ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

Customer Service Level Agreements Measure Order Fulfillment Rates Delivery Performance Through Real Time Analytics Dashboard

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Publication Date: 2025/11/10

Abstract: The optimization of order fulfillment performance and its measurement in the context of the modern supply chain management have become a crucial factor that defines the competitive advantage and customer satisfaction. This study explores the model of integrating customer service level agreements (SLAs) and real-time analytics dashboard to gauge the rate of order fulfillment and delivery performance in complex supply chain networks. By taking a mixed-methodology with contingency theory and configuration analysis, the proposed study investigates how businesses can use business intelligence platforms and specifically, Microsoft power BI, strategically to work with operational data to convert them into performance management insights. The studies examine the information of various manufacturing companies in various geographical settings and industrial industries to create a complete model of the performance measurement through dashboard. Based on hierarchical regression analysis and cluster analysis techniques, the study determines five different types of analytics dashboard implementation, which span between the fundamental operation monitoring to sophisticated predictive analytics implementation. The results indicate that when the organizations have an extreme integration of internal processes, customer relationship, and supplier coordination, the best level of order fulfillment performance is attained when assisted by the ability to provide real-time analytics. Moreover, the study proves that with the appropriate combination of customer service level agreements and dashboard analytics, alignment of operation execution and strategic goals occurs, which leads to quantifiable results in the rate of on-time delivery, accurateness of orders, and the customer satisfaction metrics. The paper can add to the existing body of research on supply chain management by offering empirical information about the connection between performance measurement based on SLA and operational performance and presenting the practitioner with an empirically tested model of implementing real-time analytics dashboards.

Keywords: *Order Fulfillment Performance, Delivery Performance Measurement, Real-Time Analytics Dashboards, Business Intelligence Systems, Supply Chain Integration, Supply Chain Visibility, Performance Management Systems, Digital Transformation, Supply Chain Analytics.*

How to Cite: Benjamin Yaw Kokroko; Joseph Kobi; Edmund Kofi Yeboah (2025). Customer Service Level Agreements Measure Order Fulfillment Rates Delivery Performance Through Real Time Analytics Dashboard. *International Journal of Innovative Scienceand Research Technology*, 10(10), 2892-2938. https://doi.org/10.38124/ijisrt/25oct1433

I. INTRODUCTION

➤ *Background and Context of Order Fulfillment Performance Management*

The modern business world has required extreme operational excellence regarding its operations in terms of order fulfillment and delivery performance (Croxton, 2003). Companies have acknowledged that successful order fulfillment is one of the most important customer experience interfaces that have a direct impact on satisfaction, loyalty, and business performance. Supply chain management also includes the integration and management of business processes in the whole supply chain network including the tier-two suppliers as well as the final consumer (Swaminathan, 2001). Contemporary supply chains are characterized by the geographically dispersed operation, the existence of numerous stakeholder relationships and dynamic market environments that demand the use of advanced performance measurement and management techniques (Pettersson, 2008). The conventional order fulfillment management that is based on periodic reporting and analysis of historical data is not sufficient in terms of real time decision making. The development of digital technologies and highly developed analytics has provided new possibilities

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

to improve the performance of order fulfillment with real-time visibility and proactive managerial interventions.

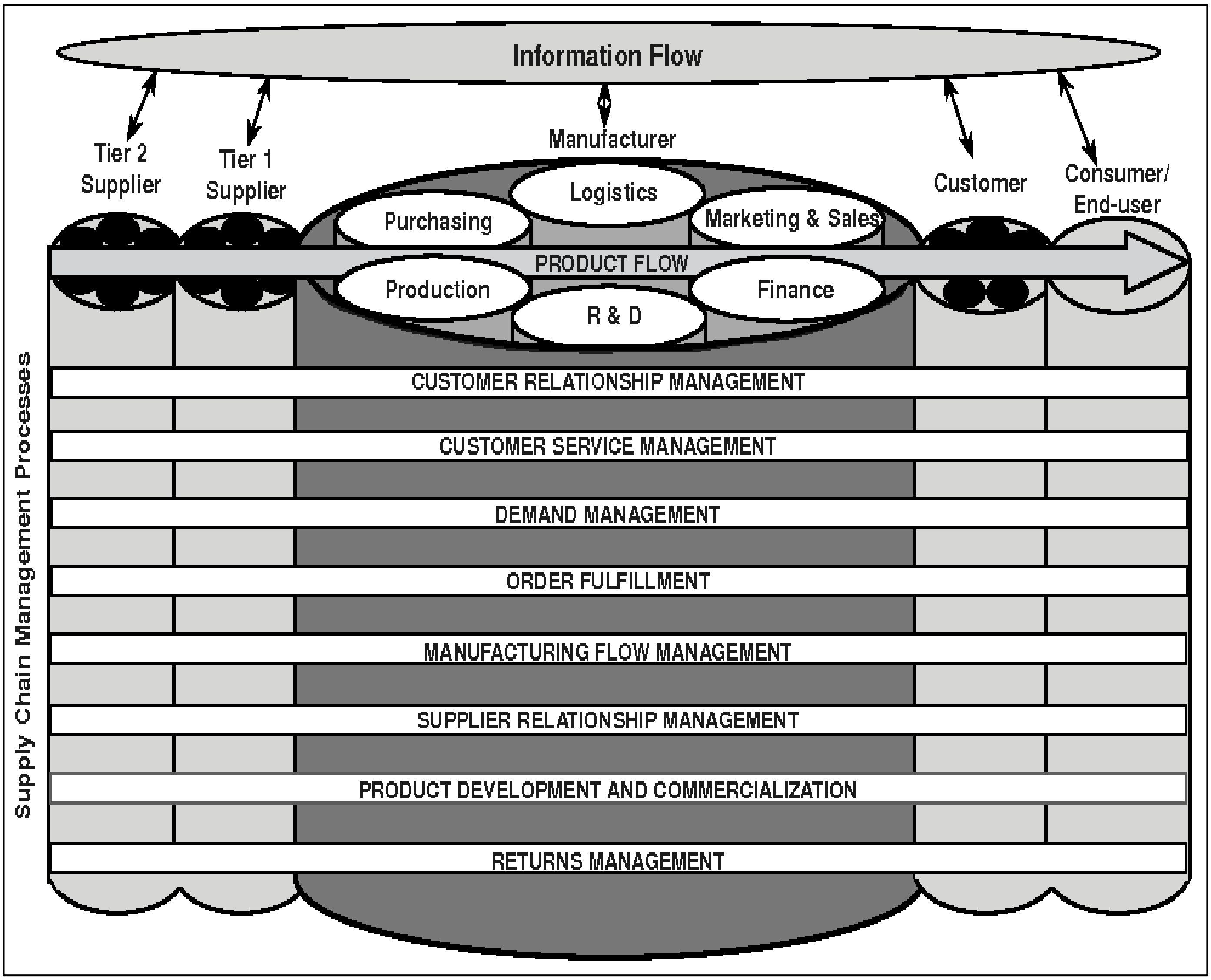

Fig 1 Supply Chain Management: Integrating and Managing Business Processes Across the Supply Chain

The customer service level agreements have become formalized processes of specifying performance expectations, communicating performance expectations, and managing performance expectations between the partners in the supply chain (Gunasekaran et al., 2001). Such agreements are applied with several strategic objectives such as meeting of operational priorities with customer needs and determining accountability structures. The combination of SLAs and real-time analytics dashboard is an important step in improving the practice of supply chain management. With this kind of integration, organizations are able to track performance against agreed-upon metrics in real-time and quickly address the deviations. The entire supply chain management processes include customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, supplier relationship management, product development, and commercialization, and returns management (Croxton, 2003).

The supply chain operations have been digitized, which has entirely changed the performance measurement sceneries, allowing real-time data collection and processing and visualization to unprecedented scales (Jackson, 2016). Business intelligence systems like Microsoft Power BI have become potent tools in the ability to integrate various data streams as well as conduct advanced analytics. These technological solutions effectively overcome the long-standing problems such as the fragmentation of data, slow reporting, reduced visibility across organizational lines and the inability to provide root causes of performance problems (Gunasekaran et al., 2004). The joining of both customer service level agreements and real-time analytics dashboards brings out strong synergy, which brings the strategic clarity of having formal performance agreements and operational responsiveness that can be realized through continuous monitoring and analysis.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

➢ *Research Problem and Significance of Supply Chain Performance Investigation*

Although there is an increased understanding that the real-time analytics dashboards are useful tools, there are still great gaps on how organizations can successfully combine customer service level agreements with the dashboard-based measurement systems (Gunasekaran et al., 2004). The current body of literature concerning the measurement of supply chain performance is concerned with determining the right metrics and the conceptual framework, and there is limited empirical research on the impacts of measurement strategies on real-life operational performance (Neely et al., 2000). There is very little literature of the interaction of SLA-based measurement systems and real-time analytics capabilities. This knowledge gap is especially notable in the light of heavy investments of the organizations in business intelligence technologies. The order fulfillment activities involve several interlocked processes such as order acquisition and order fulfillment that are aided by other supply chain management functions (Croxton, 2003).

The intricacy of performance measurement of order fulfillment has various origins such as the fact that the performance is more multidimensional and the presence of many organizational functions and external partners (Gunasekaran et al., 2004). Conventional performance measurement systems, which are characterized by a periodic reporting cycle, have difficulty in giving timely information that can be used to proactively manage the system. To solve some of the limitations, real-time analytics dashboards will help track the issues and identify them quickly. Nevertheless, there are still concerns regarding the way in which such capabilities can be utilized by organizations in the most effective manner to lead to the long-run performance enhancements (Jackson, 2016). Level agreements on customer service are complex and provide opportunity since they are formal commitments that need to be followed and controlled according to the changing business circumstances (Gunasekaran et al., 2001). The combination of SLAs and dashboard analytics has to be designed to be thorough so that the measurement systems are needed to capture appropriate dimensions of performance, and offer actionable insights.

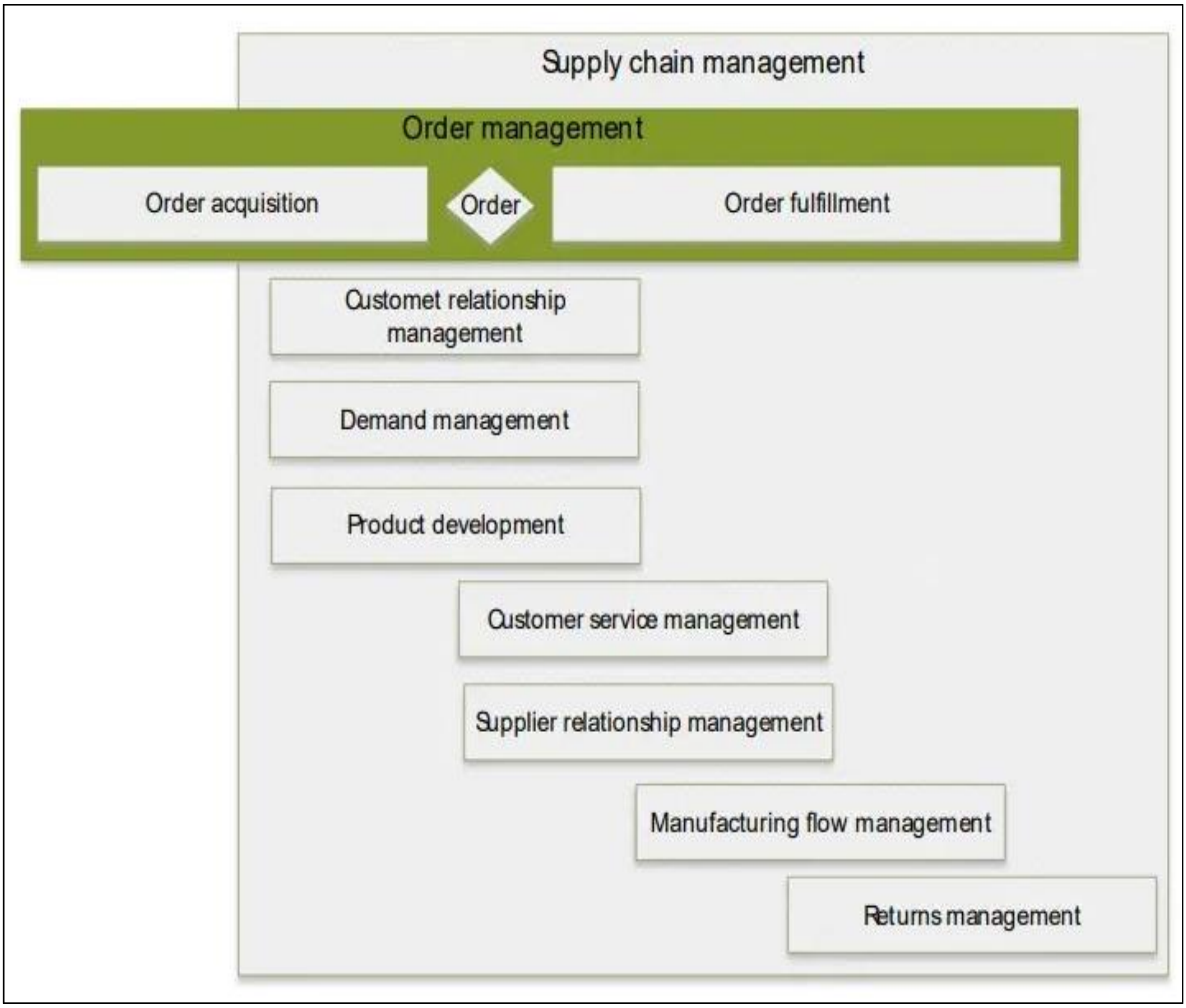

Fig 2 Connection of Order Management and Supply Chain Concepts from Order Flow Perspective

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The order fill performance measurement is a complex event that is attributed to several sources. The concept of performance is multidimensional in itself. Also, there are many organizational functions and external partners in the processes of fulfillment. Moreover, the customer demand is unstable and not predictable. Organizations also have to strike a compromise between competing goals, i.e. cost efficiency and service responsiveness (Gunasekaran et al., 2004). The existing system of performance measurement is not able to cope with the present-day requirements of operation. These systems are typified by periodic reporting cycles and backward-thinking metrics. Thus, they find it difficult to give timely information that is required to be proactive on the operating environments that are fast moving (Kaplan and Norton, 1996). Real-time analytic dashboards help to overcome some of these constraints by providing the ability to monitor the situation constantly and identify the performance problems quickly.

Another complexity and opportunity added to the performance management is the Customer service level agreements. These treaties set up official obligations which have to be overseen and controlled. In addition, they can also need to be renegotiated depending on the changing business situations and capabilities (Gunasekaran et al., 2001). A combination of SLAs and dashboard analytics is to be designed cautiously. The measurement systems are supposed to measure the relevant dimensions of performance. Also, they have to offer practical insights. Moreover, they are expected to facilitate decision making on various levels in the organization. Lastly, they should support the process of sustained improvement (Neely et al., 2000).

The importance of this study is not restricted to the intellectual sphere. It has massive practical implications to supply chain management practitioners and leaders in organizations (Pettersson, 2008). Customer satisfaction and retention is directly influenced by order fulfillment performance. Research has always shown that there are good correlations between order accuracy, customer loyalty, and reliability in delivery. With the increasing customer demands and the easy availability of alternatives, compliance with suboptimal order fulfillment performance is not affordable to organizations. Lack of execution would lead to loss of market shares and competition (Harrison and van Hoek, 2014).

The economic impact of the order fulfillment performance is also very critical. A good order fulfillment management will impact on a variety of cost categories such as inventory carrying costs, transportation expenses, warehousing operation, and customer service resources (Mattsson, 2012). When implemented correctly and combined with customer service level agreements, real-time analytics dashboards provide significant opportunities both to enhance the quality of the provided services and the efficiency of its operation at the same time due to the ability to make more informed decisions and respond faster to the emerging challenges (Eckerson, 2009). In this study, the authors examine these correlations in empirical research that offers evidence-based findings on how organizations can design and deploy SLA-based dashboard measurement system to enable them to attain high level of order fulfillment performance results (Striteska and Spickova, 2012).

➢ *Research Objectives and Comprehensive Investigative Questions Framework*

This research pursues three primary objectives that collectively address critical gaps in supply chain performance measurement knowledge and practice.

- First, the study aims to develop a comprehensive conceptual framework for integrating customer service level agreements with real-time analytics dashboards to measure and manage order fulfillment performance across complex supply chain networks.
- Second, the research seeks to empirically investigate the relationships between SLA-driven dashboard measurement systems and order fulfillment performance outcomes, examining both direct effects and moderating influences of various organizational and environmental factors.
- Third, the study endeavors to provide practical guidance for organizations implementing or refining their order fulfillment performance measurement systems, translating empirical findings into actionable recommendations that can inform managerial decision-making and resource allocation

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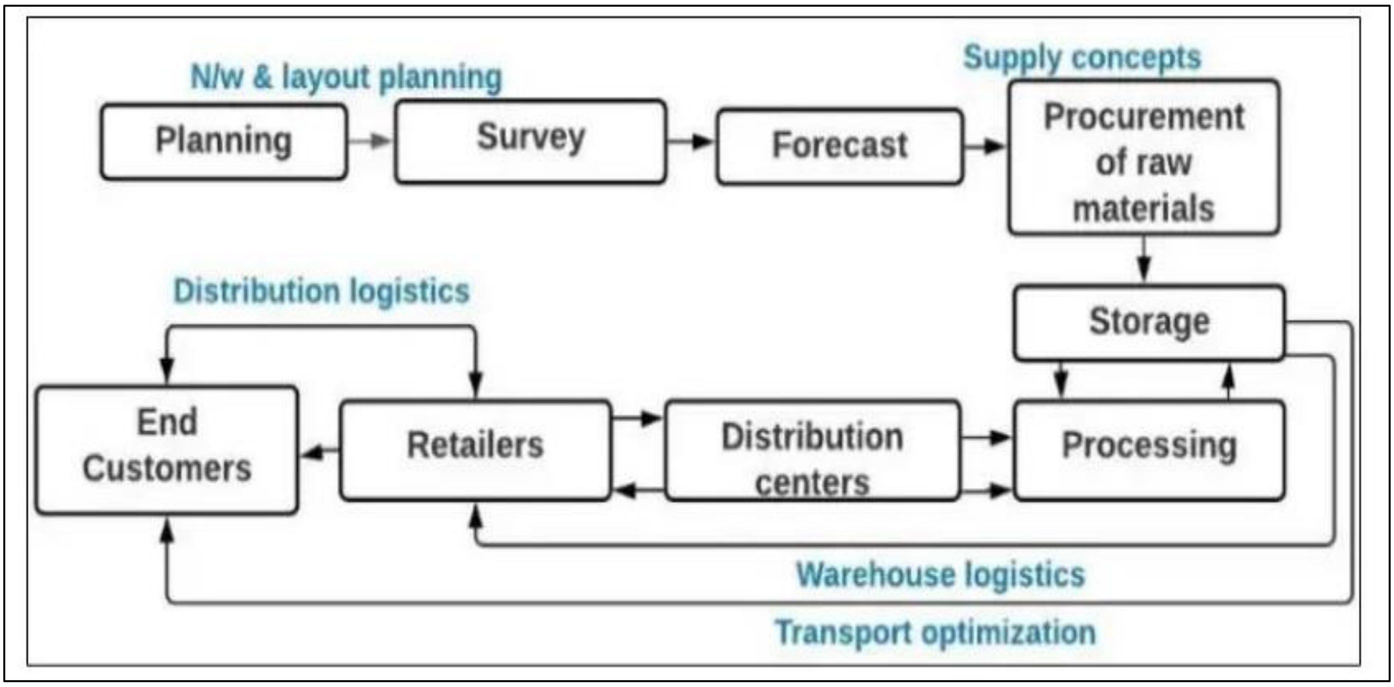

Fig 3 The Supply Chain Management Process

To address these objectives systematically, the research investigates several specific questions that guide the empirical inquiry and analysis.

- *The First Research Question Asks:*

How do different configurations of customer service level agreement metrics relate to order fulfillment performance outcomes across various organizational contexts? This question recognizes that organizations may emphasize different aspects of performance in their SLAs, including on-time delivery, order completeness, order accuracy, lead time consistency, and responsiveness to special requests, and that the specific combination of metrics selected may influence both measurement effectiveness and actual performance outcomes.

- *The Second Research Question Examines:*

What are the critical design characteristics of real-time analytics dashboards that enable effective monitoring and management of order fulfillment performance? This inquiry addresses practical considerations including data visualization approaches, refresh frequency and timeliness, user interface design, drill-down and analysis capabilities, alert and notification mechanisms, and integration with operational systems.

- *The Third Research Question Explores:*

How does the integration of customer service level agreements with real-time analytics dashboards moderate the relationship between supply chain integration dimensions and order fulfillment performance? This question builds on established research regarding the importance of internal integration, customer integration, and supplier integration for supply chain performance, investigating whether SLA-driven dashboard measurement enhances these relationships.

- *The Fourth Research Question Investigates:*

What organizational and environmental factors influence the effectiveness of SLA-driven dashboard measurement systems in improving order fulfillment performance? This broad question encompasses multiple potential contingency variables including organizational size and structure, industry characteristics, supply chain complexity, technology infrastructure maturity, organizational culture and change readiness, and competitive intensity.

Understanding these contextual influences is critical for developing nuanced recommendations that acknowledge the diversity of organizational circumstances and capabilities (Pettersson, 2008). The fifth research question asks: How do organizations evolve their approaches to order fulfillment performance measurement over time, and what patterns of maturity progression characterize successful implementations? This developmental perspective recognizes that SLA-driven dashboard measurement represents a capability that organizations build progressively rather than implementing instantaneously.

➢ *Theoretical Foundations and Integrated Research Framework Development*

The theoretical backdrop is based on three streams of scholarly inquiry (related to one another) (Pettersson, 2008). These are the supply chain integration theory, performance measurement systems theory, and organizational information processing theory. The supply chain integration theory assumes that firms can perform better by being strategic in their partnership with suppliers. This school of thought focuses on the fact that order fulfillment performance is indicative of effectiveness of coordination functionality across various functions and organizational boundaries (Croxton, 2003). The supply chain process involves a number of interrelated flows such as supply information flow in terms

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of cost, capacity, and product design, demand information flow in terms of customer requirements and orders, material flow including new and refurbished products and components, reverse material flow in terms of recycled and returned items and cash flow in terms of flow across the supply chain network between supplier and the customer (Swaminathan, 2001).

