

**A Structural Approach of Integrating Total Quality
Management and Big Data Analytics in Supply Chain
Management to Improve Business Performance in FMCG
Industry**

نهج هيكلي لدمج إدارة الجودة الشاملة وتحليل البيانات الضخمة
في إدارة سلسلة التوريد لتحسين أداء الأعمال في صناعة
السلع الاستهلاكية سريعة الدوران

by

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of the requirements for the degree of
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Abstract

The Supply Chain Management inside the industry of Fast-Moving Consumer Goods is considered one of the most complex supply chains due to high uncertainties and complexities due to involvement of different supplier, transportation problems and lead time issues. Therefore, this study examines the ability of integrating the concept of Total Quality Management which is considered one of the vital philosophies which tends to improve organizations in terms of achieving customer satisfaction and maintain continuous improvement which is highly needed inside the Supply Chain Management, as well as the Data Analytics tools which became very vital in decision making with the ability to clean, examine and analyze data to predict for future supply and demand, lead times and provide flexibility inside the Supply chain cycles, in improving the Supply Chain Management performance providing the Supply Chain Managers with high ability to predict future issues, selection of supplier, improve relation with costumers which will improve overall performance. Therefore, this study is conducted to identify areas of improvements in Supply Chain Management which can be improved through integrating the Supply Chain Management Practices with Total Quality Management Practices and Data Analytics tools. The study is based on collecting the main practices of each variable and collect data through preparing a questionnaire provided to experienced Supply Chain Managers in the field of Food Moving Consumer Goods. Structured Equation Modelling is used to test and validate the correlations between the variables examined and to test for the hypotheses developed. Thus, this study is considered very beneficial in terms of investigating the importance of integrating of the philosophies and practices to lead to better business performance and prepare organization for continuous improvements in every measure of the supply chain cycle.

الملخص

يعد تكامل إدارة الجودة الشاملة (TQM) وإدارة سلسلة التوريد (SCM) وتحليلات البيانات لتحسين أداء الأعمال مجال بحث ذي تطبيق محدود. على الرغم من أن العديد من الباحثين درسوا تأثير دمج إدارة الجودة الشاملة على إدارة سلسلة التوريد SCM وتأثير تطبيق تحليلات البيانات على SCM في تحسين أداء الأعمال ، إلا أن هناك فجوة في دراسة تأثير دمج المفاهيم الثلاثة معًا لتحسين أداء الأعمال. الغرض من هذه الدراسة هو غرض مزدوج، من خلال أولاً: معالجة الفجوة في البحث عن تكامل إدارة الجودة الشاملة و SCM وتحليلات البيانات لتحسين أداء SCM المطلق في صناعة السلع الاستهلاكية، وثانياً : اقتراح نموذج مفاهيمي يحقق في العلاقات المباشرة وغير المباشرة بين المفاهيم الثلاثة وتأثيرها على أداء SCM المطلق من حيث المرونة ، وتحسين التكلفة ، والتحسين المستمر وفعالية الموظفين مما سيؤدي إلى تحسين أداء الأعمال. تعتبر هذه الدراسة بمثابة مبادرة ولفت الانتباه إلى أهمية تطبيق ممارسات إدارة الجودة الشاملة وبنيات تحليلات البيانات في تحسين ممارسات SCM و SCM المطلق ومن ثم خلق ميزة تنافسية. ستدرس الدراسة أيضاً تأثير تطبيق تحليلات البيانات في ممارسات إدارة الجودة الشاملة. تم جمع البيانات المستخدمة في هذه الدراسة من خلال مدراء سلسلة التوريد ذوي الخبرة والذين لديهم أكثر من ثلاث سنوات من الخبرة في مجال السلع الاستهلاكية والمعرفة في مجال إدارة الجودة الشاملة. اعتمد البحث على نمذجة المعادلات الإنشائية بعد بناء النموذج المفاهيمي والتحقق من صحته باستخدام تحليل عامل الاستكشاف وتحليل عامل التأكيد. أظهرت النتائج أن ممارسات إدارة الجودة الشاملة تؤثر بشكل كبير على ممارسات SCM ، وهذا يؤثر بالمقابل على أداء SCM المطلق. أظهرت النتائج أيضاً أن تحليلات البيانات مرتبطة بشكل كبير بممارسات إدارة الجودة الشاملة وممارسات إدارة سلسلة التوريد SCM. يمكن استخدام نتائج البحث بشكل أكبر لتحسين إدارة سلسلة التوريد في صناعة السلع الاستهلاكية .

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Abbreviations

AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CR	Composite Reliability
EFA	Exploratory Factor Analysis
DA	Data Analytics
DMAIC	Define, Measure, Analyze, Improve and Control
FMCG	Fast Moving Consumer Goods
KMO	Kaiser Meyer Olkin Test
MSV	Maximum Shared Variance
QM	Quality Management
HR	Human Resources
SC	Supply Chain
SCM	Supply Chain Management
TQM	Total Quality Management

Chapter I.

1.1. Introduction

We are living in a dynamic environment in which big organizations faces high pressure to meet their customer demands in terms of quality and delivery. Many companies have utilized the approach of supply chain in their strategy to meet customer demands. However, as the competition in the market increases supply chains become more complex and needs optimization to cut the costs and optimize delivery. Therefore, integrating the supply chain with quality management would lead to significant improvements in running businesses by being able to consider both internal and external factors to optimize productivity and reduce expenses (Mahdiraji et al. 2012). Total Quality Management (TQM) and Supply Chain Management (SCM) both are considered important philosophies utilized by manufacturers in order to gain an edge in competitive markets. TQM tends to emphasize on optimizing the internal effectiveness in terms of employees and product quality, while SCM emphasizes on the importance of external factors and partnerships. Integrating TQM and SCM would help organizations to reach customer satisfaction which is the ultimate goal of any business to improve their performance. Quality is associated with eliminating non-value adding process through the whole process from receiving of the raw materials until the delivery of the product to the customers. Therefore, the aim of quality is to deliver non-defective product to the end user (Serdar Asan et al. 2007). Quality management also play an important role in making a business more proactive to meet their demands, rather than being just reactive to their requirements (Mahdiraji et al. 2012). Any organization associated with supply chain is considered as both a customer and supplier. Therefore, it is vital to have customer focused strategy in the business while implementing both philosophies in upstream and downstream supply chains to improve their absolute business performance, optimize productivity, decreasing of inventory levels and reducing cycle time. The FMCG (Fast Moving Consumer Goods) is considered a very competitive market

these days in which the quality and supply chain managers face new obstacles and challenges to be able to withstand the fluctuating dynamic market. Furthermore, as the world is approaching the term Industry 4.0 and the number of machines, products, customers, suppliers and processes are extensively increasing with large amount of data is collected, the term Data Analytics can be used in this context to SCM which handles large amount of data and information which cannot be analyzed by traditional means. The advantages of using Data Analytics in Supply chain is numerous in which the processes and logistics within a supply chain is enormous and complex. Thus, the use of data analytics can help to answer questions about these data, execute insights to future prospect or current problems which will help in decision making (Awwad et al. 2018). The topic of this research is implementing TQM and Data Analytics in Supply Chain processes will lead to optimization of internal operations and processes and connecting them with external users including the customers and suppliers which will lead to higher efficiency and enhancement in the absolute performance of a company.

