collaboration. The desire for productivity and process improvements centred around the optimisation of processes, increasing labour productivity, improving data accuracy, empowering people and establishing sound reporting mechanisms. Effective decision-making is cited as another desired outcome for DCT implementation (Van Doesburg & Tholhuijsen, 2018).

The responses from the User Group: In-house participants can be clustered in three key themes, namely visibility, financial control and cost savings, and productivity and process improvements. The participants expressed the desire to have a single view across the different operational areas of their business and monitor the application and performance of their assets. They also indicated they would like to control their costs and create the capability to report on their organisation's profitability. Emphasis was given to gaining control of assets, optimising processes and having various business units working closer together. Table 4 summarises the participants' responses regarding the motivations for DCT implementation.

Table 4: Motivating factors for DCT implementation

THEME	USER GROUP: 3PL	USER GROUP: IN-HOUSE
Visibility	• Visibility across multiple supply chain activities. • Give a single version of the truth. • Decentralised visibility. • Increased end-to-end visibility.	• There was no single view of operations in the various business units. • Before implementation, operations were decentralised. Wanted to change the situation. • Safeguarding fleet and gaining visibility. • Wanted clear visibility of all operations in the business.
Financial control and cost-saving	• Cost saving. • Good payback. • Audit control for rates management. • Improved cash-to-cash cycle. • Capacity improvements and reducing staff costs. • Inventory holding and transport savings.	• No clarity on cost. Business units reported separately on profitability. • Wanted to control fuel and maintenance costs. • Costs were running away. There was no control.
Productivity and process improvement	• Increase throughput. • Business Intelligence (BI) reporting. • Central control and team enablement. • Process optimisation. • Empowering people to make better decisions. • Improved data accuracy and reporting. • Gain better tactical decision-making.	• Looking for opportunities to optimise processes and get different business units to work together. • Needed to gain better control of assets. • Achieve overall operational excellence. • Needed to gain control of business activity and use of resources.
Customer service	• Improved collaboration in the overall supply chain. • Reduce noise.	

Both groups communicated that having greater control of their assets, establishing better working relationships between business units, and optimising processes will lead to improved productivity. The groups share the view that a DCT platform gave them greater control of their finances, including savings on operational costs.

5.2 Impact of DCT implementation

5.2.1 Supply chain visibility

Before project implementation, both groups reported poor supply chain visibility, which extended to their first-tier partnerships. The post-project implementation resulted in both groups reporting full supply chain visibility, which, according to Crandall (2019), is a benefit of a DCT.

5.2.2 Integration and collaboration

As far as the levels of supply chain integration and collaboration with partners were concerned, before the DCT solutions were established, both groups reported partial integration and collaboration. The post-project implementation report from each respondent indicates that the DCT platforms resulted in full integration and collaboration for all participants in both groups. This confirms that DCTs increase supply chain collaboration.

5.2.3 Performance measurement

The motivation for the establishment of KPAs and KPIs was driven by the respective strategic motivators for implementing DCT solutions. The User Group: 3PL was primarily motivated by providing an outward-based solution focused on their client's requirements, while the User Group: In-house was motivated by finding solutions for their own organisations.

Before implementation, the User Group:3PL established that their customers had limited reporting on their KPAs and KPIs. Reports were focused on the dominant activity of the customers. In addition, customers had poor data sets. The User Group: In-house had limited to no integrated reporting for their own operations, and this resulted in them not being able to determine the profitability of their operations.

After project implementation, the User Group:3PL defined a wider range of KPAs and KPIs for their customers and the supply chain partners of their customers. The first benefit was that measurements were changed from manual recordings to direct inputs into an automated system. A second consequence was that the number of KPAs and KPIs were expanded beyond the internal operations of their customers to interface with other supply chain partners. KPAs and KPIs are tracked on dashboards and cover activities beyond the dominant operational activities of the clients.

User Group: In-house expanded their reporting to include a wider basket of internal reporting matrices. The post-implementation DCT solution provided dashboards that enabled the monitoring and measuring of KPAs and KPIs that would inform the operational performances of internal operations. It further enabled the integration and sharing of reporting with the organisation's customers.

Due to their motive to provide a commercial DCT solution from which they would earn revenue, User Group: 3PL ensured that their solutions served their customers and their corresponding supply chains. The motive for User Group: In-house was internally focused on enhancing their own operations. Their solution was focused on measuring internal operations to expedite their operations and, ultimately, the customer service offerings.