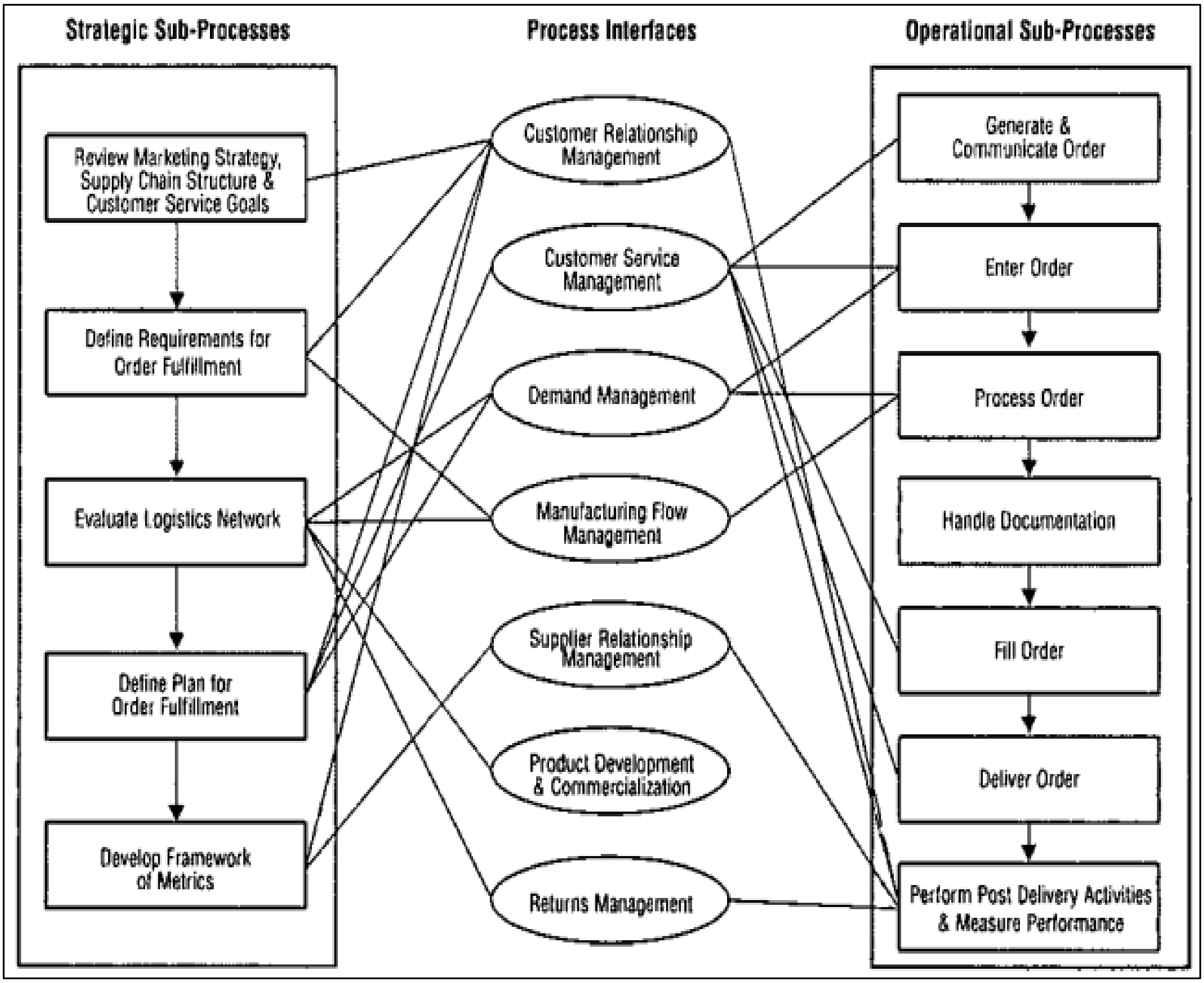

Fig 4 Order Fulfillment

The second significant theoretical framework upon which this research will rely is the performance measurement systems theory (Neely et al., 1995). It provides guidelines on how organizations design measurement systems, introduce them and how they apply them. To perform effective performance measurement, it is important to pay attention to various design aspects such as strategic alignment to ensure that the measurement covers organizational priorities; balanced coverage to capture various dimensions of performance; actionable insights to help in decision-making and improvement efforts; and dynamic adaptability to enable the evolution of the measurement system as the circumstances change (Neely et al., 2000). Order fulfillment involves the strategic sub-processes and the operational sub-processes. Such strategic sub-processes are: marketing strategy and supply chain structure review, order fulfillment requirement definition, logistics network evaluation, and fulfillment plans definition. Some of the operational sub-processes are production and communication of orders, receiving orders, receiving orders, processing orders, documentation handling, filling orders, delivery of orders, and performance measurement (Croxton, 2003).

The third theory is the organizational information processing theory. It describes the process through which organizations accumulate, manipulate, and use information to minimize doubt and facilitate the ability to make good decisions. This theory is especially applicable in real-time analytics dashboards in order to improve the performance of order fulfillment (Jackson, 2016). Different levels of task uncertainty in organizations are associated with the variability of demand, complexity of supply chains, products variety, and dynamism of the environment. They should equip themselves with the information processing ability to match

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such levels of uncertainty. Real-time analytics dashboards enhance the capacity to process information in a variety of ways such as data integration between once fragmented sources; automatic collection and processing save time and money on manual effort and delays; advanced analytical features that identify patterns and relationships; easy-to-understand visualization; and exception alerting puts the focus on the key problems (Jackson, 2016).

Further basing on these grounds, this study constructs a combined framework based on how the customer service level agreement and real-time analytics dashboard co-determine the performance of order fulfillment (Striteska and Spickova, 2012). The framework acknowledges that SLAs put in place performance expectations and accountability provisions that influence the organization priorities and resource allocation decisions, and real time dashboards give visibility and responsiveness provision to effectual implementation and continuous enhancement (Gunasekaran et al., 2004). Combination of these complementary mechanisms leads to synergistic outcomes, as SLAs offer strategic guidance, and dashboards allow to act tactically (Harrison and van Hoek, 2014). The framework also includes contingency perspectives since the effectiveness of SLA-driven dashboard is contingent on several contextual factors such as the level of supply chain integration, the capabilities of the organization, the nature of the industry, and the competitive forces (Pettersson, 2008). The result of this contingency recognition is expectations of varying performance consequences being achieved in various organizations based on the effectiveness of measurement system designs in relation to circumstances and demands.

- *Research Scope, Comprehensive Methodology Overview, and Article Organizational Structure*

This research employs a mixed-methods approach combining quantitative analysis of survey data with qualitative examination of organizational case examples. The quantitative component utilizes data collected from manufacturing organizations across multiple geographic regions and industry sectors, enabling statistical testing of hypothesized relationships. The survey instrument captures information regarding order fulfillment performance metrics, customer service level agreement characteristics, real-time analytics dashboard capabilities, and supply chain integration dimensions (Pettersson, 2008).

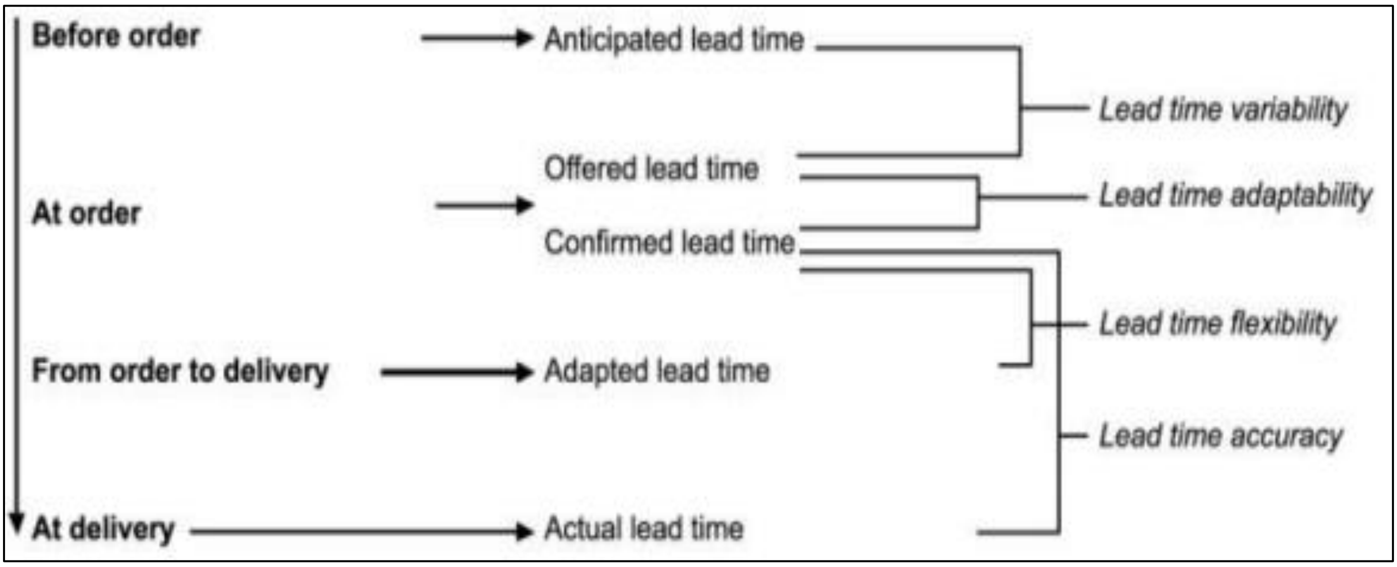

Fig 5 Different Aspects of Lead Time

The investigation covers organizations working in various manufacturing business such as electronics and electrical equipment, metal and mechanical products, chemicals and petrochemicals, textiles and apparel, food and beverages, and building materials. Its wide coverage of industries contributes to generalizability and allows investigating the industry-specific trends (Pettersson, 2008). The study pays particular attention to the order fulfillment as the area of performance of interest (Croxton, 2003). Lead time should be addressed different facets during the process of order fulfillment such as the expected lead time prior to the placing of an order, lead time provided and accepted during the order placement, adjusted lead time during order to delivery and actual lead time during delivery (Forslund et al., 2008). The performance in terms of order fulfillment is measured on a variety of dimensions such as delivery timeliness, order completeness, order accuracy, flexibility and responsiveness, and customer satisfaction (Gunasekaran et al., 2004). In addition, the investigation explores content characteristics of SLAs such as metric and targets, and process characteristics such as development, communication, and time monitoring (Gunasekaran et al., 2001).

The methodological strategy is a combination of hierarchical regression analysis to examine the hypothesized relationships and cluster analysis to determine the emergent patterns of configuration of measurement systems. Hierarchical regression allows to look at direct effects and interaction effects. Further, the cluster analysis enables the determination of specific organizational profiles in terms of SLA metrics, dashboards, and dimensions of integration. These two analytical methods offer specific relationship insights as well as the comprehensive insights into the measurement system configurations (Striteska and Spickova, 2012). In addition, the study takes into consideration rigorous adherence to the quality of methodology by paying attention to instruments development and validation.

The rest of this paper is divided into five significant parts. Section 2 is an extensive review of the related literature streams that synthesize the already existing knowledge. Section 3 explains the research methodology explaining the sampling method, development of survey tools and methods of analysis. Both the contingency and configuration analysis results are given in section 4 (Pettersson, 2008). Section 5 talks about implications of findings on both theoretical and managerial practice. Lastly, section 6 provides a conclusion, making some final contributions and future research interests. This theoretical development, methodological rigor, and practical relevance are taken care of throughout the article in a balanced manner.

II. MATERIALS AND METHODS

➢ *Research Design and Philosophical Foundations*

The philosophy of this study is positivism based on the belief in the existence of objective reality and systematic empirical research shows the generalizability of patterns. The positivist paradigm is suitable due to the concentration on the measurable constructs such as the order fulfillment performance and dashboard capabilities. The study design will bring about both the contingency and configuration views (Striteska and Spickova, 2012). The contingency approach involves analysis of certain relationship between the independent and dependent variables using hierarchical regression analysis. It allows to understand in detail how personal factors affect results. The configuration approach is a holistic way of looking at the data in the form of cluster analysis in order to determine the patterns that occur naturally.

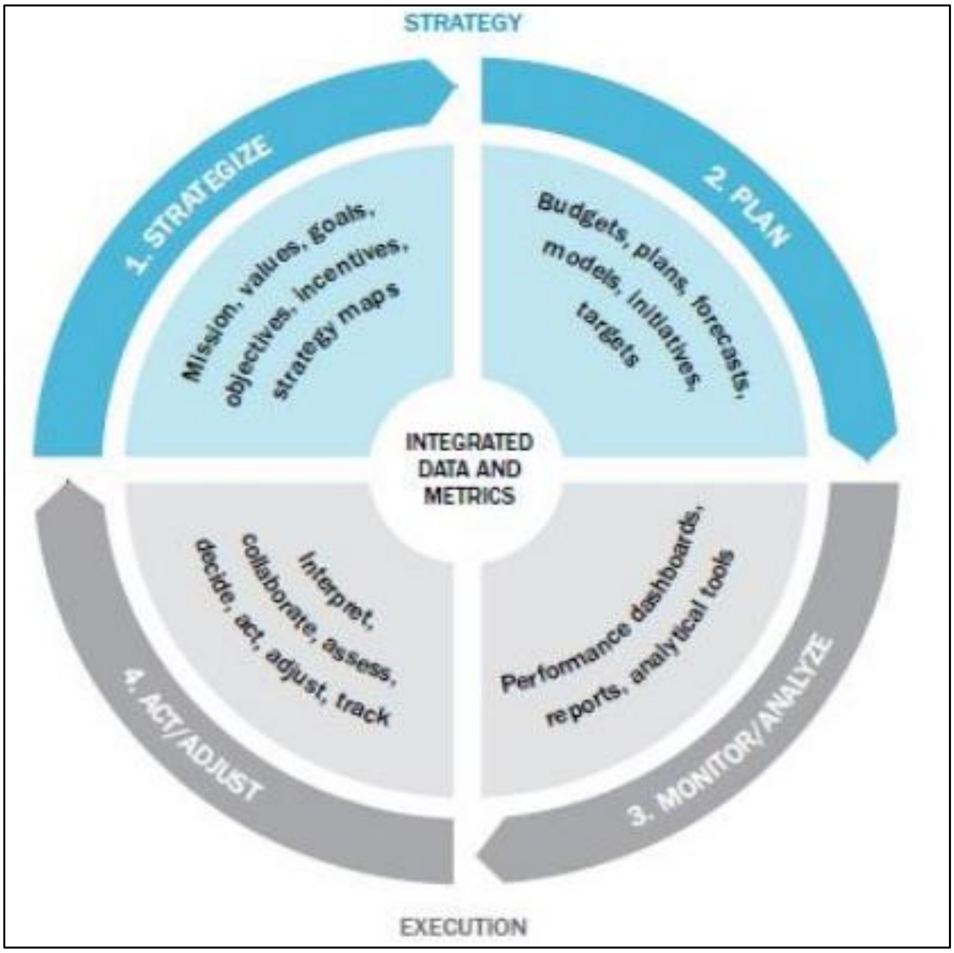

Fig 6 The Continuous Circle of Performance Management

The mixed-methods design provides more in-depth insights into the phenomena because of the limitation of any of the two perspectives applied separately (Striteska and Spickova, 2012). Contingency analysis sheds light on the causal agents, but can distort the complexity of realities in an organization. Configuration analysis depicts multidimensional reality in an organization and reveals emergent patterns, however does not give a clear insight into causal processes. The ongoing cycle of the performance management includes four related stages which include strategize through the creation of mission and objectives, plan through budgets and forecasts, monitor and analyze through evaluation of the performance, and act and adjust through taking corrective measures (Eckerson, 2009).

The study will use a cross-sectional survey design where data will be collected at a given time on several organizations. Although cross-sectional designs do not allow

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making conclusive causal conclusions, they have such practical benefits as the possibility and efficiency. The study recognizes that the implementation of SLA and dashboard is the organizational potential that requires the period to be established (Sundstrom and Tollmar, 2018). To partially take care of the temporal consideration, the survey will contain questions regarding the time of implementation.

➤ *Sample Selection, Data Collection Procedures, and Comprehensive Response Analysis*

The research targets manufacturing organizations recognizing that order fulfillment performance is particularly critical in manufacturing contexts (Croxton, 2003). Manufacturing industries exhibit substantial diversity providing rich variation for identifying general patterns. The sampling frame encompasses organizations across multiple geographic regions including Hong Kong, Guangzhou, Chongqing, Shanghai, and Tianjin. This geographic diversity enhances sample representativeness. Random sampling procedures were employed within each region to reduce selection bias. Initial contact was established through telephone calls to identify appropriate respondents (Pettersson, 2008).

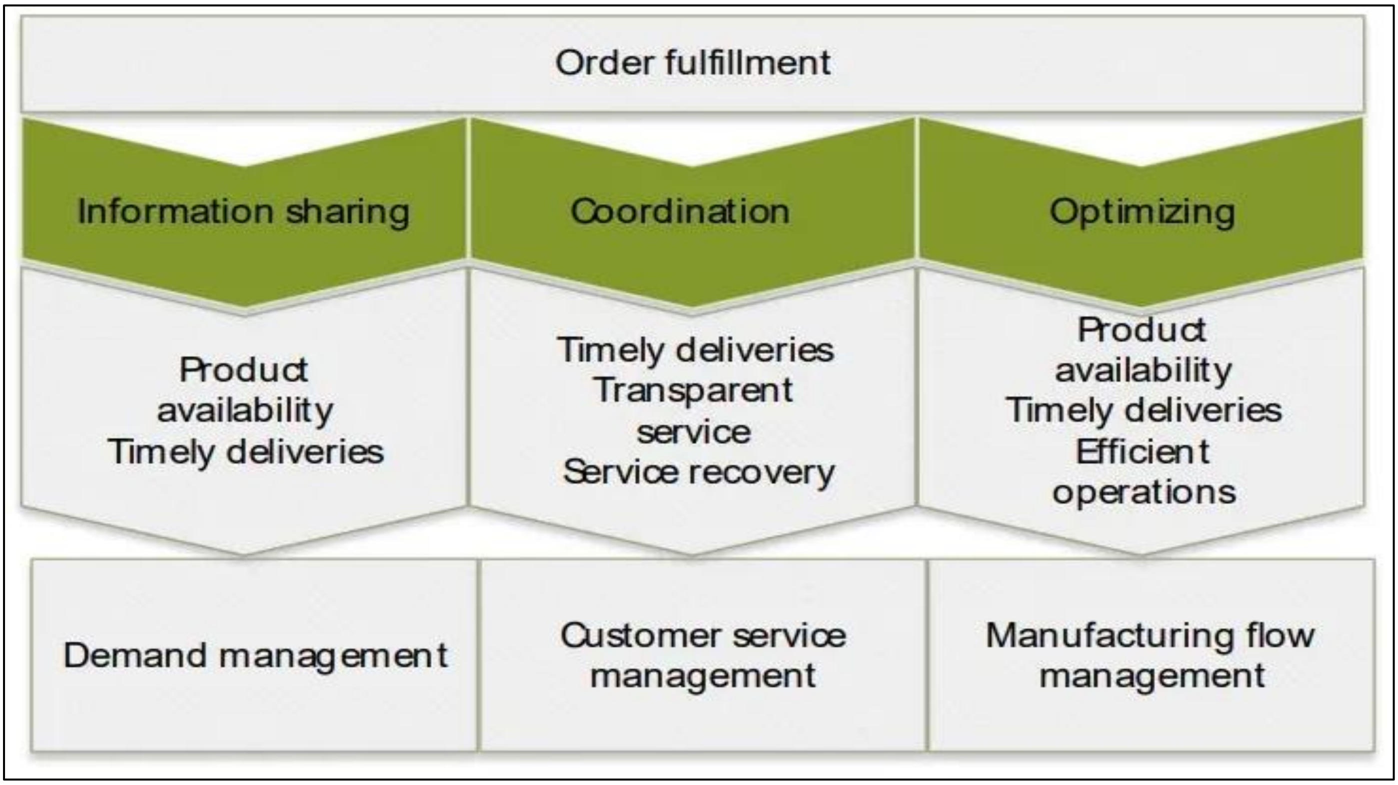

Fig 7 Links of Information Sharing, Coordination and Optimizing Between Order Fulfillment, Demand Management, Customer Service Management and Manufacturing Flow Management

The survey tool was constructed through an intensive multi-stage procedure that was aimed at making sure there is content validity and a measurement of reliability. The early generation of items was based on the existing scales within the literature of supply chain management. New items on constructs where the current measures were not adequate were made. Order fulfilment deals with three important dimensions namely information sharing that allows product availability, coordination that facilitates timely delivery through open service, and optimization that contributes to efficiency (Croxton, 2003). The tool was created in English and translated to Chinese by the bilingual scholars.

A multi-contact method, which is aimed at maximizing a response rate, was used as a method of data collection. After receiving the first telephone response, questionnaires were sent as a mail with cover letters on the purpose of research. Follow-up contacts were done many times to foster participation. Out of the 4,569 organizations who were first contacted, 1,356 out of all were interested and sent questionnaires back and 617 of them were returned in usable form giving a response rate of 45.5%. These rates are favourable to other studies on supply chain management (Pettersson, 2008). The sample that has been obtained is very diverse in terms of industry industries and the size of organizations.

The non-response bias was evaluated by conducting the comparison of early and late respondents on the main aspects of organizations. The independent samples t-tests did not indicate any statistically significant differences which proved that non-response bias is not massive. The bias of common method was evaluated in various ways as there was dependence on the one-informant responses. The single factor test by Harman shows that there were nine separate factors (attributed to) which explained 72.1% variance (first factory explained 33.8%). This makes sense in a study that is researching constructs that are allied. The result of confirmatory factor analysis of single factor model showed inadequate levels of fit which were significantly lower than those of measurement model, which further supports the claim that common method bias is not severe. Although this percentage is higher than the 50% level that is given as a conservative value, it is understandable that research of related constructs is predicted to show some kind of correlation. The use of single-factor model in confirmatory factor analysis produced poor fit indices ($X^2 = 11690.67$, df = 986, NNFI = 0.85, CFI = 0.86, RMSEA = 0.18, SRMR = 0.13), which were significantly poorer than measurement model, further demonstrating that common method bias is not severe.

➤ *Measurement Scale Development and Comprehensive Construct Validation*

Customer service level agreements are measured using several dimensions that capture the content of agreement based on performance and processes through which agreements are made and managed (Gunasekaran et al., 2001). The survey tool consists of questions that measure comprehensiveness of SLAs in various performance aspects such as on-time delivery, completeness of the order, accuracy of the order, consistency in the lead time and reaction to special orders (Croxton, 2003). Moreover, the items gauge specificity of performance targets that are set in SLAs differentiating between vague aspirational set of goals and tangible quantifiable objectives (Gunasekaran et al., 2004). Process-oriented items test the development of SLAs in the form of the degree of cooperative development of the performance measures with the customers, the frequency of agreements reviews and updates, and the regularity of monitoring and performance communication. Each of the items uses seven-point Likert scales with larger values implying more complete coverage of SLA, more specificity of the target or more intensive processes managing SLA that would offer interval-based measurements that could be analysed using parametric statistics.