1.2. Background of the Study

There are various research and studies performed on both Total Quality Management and Supply Chain Management Separately and both together under the name of Supply Chain Quality Management as well as Data Analytics. Most of the previous studies contributes in studying the inclusion and integrating of these two concepts in order to improve the operations within different industries.

Suhardi et al. (2019) researched the integration of Total Quality Management in the Supply Chain Management inside the Textile Manufacturing. The research is centered around difficulties within the operating and supply chain of the textile manufacturing industry due to weak human resources and difficulty of obtaining the raw materials at the optimum cost and problems with defining the raw materials quality. Therefore, the researchers found out that the solution for these issues can be

overhauled by a management plan to overcome the issues. Which can be done by integrating the TQM in the SCM of the company. The research involved using of studying the effect on a number of employees at 8 different factories after applying TQM in SCM and test the results using simple regression. The study showed the TQM was influenced by SCM and the integration was successfully performed and affected the financial and operational processes of the factories.

Sharma and Modgil (2015) studied the importance of integrating of SCM and TQM in order to improve supply chain overall performance. The study involved examining four different case studies to find the independent variables which impacts the business performance. The variables were categorized into four categories which include exploration and exploitation related to Quality Management (QM) and SCM. The study provides how SCM and QM can be introduced to firms to enhance their performance, and how to introduce to organizational structure and how it can be used to emphasize on customer requirements.

Talib et al. (2010) researched the common practices of TQM and SCM by utilizing literature review. In which the research was able to list all or most common practices in each of the concepts and identifying the relations between both concepts. The research found out that the commitment and support of management, customer focus as well as good relationships with suppliers are most common principles and practices in both concepts and affect the integration of both concepts together significantly.

Tutuncu et al. (2008) focused on the influence and the effects of the integration of Quality Management and Supply Chain Management inside the health care sector. In which the supply chain includes purchasing of equipment and machines for hospitals. The study showed a positive impact of applying Quality Management in the Supply Chain Management.

Zimion (2016) examined the influences of applying Total Quality Management in the logistics processes in the Supply chain and how the integration of both concepts can improve operations in the logistics. The study showed the positive impact of TQM on Supply chain in which it enhances the relationships with customers, improve the customer service and evolve subsystems of logistics. As well as, ensuring high quality products.

Zimon (2017) studied the effects of quality management on the distribution channels in the FMCG industry. The research was based comparison between distribution channels with standardized quality management and without. The study found out that applying quality management to distribution channels improved accuracy, customer service, reduced faults and reduced delays.

Lai et al. (2004) studied the implementation of Quality Management in the logistics industry and constructed ten steps guide in order to implement quality in the industry, to optimize costs and services. The approach was based on certain steps to implement Quality Management System (QMS) which begin with the commitment of the management and raising awareness about the importance of quality improvement. The second step is by defining a quality improvement department or team to lead to quality improvement inside of the organization and define objectives by understanding the customer needs and requirements. Followed by Quality Measurements and setting methods for measuring the performance and setting Key Performance Indicators (KPIs) to gauge the outcomes. Then creating quality awareness within top management and employees to lead to commitment of all employees in quality improvement. Followingly, creating a trainings and sessions for managers and employees as well as setting up goals (such as zero defects) to optimize the efficiency. Then provide corrective and preventive actions to maintain quality improvement. Finally, maintaining a continuous improvement system to be able to sustain the dynamic environment.

1.3. Research Importance

The importance of the research is to integrate two important philosophies Supply Chain Management and Total Quality Management with the Big Data Analytics to improve the absolute supply chain management performance in FMCG industry. The research will focus on the main principles of both philosophies SCM and TQM and their practices and how they are similar and different to each other's. As well as the means of utilizing Big Data Analytics to give insights on complexity of SCM and be able to forecast and visualize. The research will further investigate new factors that weren't discussed before in previous studies which will be analyzed by studying both philosophies and analyzing areas that wasn't discussed before. As well as the research will provide a framework for FMCG industry leaders on how to integrate the TQM to SCM in order to improve their competitive advantage in the market, optimize cost and produce high quality products and provide why the FMCG needs the integration of the philosophies to fulfill their needs and gain an advantage.

1.4. Research Problem Statement

Supply Chain Manufacturers are facing complexities regarding implementing a SCM in FMCG industry which will lead to optimize the costs of production and transportation, maintaining a good relationship with co entities involved in the supply chain and decrease the response time (Zimon 2017). Therefore, Total Quality Management principles which involves certain principles will be utilized to assists the supply chain management to hinder the issues and become a more efficient system which will improve the overall business performance in the FMCGs. As well as the use of Data Analytics which will help in analyzing data and provide insights detailed about the supply chain cycle. Many practices and principles were discussed in the previous literature review, that will be investigated, and new further practices and factors will be investigated within the context of study.

1.5. Research Aims and Objectives

The aims and objectives of this research is to study the importance of integration of Total Quality Management and Supply Chain Management in the FMCG sector to improve the Absolute SCM performance performance of the companies working in the industry. As well as the role of using Data Analytics to facilitate the integration and optimizing the performance. The study will examine the important principles and practices associated with Quality Management, as well as Supply Chain Management and the utilization of Data Analytics to improve the Absolute SCM Performance. The study will further examine the common practices and comparison between two concepts and provide a guide for integrating both concepts into a new concept of Supply Chain Quality Management. The study will also examine the issues which is encountered in the Supply Chain Cycles of FMCG industry, and the importance of implementation in this agile industry and how it is different from other industries. As well as, validating how the adoption of Supply Chain Quality Management will aid in clearing these issues and improve the business performance of the companies in this industry.