5.2.4 Reporting and analytics

DCTs enable organisations to collect and analyse data to formulate the correct business solutions within each functional area (PwC, 2016). The technology enables the use of data modelling and analytics tools to evaluate business activities (Souza, 2014). User Group: 3PL reported that some of their customers could provide some level of data and others could not provide any data for setting baselines.

In the event where baselines were set, User Group: 3PL reported performance improvements against the set baselines. Some post-implementation improvements included:

- Logistics cost reductions of 14%;
- Adherence to delivery schedules improved between 20% to 100%;
- Vehicle utilisation improved by as much as 9%;
- Improvements in volumes transported between 19% and 36%;
- On-time vehicle performance improvements by 9% or actual on-time deliveries of 99%;
- POD availability became immediate;
- Reductions in inventory carrying costs;
- Establishment of fleet standing time.

Both groups reported that before DCT implementation, Microsoft Excel was their primary reporting and data analytics tool. They stated that the DCT solution resulted in the establishment of comprehensive dashboards that are primarily driven by PowerBI as the data integrator of choice.

5.3 Challenges of DCT implementation

Both user groups identified three categories of challenges, namely people, project management, and systems and technology. Common challenges in the people category included lobbying executives to solicit project sign-off, staff training, ensuring technological issues are addressed, and gaining executive buy-in for DCT projects. Participants attribute project aversion to lacking understanding and knowledge by the executive team. Regarding staff training and technology, Sanchez-Morcilio and Quiles (2016) assert that an appropriately skilled labour force directly influences the cost, quality and customer satisfaction of the business. Information technology skills and knowledge are often unique to a business (Wong & Karia, 2010). This includes the skills and knowledge to apply appropriate project management methodologies. This is an aspect that both user groups listed as a challenge, which often results in incoherent scope definition and scope creep.

Using technology in supply chains resulted in an increased possibility of cybercrimes (Khan & Varma, 2014). This is exacerbated by using cloud-based technology (Sehgal & Bhatt, 2018) which is a key enabler of DCTs. Both groups report the application of one of the following strategies for cyber protection: the use of external consultants or the use of internal resources and existing IT policies designed to safeguard the IT infrastructure. The use of existing infrastructure and policies, whether in-house or from a third party, proved to be the most successful, as there were no reports of significant security breaches by either of the user groups.

A common hurdle of systems and technology is the integration of the various IT systems. DCT platforms consist of large data repositories with connected devices, which require coding, processing and analysis (Botta *et al*., 2016). Such data requires massive storage facilities and high-speed processing capabilities (Lee & Lee, 2015). A lack of integration, as reported by participants, will result in poor DCT benefit realisation. Table 5 presents the challenges identified in implementing DCT solutions, as stated verbatim by the participants, and confirms many of the challenges identified from the literature, as summarised earlier in Table 2.

Table 5: Challenges of DCT Implementation

USER GROUP: 3PL	USER GROUP: IN-HOUSE
Complexity • People get over-excited and tend not to keep the solution "simple" and practical, resulting in over-specification. • Complexity in the involvement of multiple users in different companies. • Co-ordinating the activities of multiple operations at implementation. **Scope specification** • Scope creep – client system shortcomings are passed over to the service provider to fulfil. • Clarification of the client's scope. Numerous scope definition sessions held.	**Technology** • Learning about new technology. • The overall slow adoption of technology in South Africa. • Had to convince the EXCO team due to a suspected fear of technology among members. **Change management** • Changing the views of some of the top management team members. **Project scope** • Contractual arrangement with a third-party technology partner.

• Defining the user requirement specification. • Clarification of the client's scope. Numerous scope definition sessions held. • (URS) because the customer was unclear about the specifications. **Systems integration** • Integration of the client's system with own. **Training** • Providing training to more than 400 people. • During "go live" there was a need to have enough people with knowledge of the system from day one. • Availability of customer integration team members. • Resignation of two key technical resources. • Training of clients and changing attitudes and old habits. **Change management** • Change management – 6 brands with different business approaches. • EXCO's expectations are not aligned among members. Not clear to the team. • Sign-off on milestones from clients.	• Defining the scope of the project and agreeing with everyone to stay within it. • It was difficult to clearly identify what needed to be done. • Had to decide what was priority and refrained from wanting to do everything. **Teams** • It was difficult to bring the diverse skill sets together because some members of the teams were functioning on their own. Not used to teams. • The team consisted of younger generation members who had different thinking and working cultures. • Get the team members to work together because of the independence of various team members in their fields.