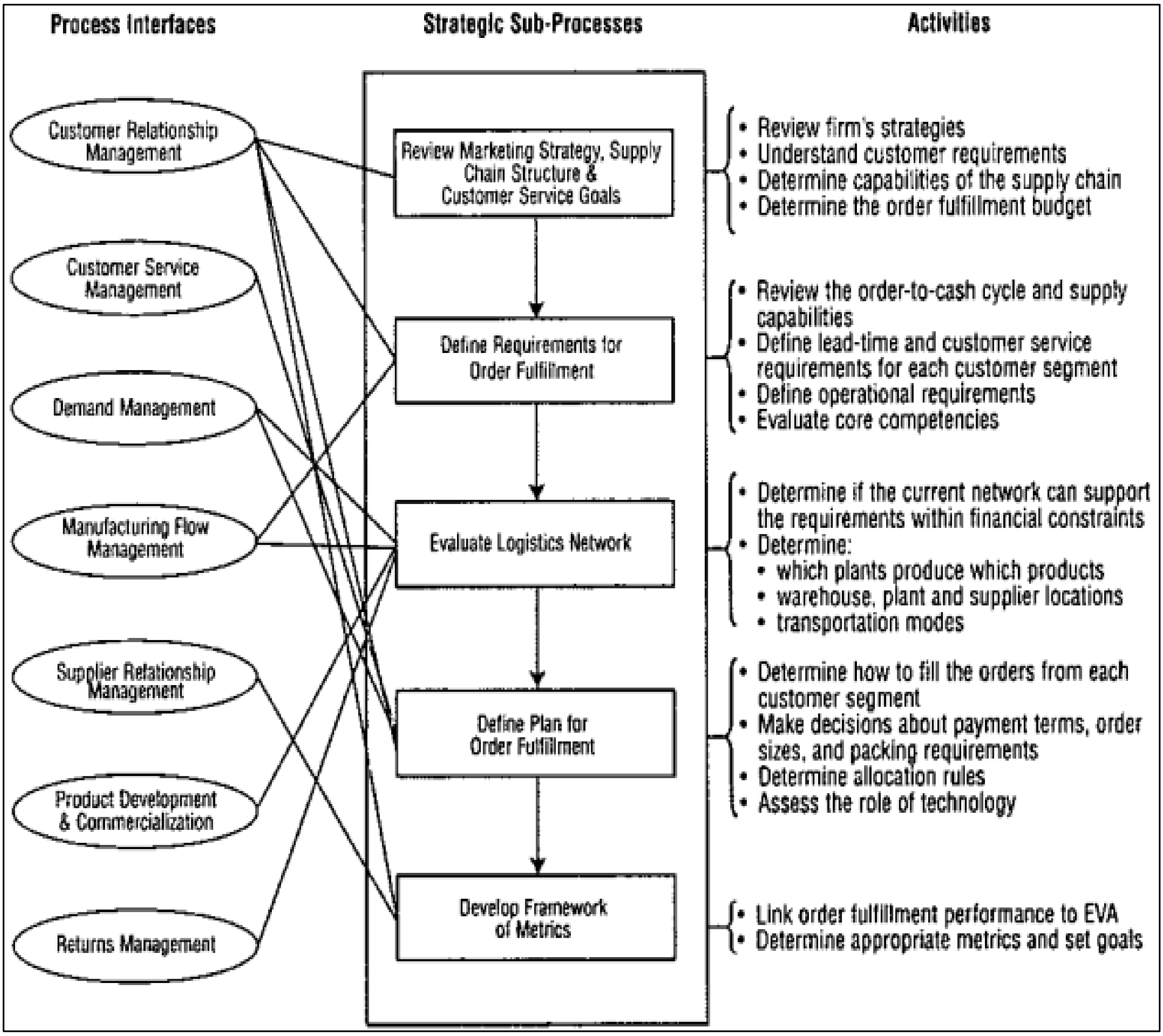

Fig 8 The Strategic Order Fulfillment Process

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

The capabilities of real-time analytics dashboard are evaluated by measuring items that concern the technical functionality and the organizational utilization patterns. It is not just availability of technology that can be converted into performance advantages unless it is implemented and used accordingly. Technical capability items evaluate data integration among multiple source systems, the speed and frequency of processing allow updating the data almost in real time, analytic functionality, such as drill-down capability and root cause analysis capability and visualization quality, which makes it easy to understand the status of the performance (Jackson, 2016). The organizational utilization items include the question of who accesses dashboards in the organization, the frequency with which dashboards are accessed, whether dashboard insights are systematically used to make operational decisions in the organization, and the degree to which dashboard data is distributed across organizational units and with the supply chain partners (Eckerson, 2009).

Several important sub-processes were present in strategic order fulfillment process which were assisted by process interfaces. To begin with, the marketing strategy and supply chain structure review with customer service goals can assist in knowing customer requirements and finding order fulfillment budget using customer relationship management and customer service management. Second, determining conditions of requirement of fulfillment of orders creates necessary lead-time, customer service conditions of customers segment and defines operational conditions and assessment of core competencies as core competencies are deterred with the help of customer service management and demand management. Third, logistics network assessment helps in identifying whether the current network can meet the requirements at the financial limit and identify the plants that manufacture each product, where to locate the warehouses, suppliers, and transportation modes by managing demand, manufacturing flow, and supplier relationship. Fourth, creating plans about order fulfillment establishes how to fill an order of each customer segment, makes choices related to payment terms, order quantity, packing, decides rules of allocation and evaluates technology roles.

Integration of the supply chain consists of three different yet interconnected dimensions internal integration which is the integration in the functional areas within the organization, the integration with the customers which is collaboration relationship and information exchange with the downstream partners, and supplier integration which is a coordination with the upstream members of the supply chain (Pettersson, 2008). The measure of internal integration is in terms of items that determine scope to which various functional areas operate as integrated process, extent of information sharing, and participate in joint planning and decision-making. Customer integration uses items focused on strategic nature of customer relationships, level of information sharing regarding demand forecasts and production plans, collaborative participation in product development and process improvement programs, and collectively solving problems.

The main dependent variable in this study is the order fulfillment performance, which is measured using various items covering various areas of performance (Gunasekaran et al., 2004). The performance of on time delivery is measured using items based on the percentage of orders to be delivered on the promised date, the performance of delivery over time, and the perceptions of customers on the reliability of the delivery. Order completeness items deal with the degree to which orders are completed with no back-orders or partial shipments including both the quantity and product mix accuracy (Gunasekaran et al., 2001). The order accuracy includes the content of items that measure the absence of errors in processing of orders, picking, packing, and recording (Croxton, 2003). Flexibility and responsiveness items measure the capacity of an organization to make special requests, faster turnaround of urgent orders as well as respond to the changing customer needs. The customer satisfaction items consider general customer satisfaction of the quality of order fulfillment service and desire to recommend organization to others.

➢ *Analytical Techniques for Contingency and Configuration Examination*

The analytical plan uses two complementary methods to explore linkages in the agreement of level of customer service, realtime analytics boards, dimension of supply chain integration, and order fulfillment performance results (Striteska and Spickova, 2012). The contingency approach applies the hierarchical multiple regression analysis to test the relationship between individual variables and their relationship with performance. In this way, it is possible to test certain hypotheses regarding direct effects and mediating relations. First, control variables such as the size of the organization, industry, and geographical area are keyed in to take into consideration the potential confounding factors of performance. This is followed by introduction of main effects of dimensions of supply chain integration, level agreement of customer service, and real-time analytics dashboard capabilities, with incremental variance attributed to each group of variables. Lastly, the terms of interaction that are two-way and three-way between supply chain integration dimensions and integration dimensions and SLA-dashboard measurement systems are included. The statistical significance of regression coefficients gives information as to whether the relationship proposed by hypothesis is supported by the evidence, and the change in R 2 gives information on an incremental contribution to the overall explanatory power made by sets of variables. The interaction terms are constructed through cantering of independent variables and calculating their product to eliminate the possible problems of multicollinearity.

The configuration approach uses cluster analysis to define naturally occurring patterns of organizational features on the dimensions of supply chain integration, the features of SLA implementation, and dashboard capabilities. There are numerous process interfaces, which support the use of numerous sub-processes and activities in the operational order fulfillment process. The generation and communication of orders results in the generation and communication of orders via the customer relationship management and

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customer service management. Entering orders entails the customer service management of receiving, entering, and editing orders. Customer service management and demand management process order flow and transportation, inventory checking and credit processing orders. The process of documentation recognition recognizes orders, creates bills of lading and picking instruction along with packing slips and creates invoices by use of demand management and manufacturing flow management. Picking, packing and shelf loading orders and packing and preparing load confirmation by manufacturing flow management and directly with supplier relationship management. Application of shipping documents, delivery confirmation, and auditing and payment of freight bills is done through supplier relationship management and product development and commercialization to deliver orders.

Clustering analysis is done followed by discriminant analysis to justify the cluster solution and the ability of the clustering variables to distinguish the groups. The technique produces discriminating functions, and these functions are linear combinations of original variables that are weighted to maximize the separation between clusters. Analysis of standardized discriminant function coefficients indicates which variables lead to the greatest contribution of differentiation of clusters. Besides, structure correlations show bivariate relationships among variables and discriminant functions. The procedures of cross-validation measure the accuracy of classification by predicting the membership of the clusters of held-out cases and when the classification accuracy is high, the clusters are separated and distinct. After cluster validation, analysis of variance is conducted to compare the order fulfillment performance by cluster and the hypothesis is whether patterns of SLA implementation, dashboard capability, and supply chain integration empirically developed relate to varying performance outcomes (Pettersson, 2008). The high F-statistics imply that there are general differences in performance across clusters. Also, Scheffé post-hoc pair-wise comparisons determine which pairs of clusters differ significantly.

- *Reliability, Validity Assessment, and Measurement Model Evaluation*

The quality of measurement needs to be thoroughly evaluated to ascertain that empirical results represent real relationships among theoretical constructs and not measurement artifacts. The analysis of reliability studies the internal consistency of multi-item scales and computes the coefficients of alpha of Cronbach in relation to each construct. Alpha values that are above 0.70 are said to be acceptable meaning that some items in a scale are interrelated enough to warrant the aggregation of the items into composite scores. The alpha values of all constructs in this study are between 0.84 and 0.94 which is well above the minimum threshold and gives confidence over the scale reliability (Pettersson, 2008). A principal axis factoring with oblique rotation exploratory factor analysis is performed to determine dimensionality of measurement scales, and whether items load on the constructs they are intended to measure. Analysis of factor loadings proves that the items have high loadings with a value above 0.50 on the measure factors and relatively low loadings on cross-measure factors, which justifies the suggested measurement structure.

Confirmatory factor analysis gives a stricter measure of quality of the measurement models by testing the hypothesis factor structure whether it fits sufficiently positive covariance matrix. According to the measurement model, every item is loaded onto its corresponding latent construct, the latent constructs are permitted to correlate with each other and the error terms of the items are not correlated. Various fit indices are also used to determine the goodness of fit of the model which are chi-square statistic, comparative fit index (CFI), non-normed fit index (NNFI), root and square error of approximation (RMSEA), and standardized root mean square residual (SRMR). The goodness of fit of the measurement model is reasonable (2 = 4751.23, 976, NNFI = 0.95, CFI = 0.95, RMSEA = 0.090, SRMR = 0.070), which suggests that the results of the measurement are consistent with the hypothesized structure of the factors. Factor loadings are all statistically significant and have a value above 0.50 and the t-values are above 2.0 which proves convergent validity. Every construct is averaged in squared factor loadings to obtain average variance extracted (AVE). Four constructs pass the 0.50 mark with one passing the 0.46 mark a little short of the recommended minimum though still acceptable considering the rest of the validity indicators.

The assessment of discriminant validity is done in a variety of ways to make sure that the constructs are empirically different as opposed to the measurement of the same underlying dimension. The major test presents the comparison of average variance extracted per construct with the squared correlation between that construct and all the other constructs. Correlations greater than the squared have been used as evidence of discriminant validity. This is the criterion that all the construct pairs in measurement model meet i.e. constructs have more variance with their indicators compared to their counterparts. Further assessment of the discriminant validity entails chi-square difference tests of constrained models with correlation between two constructs at a fixed value of 1.0 to unconstrained models with freely estimated correlations. The chi-square statistic of all construct pairs is significant showing that the correlations are significantly less than unity which is another supposition of the validity of the discriminants.

III. RESULTS AND ANALYSIS

- *Sample Characteristics and Descriptive Statistics*

The obtained sample of 617 responding organizations reflects a significant diversity in a variety of dimensions, which promotes their generalizability to the entire population of manufacturers. Geographic coverage is Hong Kong (206 organizations, 33.4%), Guangzhou (104 organizations, 16.9%), Chongqing (104 organizations, 16.9%), Shanghai (100 organizations, 16.2), and Tianjin (103 organizations, 16.7) that represent various levels of economic progress and market maturing. The industry representation is a heterogenous manufacturing industry with many industries such as metal, mechanical and engineering products (25.4%), textiles and apparel (17.8%), electronics and electrical equipment (13.1%), chemicals and petrochemicals (6.3%), rubber and plastics (6.6%), building materials (5.0%), and food, beverage and alcohol (4.9%), and printing and publishing (4.4%), among other smaller industries (Pettersson, 2008). The organizational size by annual sales shows a high diversity: 32.4% of them report less than HK sales, 14.1% between HK sales, 12.4% between HK sales, 15.8% between HK sales, 10.2% between HK sales, and 15.0% above HK sales. The sample size covers small and large organizations and allows to investigate whether the performance relationships vary according to the size of the organization (Pettersson, 2008).

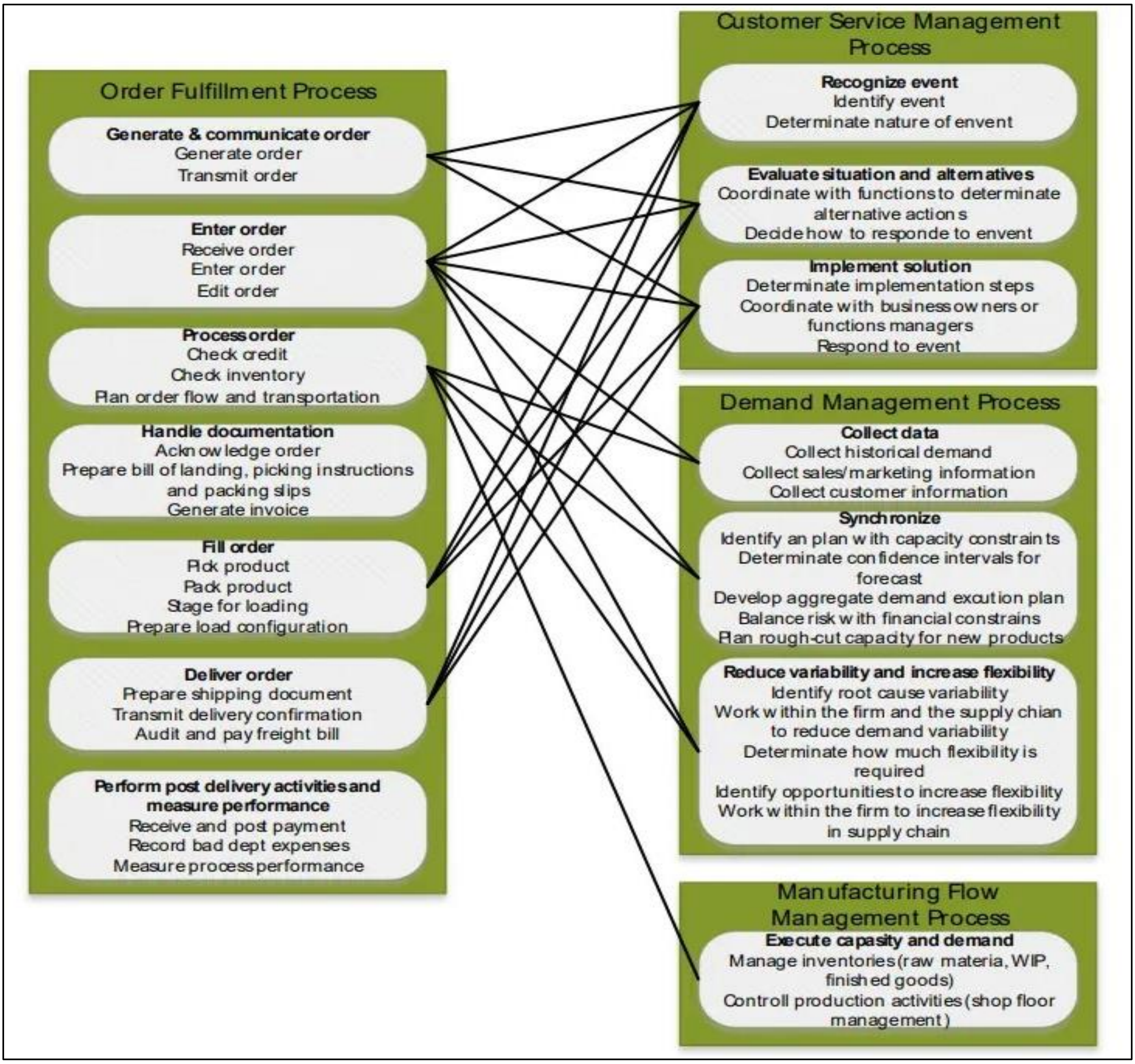

Fig 9 Clarification of Operational Sub-Process Links Between Supply Chain Processes and Activities in the Sub-Processes

The characteristics of the respondents show that the survey respondents are knowledgeable enough to make informed answers regarding order fulfillment performance and order fulfillment measurement systems (Pettersson, 2008). The levels of position are top management (39.9%), middle management (56.9%), and other positions (3.2%), most of the respondents hold senior positions where they offer visibility on functions within the organization. Experience in current role is between one to three years (26.9%), four to six years (22.9%), seven-12 years (24.6%), and over twelve years (25.6%). Many of the respondents have enough experience to know the processes and performance trends of an organization. The elucidation of the operational sub-process interrelationships illustrates how the order fulfillment interface communicates with the customer service management in various touchpoints. The creation and transfer

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

of orders are related to identify event activities. Order processing is linked to evaluate situation and alternatives activities. The implementation of post-delivery activities is tied to the manufacturing flow management process activities and the demand management.

Primary study variables in their descriptive statistic state distributional characteristics and relationships to be used in further analysis. The means of the dimensions supply chain integration are 3.51 for supplier integration (SD = 1.41), 4.05 for internal integration (SD = 1.45), as well as 4.26 for customer integration (SD = 1.26), which are moderate to moderately-high levels of integration (Pettersson, 2008). Operation performance of the order fulfillment has a mean of 5.43 (SD=0.97) and business performance has a mean of 3.99 (SD= 1.16) on a scale of seven points. The customer service level agreement implementation shows that the mean of 4.72 (SD = 1.38), and real-time analytics dashboard capabilities show that the mean of 4.28 (SD = 1.52) represent moderate levels of adoption in terms of significant variation (Gunasekaran et al., 2004). Correlation coefficients show that most of the variables are associated with significant positive relations. Internal integration has a correlation of 0.52 and supplier integration and 0.59 and customer integration. The relationship between customer integration and supplier integration is 0.65. Supplier integration is associated with operational performance, internal integration is associated with operational performance and customer integration has a correlation of 0.31, 0.40, and 0.46 respectively. Supplier integration, internal integration, and customer integration have a correlation of 0.22, 0.35, and 0.25 respectively (all significant at p = 0.001), which is preliminary evidence that the hypothesized relationships are true (Pettersson, 2008).

Table 1 Sample Characteristics and Geographic Distribution of Responding Organizations

Characteristic	**Hong Kong**	**Guangzhou**	**Chongqing**	**Shanghai**	**Tianjin**	**Overall**
Sample Size (n)	206	104	104	100	103	617
Percentage of Total	33.4%	16.9%	16.9%	16.2%	16.7%	100.0%
Industry Distribution						
Arts and Crafts	0.5%	3.8%	4.8%	1.0%	1.0%	1.9%
Building Materials	1.9%	6.7%	8.7%	7.0%	3.9%	5.0%
Chemicals and Petrochemicals	1.5%	8.7%	7.7%	8.0%	10.7%	6.3%
Electronics and Electrical	13.6%	9.6%	11.5%	11.0%	19.4%	13.1%
Food, Beverage, and Alcohol	5.8%	5.8%	4.8%	1.0%	5.8%	4.9%
Jewellery	1.0%	0.0%	0.0%	0.0%	1.0%	0.5%
Metal, Mechanical and Engineering	9.2%	28.8%	35.6%	42.0%	28.2%	25.4%
Pharmaceutical and Medical	2.4%	0.0%	3.8%	0.0%	1.9%	1.8%
Publishing and Printing	2.4%	1.9%	9.6%	7.0%	2.9%	4.4%
Rubber and Plastics	9.2%	2.9%	2.9%	8.0%	7.8%	6.6%
Textiles and Apparel	35.4%	14.4%	3.8%	10.0%	7.8%	17.8%
Toys	3.9%	0.0%	0.0%	0.0%	0.0%	1.3%
Wood and Furniture	1.0%	3.8%	1.9%	0.0%	3.9%	1.9%
Annual Sales Distribution						
Less than HK$5M	9.1%	49.0%	33.7%	30.0%	56.3%	32.4%
HK$5M to HK$10M	9.1%	18.3%	12.5%	16.0%	18.4%	14.1%
HK$10M to HK$20M	15.3%	4.8%	19.2%	12.0%	8.7%	12.4%
HK$20M to HK$50M	22.2%	12.5%	16.3%	15.0%	8.6%	15.8%
HK$50M to HK$100M	13.6%	9.6%	7.7%	15.0%	2.9%	10.2%
HK$100M or More	30.7%	5.8%	10.6%	12.0%	4.9%	15.0%
Respondent Position						
Top Management	42.7%	38.5%	36.5%	41.0%	37.9%	39.9%
Middle Management	54.4%	58.7%	60.6%	55.0%	58.3%	56.9%
Other	2.9%	2.9%	2.9%	4.0%	3.9%	3.2%
Years in Current Position						
1 to 3 Years	28.6%	24.0%	25.0%	29.0%	25.2%	26.9%
4 to 6 Years	21.8%	25.0%	23.1%	22.0%	24.3%	22.9%
7 to 12 Years	24.3%	26.0%	25.0%	23.0%	24.3%	24.6%
More than 12 Years	25.2%	25.0%	26.9%	26.0%	26.2%	25.6%

- *Note: Percentages within each category may not sum to exactly 100% due to rounding. Sample characteristics demonstrate substantial geographic, industry, size, and respondent diversity, enhancing generalizability of findings across manufacturing contexts.*

➢ *Contingency Analysis of Supply Chain Integration and Performance Relationships*

Hierarchical multiple regression model investigates the connections between supply chain integration dimensions, level agreements on customer service, real-time analytics

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

dashboard, and order satisfaction performance outcomes via sequential model construction. The first variable of analysis is the operational performance which is the dependent variable. The first step involves the entry of control variables such as organizational size, industry sector, and geographic region to control the potential confounding effect. Step two offers internal integration as the main predictor in that internal integration does not show significant direct relation with operational performance or not (Pettersson, 2008).

The findings show that internal integration has a positive significant relationship with operational performance (= 0.27, =10.94, $p < 0.001$). This model has an explanatory power of 16.3% in the operational performance ($R^2 = 0.163$, F = 119.58, p = 0.001). This helps prove the theory according to which internal integration is a premise of order fulfillment excellence. This observation follows the supply chain integration theory, which argues that synchronized internal operations help organizations to process customer orders effectively and make necessary response to customer needs (Croxton, 2003).

In step three, customer integration and supplier integration are added to the model, and it determines whether the external integration dimensions can explain anything additional to internal integration (Pettersson, 2008). The expanded model accounts for 23.7 percent of variance in the team performance ($R^2 = 0.237$, F = 63.51, $p < 0.001$), which is a large improvement over the step two model (0.074, $p < 0.001$), and therefore the external integration dimensions are significant predictive variables. The individual regression coefficients indicate that customer integration is positively and significantly related to the operational performance (0.27, t = 6.97, p = 0.001). Supplier integration on the other hand fails to exhibit any significant direct impact (0.02, t = 0.57, $p > 0.05$). Internal integration is still important but with less intensity (0.14 = -0.14, t = -4.62, p = <0.001) (Pettersson, 2008).

The direct customer integration helps to support the improved performance of the operations with the help of the better visibility of demands, joint problem solving and co-adaptation (Croxton, 2003). The non-significant direct impact of supplier integration implies that the coordination of the upstream can affect the performance via the indirect routes instead of direct mechanisms.

The fourth step adds terms of interaction that describe bilateral and ternary interactions between dimensions of supply chain integration which tests whether external integration mediates the relationship between internal integration and performance in operations. The entire model accounts of 25.5% of operational performance (R 2 = 0.255, F = 29.71, p = 0.001), which is a slight yet significant improvement as compared to the step three model (D = 0.017, p = 0.05). Only the two-way interaction between the customer integration and the supplier integration is statistically significant (= 0.06, t = 2.50, $p < 0.05$) (Pettersson, 2008). This trend indicates that customer and supplier integration are synergistic in performance of operations and organizations perform optimally where they are highly integrated upstream and downstream at the same time (Croxton, 2003). The insignificant interactions with internal integration imply that the dimensions of external integration do not mediate the internal integration performance relationship as proposed in stage theory of external integration being founded on internal integration.