1.6. Research Conceptual Framework

The conceptual framework (Figure 1) of the study is defined by measuring the correlations between integrating the Total Quality Management Practices, Supply Chain Management Practices, Data Analytics tools in order to improve the Absolute Supply Chain Management Performance in FMCG industry to build a competitive edge in the market, by being able to respond faster for dynamic environment, improve internal environment of the firm and gain more flexibility in Supply Chain. There are variables which are TQM practices, SCM practices, Data Analytics tools which contribute together to lead to better Supply Chain Management. Six hypotheses are formulated then developed to test direct correlations between the four latent variables. In which each variable consists of certain items which is the practices such as Leadership in TQM which will be

investigated using set of statements contributed together to a questionnaire which is distributed on Supply Chain Manager in the field of FMCG with over three years of experience and knowledge of Total Quality Management Practices.

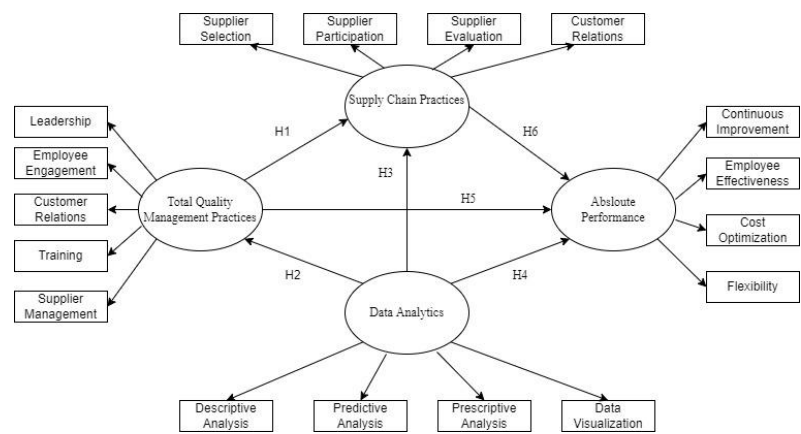


Figure 1 Conceptual Framework

Chapter II.

2.0. LITERATURE REVIEW

2.1. Supply Chain Management (SCM)

Supply chain contains every party connected in a direct or indirect way in order to meet customer requirements. The parties included involves suppliers, manufacturers, retailers, warehouses and customers in both downstream (Customers) and upstream (Suppliers) flows of products or services. Supply chain management allows customer to be involved internally in the chain. Supply chain (Figure 2) is a complex dynamic flow of data in different levels which its ultimate aim is to satisfy their consumers and fulfill their demands (Mahdiraji et al. 2012). A customer will be satisfied as long as his goods/service is delivered in a high quality, flexibility and fast delivery. This is true in all sectors of supply chain from raw materials suppliers to manufactures to disciplined entity to customers. The success of this chain can be successful if the chain follows certain activities including integration, co-operative environment, long-term partnering and successful communication. The overall idea of Supply chain management is unifying business processes throughout the chain in order to achieve co-ordination, visibility and synchronizing information sharing, in order to be able to identify improvements areas and define factors for success in the business operations in order to be able to meet their customers' needs and expectations (Serdar Asan et al. 2007). There are three processes inside an integrated SC which are Strategic Supplier Partnership, Customer Relationship and Sharing of Information. In which Customer relationship is a strategy of building a trust bond between the entity with customers including existing and new ones in order to achieve customer loyalty. This includes technical support, call center and sales workforce which maintain a bond between entity and direct consumers (Suhardi et. al 2019)



Figure 2 Supply Chain Cycle (Suhardi et. al)

2.1.1. Issues Related to SCM

The issues associated with SCM are summarized in (Figure 3) includes the communication between the entities inside the supply chain between them each other's and the end user, uniformity of supply, marketing, leadership and quality improvements and logistics (Mahdiraji et al. 2012).



Figure 3 Issues related to SCM (Mahdiraji et al. 2012)

2.2. Total Quality Management (TQM)

Quality has different definition approaches the most used one is defined by ISO 9000 is that quality is the extent of a set of characteristics conforms to requirements. In which requirements are divided into three terms: quality requirements for process (being able to achieve high process capability), quality requirements for systems and quality requirements for products (regarding specification and standards and customer needs and requirements). Therefore, Quality Management can be defined as

set of activities used to manage and operate an entity based on quality perspectives. QM have certain perspectives which are establishing quality policy, determining quality plan to determine specifications and inspection scheduling, quality control (Inspections, Audits and Quality Reports), develop and organizing quality assurance and planning of quality improvements. Quality Management Systems is the department inside an entity which is responsible for achieving organizational goals with direct relatedness with the quality perspectives to be able to meet customer needs and expectations (Serdar Asan et al. 2007).

In another words, QM is supervising all activities and practices of a certain process to ensure that end product is fulfilling the standards and specifications as well as customer needs. This QM cycle takes place from the stage of ordering raw materials until the stage of selling and after sales as well (Mahdiraji et al. 2012). There are eight principles defined by ISO 9000 for Quality Management. These eight principles are defined below with their positive impact on SCM (Serdar Asan et al. 2007).

- a. Customer focus: firms should be able to define their customers and their needs and expectations. Which will allow entities to manage customer relationships and allow engagement of customer within supply chain cycle.
- b. Leadership: each department and team of this entity should have a leader which provide unification of purpose and direction of the firm and ensure engagement of every person inside in the entity to meet customer requirements. This will ensure good communication channels, build trust and create shared values inside the organization and other parties.
- c. Engagement of People (Employee): Everyone inside the entity is responsible for quality, which enable them to show their abilities which will work as an asset for the firm. The employee also will be motivated and encouraged to perform their tasks and engage in continuous improvements plans.

- d. Process Approach: In which every activity or tasks is treated as a process. Which will tend to cut the costs and expenses, allow shorter lead time and improve the overall quality of the outcome. As well as assisting in analyzing and evaluating the risks involved of these tasks and activities delay on the customers.
- e. System Approach: in which inter-related process are defined and analyzed as a whole system which affects the overall effectiveness and efficiency of the output. This will lead to better focus on key process and their connectivity to other processes which will lead to better synchronization.
- f. Continuous Improvement: which follows kaizen approach of continuous improvements of the whole performance of the entity and defining improvement factors. Which will ensure flexibility.
- g. Decision Making: Decisions should be taken after evaluating and analyzing of data extracted.
- h. Supplier Relationships: Is establishing a relationship with the suppliers based on benefits to both of them. This will ensure long term partnerships with suppliers as well as ensuring better data sharing which will lead to conforming to customer needs.