6. MANAGERIAL IMPLICATIONS: DEVELOPING A DCT IMPLEMENTATION FRAMEWORK

There is limited availability of detailed written records of DCT implementation and their associated benefits. Available write-ups tend to provide high-level descriptions but limited information on the detailed implementation processes, issues, and benefits realisation. This continues to be prevalent as participants could not give in-depth accounts of each of the factors involved in DCT implementations. Very few participants could comprehensively quantify outcomes or provide detailed timelines and records of their DCT projects.

The opportunity, therefore, exists to develop a structured approach aimed at addressing the challenges and achieving the envisaged benefits of DCTs. A framework consisting of three phases is proposed to guide executives and project managers to deliver a DCT platform that considers the technical, financial, commercial and operational specifications. Managers are guided by a defined project plan designed to identify project resources, tasks and milestones while allowing the detection of associated risks.

6.1 Phase 1: Pre-implementation

This phase sets out the initial activities needed to ensure approval is obtained for the project. Participants identified executive sign-off, training and resistance to accepting change in technology as significant challenges (see Table 3). The intended outcome of the pre-implementation phase is to ensure the development of a business case that is fully aligned with the organisation's strategic objectives, ensuring that all the challenges are mitigated and packaged for approval by the relevant decision-makers. Key activities include:

6.1.1 Defining the strategic intent of the project

Organisations should start by defining their strategic intent and ensure that this is aligned with the organisation's strategic objectives. Executive buy-in is critical in this phase to ensure continued high-level support for the project. In doing so, the business can decide if the intended DCT will be used to service their internal operations or external customers. This will assist in deciding whether to design customised solutions or to adopt existing platforms. In this phase, it is critical to clearly define and specify the project scope. This will also guide in determining the best funding model.

6.1.2 Team selection

Selecting a team with the prerequisite experience, skills, and expertise is key to ensuring the effective delivery of a DCT project (Mena *et al*., 2014). Team members should be subject matter experts who can identify the correct requirements for technology, people management, processes and financial management. These resources will be important for setting a realistic project plan, defining milestones and dealing with project risks and deviations. The project team can be a core team and a supplementary pool of experts who can be consulted to deliver specific outputs. The latter group may include external experts contracted at specified project delivery gates or workstreams. A final output of the project team will be to produce a project plan that will identify milestones, critical paths, task allocations, and risks and associated mitigation actions.

6.1.3 Developing the business case

Benotmane *et al*. (2017) posit that the high costs of hardware and software infrastructure for DCTs necessitate an organisation securing sufficient funding. Chugh (2018) advises that the costs must be identified and sufficiently detailed. Developing a business case addresses the financial aspects of the investment and allows for identifying and measuring the KPAs and KPIs. At this stage, various complexities and risk factors which may impact the feasibility of the project are identified, and the associated mitigating factors are discussed.

Included in the business case should be a proposed dashboard that indicates the planned KPAs and KPIs that will be tracked and measured after implementation. The compiling of KPAs and KPIs starts with identifying the current measures in place, identifying the future indices to be tracked and agreeing to baselines for those indices. At this stage, the final business case is submitted for approval.

6.2 Phase 2: Implementation

An approved business case indicates to the project manager that the executive manager supports and understands the project. Project management and the associated skills required by project teams proved to be a challenge for both user groups. Common project management challenges included scope definition, milestone setting, task prioritisation, and risk management. The recommended implementation phase for the project should consist of:

6.2.1 Approval

The business case is submitted and presented to the relevant approval authority in the organisation. DCT project managers may encounter resistance from authoritative members tasked to consider their business case applications. To gain the required approvals requires them to lobby other members, and/or apply change management approaches. A final step in the process is to secure project sign-off from the relevant decision-makers.

6.2.2 Project management

The selected project management methodology is informed by the type of solution agreed on, as set out in the organisation's strategic intent. Where the decision is taken to adopt an existing solution, the organisation may use various mechanisms to acquire it. This may include forging a strategic partnership with a service provider, soliciting proposals through a bidding/tender process or buying the solution as a standalone package. This will require due consideration for the organisation's ability to implement, provide funding or agree to amicable terms with potential partners.

Deciding to develop an in-house solution requires a team with the correct skills which can develop the technology or define the correct specifications to source the applicable technology. This should be accompanied by a solid training plan to address any skills gaps. Project management expertise requires management of the set milestones, approved budgets and agreed timelines. The project manager is responsible for managing risks, such as critical path deviations, scope creep, technology challenges, and people management.