Table 2 Hierarchical Regression Analysis Results for Operational Performance

Model	Independent Variables	β	t-value	R^2	F-statistic	ΔR^2
Step 1: Control Variables				0.082	18.43***	-
	Organizational Size	0.18	4.47***			
	Industry Sector (dummy variables)	Various	Various			
	Geographic Region (dummy variables)	Various	Various			
Step 2: Internal Integration				0.163	119.58***	0.081***
	Constant	-	40.78***			
	Internal Integration	0.27	10.94***			
	Control Variables (continued)	Various	Various			
Step 3: External Integration Dimensions				0.237	63.51***	0.074***
	Constant	-	30.10***			
	Internal Integration	0.14	4.62***			
	Customer Integration	0.27	6.97***			
	Supplier Integration	0.02	0.57			
	Control Variables (continued)	Various	Various			
Step 4: Interaction Terms				0.255	29.71***	0.017*
	Constant	-	19.90***			
	Internal Integration	0.16	4.75***			
	Customer Integration	0.30	7.47***			

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

	Supplier Integration	0.03	0.93			
	Internal × Customer Integration	0.00	0.15			
	Internal × Supplier Integration	0.00	0.10			
	Customer × Supplier Integration	0.06	2.50*			
	Internal × Customer × Supplier Integration	0.01	0.73			
	Control Variables (continued)	Various	Various			

- *Note: n = 617. Standardized regression coefficients (β) reported. * p < 0.05, ** p < 0.01, *** p < 0.001. Control variables include organizational size, industry sector dummy variables, and geographic region dummy variables. All independent variables were mean-centered prior to creating interaction terms to reduce multicollinearity.*

Parallel hierarchical regression analysis will be used to analyze business performance as the dependent variable based on the same sequential model-building approach. Step one introduces control variables in the model. It is the introduction of internal integration as the primary predictor variable in step two. The third step presents dimensions of customer and supplier integrations. Lastly, the fourth step will involve interaction terms with the aim of testing the moderating effects. Per the results, internal integration has a positive and significant correlation with business performance (2= 0.28, t= 9.29, p=0.001), in step two. It describes 12.3% in variance in business performance (R^2 = 0.123, F = 86.24, p = 0.001). The discovery helps confirm the hypothesis according to which internal integration makes significant contributions to the business performance outcomes such as profitability, market share, and growth (Slack et al., 2015).

Nonetheless, customer and supplier integration addition in step three does not add any significant explanatory power (ΔR^2 = 0.003, p > 0.05). The two external integration dimensions do not have any significant regression coefficients in the extended model, which means that customer and supplier integration are not directly related to improve business performance on top of the impact of internal integration (Pettersson, 2008). Likewise, the terms of interactions in the fourth step do not add significant value to model fit (ΔR^2 = 0.005, p > 0.05) and each of the interaction terms is not statistically significant. These results indicate that the integration of supply chain and business performance have a rather different relationship as compared to that of the integration-operational performance relationship. Internal integration comes out as the main factor in business performance, and external integration dimensions do not show noteworthy direct and moderating impacts on financial performance (Slack et al., 2015).

The dissimilarity in the outcomes of the operational and the business performance should be interpreted with special caution to the expectation of the theoretical results and the pre-existing empirical results. This close correlation between the internal integration and operational as well as business performance is congruent with the fact that there is a lot of literature on cross-functional coordination as a contributor to organizational performance (Croxton, 2003). Internal integration empowers organizations to perform processes effectively and be flexible to emerging needs, utilize various functional areas in solving problems, which serve as a source of short-term operational and financial gains in the long term (Slack et al., 2015). The strong direct impact of customer integration on the operational performance indicates the immediate operational advantages of close customer relationship such as improved demand visibility, team problem-solving and harmonized expectations (Croxton, 2003). Nevertheless, this result of the insignificance of direct customer integration effects on business performance could be because of time lags between operational performance improvement and financial performance or customer integration can have indirect impacts on business performance through the operational performance as opposed to direct impacts (Gunasekaran et al., 2001).

➢ *Integration of Customer Service Level Agreements and Real-Time Analytics Dashboards in Performance Relationships*

Further hierarchical regression analyses investigate whether the level of agreement of customer service and real-time analytics dashboard mediate the relationships among the supply chain integration dimension and the order fulfillment performance outcomes. These analyses are a test of whether there are measurement system features that serve to increase the performance benefits of integration. The analyses use the same dependent variables as the operational and business performance and are based on similar sequential model-building logic. Nevertheless, they add SLA and dashboard variables and their relationships with the dimensions of integration. To do operational performance analysis, step one puts control variables in regression model. Supply chain integration dimensions are introduced as primary effects of step two. Introduction of SLA implementation and dashboard capabilities are also new main effects that step three introduces. Further, step four involves two-way communication between dimensions of integration as well as variables of measurement system.

According to the results, the level of agreement of customer service implementation has a positive and significant correlation with operational performance (0.19, t = 5.84, p < 0.001). Also, the capability of real-time analytics dashboard has a positive and significant correlation with the operational performance (0.23, 6.92, p < 0.001). The expanded model has an explanatory power of 31.2% of variation of operational performance (R^2 = 0.312, F = 48.73, p 0.001), which is significant incremental explanatory power in addition to integration dimensions alone (0.075, p 0.001) (Gunasekaran et al., 2004). These direct impacts indicate that the performance commitments in the form of SLAs and real-time accountability in the form of analytics dashboards play independent roles in enhancing order fulfillment beyond the impacts of the integration of the supply chain. The value of integrating SLAs and dashboards is complementary in terms of value neither the system would be able to offer individually.

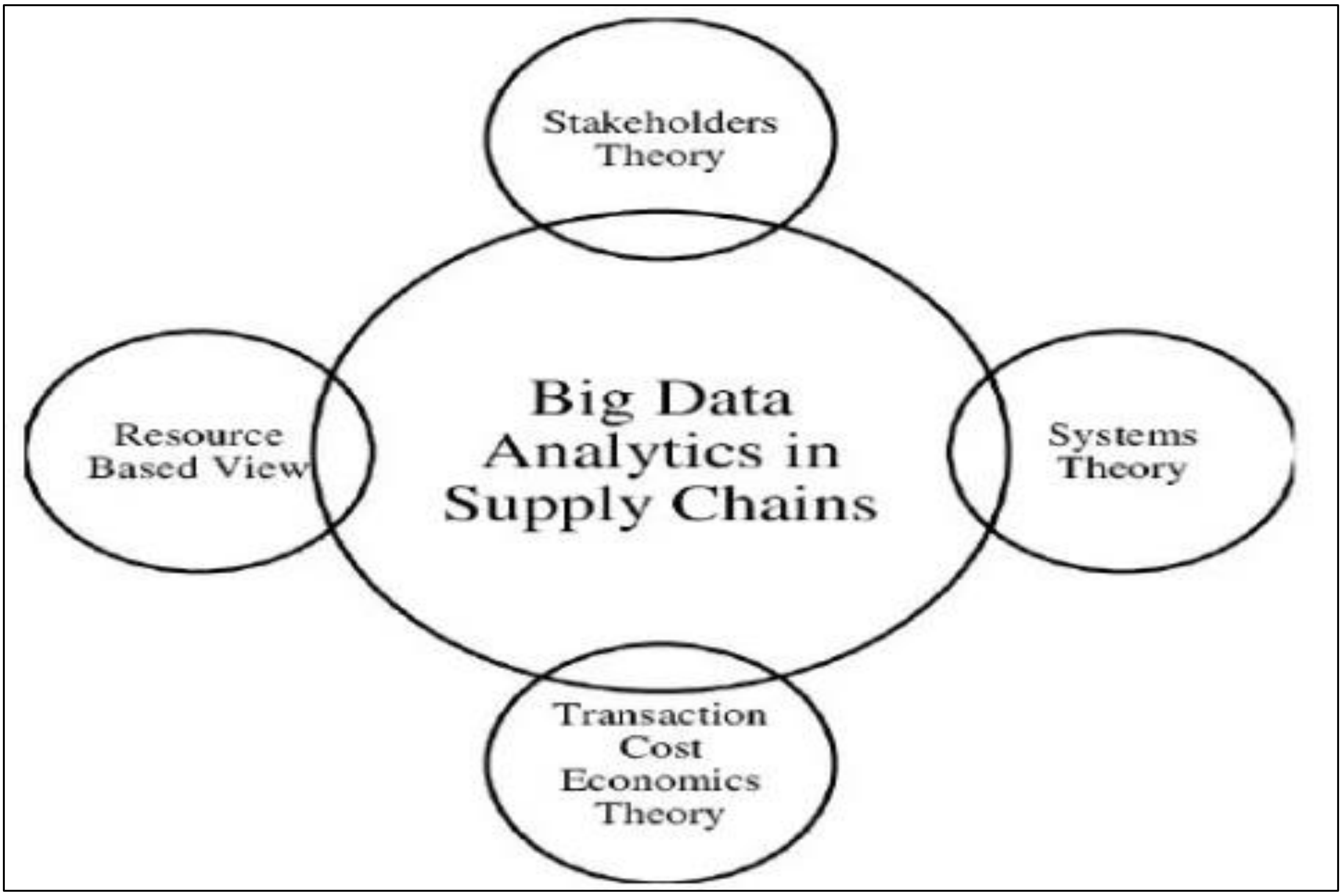

Fig 10 Theoretical Background of Big Data Analytics in Supply Chains

Analysis of the interaction terms on step four demonstrates significant relationships of moderation. Agreements with customers of customer service levels play a significant moderating role in the relationship between the customer integration and operational performance (0.12, t = 3.45, p < 0.001). Moreover, real-time analytics dashboard has a significant moderating effect on the association between internal integration and operational performance (0.14 = -0.04, t = 4.02, p < 0.001). But non-significant are other interactions. Theoretical background of big data analytics in supply chains has various theoretical perspectives. The theory of stakeholders focuses on the creation of value to all partners in the chain of supply by providing an analytical insight. The Systems theory appreciates the interrelationship between information flow and processes of the supply chain. The resource-based view emphasizes the ability to analyze as strategic resources that can be used to gain a competitive edge. According to the theory of the transaction cost economics, analytics have a beneficial impact on the decrease of information asymmetries and coordination costs across organizational boundaries (Jackson, 2016).

These moderating effects indicate some significant information on the performance enhancement. The customer integration performance is improved when formal SLA commitments between organizations are made to help parties develop an understanding of the expectations and responsibility. Moreover, advantages of internal integration are enhanced in cases where real-time dashboard gives a visibility of cross-functional operations (Eckerson, 2009). The more detailed analysis of these interactions is simple slope analysis. There are positive significant relationships between customer integration and operational performance (= 0.38, t = 8.21, p < 0.001) when the implementation of SLA is high. By contrast, customer integration demonstrates less strong relationships in case of the low level of the SLA implementation (= 0.19, t = 4.15, p < 0.001). Likewise, internal integration proves to exhibit high performance relationships in case the dashboard capabilities are highly developed (= 0.42, = 9.18, = 0.001). Internal integration however indicates lower relationships when dashboard capabilities are constrained (= 0.24, t = 5.23, p = 0.001).

In the case of business performance, parallel tests indicate the opposite, as the relationships appear to be the same as in the previous study which found that there is no direct effect of external integration dimension on financial results (Pettersson, 2008). The level of agreement of customer service and business performance ($\beta = 0.08$, $t = 2.15$, $p < 0.05$) shows a marginally significant positive correlation, and the real-time analytics dashboards do not show any significant direct impact (0.05, t = 1.42, p > 0.05), and the interactivity of the variables of the measurement system and integration dimensions are statistically insignificant. These findings indicate that SLA and dashboard measurement systems have a more significant effect on the operational performance, without necessarily directly affecting financial results, but they can significantly affect the business performance indirectly via the effects that they have on operations (Slack et al., 2015). The difference in impact on operational and business performance might be time lags between operational gains and monetary outcomes, challenge of measurement in realizing financial gains of operational excellence or the mediating impact of operation performance in converting integration and measurement system strengths to business performance and results.

Table 3 Hierarchical Regression Analysis Results for Operational Performance with SLA and Dashboard Moderators

Model	Independent Variables	β	t-value	R^2	F-statistic	ΔR^2
Step 1: Control Variables				0.082	18.43***	-
	Organizational Size	0.18	4.47***			
	Industry Sector (dummy variables)	Various	Various			
	Geographic Region (dummy variables)	Various	Various			
Step 2: Supply Chain Integration Dimensions				0.237	63.51***	0.155***
	Internal Integration	0.14	4.62***			
	Customer Integration	0.27	6.97***			
	Supplier Integration	0.02	0.57			
	Control Variables (continued)	Various	Various			
Step 3: SLA and Dashboard Main Effects				0.312	48.73***	0.075***
	Internal Integration	0.11	3.82***			
	Customer Integration	0.21	5.64***			
	Supplier Integration	-0.01	-0.28			
	Customer Service Level Agreements	0.19	5.84***			
	Real-Time Analytics Dashboards	0.23	6.92***			
	Control Variables (continued)	Various	Various			
Step 4: Interaction Terms				0.348	38.52***	0.036***
	Internal Integration	0.10	3.54***			
	Customer Integration	0.20	5.48***			
	Supplier Integration	-0.01	-0.35			
	Customer Service Level Agreements	0.17	5.26***			
	Real-Time Analytics Dashboards	0.21	6.38***			
	Internal Integration × SLA	0.03	0.89			
	Internal Integration × Dashboard	0.14	4.02***			
	Customer Integration × SLA	0.12	3.45***			
	Customer Integration × Dashboard	0.04	1.15			
	Supplier Integration × SLA	0.02	0.58			
	Supplier Integration × Dashboard	0.01	0.29			
	Control Variables (continued)	Various	Various			

- *Note: n = 617. Standardized regression coefficients (β) reported. * p < 0.05, ** p < 0.01, *** p < 0.001. All independent variables were mean-centered prior to creating interaction terms. Simple slope analyses for significant interactions indicate that customer integration effects on operational performance are stronger when SLA implementation is high versus low, and internal integration effects are stronger when dashboard capabilities are advanced versus limited.*

➢ *Configuration Analysis: Identifying Patterns of Supply Chain Integration and Measurement Systems*

Cluster analysis complements these findings with patterns of organizational characteristics that occur naturally and how the holistic patterns are related to performance outcomes. The cluster analysis uses five variables as dimensions of supply chain integration (internal, customer, and supplier integration) and characteristics of the measurement system (SLA implementation and dashboard capabilities), which allows defining organizations that have similar profiles in each of these numerous dimensions. Using the hierarchical cluster analysis with the Ward method, the

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

agglomeration schedule is analysed to estimate the number of clusters to use, whereby analysis of change in percentage in agglomeration coefficients indicates the change as substantial when the number of clusters reduces by five to four, and by four to three, but minor changes when adding on to it. After this, the number of groups is further refined in non-hierarchical k-means grouping with five groups, where each group is re-designated to increase between-group and minimize within-group variance.

Fig 11 Supply Chain Management Dashboard Overview Page

The five solutions formed with the resultant solution have different profiles regarding mean scores based on the clustering variables (Pettersson, 2008). Cluster 1 "so-called Low Uniform Limited Measurement" contains 98 organizations (15.9) with low scores in the integration dimensions (supplier integration M = 2.14, internal integration M = 2.28, customer integration M = 2.67) and low scores in the SLA and dashboard implementation (SLA M = 2.35, Dashboard M = 2.18) as reflecting underdeveloped capabilities in supply chain integration and measurement (Croxton, 2003). Within the supply chain management dashboard overview page, the most important performance measures are in the first row, which are total orders (326), total sales ($9.60M), total product quantity (106K), unique products ordered (27), and countries served (109). There is also a date range slicer that allows selection of the specific period. The middle row shows quantity ordered by product in the form of column chart and order counts by status in the form of pie chart where shipped, cancelled, in process, on hold, resolved and disputed are the categories. The last row demonstrates quantity ordered by year in the form of bar chart, quantity ordered by country in the form of horizontal bar chart, and sales by product in the form of horizontal bar chart (Jackson, 2016).

Cluster 2, which is called Medium Uniform Developing Measurement, incorporates 134 organizations (21.7) whose integration of suppliers, internal, and customer is moderate (supplier integration M = 3.89, internal integration M = 3.72, customer integration M = 4.08) and whose implementation of the measurement system is moderate (SLA M = 4.15, Dashboard M = 3.94), which mean intermediate development in both integration and measurement capabilities (Sundström and Tollmar, 2018 Cluster 3, named High Uniform Advanced Measurement, includes 117 organizations (19.0%), which are highly integrated based on all the three dimensions (supplier

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

integration M = 5.63, internal integration M = 5.58, customer integration M = 5.74) and highly integrated in implementing the measurement systems (SLA M = 5.82, Dashboard M = 5.67), implying comprehensive development of both integration and measurement systems (Pettersson, 2008). Cluster 4, which is named as Medium Customer-Leaning Selective Measurement, has 136 organisations (22.0%), with a moderate but strong supplier and internal integration (supplier integration M = 3.24, internal integration M = 3.96) and stronger customer integration (M = 4.72), with SLAs as their main focus (SLA M = 4.88, Dashboard M = 3.45) and therefore represent organisations that focus on customer relationship and make formal commitments to the service (Croxton, Cluster 5, which is called High Customer-Leaning Dashboard-Focused, consists of 132 organizations (21.4%), where internal and customer integration (internal integration M = 5.32, customer integration M = 5.48) are high but supplier integration (M = 4.18) is moderate, in which organizations emphasize advanced dashboards, rather than formal SLAs (SLA M = 4.25, Dashboard M = 5.73).

The cluster solution is verified by discriminant analysis which helps determine the underlying dimensions that discriminate groups. Two discriminant functions whose eigenvalues are greater than 1.0 are obtained, which explain jointly 99.7 percent of variance between clusters (Function 1: eigenvalue = 4.832, 78.4% of variance, canonical correlation = 0.910, p < 0.001; Function 2: eigenvalue = 1.314, 21.3% of variance, canonical correlation = 0.754, p < 0.001), which are well separated and distinct clusters. Imperfect fit Function 1 heavily loads all five variables with comparatively equal coefficients (internal integration = 0.42, customer integration = 0.38, supplier integration = 0.35, SLA = 0.41, Dashboard = 0.39) which signifies the overall supply chain integration and strength of measurement system, and distinguishes between high-capability organizations (Cluster 3) and medium-capability (Cluster 2 and 4) versus low-capability organizations (Cluster 1) (Pettersson, 2008). Function 2 also indicates opposite positive loadings on customer integration (0.52) and SLA implementation (0.48) compared to negative ones on supplier integration (-0.41) and dashboard capabilities (-0.38), with internal integration having slight loading (0.08), indicating customer-supplier balance, and SLA-dashboard balance. The classification analysis shows that 97.2% of the cases would be properly classified in the respective clusters giving a good indication of cluster validity and specificity.

Table 4 Cluster Analysis Results: Profiles of Supply Chain Integration and Measurement System Patterns

Cluster Characteristics	**Cluster 1: Low Uniform Limited**	**Cluster 2: Medium Uniform Developing**	**Cluster 3: High Uniform Advanced**	**Cluster 4: Medium Customer-Leaning Selective**	**Cluster 5: High Customer-Leaning Dashboard-Focused**	**F-statistic**
Sample Size (n)	98 (15.9%)	134 (21.7%)	117 (19.0%)	136 (22.0%)	132 (21.4%)	-
Supply Chain Integration Dimensions						
Supplier Integration (Mean)	2.14	3.89	5.63	3.24	4.18	428.35***
Internal Integration (Mean)	2.28	3.72	5.58	3.96	5.32	392.74***
Customer Integration (Mean)	2.67	4.08	5.74	4.72	5.48	318.62***
Measurement System Characteristics						
SLA Implementation (Mean)	2.35	4.15	5.82	4.88	4.25	276.48***
Dashboard Capabilities (Mean)	2.18	3.94	5.67	3.45	5.73	312.91***
Performance Outcomes						
Operational Performance (Mean)	4.52	5.28	6.18	5.43	5.95	62.84***
Business Performance (Mean)	3.24	3.87	4.68	4.02	4.41	28.73***
Cluster Characteristics Summary						
Integration Pattern	Low across all dimensions	Moderate balanced integration	High across all dimensions	Customer emphasis	Customer emphasis	-

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Measurement System Pattern	Minimal SLA and dashboard	Developing both systems	Advanced both systems	SLA emphasis	Dashboard emphasis	-
Integration Strength	Low	Medium	High	Medium-High	High	-
Integration Balance	Balanced	Balanced	Balanced	Customer-leaning	Customer-leaning	-
Measurement Balance	Balanced	Balanced	Balanced	SLA-leaning	Dashboard-leaning	-

- *Note: n = 617. All cluster means are significantly different from each other at p < 0.001 based on ANOVA and Scheffé post-hoc tests. Means reported on seven-point scales. Cluster percentages indicate proportion of total sample. Integration strength reflects overall level of integration capabilities. Integration balance indicates whether supplier, internal, and customer integration are developed uniformly or with emphasis on dimensions.*

➢ *Performance Comparisons Across Supply Chain Integration and Measurement System Configurations*

The analysis of variance assesses whether the empirically obtained clusters display the performance results of differential order fulfillment, and whether the patterns of holistic integration and the properties of measurement systems are applicable to performance variance. On operational performance, ANOVA shows significant difference between clusters ($F = 62.84$, $df = 4, 612$, $p < 0.001$), which means the patterns of configurations in clusters that are determined in terms of cluster analysis are meaningfully related to order fulfillment excellence (Pettersson, 2008). It can be analyzed that Cluster 3 (High Uniform Advanced Measurement) has the highest level of operational performance (M = 6.18), then Cluster 5 (High Customer-Leaning Dashboard-Focused, M = 5.95), Cluster 4 (Medium Customer-Leaning Selective Measurement, M = 5.43), Cluster 2 (Medium Uniform Developing Measurement, M = 5.28, and Cluster 1 (Low Uniform Limited Measurement, M = 4.52 According to Scheffe post-hoc pairwise comparisons, Cluster 3 is significantly different than any other cluster (all comparisons $p < 0.01$), Cluster 5 is significantly different than Clusters 1, 2, and 4 (all $p < 0.05$) but not than Cluster 3, Cluster 4 is significantly different than Cluster 2 and Cluster 1 is significantly different than all other higher-performing clusters (all $p < 0.01$) which implies that organizations which have high measures of integration gain significant performance advantages in.