2.2.1 TQM Practices Items

2.2.1.1 Leadership

Jermstittiparsert (2019) studied the influence of Leadership on Supply Chain Management and found out that leadership plays important role in supply chain industry in which it provides improvements and enhancements within the firms. Therefore, it leads to increase in productivity of employees and performance of the organization will gradually increase. The improvement in performance is entitled with everything through the supply chain cycle from design of process, innovations facilities, delivery scheduling, planning, visualizations and insights and supplier relations. The third statement is ‘Top Management plays important role in driving leadership practices inside the organizations.’ Hameed et. al (2018) studied the integration of leadership on supply chain overall performance and proved there is a positive relationship between supply chain top management leadership and supply chain management effectiveness.

2.2.1.2. Customer Relations

Omoryui and Mafini (2016) investigated in their research study “Supply Chain Management and Customer Satisfaction in Small to Medium Enterprises” the relation between customer satisfaction and SCM practices to improve SCM performance. The paper stated that customer satisfaction is considered one of the major elements for the business improvements and evolvments. In which building a loyal base of customer is important for small and medium firms to increase performance and profits. The study tested the performance of supply chain through product quality and its flexibility and found out that there is a relationship between interfering of customers inside supply chain.

2.2.1.3. Supplier Management (Process Management)

Quality Management is related to the Supply Chain with practices contributing to quality of products, cost optimization and whole performance (Chalotra 2015). In which process management include the effective implementation of a process to maximize output and avoid delays. In which, TQM is included in the process of supplier management which tends to improve product quality, aid in problem solving and decision-making skills which will lead to continuous improvement and applying corrective actions. Thus, the organization is able to deliver quality products which fit clients' needs and expectations (Balamurugan 2020).

2.2.1.4. Employee Engagement

Sharma (2014) considered the importance of employee engagement in supply chain cycles. In which she defined employee engagement as an employee who is fully contributing to his work as well as share his perspectives and opinions within the firms he belongs to, which would improve employee satisfaction and improve his productivity and performance.

2.2.1.5. Trainings

Tramarico et. al (2015) suggested in their research paper "Benefits Assessment of Training on Supply Chain Management" that trainings presented to Supply Chain Managers is beneficial for individuals and on the organization. Therefore, firms should provide trainings to employee to improve their competencies and enhance their performance.

2.3. Supply Chain Quality Management (SCQM)

Both SCM and TQM main purpose is to reach customer satisfaction, by having a great effect on enhancing the entity performance and gain competitive edge in the market. However, they have different approaches to meet customer needs. For instance, TQM depends on ensuring quality through the whole process from ordering raw materials until after sales. While SCM tend to ensure

the delivery of products in certain costs and lead times. Therefore, integrating both TQM and SCM concepts into Supply Chain Management (SCQM) will lead to delivery of high-quality product and delivered appropriately will lead to customer satisfaction. QM tends to focus on internal operations inside the entity, while SCM tend to focus on external operations outside the entity with suppliers (Mahdiraji et al. 2012). Applying QM through every stage of SC will lead to better outcome and would enable higher engagement of employee and customer satisfaction. Integrating both concepts will lead to certain common perspectives which overlaps between both concepts. These perspectives are customer focus, continuous improvements, long term supplier relationships, co-operation, systematic approach and information sharing (Serdar Asan et al. 2007). SCQM is a concept derived from both TQM and SCM to improve the overall performance of entities in a supply chain cycle. SCQM co-ordinates and integrates different entities working in a supply chain to analyze and continually improve of outcome and services to create value and conform to customer requirements and expectations. This will lead to cutting costs of products and faster deliver (upstream and downstream flows) and be able to respond quickly and robustly to meet demands of customers (Mahdiraji et al. 2012).

2.3.1 Comparison between SCM and TQM

(Mahdiraji et al. 2012) provided a comparison table between both concepts, which will ease the approach of defining the similarities between both concepts and how Quality Management can be utilized in Supply Chain Management practices to enhance it.

2.3.2. The Benefits of Integrating of TQM and SCM

Integrating both techniques can be done by applying the QM principles in the SCM activities and practice, which would be an idle method to improve the performance of the chain. The unification of both methods can be achieved by unifying the focus between all the entities inside the supply chain to create a quality chain. In which every member of the chain is responsible for quality within

the chain and each entity acting as a supplier for both downstream flows (End users) and upstream flows. This integration will lead to provide a SCQM philosophy which will include both advantages of the two concepts and use QM concepts to overcome SCM issues (Serdar Asan et al. 2007). The advantages of each concept are provided in Table 3. In this way the SCQM will focus on both internal and external corporate supply chain and relationships between members of the chain (Mahdiraji et al. 2012).

2.3.3. SCM Practices

2.3.3.1. Supplier Selection

Rathore (2016) suggested that selecting the supplier is one of the major activities within the supply chain management which include evaluation through both quantitative and qualitative methods. In which quality, delivery times and price are the top of the criteria for choosing the suppliers.

2.3.3.2. Supplier Participations

Zahraee and Kafuku (2015) examined the effect of supplier participation on SCM. The research stated that there is a positive correlation between supplier participation in the SCM activities and supply chain management performance. Liang et. al (2011) also suggested the importance of coordination between the manufacturer and supplier in decision making in order to ensure enhancement in the supply chains and fast response to the increase in demand.

2.2.3.3. Supplier Evaluation

Abror et. al (2011) studied the importance of suppliers' selection and evaluation within supply chain management. In which the supplier selection and evaluation is considered the first strategy step in order to ensure a good supply chain management. In which a rating criteria model should be developed to evaluate the supplier using certain developed rating scale in terms of quality, deliver, service and internal management of the supplier. In which the study found out that following and

supplier evaluation model would lead to improvements in decision making within the supply chain management.

2.2.3.4. Customer Relations

Sigala (2013) suggested that involving customers in supply chains in which involvement of customer provides flexibility and better efficiency within the supply chain cycles. Ozlen and Hadzihametovic (2013) also studied the importance of customer relationship management on the SCM. In which the research stated that maintain long term relationships between the manufacturer and customers is important for improvements in supply chain management.