6.2.3 "Go-live"

According to CoreSolutions (2017), an IT project should have a testing strategy that includes a testing site and users who can conduct early tests on the site. This site is not the actual domain where the final solution will be deployed. They postulate that testing allows the identification of user interface challenges, system integration issues, and the recalibration of user requirements and system capabilities. Once these challenges are attended to, final retesting is conducted to prepare for deployment into the "live" site.

6.2.4 Track performance

After the deployment of the solution, an agreement must be reached to have sessions to review the performance of the solution. At these sessions, the dashboards are presented with all identified KPAs and KPIs, reflecting the actual performance achieved against the set baselines. Such sessions present opportunities for reviews of the matrices for applicability and relevance. It allows the teams to identify areas of improvement and design and implement actions to execute improvements.

6.3 Phase 3: Post-project reviews

The post-project review aims to conduct a comprehensive audit to record each element of the project deployment. It should start with key motivators for the project, the reasons for the chosen solution, and highlight how the project team and methodologies were selected. Further details would include a comprehensive financial justification, including the gains anticipated from the projects. An account should be given of the pre- and post-project matrices to be measured and their applicable baselines to track progress.

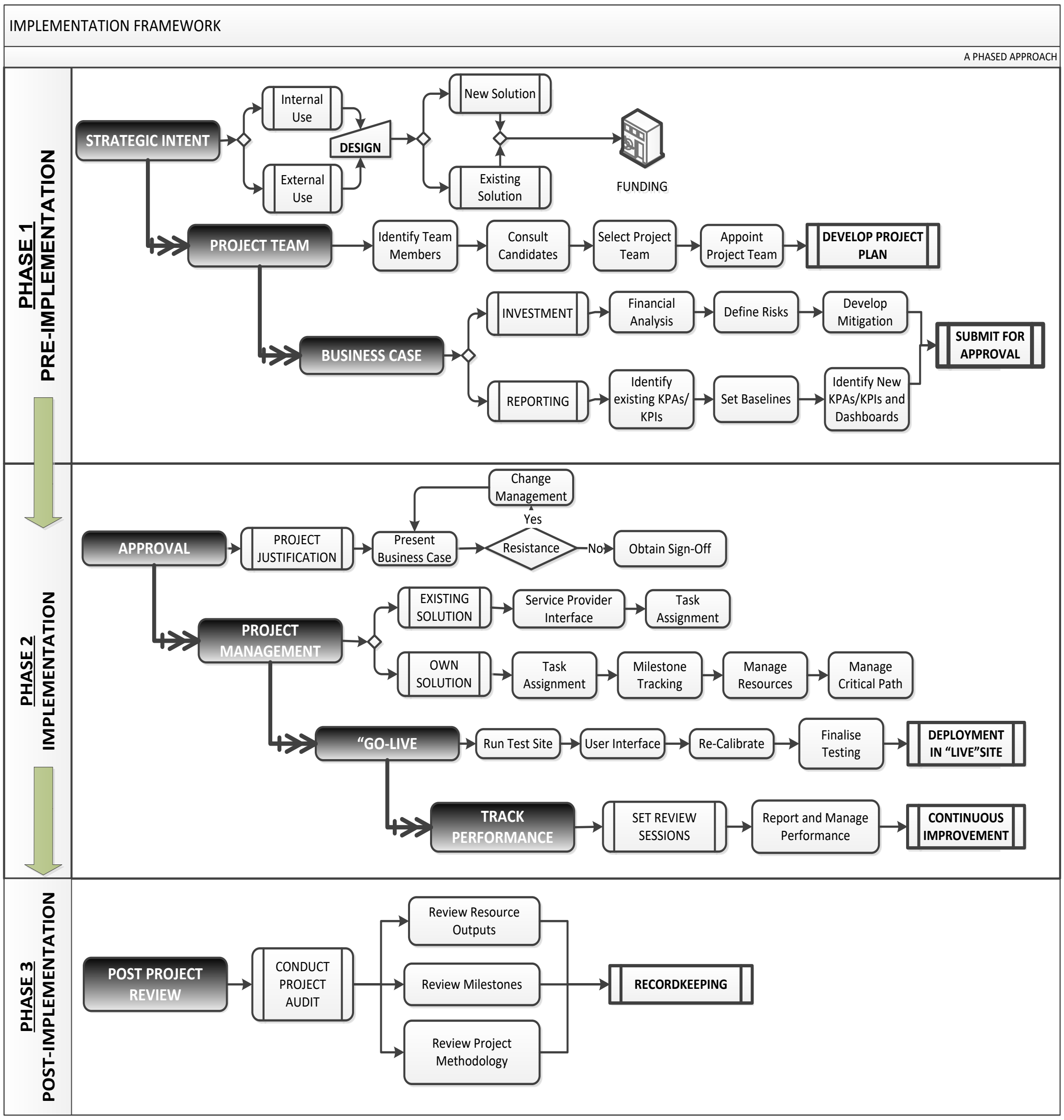
The audit must include a review of the success of the selected project methodology. This will ascertain the efficacy of the project resource and timeline management, identify the risks and associated mitigating actions, and set milestones. The audit process should be recorded to use as a testimonial for marketing, advertising and capability-building purposes. It also presents empirical evidence of the benefits that a DCT can deliver.