Fig 12 Supply Chain Management Dashboard Order Details Page

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

➢ *Practical Implications for Supply Chain Management Practitioners*

In the case of business performance, the analysis indicates that there are significant differences amid clusters ($F = 28.73$, $df = 4, 612$, $p < 0.001$). Nevertheless, the effect is lower compared to operational performance differences, which aligns with the previous regression findings that integration and measurement systems are more associated with operational than business performance (Slack et al., 2015). The supply chain management dashboard order details are indicated with key metrics in the top row comprising of average quantity ordered (35.22), average delivery days (3.76), total number of orders dropped (326), and date range slicer. Also, the drop downs are organized by an order number and allow users to search selections of order numbers. The lower part is the shipped orders presented as a gauge chart of progress towards target (303 out of 326 orders shipped). In addition, a waterfall chart separates growths, declines, and overall amounts within every order, offering a detailed view into the patterns of orders and order fulfillment (Jackson, 2016). Cluster averages of business performance are like the operational performance. Cluster 3 has the highest score in business performance ($M = 4.68$), then Cluster 5 ($M = 4.41$), Cluster 4 ($M = 4.02$), Cluster 2 ($M = 3.87$), and Cluster 1 ($M = 3.24$). Nevertheless, the size of variations between neighbouring clusters is less than in the case of operational performance. Cluster 3 is significantly different ($p < 0.05$) when compared with Cluster 1, 2 and 4 but not when compared with Cluster 5 (Scheffe post-hoc tests). Moreover, Cluster 5 is different to a considerable extent compared to Clusters 1 and 2 (both $p < 0.05$). Furthermore, Cluster 1 is significantly different compared to all the others clusters (all $p < 0. 01$). Based on these findings, the benefits of business performance are the greatest when companies are highly uniformly integrated and highly measurement-oriented (Cluster 3), or are highly customer-oriented integrated and highly dashboard-focused (Cluster 5).

The finding of the configuration analysis complements and expands the results of the contingency regression analysis by showing that organizations are grouped into specific patterns of integration and features of measurement system and that the holistic configurations may have significant performance variability (Striteska and Spickova, 2012). The appearance of five different clusters shows that organizations are choosing varied ways of integrating the supply chain and measuring its performance to show various strategic priorities, availability of the resources, and development paths (Sundström & Tollmar, 2018). The High Uniform Advanced Measurement pattern (Cluster 3) is an ideal pattern that is characterized by the extensive integration across all the dimensions and advanced measurement systems which include both operational and formal SLA commitments as well as advanced real time dashboards that organizations adhering to this pattern are more successful in their performance in all the dimensions of operation and business (Pettersson, 2008).

The good performance however of the High Customer-Leaning Dashboard-Focused pattern (Cluster 5), which only slightly diverge on the performance dimensions as compared to Cluster 3, although with less integration and SLA implementation, indicates that organizations can get close to the optimal results by selective emphasis on both customer integration and integration capabilities through dashboard capabilities (Croxton, 2003).

➢ *Real-Time Data Processing Architecture and Analytics Implementation*

Technical real-time analytics dashboards to measure performance in terms of order fulfillment involve complex data processing architectures, which can integrate a variety of data, conduct a fast analysis, and provide timely information to decision-makers (Jackson, 2016). There are numerous integrating elements and processes that make up real-time data processing that together facilitate near-instant conversion of operational events into actionable intelligence. The architecture will start with data sources, which can be both structured and unstructured data, such as Internet of Things sensor readings of equipment performance and weather, social media posts of customer sentiments and experiences, clickstream data of online browsing, web data of market intelligence, and search history of customer intent (Jackson, 2016).

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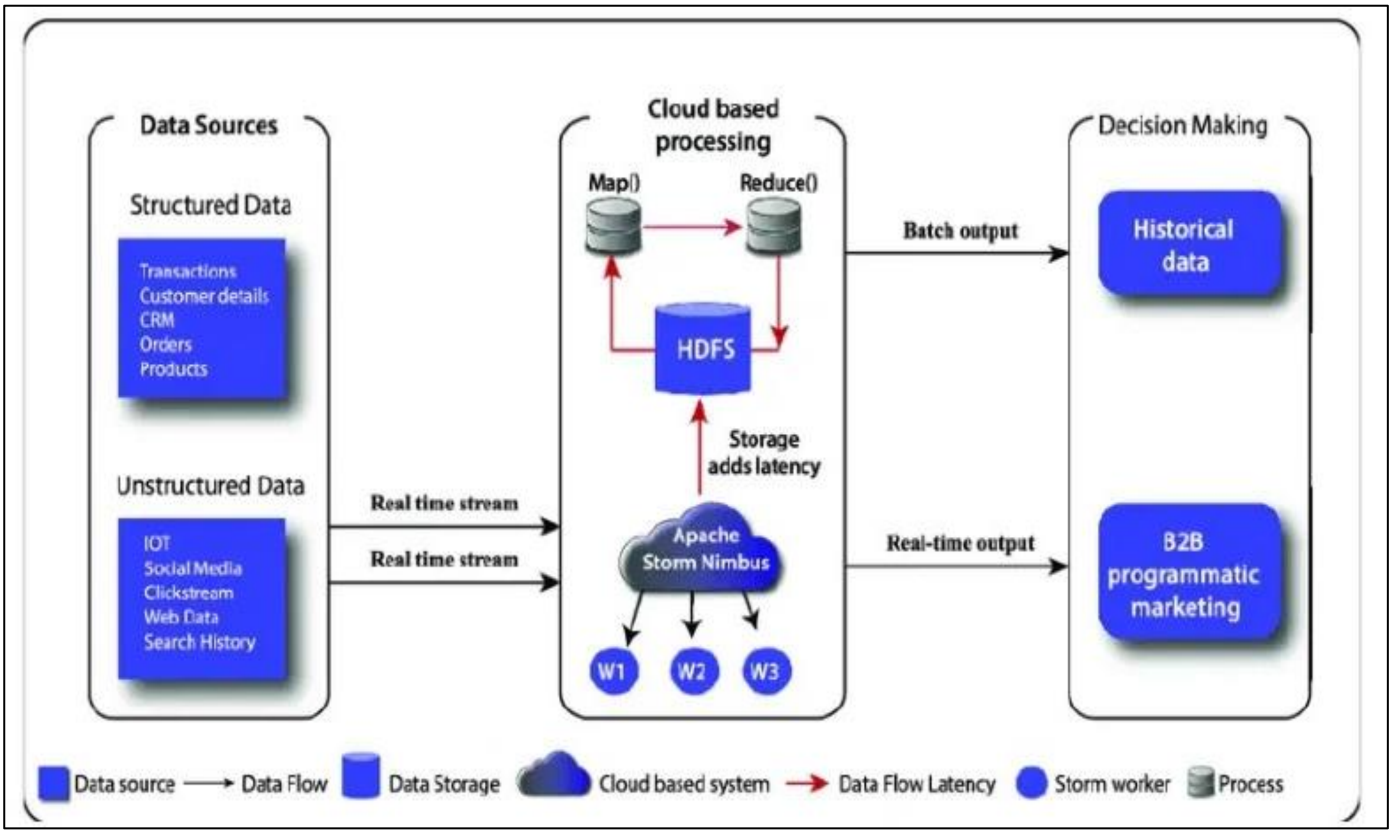

Fig 13 Real-Time Data Processing Architecture

Cloud computing processing makes use of distributed computing systems such as MapReduce to process large volumes of data in parallel across multiple nodes or HDFS (Hadoop Distributed File System) to store data in many copies across cluster nodes (W1, W2, W3) to ensure reliability and to be able to process multiple data streams in parallel. Real-time data processing architecture Data sources are structured data such as transactions, customer relationship management systems, orders, and products as well as unstructured data of the Internet of Things, social media, clickstreams, web data and search history; data processing in the cloud using MapReduce and Reduce operations using HDFS storage with the coordination of Apache Storm or Nimbus across multiple worker nodes; and the output of decision making differentiating historical data analysis processed through batch operations with storage by adding latency to retrospective reporting and business-to-business programmatic marketing and operational decision support created by real- The architecture separates between historical data analysis, where some latency is tolerated, and comprehensive but retrospective reporting is possible, and stream processing, where minimal latency is paramount, and operational events and emerging patterns can be responded to immediately (Jackson, 2016).

The introduction of real-time analytics dashboards that calculate order fulfillment performance should overcome various technical and organizational issues to make the performance effective (Eckerson, 2009). One of the key challenges is data integration because order fulfillment information is stored in various systems such as order management systems that store customer orders and order status, warehouse management systems that store the inventory, pick-pack-ship activities, transportation management systems that store shipment status and carrier performance, and customer relationship management systems that store customer information and service history (Gunasekaran et al., 2004). To successfully implement a dashboard, it is necessary to build data pipes that obtain data in these varied sources, convert it into simple forms, and create dynamic data warehouses or data lakes that are available to analytic software. Problems like missing records, irregular formats, duplication, and incorrect values in data should be solved by undertaking the process of data cleansing that helps identify problems and correct them so that the operational realities portrayed in the dashboard are accurate (Jackson, 2016).

The choice of dashboard design is critical in determining whether analytics capabilities can deliver better performance results as even advanced analytical infrastructure cannot add value when their users find it hard to access, interpret confusingly, or irrelevant to their duties (Eckerson, 2009). Good dashboard design follows such principles as visual clarity and intuitive charts and graphs to communicate performance status without extensive analysis, information hierarchy that displays summary metrics higher in the chart, contextual reference point such as targets or historical trends, other benchmarks to put current performance into perspective and alert exception through colour coding or other alerts that instantly attract attention to metrics needing some form of action, and responsiveness to be usable on devices both big desktop monitors and mobile phones (Eckerson, 2009). The compromise between completeness and simplicity is a constant debate, with the danger of adding an excessive number of metrics that will overload the user and obscure vital performance areas, and the danger of adding a very limited number of metrics that will not adequately describe a significant performance dimension or offer adequate diagnostic power (Eckerson, 2009).

➢ *Performance Measurement Framework and Key Performance Indicators*

Formulation of holistic performance measurement processes of order fulfillment must involve the prudent choice and characterization of key performance indicators that reflect critical aspects of order fulfillment excellence and must be few enough and easy to measure accurately (Gunasekaran et al., 2004). Order fulfillment performance is multidimensional by nature, and is defined in terms of efficiency aspects, such as resource use and cost management, effectiveness aspects, such as service goal accomplishment, and flexibility aspects, such as responsiveness to new needs and special orders (Rodriguez et al., 2009). Best KPI systems strike a balanced scorecard between all these dimensions instead of laying excessive emphasis on one component to the disadvantage of others, and all these stakeholders need organizations to meet their expectations of reliable service to customers, profitable operations to shareholders and safe and sustainable working environments (Neely et al., 1995). The KPIs that are covered in measurement frameworks must be in line with organizational strategy and competitive priorities and the various organizations will need to focus on varying dimensions of performance accordingly, depending on their market positioning and value propositions (Kaplan and Norton, 1996).

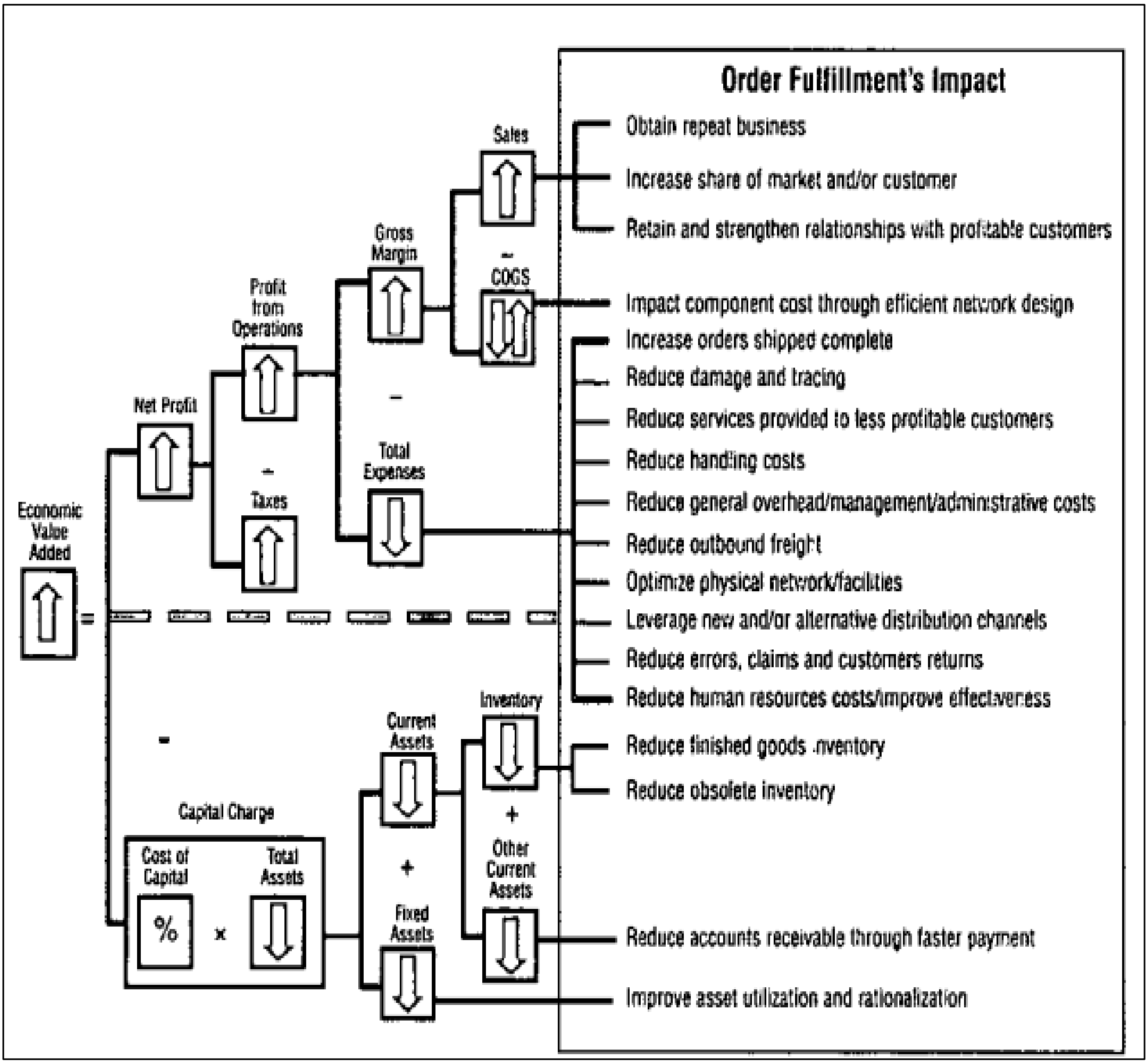

Fig 14 How Order Fulfillment Affects Economic Value Added

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

Delivery performance is a key-parameter of excellence in order fulfillment that is directly observable on the customers, and that is of critical importance in the satisfaction and loyalty of customers. On-time delivery is used to measure the percentage of orders that were ordered or promised to be delivered by a specified date and is used as the main indicator of the reliability of delivery and represents the organizational capability to fulfill their time promises (Gunasekaran et al., 2004). This measure can be estimated at different aggregation levels. Individual SKUs in orders, complete orders irrespective of the situation of the appearance of all items at the same time, and customer accounts where the performance of the organization is measured over a series of orders over time can be evaluated (Gunasekaran et al., 2001).

The lead time of delivery is the duration required by the supply chain to take to deliver the product to the customer after receiving orders as an indication of supply chain speed and responsiveness (Forslund et al., 2008). Low time performance incorporates several sub-dimensions. Average lead time will show the average level of performance. Variability in lead time shows consistency of performance. Flexibility in the lead time is the capacity to be able to respond to either urgently needed or tardy delivery order requests (Forslund et al., 2008). With economic value added, it is possible to trace how fulfillment of orders matters in various ways. It starts with the sales opportunities to secure the repeat business; market share as well as maintain the relationship with the profitable customers. Moreover, it is also passed through gross margin effects with lower cost of goods sold due to effective network planning and higher numbers of orders delivered full. Also, it influences profit generated in operations such as reducing costs such as the cost of damage and tracing costs, services to non-profitable customers, handling costs, general overhead and administrative costs, outbound freight costs, and optimally physical network facilities. The alternative distribution channels can be used to leverage by organizations; errors, claims, and customer returns are minimized. In addition, it affects after tax net profit (Croxton, 2003).

The order accuracy measures are indicators of the absence of order error during the process of order fulfillment and understanding that the error costs both the company and the customers irrespective of the time of order delivery (Gunasekaran et al., 2001). Order completeness is used to check whether customers obtain what they had ordered in a single delivery instead of the inconvenience and cost involved in back-orders or partial deliveries (Gunasekaran et al., 2004). Perfect order fulfillment is a composite measure that evaluates the completeness of the orders, on-time delivery, error-free order, and flawless documentation that indicates a full measure of fulfillment excellence (APICS, 2017). The inventory performance measures determine the effectiveness of organizations in balancing between the competing goals of product availability and inventory investment with the understanding that too much inventory is a waste of working capital and too little causes stockouts and lost sales (Mattsson, 2012). the inventory turnover ratio is used to measure the frequency of sales and replacement of inventory over a duration of time where a higher inventory turnover ratio is more efficient inventory management but the best turnover ratio depends on various industries and types of products (Baroudi, 2010). Inventory days of supply gives us the number of days the current inventory will remain at the current sales rate, this is an intuitive measure of inventory in relation to demand (Mattsson, 2012).

The measures of cost efficiency provide evaluations of resource use and cost management in operations of fulfilling orders and taking into consideration that organizations need to provide exemplary service, at the same time managing costs to stay profitable (Mattsson, 2012). Cost per order is a unit cost measure showing total fulfilment costs divided by quantity of orders taken against which a company can compare and analyse trends (Hausman, 2002). This measure ought to be considered cautiously because it is affected by the characteristics of the orders like size, complexity, and special requirements and where the organization has different types of orders then the calculation of the cost per order may be done on different types of orders separately (Hausman, 2002). The transportation cost as a percentage of sales is a transport related cost as the ratio of outbound freight to sales and shows the efficiency with which the logistics resources are utilized (Mattsson, 2012). Warehouse cost per unit shipped measures the cost of warehouse activities such as labor, equipment and facility costs divided by warehouse units that have been processed to evaluate the productivity and efficiency of the warehouses (Hausman, 2002). Customer service measures reflect customer satisfaction in order performance at the customer point of view and this occurs because accomplishing internal targets may not always translate to customer satisfaction when the expectations are not related to measured performance or when the measurement systems do not include dimensions that are important to the customers (Gunasekaran et al., 2001).

Table 5 Comprehensive Framework of Order Fulfillment Key Performance Indicators and Management Actions.

KPI Category	Specific KPI	Definition / Measurement	Management Actions When Performance Deviates	Data Sources	Update Frequency
Delivery Performance	On-Time Delivery Rate	Percentage of orders delivered by promised date	Investigate root causes of delays; adjust capacity planning; enhance supplier coordination; improve transportation scheduling	Order management system; Transportation management system	Real-time / Daily

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	Delivery Lead Time	Average elapsed time from order receipt to delivery	Streamline order processing; optimize warehouse operations; evaluate transportation alternatives; consider safety stock adjustments	Order management system; Warehouse management system	Daily / Weekly
	Lead Time Variability	Standard deviation of delivery lead times	Identify sources of variability; standardize processes; improve demand forecasting; enhance supply chain visibility	Order management system	Weekly / Monthly
	Delivery Accuracy	Percentage of orders delivered to correct location and time	Review shipping documentation processes; enhance address validation; improve communication with carriers; implement verification checkpoints	Transportation management system; Customer service system	Real-time / Daily
Order Accuracy	Order Completeness	Percentage of orders fulfilled complete in single shipment	Improve inventory accuracy; enhance demand forecasting; optimize safety stock levels; coordinate supplier deliveries	Warehouse management system; Inventory system	Real-time / Daily
	Perfect Order Rate	Percentage of orders complete, on-time, damage-free, with perfect documentation	Conduct root cause analysis of imperfections; implement quality control checkpoints; enhance employee training; improve system integrations	Multiple systems integrated	Daily / Weekly
	Picking Accuracy	Percentage of items picked correctly from warehouse locations	Review warehouse layout; implement verification technologies; enhance picker training; optimize pick path algorithms	Warehouse management system	Real-time / Shift
	Invoice Accuracy	Percentage of invoices without pricing or quantity errors	Validate pricing data; improve order entry processes; enhance system validations; reconcile discrepancies promptly	Order management system; Financial system	Daily / Weekly
Inventory Performance	Inventory Turnover	Cost of goods sold divided by average inventory value	Identify slow-moving items; adjust purchasing policies; implement promotional strategies; consider inventory reduction initiatives	Inventory system; Financial system	Monthly / Quarterly
	Inventory Days of Supply	Average inventory divided by daily demand	Adjust reorder points; evaluate supplier lead times; optimize safety stock calculations; implement vendor-managed inventory	Inventory system; Demand planning system	Weekly / Monthly
	Fill Rate	Percentage of customer demand	Increase safety stock for high-demand items; improve demand	Inventory system; Order management system	Real-time / Daily

International Journal of Innovative Science and Research Technology
ISSN No: -2456-2165
https://doi.org/10.38124/ijisrt/25oct1433

		fulfilled from available stock	forecasting; expedite supplier deliveries; consider alternative sourcing		
	Stock-Out Frequency	Number of stock-out incidents per time period	Analyze demand patterns; adjust inventory policies; improve supplier reliability; implement early warning systems	Inventory system; Sales system	Daily / Weekly
Cost Efficiency	Cost Per Order	Total fulfillment costs divided by number of orders processed	Streamline processes; automate routine tasks; negotiate better carrier rates; optimize facility layout; consolidate shipments	Financial system; Order management system	Weekly / Monthly
	Transportation Cost % of Sales	Total outbound freight expense divided by revenue	Optimize load consolidation; negotiate carrier contracts; evaluate alternative modes; implement route optimization	Transportation management system; Financial system	Weekly / Monthly
	Warehouse Cost Per Unit	Warehouse operating expenses divided by units shipped	Improve labor productivity; optimize space utilization; evaluate automation opportunities; negotiate equipment leases	Warehouse management system; Financial system	Monthly / Quarterly
	Order Processing Cost	Administrative and system costs per order processed	Automate manual processes; implement self-service portals; streamline approval workflows; integrate systems	Order management system; Financial system	Monthly / Quarterly
Customer Service	Customer Satisfaction Score	Average rating on satisfaction survey (1-10 scale)	Address specific complaint themes; improve communication; enhance service recovery processes; recognize high performers	Customer relationship management system	Monthly / Quarterly
	Net Promoter Score	Percentage promoters minus percentage detractors	Investigate detractor feedback; implement service improvements; enhance customer communication; build loyalty programs	Customer relationship management system	Quarterly
	Order Inquiry Volume	Number of customer inquiries about order status	Improve proactive communication; enhance order visibility; streamline inquiry response processes; address systemic issues	Customer service system	Daily / Weekly
	Returns Rate	Percentage of orders returned by customers	Analyze return reasons; improve product descriptions; enhance quality control; address delivery damage issues	Returns management system	Weekly / Monthly
Flexibility & Responsiveness	Rush Order Capability	Percentage of rush orders	Maintain flexible capacity; develop expedited processes;	Order management system	Daily / Weekly

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

		accommodated successfully	establish premium service offerings; coordinate with suppliers		
	Order Change Accommodation	Percentage of order changes processed without penalties	Implement flexible order cutoff policies; maintain system flexibility; train staff on exception handling	Order management system	Weekly / Monthly
	Special Request Fulfillment	Percentage of special packaging/labeling requests satisfied	Develop standard procedures for common requests; train personnel; maintain necessary materials; communicate capabilities	Order management system; Warehouse system	Weekly / Monthly

- *Note: Management actions represent typical responses to performance deviations but should be tailored to specific organizational contexts and root causes. Update frequencies may vary based on organizational requirements and system capabilities. Integration across multiple data sources enables comprehensive performance visibility.*

➢ *Dashboard Implementation Patterns and Organizational Utilization*

The real-life application of the use of real-time analytics dashboard to measure the performance of order fulfillment takes various shapes among different organizations, which portray the varying technological capacity, organizational structure, and management philosophies (Eckerson, 2009). According to survey, there is a wide range of dashboard features and use behaviors, which can be used to get an idea of what grants more successful and less successful implementations (Eckerson, 2009). Patterns of dashboard accessibility include limited performance accessibility where the senior managers are the only ones with access to performance data that is provided in periodical reports, moderate performance accessibility that allows the management level access to dashboard performance data with daily or weekly access, and advanced performance accessibility that allows the operational personnel to access their real-time dashboard performance data at any time during their workday (Jackson, 2016). Companies that have more accessible dashboard information have reported better performance results, which indicates that when performance information is democratized, more problems can be detected and solved at their working levels instead of having to work to the top of the management channel before they get attended to. But extensive accessibility should be associated with the proper training and assistance so that the users should know how to interpret the information presented on the dashboard and how to convert the insights into productive actions (Eckerson, 2009).