2.4. Supply Chain Management Six Sigma

SCM was initially utilized to improve inventory management and reduce cost of operation.

However, currently SCM is used by the organizations in terms of process innovation, planning and execution in order to improve the business operations. Therefore, six-sigma can be utilized within the SCM in order to reduce variability and improve the supply chain cycles (Yang et al. 2007). Six Sigma is a Quality Management approach which is a set of statistical tools within the QM in order to improve the processes. Six Sigma level of performance measures is related to Critical to Quality which is related to customer requirements. Achieving six sigma means being able to achieve a process which will yield less than 3.4 defected units per million (Tjahjono et al. 2010). Yang et al. (2007) suggested that there are four areas can be defined in implementing the six-sigma philosophy in SCM:

- Project discipline: In which the process of Six Sigma follows a process defined as DMAIC which include five processes Define, Measure, Analyze, Improve and Control. In which this process can be used to reduce variability within in the SCM by make sure the elements of SCM were identified correctly and executed

following a proper methodology. Also, defining the root causes and being able to investigate it and able to correct and improve it.

- **Sustaining Results:** One of the major challenges within the SCM is being able to sustain the outputs which can be achieved by continuous improvements. In which the approach of closed loop which feedback is given within the last stage of the DMAIC process Control or the verify stage of DMADOV by following up to make sure continuous improvements take place.
- **Efficient Human Resources framework:** In which the continuous improvements within the SCM is depending on the people. In which employees within the organizations should be continuously trained, qualified in order to be able to innovate within the SCM and totally utilize any room for improvement within the SCM. Therefore, the HR should be able to find qualified talents which could improve the process and provide room for innovations within the SCM.
Therefore, the six-sigma approach can be utilized to improve and develop the employees which would increase the competency within the employees. For example, using the colored belts system of six sigma as adopted within Samsung Group to be able to develop and qualify the employees.
- **Strengthen the Quantitative Analysis:** Six Sigma could improve the quantitative data analysis within the SCM, in which data can be used to solve problems and issues within the SCM and make decisions.

2.5. Big Data Analytics

Big Data Analytics it is the use of statistics and visualizations in order to handle a lot of data and information in order to extract important details and knowledge from large quantities of spread sheets and data. It aids in the process of decision making by being able clean, wrangle and visualize

important data from the existing data. There are three stages of analyzing data which are perspective, predictive and descriptive analysis. First, perspective analysis is used when we have activity or process such as manufacturing or logistics in which the decision maker can use the data to act accordingly. The second one is Predictive; it is the use of data to make forecasts for the future by measuring and visualizing data. Finally, descriptive analytics which is exploring data and getting the main descriptive data you need from the large amount of data such as mean, mode and median and other questions you may ask about the data (Soomro et al. 2017).

2.5.1. Importance of Big Data in Supply Chain

As the supply chain management is improving with the time and the technological advancements in this field is also growing and chains become more complex, the amount of data retrieved is also increasing very fast. Every supply chain has lots of information which can be allocated from different spreadsheets which need to be analyzed in order to find important insights. These lots of data is considered as big data. This could help supply chain managers to get to know what their customer needs is and be able to optimize the cost upon these data by making decisions according to the data he analyzed. (Figure 6) shows the most common sources of data inside the supply chain. They are classified into three categories structured data, semi-structured data and unstructured data, which is related to the volume and velocity of the data upon its generation. It was found out that most sources of data allocated are from Transactions, Social Media and Point of Sale indicators (Awaad et al. 2018). The use of Big Data Analytics can help supply chain managers to be able to solve complex issues which they face in the processes or unstructured information which is extracted from it. In which supply chain cycles includes many entities including raw materials, work in progress and products returned and a lot of data which can be complex to analyze using traditional means and traditional use of spread sheets. In which every supply chain includes different elements which can be linked to each other's in a straightforward way or not. Therefore, the use of data

analytics can help to handle lots of supply chain data and compute certain needs and visualize the data. Complexity in Supply chain includes, numerous amounts of supply chain entities, diversity of supply chain in terms of heterogenous or homogenous, variety of systems, uncertainties in which supply chain data may include missing data about actual delivery data and other elements (Awaad et al. 2018).

Applications of Data Analytics in Supply chain are numerous in which it will help the organization using it to uncovers hidden information which can aid the entity to overcome the challenges of supply chain to be able to improve and optimize the processes. Being able to know the customer needs and demands and assess the whole chain in terms of efficiency and risk and cycle time. First of all, it will aid in providing insights about customer requirements which will aid the company to satisfy their customer and meet their requirements and expectations. This will increase the entity reputation and will help the company to find their target customer and their demanded product and deliver at optimum time. Therefore, Data Analytics help organizations to analyze historical data and predict future needs of the customers and understand their requirements. It will help in improving efficiency of supply chain cycle in which a company can optimize the costs and eliminate unwanted processes. The data analytics will also help to assess the overall performance of the supply chain cycle and help in understanding the problems and predict future problems. As well as being able to improve the agility by being able to react fast and flexibly to meet customer needs and gain competitive advantage in the market (Awaad et al. 2018).

2.5.2. Data Analytics Constructs

2.5.2.1. Descriptive Analytics

Descriptive Analysis involves different type of variables such as nominal, ordinal, interval, and ratios (Yellapu 2018). The main aim of descriptive analytics to summarize data about certain population by breaking down large amount of data into simpler measures. Descriptive analysis includes measures of central tendency which describe the set of data with a number which indicates the center position of the distribution of data such as, Mean, Median and Mode. The measures of dispersion which describe the spread of data in a distribution such as Range, Variance, Standard Deviation and Skewness (Sharma 2019). Descriptive Analytics are used in SCM to describe the historical data, to describe certain patterns. It is an Exploratory method to explore the data to answer questions regarding certain situations happened and gain insight when approaching the future. They include reports and dashboards and visualization of data to better capturing patterns and facts cannot be identified using data only (Rozados & Tjahjono 2014).

2.5.2.2. Predictive Analytics

Predictive Analytics includes the utilization of historical data to predict future insights. In which a mathematical model is constructed from the historical data which is then used on the current data to provide predictions for the future (Ashfaq 2020). This type of analytics uses machine learning to analyze data and make certain algorithms. Predictive analytics can be used in SCM such as Time Series and advanced forecasting which is used in SCM to predict number of sales and inventory management. Other predictive analytics techniques such as use of Discriminant Analytics and Data clustering (Rozados & Tjahjono 2014).