As a planning tool, the proposed framework provides managers with high-level guidelines that are structured and sequenced to avoid omitting any important steps when preparing for a DCT project. Application of the model enables managers to identify the financial, human resources, technological and operational requirements needed for the project. It can be used to package such requirements into a comprehensive plan to present to stakeholders for project justification; secure project funding; identify and acquire appropriate skills; identify appropriate technology solutions; create or align operational procedures; and highlight foreseeable risks. It serves as a tool that will assist managers in planning the project, leading the project execution, organising resources, and controlling delivery and outcomes. The proposed framework that could be followed to implement a DCT solution is presented in Figure 1.

7. CONCLUSION

A distinction can be drawn between the different users who would employ DCT technology as a solution. Feedback from participants illustrated that, although the focus of application may differ between the two groups, they all aspire to achieve the same benefits (see Table 1). User Group: 3PL aims to provide a customer-centric solution as a service offering and revenue stream, while User Group: In-house seeks to implement a solution to streamline and improve its internal controls and processes. Both groups reported an overall improvement in their reporting of supply chain visibility, integration, collaboration and analytics. They also concede that such achievements were realised against the backdrop of a lack of properly defined KPAs and KPIs, poor baseline setting and limited performance management capabilities. A further indication is given that whether an internal or external solution, implementing a DCT platform yields similar challenges, such as project management skills and aversions to adopting new technology. Some participants had to employ change management protocols and lobby senior executives to obtain the green light for their projects.

Figure 1: Proposed implementation framework



A notable finding is that all participants indicated an adherence to the planned timelines for project implementation. The complex and varied challenges highlighted in Table 5 would require a robust project management programme with stringent adherence to deliverables, costs and timelines. In addition, these challenges would contribute to the complexity of project execution. The expectation would be that project delivery would remain challenging throughout the project lifecycle. Participants attributed the successes of their on-time project delivery to the application of stringent project management practices and project teams with the correct and relevant skills. Critical path challenges were dealt with by following a stringent project management regime.

According to Khan *et al*. (2014), information technology usage in supply chains is increasing opportunities for cybercrimes. For the participants, the threat of cyber security breaches was combatted by applying existing resources and related policies. Participants expressed confidence in their existing IT resource capability and infrastructure. The employment of robust IT technology proved to be the solution for participants to deal with such threats. The DCT platforms presented common gains and challenges to the two distinct user groups. Gains included enhanced supply chain visibility and collaboration with partners. The solution provided increased operational and process efficiencies for internal operations and customer activities.

The challenges that were highlighted included people and stakeholder management, technology and systems challenges, managing commercial imperatives, and the application of correct project management processes. Neither of the user groups declared that a predefined process was followed when implementing the DCT solutions, which could have provided the ability to predict some of the gains and challenges encountered.

A key limitation of the study was the low number of participants, necessitated by the fact that there are few successful DCT implementations in South Africa. The protection of IP further hindered the data-gathering process because participants showed a reluctance to share specific details about financial information, benefit realisation and customer information. Participants adopted a guarded approach when divulging information beyond the normal marketing messages.

It is therefore suggested that this research be expanded to solicit customers' views on their experience with the DCT deployment and the resultant experience as a user. This will provide an alternative perspective and a balanced view of DCT challenges and benefits. Future research can also focus on obtaining a broader perspective from logistics service providers operating in other countries where DCT implementation is more widespread and has a longer history to allow for comparisons between different operating environments and learnings from successful implementations.

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