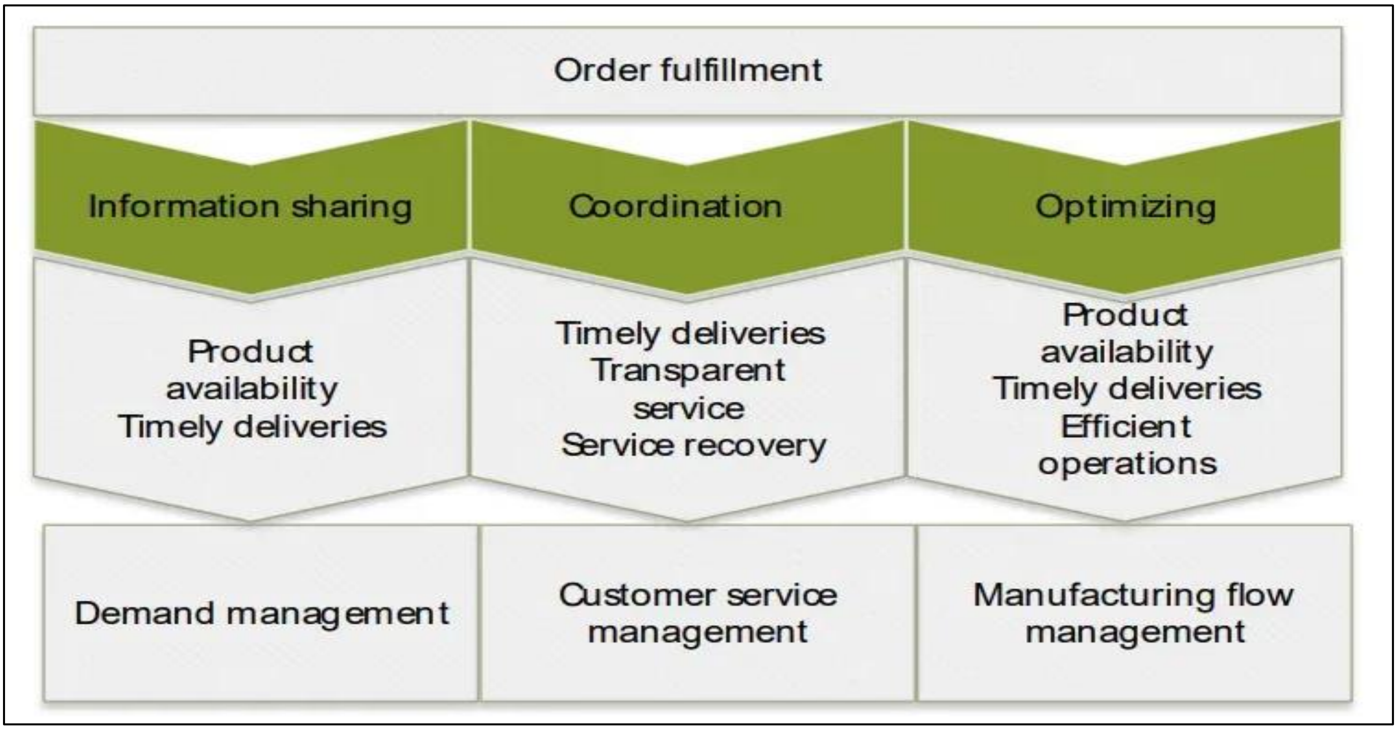

Fig 15 Links of Information Sharing, Coordination and Optimizing Between Order Fulfillment, Demand Management, Customer Service Management and Manufacturing Flow Management

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

Dashboard refresh rate is another variable with high levels of variation. Certain organizations refresh their dashboards at daily or lower rates. Others have nearly real-time refreshes with delays as short as several minutes or seconds (Jackson, 2016). The best refresh rate is determined by the features of the operations. These include the volume and velocity of orders, the cycle time in the process, and the time limits for taking corrective measures. Distribution operations of high-volume process thousands of orders per day. These operations benefit from real-time or near-real-time updates. Such updates enable quick identification and correction of arising problems (Eckerson, 2009). In contrast, low-volume operations have longer fulfillment cycles. These operations may not need to invest in real-time data infrastructure. Daily updates may be sufficient and timely for their needs.

Order fulfillment relies on several key elements. Information sharing facilitates the availability and timely delivery of products. Demand management facilitates timely deliveries through clear service and service recovery (Croxton, 2003). Optimization facilitates product availability and timely deliveries as well as efficient operations. Demand management provides support through forecasting and planning. Customer service management supports operations through responsive issue resolution. Manufacturing flow management ensures that production aligns with demand requirements.

Dashboarding with operational systems is a key aspect of implementation maturity that is both underdeveloped and critical. Simple dashboard systems are reporting mechanisms, which show data but do not allow users to do anything directly via the dashboard screen, so users must go out of the dashboard system to research problems, modify settings, or start the corrective cycle (Eckerson, 2009). Intermediate implementations offer direction indicators among dashboards to pertinent operational systems which diminish the friction of getting to the instruments required to resolve the issues found yet still necessitate the user to go back and forth across multiple interfaces (Eckerson, 2009). More advanced implementations provide greater integration so that users can perform routine tasks directly on dashboard interfaces, e.g. reallocating inventory between warehouses, expediting orders or calling carriers about shipment delays, which will reduce the response time and increase the probability of action being taken on identified problems. According to the survey data, merely 23% of organizations have already managed to attain highly integrated dashboard-operational systems, which implies that there is still a great potential to develop capabilities among the larger population.

The organizational processes that are related to the dashboard use are critical in addressing the issue of whether the technological capabilities can lead to performance improvement (Eckerson, 2009). Well executed dashboard applications incorporate performance assessment into routine management processes using mechanisms such as daily stand up meetings where operational teams evaluate previous night performance and identify issues that need to be resolved, weekly meetings with management focusing on trends and patterns in various measures, monthly business reviews evaluating performance against target and strategic goals, and reviews of exceptions where dashboard notifications alert the management to the presence of issues which need to be addressed (Kaplan and Norton, 1996). Institutionalized dashboard-based performance review is associated with much greater performance results in organizations where the use of a dashboard is institutionalized (formal) and routine (sporadic) than in those where dashboard usage is discretionary (Eckerson, 2009). The survey data has indicated that a 67 percent of the best performing organizations in the top quartile established routine daily dashboard review practices versus 31 percent in the less successful organizations and this demonstrates that systematic review disciplines are a key success factor.

Table 6 Dashboard Implementation Characteristics and Utilization Patterns Across Performance Quartiles

Dashboard Characteristic	**Top Quartile Performance Organizations (n=154)**	**Second Quartile Performance Organizations (n=155)**	**Third Quartile Performance Organizations (n=154)**	**Bottom Quartile Performance Organizations (n=154)**	**Chi-Square Test**
Accessibility Patterns					
Limited (Management Only)	8.4%	17.4%	29.2%	44.8%	$\chi^2 = 58.73^{***}$
Moderate (Management + Supervisors)	23.4%	38.7%	42.2%	39.6%	
Broad (All Operational Personnel)	68.2%	43.9%	28.6%	15.6%	
Refresh Frequency					
Daily or Less Frequent	12.3%	28.4%	45.5%	62.3%	$\chi^2 = 82.41^{***}$
Hourly Updates	15.6%	33.5%	38.3%	28.6%	
Near Real-Time (< 15 minutes)	72.1%	38.1%	16.2%	9.1%	
Analytical Capabilities					
Basic (Current Metrics Only)	5.2%	14.8%	32.5%	51.9%	$\chi^2 = 94.28^{***}$

Intermediate (Trends & Variance)	22.7%	45.2%	48.7%	38.3%	
Advanced (Predictive & Root Cause)	72.1%	40.0%	18.8%	9.7%	
Integration with Operational Systems					
Minimal (Reporting Only)	11.7%	23.9%	41.6%	58.4%	$\chi^2 = 78.92^{***}$
Moderate (Navigation Links)	34.4%	48.4%	42.2%	32.5%	
Advanced (Direct Action Capability)	53.9%	27.7%	16.2%	9.1%	
Organizational Review Routines					
No Formal Review Process	3.9%	12.3%	28.6%	47.4%	$\chi^2 = 89.65^{***}$
Monthly or Quarterly Reviews	11.0%	24.5%	35.1%	31.8%	
Weekly Reviews	18.2%	35.5%	28.6%	16.2%	
Daily Reviews	66.9%	27.7%	7.8%	4.5%	
User Training and Support					
Minimal (Self-Service Only)	7.1%	19.4%	37.7%	53.2%	$\chi^2 = 81.47^{***}$
Moderate (Initial Training Provided)	24.7%	42.6%	41.6%	35.7%	
Extensive (Ongoing Support & Training)	68.2%	38.1%	20.8%	11.0%	
Dashboard Customization					
Fixed (Standard Views Only)	15.6%	31.6%	48.7%	61.0%	$\chi^2 = 72.38^{***}$
Limited (Predefined Options)	32.5%	43.9%	38.3%	29.9%	
Flexible (User-Configurable)	51.9%	24.5%	13.0%	9.1%	
Mobile Access Availability					
Not Available	18.2%	35.5%	52.6%	68.2%	$\chi^2 = 79.84^{***}$
Limited Mobile Views	29.9%	38.7%	33.1%	23.4%	
Full Mobile Functionality	51.9%	25.8%	14.3%	8.4%	
Alert and Exception Notification					
No Automated Alerts	9.1%	23.2%	42.9%	59.7%	$\chi^2 = 92.73^{***}$
Email Alerts for Major Issues	24.7%	41.9%	40.3%	31.2%	
Real-Time Multi-Channel Alerts	66.2%	34.8%	16.9%	9.1%	

- *Note: Percentages represent proportion of organizations in each performance quartile exhibiting each characteristic. Performance quartiles based on composite operational performance scores. Chi-square tests assess whether distribution of characteristics differs significantly across performance quartiles. *** $p < 0.001$. Results indicate that top-performing organizations exhibit significantly higher adoption of advanced dashboard capabilities and utilization practices across all dimensions examined.*

➢ *Synthesis of Contingency and Configuration Findings*

The combined knowledge of the findings of contingency regression models and model configuration cluster models give a complete picture of the influence of the combination of customer service level agreements, real-time analytics dashboards, and supply chain integration on the performance of order fulfillment (Striteska and Spickova, 2012). The contingency analyses show that individual variable relationships have a specific relationship and that internal integration, customer integration, SLA

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

implementation, and dashboard capabilities are at any rate contributing to the operations performance and there are also interactions where customer integration benefits are boosted by SLA implementation and internal integration benefits are boosted by dashboard capabilities (Pettersson, 2008). The results give specific information on how integration and measurement systems can affect performance in support of specific recommendations on the capabilities it should develop and how they interrelate.

The overlap of results obtained through different methods of analysis enhances the belief in the conclusions, and questions of results based on methodological artifacts are excluded. The contingency and configuration analyses recognize internal integration and customer integration as key performance drivers, contingency analyses indicate notable positive regression coefficients, and configuration analyses indicate that high internal and customer integration score clusters develop better performance (Pettersson, 2008). The two methods suggest that supplier integration does not work in the same way as internal and customer integration, and that contingency analyses demonstrate that supplier integration does not have a significant direct impact on performance analysis and configuration analysis, which are contingent on the fact that organizations may achieve strong performance with customer-leaning patterns, without homogenous supplier integration (Croxton, 2003). Both analytical approaches prove that features of the measurement systems are relevant to performance effects where contingency analysis results reveal that the features have strong effects and relationship whereby configuration analysis results reveal that clusters with more developed measurement systems are performing better than those with less developed measurement capabilities despite similar levels of integration (Gunasekaran et al., 2004).

IV. DISCUSSION

➢ *Theoretical Contributions to Supply Chain Integration and Performance Measurement Literature*

This research makes several important theoretical contributions to the field. These contributions advance scholarly understanding of supply chain integration, performance measurement systems, and their relationships to organizational outcomes. The theoretical advances span multiple domains and provide foundational insights for future research.

- *Extensions to Supply Chain Integration Theory*

Most importantly, the study makes an important contribution to supply chain integration theory as it offers an in-depth empirical analysis based on the combination of internal, customer, and supplier integration dimensions that determine the level of order fulfillment (Pettersson, 2008). This hitches significant calls in the literature where previous studies concentrated on external integration only. The recent study integrates all the three dimensions of integration simultaneously (Pettersson, 2008).

Of interest are the findings on the mechanisms of integration. There are high direct links between internal integration and the operational and business performance. Moreover, the consequences of external integration dimensions are much more subtle than it was previously perceived (Croxton, 2003). This result contributes to the theoretical knowledge of integration processes and explains the performance consequences of various integration strategies.

The study shows significant differences among the types of integration. Customer integration has an important impact on the performance of the operations. On the other hand, supplier integration is mainly conducted by interaction effects (Croxton, 2003). This result debunks naive beliefs in the literature that tried to imply that there is no difference in the workings of all dimensions of integration. The existing studies favour more differing theoretical frameworks rather than those which appreciate individual roles of upstream and downstream integration.

- *Advancements in Performance Measurement Systems Theory*

Second, the study can also add value to the theory of performance measurement system because it explores the impact of formal service level agreements and real time analytics dashboard on order fulfillment performance (Neely et al., 1995). The study shows that measurement systems can improve the effectiveness of supply chain integration.

The results concerning the use of SLA and dashboard are important. The use of SLA has both direct and moderating effects on performance and integration performance relationships (Gunasekaran et al., 2004). This goes further than the theoretical knowledge on past studies that only analysed the measurements systems without considering other organizational competencies.

The study demonstrates certain ways in which measurement systems generate value. The customer integration performance is reinforced by the level agreements on customer service. In addition, real-time dashboards enhance internal integration performance impact (Eckerson, 2009). The findings bring in new theoretical understanding on value creation of measurement systems. In particular, the various elements of measurement systems supplement various dimensions of integration and work along different pathways to bring value.

The study defines key portfolio considerations to measurement systems. There are various ways through which organizations come up with measurement systems. There are organizations that have balanced development that includes SLAs as well as the dashboards (Kaplan & Norton, 1996). The other organizations lay more stress on either of the two methods of measurement (Kaplan and Norton, 1996). This provides the portfolios of measurement systems with theoretical depth, and makes it clear how various portfolios lead to the development of performance.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

- *Contributions to Organizational Information Processing Theory*

Third, the research advances organizational information processing theory significantly by demonstrating Third, the study contributes to the organizational information processing theory, as it shows how real-time analytics dashboards can help an organization to have the capacity to collect, process and use information to aid in making better decisions to fulfill orders (Jackson, 2016).

The results give empirical evidence to valuable theoretical hypotheses. Dashboard features directly affect the performance of an operation and moderate the correlation between and performance and internal integration (Jackson, 2016). These results corroborate hypothetical hypotheses regarding information processing needs, namely that the organizations need to evolve the information processing functions that are relevant to the degree of task uncertainty.

The study determines various dimensions of dashboard capabilities. One of the important dimensions is data integration. The other important factor is frequency of refresh. There are additional levels of capability added by analytical sophistication. In addition, operational system integration allows taking immediate action (Jackson, 2016). This goes further to expand the theoretical knowledge beyond past studies that defined information technology as a set of unidentified constructs. The existing study acknowledges the contribution of various technological capabilities to different effectors.

The study emphasizes the social-technicality of information systems. The use of dashboards is effective not based on the technological capabilities, but also on the patterns of organizational utilization (Eckerson, 2009). In particular, the users of dashboards determine efficiency. Moreover, the frequency of consultation of dashboards is an important issue. Additionally, it is essential to determine whether insights are systematically informative or not. This illustrates the relevance of the complementary organizational practices which are critical towards the actualization of technology benefits.

- *Methodological Contributions to Supply Chain Research*

Fourth, the study contributes significantly to the research in supply chain management by enhancing the general analytical methodologies of contingency and configuration in single research (Striteska and Spickova, 2012). This is in light of arguments as to whether the correct research techniques should be applied, namely what techniques are most suitable in researching the correlations between organizational traits and performance outcomes.

The illustration of the complementary analytical insights is especially helpful. Through contingency regression analyses, certain variable-level relationships are obtained. The findings of configuration cluster analyses are holistic pattern-level results (Striteska and Spickova, 2012). The combination of these approaches offers deeper insights as compared to either approach on its own. This combined strategy enhances the trust in the research findings. It is notable that the results obtained using different methods of analysis are consistent. Certain variable-level relationships determined using contingency analysis are consistent with configuration analysis outcomes. This consistency enhances the belief that findings are a representation of real organizational phenomena and limits the possibility of methodological artifacts. The overlap of approaches implies that the results indicate real organizational reality.

Table 7 Summary of Theoretical Contributions and Extensions to Existing Literature

Theoretical Domain	**Prior Literature Limitations**	**Current Research Contributions**	**Key Supporting Findings**	**Implications for Future Research**
Supply Chain Integration Theory	Most research examined only external integration (customer and supplier) without incorporating internal integration	Comprehensive investigation of internal, customer, and supplier integration simultaneously and their joint effects on performance	Internal integration significant for both operational (β=0.14***) and business performance (β=0.28***); Customer integration significant for operational performance (β=0.27***); Supplier integration operates through interaction with customer integration (β=0.06*)	Investigate temporal sequencing of integration dimension development; Examine industry-specific optimal integration configurations
	Limited understanding of whether all integration dimensions must be developed equally	Identification of both uniform and customer-leaning high-performance patterns through cluster analysis	High Uniform cluster (M=6.18) and High Customer-Leaning cluster (M=5.95) exhibit statistically equivalent operational performance despite different supplier integration levels	Explore contingency factors determining when balanced versus selective integration is optimal; Study integration evolution pathways
	Inconsistent findings about supplier	Demonstration that supplier integration works synergistically with	Supplier integration alone non-significant (β=0.02, p>0.05) but significant interaction with	Investigate mechanisms through which supplier-customer integration synergies operate;

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

	integration effects on performance	customer integration rather than independently	customer integration (β=0.06, p<0.05)	Examine conditions moderating supplier integration effectiveness
Performance Measurement Systems Theory	Limited research on how SLAs and dashboards interact with integration capabilities	Investigation of direct effects and moderating effects of SLA implementation and dashboard capabilities on integration-performance relationships	SLA implementation moderates customer integration effects (β=0.12***); Dashboard capabilities moderate internal integration effects (β=0.14***)	Develop theory explaining why specific measurement systems complement particular integration dimensions; Study optimal sequencing of measurement system and integration investments
	Unclear whether formal commitments (SLAs) versus technological capabilities (dashboards) contribute differently	Differentiation of SLA and dashboard effects and identification of organizations emphasizing one versus both	SLA and dashboard both significant direct effects on operational performance; Cluster analysis reveals organizations with balanced versus selective emphasis achieving different outcomes	Investigate trade-offs between formal and technological approaches to performance management; Examine complementarities and substitution effects
	Limited understanding of measurement system portfolio effects	Demonstration that organizations with advanced capabilities across both SLA and dashboard dimensions achieve superior performance	High Uniform Advanced Measurement cluster exhibits highest operational performance (M=6.18) and business performance (M=4.68)	Develop frameworks for portfolio approaches to performance measurement system design; Study measurement system evolution and maturity progression
Organizational Information Processing Theory	Technology often treated as undifferentiated construct without recognizing capability dimensions	Identification of multiple dimensions of dashboard capability and demonstration of their differential effects	Dashboard capabilities encompass data integration, refresh frequency, analytical sophistication, and system integration with different performance implications	Investigate how organizations develop multidimensional technological capabilities; Examine trade-offs and complementarities across capability dimensions
	Limited attention to organizational utilization patterns versus technological capabilities	Examination of both technological capabilities and organizational utilization patterns including access, frequency, and decision integration	Top-quartile performers significantly more likely to have broad access (68.2% vs. 15.6% bottom quartile), daily review routines (66.9% vs. 4.5%), and advanced analytical capabilities (72.1% vs. 9.7%)	Develop theory integrating technological and social dimensions of information processing; Study organizational change processes enabling effective technology utilization
	Insufficient understanding of socio-technical nature of dashboard effectiveness	Demonstration that dashboard effectiveness depends on complementary organizational practices and routines	Organizations with daily dashboard review routines achieve significantly higher operational performance than those with sporadic usage even at similar technology sophistication levels	Investigate organizational routines and practices that enhance information technology value; Examine cultural factors influencing data-driven decision-making
Research Methodology	Debates about relative merits of contingency	Application of both contingency and configuration	Contingency analysis identifies specific mechanisms (e.g., customer integration β=0.27***)	Employ multi-method approaches in future research investigating

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

	versus configuration approaches	methods within single study demonstrating complementary insights	while configuration analysis reveals holistic patterns (five distinct clusters with differential performance); Findings converge across methods	complex organizational phenomena; Develop frameworks for integrating contingency and configuration insights
	Limited guidance on interpreting convergent versus divergent findings across methods	Demonstration that convergence of findings across analytical approaches strengthens confidence in conclusions	Both contingency and configuration analyses identify internal and customer integration as primary performance drivers; Both reveal supplier integration operates differently than other dimensions; Both demonstrate measurement system importance	Develop criteria for assessing consistency of findings across analytical approaches; Investigate conditions where methods might yield conflicting conclusions

- *Note: β values represent standardized regression coefficients from contingency analyses. M values represent cluster means on operational or business performance from configuration analyses. Statistical significance: * p<0.05, ** p<0.01, *** p<0.001. Theoretical contributions span multiple domains and suggest numerous directions for future research building on these findings.*

➢ *Practical Implications for Supply Chain Management Practitioners*

The research findings yield multiple practical implications for supply chain management practitioners and organizational leaders seeking to enhance order fulfillment performance through improved integration and measurement systems. The implications that follow address key strategic and operational priorities that organizations should consider.

- *Prioritizing Internal Integration as Foundational Capability*

First, internal integration cultivation should be the priority of the organizations considering it as a core competency. This shall be developed prior to or in parallel with the external customer and supplier integration (Pettersson, 2008). Intranet coordination between the functional boundaries will allow organizations to carry out the processes with efficiency and react to the customer need effectively.

The conclusion concerning internal integration is quite important. Internal integration shows strong positive correlation with both business and operational performance in all the analytical models that were used in the study (Croxton, 2003). This consistency implies that the investments of cross-functional coordination, information sharing, joint planning activities, and joint problem solutions give significant returns and generate intentional outcomes.

There are many and practical programs of strengthening internal integration. Cross-functional teams should be created in the organization that includes the sales, operations, logistics and customer service representatives. These teams should also be tasked with end-to-end processes of order fulfillment. Also, cross-functional meetings done on a regular basis enhance the coordination of an organization. Such meetings ought to help various regions to exchange information on challenges that are expected to come ahead and to undertake efforts towards responding efficiently (Croxton, 2003). Besides, the establishment of common metrics and rewards is essential to success. These are supposed to entice the overall process performance and not functional sub-optimization. Lastly, investment on integrated information systems gives visibility across the functional boundaries, which allows co-ordinated decision-making in the organization.