2.5.2.3. Prescriptive Analytics

Prescriptive Analytics is considered as the type of statistical data analysis which follows the Descriptive and Predictive Analytics which tend to improve and increase the maturity of the data analysis which end up with better decision making for organizations to improve their performance in the future. In which data analytics are further investigated after predictive analysis to provide analytics for better decision making by taking advantage of the possible outcomes (Lepenioti et al. 2020). The prescriptive analysis also tends on studying the variability in the predicted data such as what/if scenario (Rozados & Tjahjono 2014).

2.5.2.4. Data Visualization

Data Visualization is presented by two items “Data Visualization helps in determining new demand trends such as seasonality in supply chain cycles.” and “Data Insights is important tool used in SCM.” Wang et. al (2013) suggests that supply chain visualization provides supply chain managers with aids in decisions making which provides better view of all operations including delivery scheduling and predicated delivery dates, lead times which would help in improving the SCM processes. In which SCM includes high complexities and uncertainties which could be predicated by data visualizations and insights to lower the unforeseen risks.

2.6. Supply Chain in FMCG Industry

Fast Moving Consumer Goods (FMCG) is considered as a market of fast products which include both manufacturing and retailing facilities of products including food, beverages and cosmetics. This market depends on selling large amounts of products, in which the profit per unit product is considered small. Therefore, the market includes large amount of selling and through many channels through the supply chain. Therefore, the main aim of SC inside FMCG is to optimize and maximize the flow between suppliers, manufacturers and retailer inside the chain, and minimize errors (Zimon 2017).

2.6.1 SCM in FMCG industry

Fast Moving Consumer Goods (FMCG) industry is considered one of the rapid and agile industries which involve daily goods and cosmetics products. The supply chains in the FMCG are considered one of the most challenging issues for companies and manufacturers in this industry, due to high volumes flow of product. In which, they need to continually pursue the most efficient and innovative flows to guarantee smooth flow, without delay at low cost and high quality. Therefore, FMCG industry SCM (Figure 4) is considered as exemplar for other industries and tends to be a benchmark for other industries (Mosquera 2009). The main objective of SC managers is to optimize cost by partnering with low-cost suppliers, warehouse and persuade high profit markets; in order to be able to achieve organizational goals (Bala et. al 2011).



Figure 4 Process Map for SC in FMCG (Bala et. al 2011)

2.6.2. Quality Management in FMCG Industry

As there is a huge information and products flows inside the SC of FMCG industries which include many channels, it's important for the entities inside the supply chain to enhance their management. Therefore, Quality Management can play an important role in the cycle by improving the flexibility inside the chain, help in lowering price of products, ensure high quality products and ensure customer satisfaction. Implementing QM inside the FMCG industry would lead to higher customer

satisfaction, which will involve a high-quality low-cost outcome with good customer service and low inconsistent or variability within the system (Zimon 2017).

2.6.3. Issues in SCM in FMCG Industry

The main concern of supply chain in the FMCG industry is to optimize the costs (lean) and enhance operations efficiency which includes purchasing, distributing and selling of the products. The main issues which are encountered in FMCG supply chains involves the methods which supply chain managers utilize to optimize these actions. Firstly, Supply chain cycle (Figure 5) includes various entities including manufactures, raw material suppliers, co-manufacturers, co-packing entities and retailers which make the process complex. Moreover, the distribution of the products is performed by specialized entity which involve the importance of relationships and partnerships. As well as transport and warehouse entities. Moreover, the retailing industry make pressure on manufacturers to produce products at lowest selling price and agile response to demand (Bala et. al 2011).

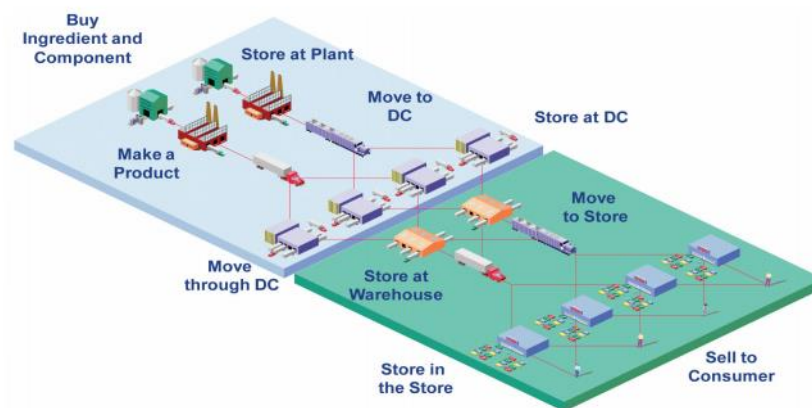


Figure 5 Supply Chain Processes in FMCG Industry (Bala et. al 2011)

Supply chain management is considered one of the dynamic fields in which it shows high advances in recent years in which extensive research take place in this field in order to optimize it. However,

when it comes to how to conduct research on this topic there is no definitive method to follow when formulating the methodology and the analysis of results either the research type is qualitative or quantitative. Unlike other research fields such as operations management the research provides guidance for research on how to construct their methodology. Therefore, SCM can be considered as not only an umbrella for different comprehend of the concepts but also it allows different applications of research mythology to be utilized. There are multiple techniques used by previous research to test results such as substantive justification for theory building, surveys and questionnaires, case studies, action research and modelling of supply chains (Seuring et al. 2005).

2.6.4. Absolute Performance of SCM Constructs

2.6.4.1. Continuous Improvement

Yeung et. al (2005) states in their study “Integrating customer expectations into the development of business strategies in a supply chain environment” in which the study presents a framework which states that integrating customer needs and expectations within the developments of the processes of supply chain activities provides better operational performance.

2.6.4.2. Employee Effectiveness

Upson et. al (2007) studied the importance of managing employee to improve the effectiveness of SCM. The research paper suggests the importance of improving the individual employee and improve the environment of work which will lead to increase in success of SCM in terms of achieving the desired outcomes which will improve the effectiveness of SCM. Therefore, the paper suggests the importance employee effectiveness in achieving absolute SCM performance. Menon (2012) identified that Human Resources (HR) activities and processes would lead to enhancement in employee satisfaction which will lead to enhancements in the performance of the supply chain management. In which HR activities including flexible working hours, recognitions, job

descriptions and cross working would lead to employee engagements and satisfaction, which will lead to better performance.

2.6.4.3. Cost Optimization

Gansterer (2008) studied the means of optimization of supply chain management. Cost optimization can be achieved by minimizing the total costs which includes the manufacturing, operating, holding and transportation costs. In which the researcher related that minimizing the costs will lead to better business results and more effective SCM.

2.6.4.4. Flexibility

Muntaka et. al (2017) studies the impact of flexibility in Supply Chain on the Business Performance. The flexibility in SCM is considered as the ability of the management to respond to uncertainties and challenges which opposes the organization and overlook the performance including the costs, delivery time and quality. The study shows that there is a positive correlation between maintaining flexibility within SCM and the overall performance in terms of financial, operational and logistics performance.

2.7. Substantive Justification for Theory Building and Measurements Analysis

It is considered a conceptual methodology and review approach of the SCM. In which, the research is based on critical assessment of the related research topic. Qualitative analysis depends on the understanding of the concepts and terms by collecting information from previous research or interviews (informant's perspective). The collected data is analyzed in order to build a substantive theory. In which the researcher provides a process model to describe the relationships between the variables and descriptions (Seuring et al. 2005).

2.8. Surveys in Supply Chain Management

Survey is an important tool used in collecting data about a certain topic. In which it allows the gathering of great amount of data and information in an organized manner. Surveys are done through a questionnaire which is sent to research and experienced people (informant's perspective) which contain certain questions to collect data and can be compared easily (Kotzab 2005). Survey approach of collecting data is extensively used in supply chain management and logistics research (Larson and Poist 2004). Surveys are commonly used in the field of logistics and SCM due to being cheap and easy tool to collect huge number of responses. However, the survey method could include a low return rate if the respondents didn't respond to it and how they are encouraged to give their response to it. The respondent in SCM surveys are usually practitioners in companies work in supply chain or include supply chain in their context (Grant et al. 2005).

The methodology of collecting data include the analysis of the method utilized to collect data, how to analyze it, how to measure it, sampling procedures, response rate and data format. Sampling is the process of choosing certain number of respondents to make conclusion about the whole population (Kotzab 2005). The type of data usually posted as closed questions in which data collected will be either list, ranking, categories or ratings. Types of data collected can be either categorical data such as nominal and ordinal or quantitative (continuous and discrete). The data collected should be following a scale which suite the situation in which not all scales are used in multi variants analysis (Kotzab et. al 2005).

Table 1 Levels of measurements/scales (Ventura 2005)

Level of measurement/scale	Characterization
nominal level (scale)	lowest level of measurement; typically used for classification
ordinal level (scale)	used for variables that cannot be classified but can be ranked in an order
interval level (scale)	used for variables where a distance between the observations is constant and exact
ratio level (scale)	used for variables with a natural or absolute zero and where a distance between the observations is constant and exact

2.8.1 Surveys in SCM using Structural Equation Modeling (SEM)

Research in the topic of SCM and logistics often includes the analysis of relations among different concepts and variables. The area of supply chain includes variables such as integration, coordination and competition between companies which can be in relations between each other's. In which most of these factors cannot be measured or observed directly, and a certain indicator should be formulated to measure it. Therefore, the use of SEM is used by research in SCM in which it can analyze both structural and measurement models. SEM is a commonly used method of analysis in which it involves the measurement model and structural models which are confirmatory factor and regressions analysis (Ventura 2005). Wallenberg and Weber (2005) states that although the research in SCM is very extensive, there is no certain methodology to follow in theory development and the verification. The formulation of a theory includes the definition of concepts, hypothesis, observations and measure the hypothesis in a whole presentation. Therefore, SEM was introduced to permit the research to validate their theory and test it. SEM is used in the fields of finance, marketing and economics, not widely used in supply chain. However, it can help in improving the research in supply chain especially complex ones.

2.9. Structural Equation Modelling (SEM)

SEM is a collection of mutually related processes that have the same characteristics. In which, the researcher should formulate an underlying model that include structural parameters and after that utilized the covariances of data collected to test the hypothesis about those parameters. It in integration between two methods in statistics which are factor analysis and simultaneous equation modeling. SEM is very powerful in its allowance to test the hypothesis formulated which are difficult to analyze or even impossible to analyze using the regular analytical models. AMOS, CALIS and MX are considered the most popular software used to solve SEM models (Ventura 2005).

SEM is used when a researcher is constructing a theory especially within the stage of empirical analyses of certain relationships between variables. The stage of theory construction includes the definition of the concepts, the hypothesis which is developed through theory or literature review, observations and measurements and the presentation of the whole elements in a whole structure. It follows a holistic approach in which it helps in relating both statistics analysis with philosophical concepts. It also presents both theory and observations and account for possible errors in specified variables and equations. It presents variables as indicators at the observed and unobserved variables at theory stage. The relationships between the constructs and indicators are then modeled which shoes the constructs are measured through the indicators. Then, the theoretical relationships between those constructs found related through equations (Wallenburg and Weber 2005).

After the theory formulation the model constructed, the data are collected to confirm or unconfirm the theory. SEM is now utilized to validate and test multi-variables statistics analysis. Most of the times research use covariance structure analysis with the SEM. However, there is another way which is Partial Lease Squares. In which covariance method analyze the data upon on the covariances of all observed variables. The empirical covariance matrix is utilized to estimate all the

free parameters from the models. Which is used to minimize the difference between the two covariance methods in iterations process. The covariance method is used to test the validity of models which is pre-constructed. It is used to validate the theory constructed and measure modellings. While Partial least squares use the principle of multiple regression to estimate all free parameters from structural and measurement models in an iterative way. This approach of SEM is used to model, construct the models and analyze the power variables and the relationships between them. This approach unlike covariance method it comes when theory is still in construction (Wallenburg and Weber 2005).