- *Recognizing Differential Mechanisms for Customer and Supplier Integration*

Second, organizations must note that customer integration and supplier integration can be used to help performance in different ways that should be given different strategic focus depending about the organizations (Croxton, 2003). Knowledge of these differences would allow allocation of resources and strategic planning to be more effective.

The research results give valuable recommendations in this distinction. The customer integration has high direct impacts on operational performance. Supplier integration on the other hand works mostly via synergistic interaction with customer integration. The finding indicates that there are critical strategic implications to organizations. Particularly, organizations that have small resources may focus on customer integration, rather than supplier integration (Croxton, 2003). This emphasis is especially critical in cases when the competitive strategies are focused on differentiation of customer service.

Practical customer integration enhancement initiatives touch on several dimensions of organizations. The formal mechanisms of receiving customer requirements and feedback must be developed by organizations, which concerns the order fulfillment performance. Also, the use of participatory planning strengthens the relationship with the customers. These processes should allow customers to provide demand forecast, promotional plans so that improved capacity and inventory planning can be done (Gunasekaran et al., 2001). In addition, it is worth creating collaborative performance enhancement measures. The strategy involves collaborating with the important customers to determine and resolve the service problems. Lastly, customer facing

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

dashboards can make it more transparent by adding real time visibility on the status of orders and delivery status.

- *Implementing Formal Customer Service Level Agreements*

Third, the companies are encouraged to have customer service level agreements which bind performance promises and controls on these promises. The performance advantages of customer integration are enhanced through SLAs by defining expectations (Gunasekaran et al., 2001) and offering objective foundations of assessing the quality of fulfillment services.

The study results on the implementation of SLA show that there are serious performance effects. The implementation of SLA has both direct and moderating impacts on the operational performance and strengthen the customer integration-performance relationships (Gunasekaran et al., 2004). These two impacts show that formal service commitments are value generating in more than one way. First, SLAs help to align the organizational priorities with the needs of the customers. Second, they create accountability of performance results. Third, they develop performance surveillance and continuous improvement frameworks.

There are practices and approaches that are necessary in the development of SLA. Companies need to work in cooperation with customers to comprehend their priorities and the measures, have to consider those dimensions that the customers appreciate. Also, it is critical to set certain measurable goals that will result in success. These should be demanding and attainable in accordance with organizational abilities (Gunasekaran et al., 2001). In addition, the introduction of regular performance reviews will enhance adherence to agreements. The real performance in SLA commitment is supposed to be measured and negotiated with the customers. Lastly, performance in SLA should be connected to the systems of internal incentives to make the organization aligned. Staff members in the entire organization should be conversant with service commitments and give this importance.

- *Investing in Real-Time Analytics Dashboard Capabilities*

Fourth, organizations must invest in real time analytics dashboard capabilities of its performance advantages. Dashboards enhance the performance advantages of internal integration by allowing one to see cross-functional processes and to quickly identify and fix problems (Eckerson, 2009).

The results of the research about the features of a dashboard are convincing and diverse. The dashboard capabilities have direct impacts on the operational performance and moderating impacts that augment internal integration-performance relationships (Jackson, 2016). These implications suggest that technological investments generate high levels of value especially when there is high internal coordination. The investments in data integration, analytical tools, and visualization abilities bring quantifiable benefits and value to the performance.

There are several important dimensions that have to be considered when implementing dashboard. The organizations are not only meant to start by clearly defining key performance indicators that translate to organizational priorities (Eckerson, 2009), but they should also be actionable and not just informative. Also, it is necessary to develop data integration capabilities to be successful. The organizations are forced to combine information across the various source systems, such as order management and warehouse management, transportation management, and customer relationship management systems (Eckerson, 2009). Besides, relevant refresh frequency depending on the characteristics of operations can be introduced. Real-time or near-real-time updates usually prove useful in high-volume operations (Eckerson, 2009). Moreover, the creation of intuitive visualization conveys the performance status in a very simple manner, which can be understood easily without much analysis.

➢ *Implementation Roadmap for Integrated SLA-Dashboard Measurement Systems*

Companies that aim to build or refinance their order fulfillment performance measurement systems by incorporating customer service level agreements, and real-time analytics dashboards must adhere to an established implementation road map; this ranks the activities in the order they should be implemented and controls the organizational change (Eckerson, 2009). The implementation roadmap consists of five steps, the first one being an assessment, followed by design, build, deployment, and continuous improvement with each stage having its activities, deliverables, and success criteria.

- Phase 1 (Assessment and Planning) is dedicated to the assessment of the current state capabilities such as current integration levels at the internal, customer and supplier levels, current performance measurement practices and systems, data infrastructure and data analytics capabilities, organizational readiness of change, and stakeholder requirements and expectations (Sundström and Tollmar, 2018). Activities of assessment involve interviews with stakeholders such as customers, functional leaders within the organization, and the major suppliers to determine performance expectations and areas of concern, documenting existing order fulfillment processes and where these handoffs occur in the organization where coordination issues are present, evaluating the existing data sources and systems to comprehend integration requirements and feasibility and benchmarking any current performance with industry norms and competitors to establish the developmental goals of improvement (Gunasekaran et al., 2004).

- Phase 2 (Design and Specification) converts the results of the assessment to specifications of improved measurement systems such as customer service level agreement structures and real-time analytics dashboard designs (Eckerson, 2009). Design activities also involve partnering with important customers to make the service level agreement measurements, targets and the review processes that will reflect their interests and still be

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

realizable given the organizational capability. Moreover, determining the key performance indicators that will be used with the implementation of the dashboard related to the delivery performance, accuracy of orders and inventory performance, cost-effectiveness, customer service, and flexibility dimensions are also an important simultaneous undertaking. Also, development of dashboard layouts, visualizations, and navigation structures that allow easy access of performance information at the right level of detail should be done during this stage. Additionally, there is a need to carefully plan technical specifications of data integration requirements such as the source systems, data elements, transformation logic, and frequency of refresh to enable dashboard functionality. Lastly, describing organizational procedures to be used in dashboard utilization such as who will look at dashboards, the rate of performance review and how the insights will be used in decision making round up the activities of design phase (Eckerson, 2009).

- Phase 3 (Build and Testing) deploys the developed measurement systems by configuring technology, integrating the information, and refining the systems with help of the testing feedback (Jackson, 2016). Build activities involve platform configuration with proper data connections, transformation logic, visualizations and user access controls; creating data integration pipelines, where data will be extracted out of source systems, where transformations are required, and data loaded into dashboard databases or where data warehouses; creating data quality checks and exception handling to ensure that dashboard information is accurate in relation to operational realities; creating user training documentation, video lessons and practical exercises to help them understand the technology; and doing test runs with representative users to identify usability problems, validate data accuracy and improve designs based on feedback (Eckerson, 2009).

- Phase 4 (Deployment and Adoption) shifts measurement systems between development and operation to facilitate organizational change to make successful adoption. Deployment activities involve carrying out formal trainings to all user communities on how to use dashboard features, performance interpretation and action taking processes; developing routine dashboard review activities such as daily operational standups, weekly management meetings, and monthly business reviews where performance is systematically explored; the customer service level agreement through formal dialogues with key customers on how metrics and targets are considered and reviewed processes and ensuring customer buy-in by offering formal dialogues on how performance is managed and offering support channel such as help desk resources, super-user networks and ongoing communication channels where questions and problems can be used to identify the obstacles to adoption and to Managing organizations need to note that successful adoption entails not only training users about the functionality of dashboards, but also forming organizational cultures that appreciate the importance of data-informed decision making and expect individuals to be accountable about the performance results.

- Phase 5 (Continuous Improvement) lays down continuous process of measurement systems refinement according to the changing requirements, technological competency, and organizational learning (Kaplan and Norton, 1996). The main activities to maintain continuous improvement are regular user feedback sessions to identify areas of improvement and resolve pain points, observe patterns of dashboard use to determine which features and information are not used, and evaluate whether the current metrics and SLA targets are still suitable under the changing business conditions, competition, and organizational capabilities; evaluate new analytical capabilities, such as predictive analytics, artificial intelligence, and machine learning, that have the potential to add dashboard value, and benchmark capabilities of the measurement system against industry standards to spot areas of improvement (Eckerson, 2009). Organizations ought to develop formal governance procedures such as cross-functional steering committees tasked with the responsibility of setting the priorities of enhancing initiatives, resource allocation, and alignment of measurement system development and strategy priorities (Eckerson, 2009).

Table 8 Implementation Roadmap for Integrated SLA-Dashboard Measurement Systems

Implementation Phase	Timeline	Key Activities	Critical Success Factors	Deliverables	Common Pitfalls to Avoid
Phase 1: Assessment and Planning	Weeks 1-6	• Conduct stakeholder interviews with customers, internal leaders, and suppliers • Document current order fulfillment processes and integration maturity • Evaluate existing data infrastructure	• Executive sponsorship and visible commitment • Broad stakeholder engagement including customers • Honest assessment of current capabilities without defensive rationalization • Realistic timelines and resource estimates	• Current state capability assessment • Stakeholder requirements document • Gap analysis identifying capability deficiencies • Business case with expected benefits	• Insufficient stakeholder engagement leading to misaligned requirements • Overly optimistic timelines underestimating complexity • Inadequate assessment of data quality and

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

		and analytical capabilities • Benchmark current performance against industry standards • Identify improvement opportunities and priorities • Develop business case and secure executive sponsorship	•Clear linkage to strategic priorities	• Implementation roadmap and resource plan	integration challenges • Lack of executive sponsorship leading to resource constraints
Phase 2: Design and Specification	Weeks 7-14	• Collaborate with customers to define SLA metrics and targets • Identify key performance indicators spanning multiple dimensions • Design dashboard layouts, visualizations, and navigation • Specify data integration requirements and architecture • Define organizational processes for dashboard utilization • Develop change management and training plans	• Customer collaboration ensuring SLAs reflect their priorities • Focus on critical few metrics rather than comprehensive coverage • User-cantered design prioritizing simplicity and actionability • Realistic data integration scope based on available resources • Early attention to organizational change management	• SLA templates with metrics, targets, and review processes • Dashboard design specifications with wireframes • Data architecture specifications and integration approach • Organizational process definitions • Training and change management plans	• Designing overly complex dashboards with too many metrics • Insufficient customer input into SLA definition • Underestimating data integration complexity and effort • Neglecting organizational change management planning • Focusing solely on technology without addressing processes
Phase 3: Build and Testing	Weeks 15-26	• Configure dashboard platform with data connections and visualizations • Establish data integration pipelines and quality controls • Develop user training materials and documentation • Conduct iterative testing with representative users • Refine designs based on testing feedback • Validate data accuracy and	• Iterative development with frequent user feedback • Rigorous data validation ensuring accuracy • Comprehensive testing addressing both technical functionality and user experience • Documentation supporting ongoing system maintenance • Realistic performance expectations under production loads	• Fully configured and tested dashboard system • Validated data integration pipelines • Comprehensive training materials • Test results and issue resolution documentation • Deployment readiness assessment	• Insufficient user involvement in testing leading to unusable designs • Inadequate data validation risking inaccurate dashboard information • Scope creep expanding requirements beyond original plan • Inadequate performance testing under realistic data volumes

		system performance			
Phase 4: Deployment and Adoption	Weeks 27-38	• Conduct formal training for all user communities • Establish dashboard review routines at multiple levels • Implement SLAs through customer discussions • Create support mechanisms including help desk and super-users • Monitor adoption metrics and address barriers • Celebrate early wins and communicate success stories	• Comprehensive training ensuring users understand functionality and interpretation • Leadership role modeling demonstrating dashboard value • Regular review routines institutionalizing dashboard usage • Responsive support addressing issues promptly • Communication of benefits and success stories building momentum	• Trained user community across all target groups • Established dashboard review routines • Implemented SLAs with key customers • Support mechanisms including help desk • Adoption metrics meeting targets • User satisfaction feedback	• Inadequate training leaving users unable to utilize dashboards effectively • Lack of leadership role modeling undermining adoption • Insufficient support resources leading to user frustration • Failure to establish review routines leaving usage sporadic • Ignoring resistance and barriers to adoption
Phase 5: Continuous Improvement	Ongoing (Post Week 39)	• Conduct regular user feedback sessions • Monitor utilization patterns identifying enhancement opportunities • Evaluate metric relevance and SLA target appropriateness • Assess emerging analytical capabilities • Benchmark against industry best practices • Implement enhancements based on evolving requirements	• Formal governance process prioritizing improvements • Balance between stability and adaptation • User feedback informing enhancement priorities • Technology monitoring identifying new capabilities • Performance assessment linking to business outcomes	• Regular feedback summaries • Utilization analytics and insights • Enhancement backlog with priorities • Technology assessment reports • Updated training materials • Continuous improvement results	• Allowing systems to become stagnant without updates • Excessive changes undermining consistency and trend analysis • Lack of governance leading to uncoordinated enhancements • Insufficient resources for ongoing improvements • Losing executive attention as initial enthusiasm wanes
Critical Cross-Phase Considerations	Throughout	• Maintain executive sponsorship and visible leadership commitment • Ensure continuous stakeholder engagement and communication • Manage scope carefully balancing ambition and feasibility	• Sustained executive commitment throughout implementation • Effective change management addressing cultural factors • Adequate resources including personnel, budget, and time • Integration with existing processes and systems • Celebration of milestones	• Regular steering committee meetings and decisions • Communication updates to stakeholders • Risk management and issue resolution • Resource allocation and utilization tracking	• Losing executive attention and resource commitments • Inadequate change management underestimating cultural barriers • Treating as purely technical project ignoring organizational dimensions • Failing to demonstrate value and benefits

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

		• Address data quality issues systematically • Build organizational capabilities through training and support • Link measurement system to incentives and accountability	maintaining momentum	• Benefits realization assessment	• Inadequate governance and decision-making processes

- *Note: Timeline estimates assume medium-sized organization with moderate technical complexity. Actual timelines may vary substantially based on organizational size, data infrastructure maturity, resource availability, and scope of implementation. Organizations should adapt this roadmap to their specific circumstances while maintaining attention to both technical and organizational change management dimensions.*

➢ *Organizational Context Factors Influencing Measurement System Effectiveness*

The implementation of the customer service level agreement and real-time analytics dashboard differ significantly in customer contexts, and there are numerous contingency factors that mediate the linkage of the measurement systems and performance outcomes (Pettersson, 2008). Organizational size is one such contextual factor, and larger organizations may have more resources to commit to advanced dashboard technologies and analytical tools but may have increased difficulty in attaining organization-wide usage and cultural shift because of the complexity of their structure and functional compartments. According to survey data, large organizations (annual sales above HK$100 million) are much more inclined to adopt advanced dashboard capabilities such as real-time data refresh (68% vs. 34% in smaller organizations), advanced analytical tools (59% vs. 28%), and deep integration of the operational system (47% vs. 19%), which is in line with the available resources and technical sophistication. Nevertheless, among large organizations, the percentages of target users accessing dashboards regularly are lower (58% as compared to 71% in small organizations) indicating that a large and complex organization faces considerable challenges on the way to widespread adoption (Eckerson, 2009).

Characteristics of an industry have the bearing of how various dimensions of order fulfillment performance are relatively important and therefore the level of emphasis to be placed in measurement systems (Gunasekaran et al., 2004). The industries with a large number of products with high product variety and customization experiences like machinery and equipment manufacturing might focus on flexibility and accommodation of special requests in their SLAs and dashboards whereas those with standard products and large product volumes like consumer-packaged goods may focus on efficiency measures such as cost per order and inventory turnover (Gunasekaran et al., 2004). According to survey data, manufacturers of electronic and electrical equipment give more emphasis in their measurement system to the lead time variability and delivery lead time adaptability (78% include these measures compared to 52% in general), which is in line with competitive forces in the technology markets whereby, time-related competitive pressures arise due to product obsolescence (Mattsson, 2012). Manufacturers in food and beverage focus on inventory days of supply and product freshness measures (71% and 45%), which is an indicator of perishable issues and governmental regulations in food and beverage sectors (Mattsson, 2012). Order change accommodation and rush order capability (68% versus 43%on average) are given preference by textile and apparel manufacturers due to instability in the fashion market and rush season of short sales (Harrison and van Hoek, 2014).

The other significant contextual issue that affects proper measurement system design is supply chain complexity, where the complexity of the global supply chain in a given organization due to the presence of multiple tiers of suppliers, varying transportation methods, and numerous distribution channels necessitates more advanced measurement capabilities compared to organizations with simpler supply chain management due to its geographically restrictive character (Harrison and van Hoek, 2014). The survey results show that organizations in three or more geographical locations deploy much more extensive dashboard capabilities (complexity score of 7.2 compared to 4.8 along 10-point scale), spend more on data integration infrastructure (average annual spending of HK$2.4M compared to HK$0.8M), and allocate more staff toward dashboard maintenance and support (average 4.2 FTEs compared to 1.6 FTEs) due to the higher volumes of information needed to support supply chain complexity. Exception-based alerting, which automatically notifies the deviations of performance, is especially helpful in complex supply chains, as managers are not able to monitor all performance dimensions on large networks (Jackson, 2016).

The technology infrastructure maturity determines the viability and cost of deploying real-time analytics dashboard where organizations that have invested in enterprise resource planning systems, data warehouses and business intelligence platforms, can utilize the available facilities, whereas those with integrated systems that are not up to date will require significant infrastructure development before the benefits of dashboards could be realized. The results of the survey data

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

indicate that the organizations that have ERP systems installed within the last five years are much more likely to have developed dashboard capabilities (72% compared to 38% of the organizations that have not yet invested in ERP systems or have older systems), which indicates both the availability of the data presented by the current integrated system and the willingness of the organizations to the analytical tools that frequently comes with the recent technology investments.

The organizational culture in terms of the use of data in decision-making is a critical factor in determining whether the dashboard capabilities will help improve the performance of the organization, and organizations with strong analytical cultures will better utilize dashboard insights than those where decision-making is largely based on intuition, experience, or politics. According to the results of the survey, organizations that self-rate themselves as possessing high data-driven cultures (top quartile on five-item scale on culture) attain much greater operational performance (M = 6.12 versus M = 4.87 on bottom quartile) even with statistically similar dashboard technical capabilities (M = 5.42 versus M = 5.38) implying that organizational cultures do moderate the effectiveness of technology significantly. To establish analytical cultures, the leadership needs to be committed over the long term through role modeling, investing resources in analytical capabilities, integrating data-based understanding to drive decision making and celebrating instances where analytical understanding resulted in desirable actions.

➢ *Integration of Performance Management with Broader Supply Chain Management Processes*

The performance measurement of order fulfillment needs to be integrated with other wider supply chain management activities and not an independent standalone activity using customer service level agreements and real time analytics dashboards (Croxton, 2003). The supply chain management framework contains eight interrelations processes such as customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, supplier relationship management, product development, and commercialization, and returns management, all of which affect and are affected by the order fulfillment performance. The processes of customer relationship management create and sustain the relationships with the key customers, identify customer requirements and expectations, and create account-based approach to services delivery, which are critical to defining customer service level agreements, which reflect individual customer priorities instead of standardized approach to commitments to various customers with different needs (Croxton, 2003).

Customer service management processes will give organizational framework and procedures involved in managing customer service level agreements such as setting service policies and communications with customers on the status of orders and issues, and services recovery in case of any problem (Croxton, 2003). The operational sub-process interconnection between the processes of supply chain illustrates how the order fulfillment interface extensively interfaces with customer service management: generating and communicating orders and entering orders interface with recognizing events, identifying events, and determining the nature of events; processing orders, managing documentation, filling orders, and delivering orders interface with evaluating situations and alternatives such as coordinating with functions to determine alternative actions and deciding how to respond; and performing post-delivery processes and performance measuring processes interface with many other processes.

Through the influence that they impose on the availability of inventory, adequacy of capacity and allocation of resources, demand management processes predict customer demand, match supply and demand, and decrease demand fluctuations, which directly affect the performance of order fulfillment (Croxton, 2003). The results of demand management processes heavily rely on the information about the order fulfillment performance on dashboards, which can help demand planners understand the correctness of the forecasts depending on the differences between the predicted and the real order patterns, detect systematic biases or anomalies that need to be investigated, and use real-time demand signals in the adaptive forecasting strategies (Jackson, 2016). Organizations need to put in place data flow between order fulfillment dashboard and demand management systems that would be done automatically to obtain the actual data about the orders to help in forecast-versus-actual analysis and update the forecast continuously. On the other hand, demand management predictions must be observable in the operation fulfillment dash boards so that operations personnel can predict the change in volumes and arrange resources and, as a guide to understand the present performance in correlation with the anticipated demand trends.

The flow management processes in manufacturing plan and execute the production operations, manage the work in process inventory, and control the operations at the shop floor which is critical in the availability of products to meet. Order fulfillment dashboards must also show customer facing measures like on-time delivery besides internal process measures including manufacturing compliance to production schedules, work-in-process stock levels, and manufacturing cycle times, as customer service performance usually relies heavily on manufacturing performance effectiveness (Mattsson, 2012). Companies are advised to incorporate manufacturing, order fulfillment dashboards to avail system-wide view of production and distribution processes, so that it can be possible to identify the bottlenecks and constraints that restrain the overall system performance (Bolstorff & Rosenbaum, 2012).

The processes of supplier relationship management form and sustain relationships between organizations and their suppliers, assesses supplier performance, and works with suppliers in the quality and delivery improvements, which affect order fulfillment performance, through its impacts on the availability and quality of inbound materials (Croxton, 2003). Supplier performance indicators, such as delivery time, order delivery, and product quality need to be reflected in the order fulfillment dashboards, as the external supplier performance has a critical impact on whether an organization can fulfill its customer obligations (Urciuoli et al., 2014). Companies ought to think about such information sharing with strategic suppliers, which allows them to see how the performance of suppliers affects customer service performance and develop common ground that inspires them to work together to initiate improvements (Gunasekaran et al., 2001). In other organizations, the major organizations develop common dashboards with key suppliers showing performance measures of both sides and agreeing to solve common problems when arising problems arise.

New products are developed and commercialized in product development and commercialization and these processes influence the performance of fulfilment of orders because they impact the manufacturing characteristics of a product that undergoes engineering through product processes, quality risk, inventory management needs, and so on. The product development decisions should be informed by the order fulfillment performance data, and it is the consistent problem in fulfilling products that leads to the reviewing of the design, which questions the possibility of product complexity or supplier problems causing difficulties in service provision (Wang et al., 2004). Organizations that apply design for supply chain principles are systematic in adding the consideration of fulfillment to the development of new products, considering the design alternatives based on their effects on order fulfillment performance such as manufacturability, quality-consistency, packaging, and transportation properties.

Table 9 Integration of Order Fulfillment Measurement with Broader Supply Chain Management Processes

Supply Chain Process	Integration Mechanisms with Order Fulfillment Measurement	Information Flows from Fulfillment Measurement	Information Flows to Fulfillment Measurement	Benefits of Integration	Implementation Practices
Customer Relationship Management	• Align SLA definitions with customer-specific requirements • Incorporate fulfillment performance into account reviews • Link customer profitability to service costs	• Fulfillment performance by customer/segment • Service level compliance versus SLA targets • Cost-to-serve by customer • Perfect order rates by account	• Customer requirements and priorities • Account strategic importance • Customer growth and profitability • Satisfaction and loyalty metrics	• SLAs reflect actual customer priorities • Account strategies consider service costs • Performance discussions grounded in data • Unprofitable service patterns identified	• Include fulfillment representatives in account planning • Share dashboard data in customer business reviews • Tailor SLA metrics to customer priorities • Calculate customer-specific cost-to-serve
Customer Service Management	• Integrate dashboard data into service systems • Establish alert-driven proactive communication • Support service recovery with performance data	• Real-time order status and tracking • Performance deviations requiring communication • Trends in inquiry types and root causes • Service recovery effectiveness	• Customer inquiries and complaints • Service issue categories and frequencies • Customer satisfaction feedback • Service recovery case outcomes	• Service reps access accurate order status • Proactive communication about issues • Root cause analysis improves processes • Service recovery tracked to resolution	• Embed dashboard views in service systems • Configure automated customer notifications • Analyze inquiry patterns to identify systemic issues • Track service recovery outcomes in dashboards
Demand Management	• Use fulfillment actuals to improve forecast accuracy • Incorporate demand forecasts into capacity planning • Share demand signals across	• Actual order patterns versus forecasts • Forecast accuracy by product/customer • Real-time demand signals and trends	• Demand forecasts by period and product • Promotional plans and volume expectations • New product launch timing	• Forecast accuracy continuously improves • Capacity plans reflect demand expectation	• Automate actual-versus-forecast reporting • Display forecasts alongside actual orders in dashboards • Conduct regular forecast accuracy reviews

	planning and execution	• Inventory adequacy relative to demand	• Market intelligence and trends	• Inventory positioned appropriately •Resources allocated to actual demand	• Incorporate real-time demand signals
Manufacturing Flow Management	• Display manufacturing metrics in fulfillment dashboards • Enable visibility into order progress through production • Link manufacturing performance to delivery capability	• Order fulfillment requirements and priorities • Product availability gaps affecting service • Customer delivery commitments • Inventory consumption rates	• Production schedule adherence •Manufacturing cycle times and throughput • Work-in-process inventory levels • Product availability by SKU and location	• Production plans align with fulfillment needs •Manufacturing delays identified early • Expediting focused on customer priorities • Holistic visibility across operations	• Integrate manufacturing data into unified dashboards • Implement order tracking through production stages • Establish expediting protocols for at-risk orders< • Include manufacturing leads in fulfillment reviews
Supplier Relationship Management	•Incorporate supplier performance in fulfillment dashboard • Share fulfillment impacts with strategic suppliers • Collaborate on joint performance improvements	• Impact of supplier performance on fulfillment • Specific supplier-caused service failures • Cost consequences of supplier issues • Root cause analysis of supplier problems	• Supplier delivery performance and reliability • Inbound quality and defect rates • Supplier production schedules • Supplier capacity constraints	• Supplier performance visibility enables management • Root causes traced through supply chain • Collaborative improvement with key suppliers • Supply base decisions informed by data	• Add supplier performance metrics to dashboards • Conduct supplier scorecards including fulfillment impact • Share performance data with strategic suppliers • Establish joint improvement initiatives
Product Development and Commercialization	•Incorporate fulfillment performance into design reviews • Evaluate new products on supply chain criteria • Use fulfillment data for portfolio decisions	• Fulfillment performance by product/SKU • Persistent quality or delivery issues by product • Packaging, handling, and transport challenges • Inventory holding costs and turnover	• New product introduction timing • Product design characteristic • Component sourcing strategies • Expected volumes and mix	• Designs consider fulfillment implications • Problem products identified for redesign • Portfolio decisions informed by fulfillment costs • New products launched with supply chain readiness	• Include fulfillment representatives in design reviews • Display fulfillment performance by product in dashboards • Conduct design-for-supply-chain assessments • Review fulfillment data in portfolio planning
Returns Management	• Track returns rates and root causes • Link returns data to quality and delivery issues	• Returns rates by product, customer, reason • Delivery damage and accuracy issues	• Returns volume and processing status • Root cause analysis of returns	• Returns patterns identify improvement opportunities	• Add returns metrics to fulfillment dashboards • Analyze correlation

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

	• Incorporate returns costs into performance assessment	• Financial impact of returns • Correlation between fulfillment issues and returns	• Restocking and disposal decisions • Customer communication about returns	• Cost of quality more visible • Delivery issues driving returns addressed • Closed-loop quality management	between fulfillment and returns • Calculate total cost including returns • Share returns root causes with relevant functions

- *Note: Effective integration requires both technological connections enabling automated data flows and organizational processes ensuring that information informs decision-making across functions. Organizations should prioritize integrations based on their specific operational characteristics and improvement opportunities.*

➢ *Role of Organizational Learning and Capability Development*

Bringing and revising the customer service level agreement and real-time analytics dashboard measurement systems are an organizational learning process, through which capabilities are not brought out in a single instance (at once), but rather built up over time (Pettersson, 2008). Organizations go through maturity stages where they start with ad hoc and informal performance measurement practices. They develop by having prescribed and standardized measurement systems. They proceed to integrated and coordinated functional and partner measurement. They eventually attain optimized measurement systems that lead to the continuous improvement and dynamism in response to changing requirements.

According to the survey data, only 18% of organizations have had mature dashboard implementations with advanced technical features, wide organizational use, regular use in decision-making, and constant improvement due to changing needs (Jackson, 2016). In the meantime, 47 percent are in early stages of maturity with primitive dashboard features and low usage and 35 percent in the intermediate stages of maturity.

Organizational learning theory highlights that the process of capability development takes a cyclical pattern of action, reflection and adjustment. The organizations explore new methods, analyze and determine the lesson learned and apply the knowledge in the improved practices (Neely et al., 2000). Effective implementation of measurement systems goes through these learning cycles in a systematic manner in several ways. These involve frequent feedback collection and analysis of the users that reveals the barriers to utilization and areas of improvement. They also contain performance outcome tracking which checks the extent to which the measurement system improvements are converted into operational improvements. Root cause analysis examines the occurrence of failure of measurement systems to lead to good actions. Recorded lessons learned retain these insights that could be used to influence future improvement efforts (Kaplan and Norton, 1996).

The importance of leadership in the facilitation of organizational learning about measurement systems cannot be overemphasized. Leaders play a very major role in the ability of organizational cultures to embrace sustained improvement and experimentation (Eckerson, 2009). Leaders led by example in terms of commitment to learning and measurement by visibly engaging in performance review practices. They use dashboards as their part of the decision-making. When the insight of measurement systems causes them to make altered decisions by undermining their previous assumptions, they openly discuss it. They invest on refinement of measurement systems even when the financial rewards will not be evident in the short term.

The leaders must establish psychologically secure conditions in which the results of the measurement are perceived as learning possibilities instead of learning merely as the personnel assessment and punishment grounds. The apprehension of negative outcomes in case of poor performance is the likely cause of gaming of measures and holding back of true performance instead of actual performance improvement (Busi & Bititci, 2007).

➢ *Limitations of Current Research and Contextual Boundary Conditions*

The study has provided critical empirical evidence on the linkage between supply chain integration, customer service level agreement, real-time analytics dashboard, and the performance of order fulfillment. However, it also admits several limitations to be considered when drawing conclusions and taking them into account to other organizational settings (Neely et al., 1995).

To begin with, the study uses cross-sectional survey design that involves the collection of data at one point of time. This makes it impossible to make definite causal conclusions of whether measurement system capabilities lead to performance improvement or that high-performing organizations implement advanced measurement systems because of high performance (Gunasekaran et al., 2004).

Second, the study targets manufacturing organizations within the Chinese geographical settings. Although the sample is representative of the wide range of industries and the companies' sizes, which presumably, has a beneficial impact on the generalizability of the findings to manufacturing sectors, it is not clear how they could be applied to service industries, not-for-profit organizations, or geographic contexts with significantly different business environments (Pettersson, 2008). The characteristics of order fulfillment are different in-service organizations. These are invisibility of deliverables, inability to pre-position inventory and production and consumption that usually occur simultaneously. These attributes can affect the suitability of measurement methods that are created in the manufacturing environment.

Third, performance measure was based on subjective ratings of organizational performance in comparison with key competitors instead of objective financial or operational data which could be more conclusive (Stewart, 1995). The reason behind this measurement method was practical limitations of accessing financial data of companies. It was alleviated by using various methods of assessment such as single-factor test of Harman. Nonetheless, the competition-based benchmarking came with the risk of bias. These are anchor effects because the performance judgment of the respondents can be determined by initial standards or his/her own performance in the organization. Halo effects can happen where some performance on some dimensions affects the measurement of other dimensions. Competitive benchmarking strategies have systematic biases (Neely et al., 1995).

Fourth, the study considered the level of agreement and real-time analytics dashboard implementations as the technology-focused systems. It failed to capture the rich organizational, interpersonal, and political dynamics that usually determine their real application and use (Bourne et al., 2000). The processes of implementation are not only technical installing systems but this is organization change in its core. They need changes in work patterns, decision making habits, authority system, and cultures. These can be avoided or avoided in different forms even after formal implementations have been made (Busi and Bititci, 2007).

Fifth, the research explored several contingency variables such as organization size, industry, and dashboard attributes; however, there are many other contingency variables that can moderate the relationship between measurement systems and performance that are yet to be explored (Gunasekaran et al., 2004). Potentially significant moderators such as competitive intensity, the level of technology infrastructure maturity, complexity of supply chain, organizational change capacity and human resource capabilities were not systematically examined (Toni & Tonchia, 2001). Depending on environmental dynamism and market turbulence, optimal design of measurement system and correct refresh frequency could be affected. More real-time measurement could help in highly dynamic environments whereas periodic reporting could suffice in the case of stable ones (Urciuoli et al., 2014).

Sixth, the study also included supply chain integration and supply chain measurement systems features as comparatively fixed features of organizations. It failed to include the dynamic development of these capabilities as time progresses or the learning of experience and the development of methods of approach by organizations (Pettersson, 2008). The configuration analysis had five clusters which depicted different patterns at a specific time.

V. CONCLUSION AND RECOMMENDATIONS

In conclusion, this study has explored how customer service level agreements can be combined with real-time analytics dashboards to measure the performance of order fulfillment using extensive empirical evidence of manufacturing firms with different industries and geographic settings. The results reveal that supply chain integration dimensions such as internal integration, customer integration, and supplier integration have strong relationships with the performance of the organization, customer service level agreements enhance the performance benefits of customer integration, real-time analytics dashboards enhance the performance impact of internal integration, and organizations adopting five different patterns of integration and measurement system creation produce varying performance results. The study makes contributions to the body of supply chain management theory by extending the supply chain integration theory to include internal integration and external dimensions, by developing the performance measurement systems theory by demonstrating how formal commitments and technological capabilities complement each other, and by offering empirical evidence of information processing theory by illustrating how real time analytics help organizations improve their decision-making capacities. In practice, the study offers evidence-based models to supply chain management professionals of how to deploy customer service level agreements and real-time analytics dashboard and as such, it provides insights into what stress should be placed on the various dimensions of performance, design choices that can execute the implementation of the dashboard successfully, strategies to enable organizational change to facilitate dashboard adoption, and integration methods to bridge the gap betwixt the measurement systems and the overall supply chain management practices.

Based on the comprehensive investigation and analysis, the following six recommendations are offered for supply chain management practitioners and organizational leaders:

➢ *Prioritize Internal Integration as a Foundational Capability:*

Understand that cross-functional coordination in the organization is one of the key basics on which the integration of external customers and suppliers should be anchored (Slack et al., 2015). Create cross-functional teams, use integrated information systems, create shared metrics and incentives, and develop organization processes that break functional silos and facilitated coordinated decision-making to support order fulfilment excellence.

➢ *Implement Customer-Focused Performance Measurement Through Collaborative SLAs:*

Establish formal customer service level agreements by engaging in joint consultation with major customers in order to make sure that the performance commitment is based on customer priorities and values (Rodríguez et al., 2009). See Frame SLAs as collaborative performance control mechanisms, as opposed to contractual punishment. Develop quantifiable goals depending on organizational strengths. Enact frequent performance appraisal mechanisms that allow

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

implementation of continuous improvement that is in line with the needs of the customers (Busi & Bititci, 2007).

- *Invest in Real-Time Analytics Dashboard Capabilities Matched to Operational Requirements:*

Implement dashboard technologies that are relevant to the size of the organization, the nature of the industry, and the amount of technical maturity instead of blindly following the latest and greatest systems. Start with key metrics on main dashboards. Create data refresh schedules through actionability of insights (Eckerson, 2009). Provide wide organization access so that performance could be monitored by operational personnel. Make dashboards closely integrated with the operational systems so that action can be taken directly in case problems arise.

- *Establish Institutionalized Review Routines Ensuring Systematic Dashboard Utilization:*

Go beyond technology use to make formal performance reviews practices at different levels of the organization such as daily operation standups, weekly management meetings and monthly business reviews. Establish these routines routinely, have proper functional representation, use of standard decision-making structures, and monitor action items holding people accountable to performance results and ongoing improvement programs (Bourne et al., 2000).

- *Build Complementary Organizational Capabilities Supporting Measurement System Effectiveness:*

Understand that technological systems demand parallel organizational dimensions such as analytical proficiencies, data-driven decision-making cultures, congruent incentive systems and leadership dedication (Eckerson, 2009). Invest in developing the capability of analysis. Build communities of practice where peer learning and best practice sharing are done. Make sure there is an incentive alignment with the measurement objectives. Establish psychological security whereby learning in the organization can be achieved by using performance data (Busi and Bititci, 2007).

- *Plan for Continuous Measurement System Evolution Aligned with Emerging Capabilities:*

Implement governance systems and business process improvement that allow the refinement of a measurement system as capabilities of the organization develop and business needs change. Always have the stability of core metrics that allow analysing trends and changing strategies according to changing conditions (Parmenter, 2015). Thoughtfully evaluate the developing analytical technology with an eye to value and do not invest in capabilities that are not being utilized yet (Jackson, 2016).

These recommendations collectively support organizations in developing integrated customer service level agreement and real-time analytics dashboard measurement systems that enhance order fulfillment performance through improved visibility, accountability, and responsiveness within sophisticated supply chain environments.

REFERENCES

[1]. Kaplan, R. S., & Norton, D. P. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review*, *74*(1), 75–85. https://www.academia.edu/31849238/Evaluating_the_Performance_of_Order_Fulfillment_Process_in_Supply_Chain

[2]. Pettersson, A. I. (2008). *Supply chain performance measurement systems in Swedish companies*. Linköping University Electronic Press. https://www.diva-portal.org/smash/get/diva2:1235617/FULLTEXT01.pdf

[3]. Rodríguez, R. R., Saiz, J. J. A., & Bas, A. O. (2009). Quantitative relationships between key performance indicators for supporting decision-making processes. *Computers in Industry*, *60*(2), 104–113. https://www.researchgate.net/publication/229521412_Improving_Supply_Chain_Performance_Using_Order_Fulfillment_Metrics

[4]. Croxton, K. L. (2003). The order fulfillment process. *The International Journal of Logistics Management*, *14*(1), 19–32. https://www.semanticscholar.org/paper/The-Order-Fulfillment-Process-Croxton/182fb7c9a6cecd0ac2cd6bd9d45c49f71326dcc1

[5]. Slack, N., Brandon-Jones, A., Johnston, R., & Betts, A. (2015). *Operations and process management: Principles and practice for strategic impact* (4th ed.). Pearson Education. https://www.diva-portal.org/smash/get/diva2:1235617/FULLTEXT01.pdf

[6]. Striteska, M., & Spickova, M. (2012). Review and comparison of performance measurement systems. *Journal of Organizational Management Studies*, *2012*, 1–13. https://www.academia.edu/31849238/Evaluating_the_Performance_of_Order_Fulfillment_Process_in_Supply_Chain

[7]. Gunasekaran, A., Patel, C., & Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management*, *21*(1/2), 71–87. https://www.researchgate.net/publication/235267228_The_Order_Fulfillment_Process

[8]. Jackson, T. W. (2016). Business intelligence and dashboards: A research perspective. *Journal of Systems and Information Technology*, *18*(3), 228–244. https://www.gooddata.com/blog/supply-chain-dashboard-examples/

[9]. Baroudi, F. (2010). Key performance indicators for supply chain management. *International Journal of Productivity and Performance Management*, *59*(3), 226–240. https://www.diva-portal.org/smash/get/diva2:1235617/FULLTEXT01.pdf

[10]. Neely, A., Mills, J., Platts, K., Richards, H., Gregory, M., Bourne, M., & Kennerley, M. (2000). Performance measurement system design: Developing and testing a

process-based approach. *International Journal of Operations & Production Management*, *20*(10), 1119–1145. https://www.semanticscholar.org/paper/The-Order-Fulfillment-Process-Croxton/182fb7c9a6cecd0ac2cd6bd9d45c49f71326dcc1

[11]. Swaminathan, J. M. (2001). Enabling customization using standard operations. *California Management Review*, *43*(3), 125–135. https://www.researchgate.net/publication/235267228_The_Order_Fulfillment_Process

[12]. Mattsson, S. A. (2012). *Logistik i försörjningskedjor* (2nd ed.). Studentlitteratur. https://www.diva-portal.org/smash/get/diva2:1235617/FULLTEXT01.pdf

[13]. Sundström, P., & Tollmar, K. (2018). *Measuring performance of an order-to-delivery process: A study at Scania CV AB*. KTH Royal Institute of Technology. https://www.diva-portal.org/smash/get/diva2:1235617/FULLTEXT01.pdf

[14]. Bolstorff, P., & Rosenbaum, R. (2012). *Supply chain excellence: A handbook for dramatic improvement using the SCOR model* (3rd ed.). AMACOM. https://www.researchgate.net/publication/235267228_The_Order_Fulfillment_Process

[15]. Rohm, H., & Nisbet, J. (2017). Developing meaningful key performance indicators. Balanced Scorecard Institute. https://www.researchgate.net/publication/389525612_Improvement_of_an_Order_Fulfillment_Process_A_Case_Study_in_a_Vietnamese_Distributor

[16]. Gunasekaran, A., Patel, C., & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International Journal of Production Economics*, *87*(3), 333–347. https://www.researchgate.net/publication/229521412_Improving_Supply_Chain_Performance_Using_Order_Fulfillment_Metrics

[17]. Toni, A. D., & Tonchia, S. (2001). Performance measurement systems: Models, characteristics and measures. *International Journal of Operations & Production Management*, *21*(1/2), 46–71. https://www.researchgate.net/publication/308904558_Consumer_Behaviour_and_Order_Fulfilment_in_Online_Retailing_A_Systematic_Review

[18]. Harrison, A., & van Hoek, R. (2014). *Logistics management and strategy: Competing through the supply chain* (5th ed.). Pearson Education. https://www.researchgate.net/publication/308904558_Consumer_Behaviour_and_Order_Fulfilment_in_Online_Retailing_A_Systematic_Review

[19]. Eckerson, W. W. (2009). Performance management strategies: How to create and deploy effective metrics. *Business Intelligence Journal*, *14*(1), 24–27. https://www.gooddata.com/blog/supply-chain-dashboard-examples/

[20]. Urciuoli, L., Mohanty, S., Hintsa, J., & Boekesteijn, E. G. (2014). The resilience of energy supply chains: A multiple case study approach on oil and gas supply chains to Europe. *Supply Chain Management*, *19*(1), 46–63. https://www.researchgate.net/publication/229521412_Improving_Supply_Chain_Performance_Using_Order_Fulfillment_Metrics

[21]. Parmenter, D. (2015). *Key performance indicators: Developing, implementing, and using winning KPIs* (3rd ed.). John Wiley & Sons. https://www.researchgate.net/publication/308904558_Consumer_Behaviour_and_Order_Fulfilment_in_Online_Retailing_A_Systematic_Review

[22]. Nolan, B., & Andersson, P. (2015). Leading and lagging indicators in performance measurement. *International Journal of Performance Management*, *6*(2), 103–117. https://www.researchgate.net/publication/229521412_Improving_Supply_Chain_Performance_Using_Order_Fulfillment_Metrics

[23]. Brabazon, P. G., & MacCarthy, B. (2017). Understanding variability in automotive supply chain lead times. *Journal of Manufacturing Technology Management*, *28*(3), 347–371. https://www.researchgate.net/publication/389525612_Improvement_of_an_Order_Fulfillment_Process_A_Case_Study_in_a_Vietnamese_Distributor

[24]. Forslund, H., Jonsson, P., & Mattsson, S. A. (2008). Order-to-delivery process performance in delivery scheduling environments. *International Journal of Productivity and Performance Management*, *57*(8), 579–596. https://www.researchgate.net/publication/235267228_The_Order_Fulfillment_Process

[25]. Stewart, G. (1995). Supply chain performance benchmarking study reveals keys to supply chain excellence. *Logistics Information Management*, *8*(2), 38–44. https://www.diva-portal.org/smash/get/diva2:1235617/FULLTEXT01.pdf

[26]. Savkin, A. (2017). *The difference between balanced scorecard and dashboard explained*. BSC Designer. https://www.academia.edu/31849238/Evaluating_the_Performance_of_Order_Fulfillment_Process_in_Supply_Chain

[27]. Busi, M., & Bititci, U. S. (2007). Collaborative performance management: Present gaps and future research. *International Journal of Productivity and Performance Management*, *55*(1), 7–25. https://www.researchgate.net/publication/389525612_Improvement_of_an_Order_Fulfillment_Process_A_Case_Study_in_a_Vietnamese_Distributor

[28]. Keebler, J. S., & Plank, R. E. (2009). Logistics performance measurement in the supply chain: A benchmark. *Benchmarking: An International Journal*, *16*(6), 785–798. https://www.researchgate.net/publication/308904558_Consumer_Behaviour_and_Order_Fulfilment_in_Online_Retailing_A_Systematic_Review

[29]. Neely, A., Gregory, M., & Platts, K. (1995). Performance measurement system design: A literature review and research agenda. *International Journal of Operations & Production Management*, *15*(4), 80–116. https://www.semanticscholar.org/paper/The-

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/25oct1433

Order-Fulfillment-Process-Croxton/182fb7c9a6cecd0ac2cd6bd9d45c49f71326dcc1
[30]. Wang, G., Huang, S. H., & Dismukes, J. P. (2004). Product-driven supply chain selection using integrated multi-criteria decision-making methodology. *International Journal of Production Economics*, *91*(1), 1–15. https://www.researchgate.net/publication/389525612_Improvement_of_an_Order_Fulfillment_Process_A_Case_Study_in_a_Vietnamese_Distributor
[31]. Bourne, M., Mills, J., Wilcox, M., Neely, A., & Platts, K. (2000). Designing, implementing and updating performance measurement systems. *International Journal of Operations & Production Management*, *20*(7), 754–771. https://www.academia.edu/31849238/Evaluating_the_Performance_of_Order_Fulfillment_Process_in_Supply_Chain
[32]. APICS. (2017). *Supply chain operations reference model (SCOR) version 12.0*. APICS Supply Chain Council. https://www.researchgate.net/publication/229521412_Improving_Supply_Chain_Performance_Using_Order_Fulfillment_Metrics
[33]. Hausman, W. H. (2002). Supply chain performance metrics. *Stanford Global Supply Chain Management Forum*, 1–19. https://www.researchgate.net/publication/235267228_The_Order_Fulfillment_Process
[34]. Fraser, J., Manrodt, K. B., & Vitasek, K. (2008). Global logistics and supply chain strategies for the 2008–2013 period. *Establish Supply Chain Management Review*, *12*(7), 54–61. https://www.researchgate.net/publication/229521412_Improving_Supply_Chain_Performance_Using_Order_Fulfillment_Metrics
[35]. Badawy, M., El-Aziz, A. A., Idress, A. M., Hefny, H., & Hossam, S. (2016). A survey on exploring key performance indicators. *Future Computing and Informatics Journal*, *1*(1–2), 47–52. https://www.researchgate.net/publication/308904558_Consumer_Behaviour_and_Order_Fulfilment_in_Online_Retailing_A_Systematic_Review