2.9.1. Advantages and Disadvantages Structural Equation Modelling (SEM)

SEM is considered a multivariate statistics method based on regression analysis which allow the analysis of relationships. For the covariance approach of SEM, it permits use of hypotheses as latent factors as well as test the relationships between various exogenous factors as well as the relationships between various endogenous factors. Therefore, it is better than use of any other multivariate regression analyses method which need independent exogenous factors and only include single endogenous factor in each analyze step. Therefore, it allows the modelling of very difficult and complex models which have multiple of variables. Therefore, all the hypothesis can be easily measured, and effects of endogenous factors are separated. However, the covariance approach of SEM needs to have a large sampling which could exceed 100-200 samples. It also needs a metric scaled indicators and multiple variables normal distribution of the analyzed data. For the PLS approach, it has the advantages of covariance method, but it also can be used with small sample sizes and no special type of data distribution. But the indicators should be more over 10 times the covariance based on. It has cons within the inconsistency in estimation which would lead to some errors in measurements. The PLS used with exploration not confirmation because sample size is low, and data can be not normally distributed (Wallenburg and Weber 2005).

2.9.2. Covariance Approach of SEM Utilization Steps

Wallenburg and Weber (2005) prepared steps to use when dealing with the SEM covariance approach to avoid the improper use due to its high complexity. Firstly, the measurement model is tested and evaluated to make sure each scale measures the certain objective needed. Then the structures are tested in which theoretical formulations are presented as a model independent variable and measured by other variables. The scale should be continuous or rating (1-5 scale) as a minimum. To make sure the validity of content refers to literature review to make sure the indicators which lower the validity are eliminated. To make sure the construct is valid they recommend using Exploratory Factor Analysis (EFA) then use Confirmatory Factor Analysis (CFA). On the other hand, if you eliminate the indicators you can proceed. If you use the first method of EFA then CFA, all given indicators should be added a 1 variable. To make sure that convergent validity is considered, in which all the indicators have different measurements. If Cronbach alpha is less than 0.6, indicators should be removed due to unreliable results. Then followed by CFA in which one factor structure is assumed and ready for analysis. Furthermore, the validity of the model is assessed with the global fit index and square multiple correlation R^2 . AMOS applications are used any misspecification can be detected and for the fixed elements and relationships not added to model the application measure the differ in chi-squared when the element is assumed to be free.

(Ventura 2005) also prepared a step for easy use of SEM within the SCM content. They state that it important to make sure of the model specifications, data collection, the analysis stage and if re-specifications and eliminations are required and finally the interpretations. (Figure 6) shows the traditional SEM guidelines. The first step is to formulate a theory model, state the variables accounted and the relationships between them by formulating your hypotheses in for of SEM. The equations driven from the model can relate dependent and independent variables as well as measure

the model which shows which variable measure each hypothesis. The model should be completely prepared to make it able for software to derive the estimates of each element of the model. Model should be prepared before data collection. Then in the second process the scholar should select the latent variables in the model created and collect data about it. Make sure the observed measurements are the one which you should measure and collect data about. SEM requires large samples in which it rely on distribution assumptions for significance tests. Better to use a sample between 100 to 200, but if it around 50 it is still acceptable sample. Missing data should be random and multi colinear because SEM is very sensitive to distribution varied from normal distribution. The next stage is estimation of model. Estimations steps include Maximum Like Hood, Ordinary Least Squares and Weighted Least Square. CFA can be used to measure measurements structures and use them to assure the reliability and validity of each part of the model separately. The next stage is used to analyze the fitness of the model. For the whole model and each structure model alone. Comparative Fix Index (CFI) and Root Mean Square Residual (RMSR) can be used to evaluate the fitness of model. Then the coefficient of estimation is used to evaluate the structural model. The final stage is interpretation and discussion which states if the observations of results are matching the stated hypotheses or not matching.

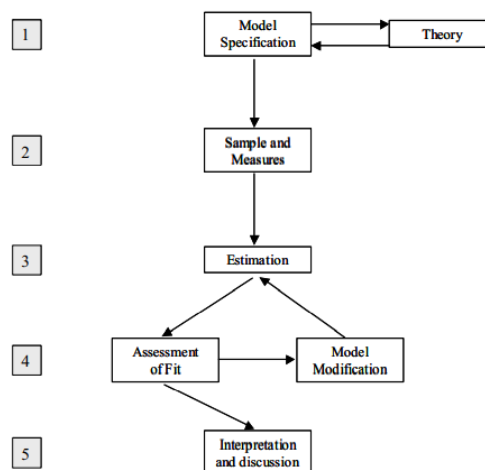


Figure 6 SEM Model (Ventura, 2005)

2.10. Questionnaire Design, Validity and Reliability tests

The questionnaires are considered one of important tools used in surveys, in which sample of people (respondents) are asked the same questions in a certain order to collect data and compare it. The first and the old type of questionnaires in research was the mail and postal one which is self-administrative questionnaires. The pros of this type there are no bias and very cheap method. But may lead to low response rate. There are two types of questionnaires the structured and unstructured ones. In which the structure questionnaires are type of questionnaire with pre-defined questions which sent to all respondents in same words and sequence. While the unstructured not same wording but using same meaning to achieve variations. The types of questions in a questionnaire can be matrix questions, scale questions (Likert Scale), open and close end questions and the contingency question. The questionnaire should have instructions and specific and easy to understand questions. Internet surveys (questionnaires) are new opportunity and method of research due to being easier to construct and easier to send to respondents (Grant et al. 2005).

2.10.1. Conditions for scale using in questionnaires

Spector (1992) provided a set of conditions to construct a scale:

- Scale should be developed on multiple items. In which single or individual item scales are considered unreliable because they limit the answers to two levels only, which might miss their intention or perception. Furthermore, some concepts are complex might need several questions to assess them.
- Every item of multivariate scale should measure something that can be converted to quantitative measurement for example a scale from strongly disagree to strongly agree can be rated from 1 to 3, 5 or 7 depending on set of available answers between them.

- There is no certain answer to the statement or question, which make allows every respondent to provide his perception on the statement.
- It is better to use statements and respondent rate the statement.

2.10.2. Multi-Items Measures

Spector (1992) suggested that the use of multi-items scale measures will be more applicable in terms of reliability and validity of the questionnaire. In which the respondent will have several items to measure his perspective and psychological attribute about certain variable. Adreniran (2019) provided motives to use multi-items measures. Single items have great errors in terms of being unable to gain the respondent main perception. Therefore, the test would be unreliable. Single items are very unprecise due to characterizing respondent to single statement or question to measure a certain construct. Thereby, single item cannot be used to measure high complexity questions which cannot be researched by only one question or item. Therefore, multi-item measures are considered more accurate, valid and reliable than single item questions.

2.10.3. Factor Analysis

Factor Analysis is a multivariate statistical method used when a researcher is trying to find out which variables (items) are independent on each other's. It is used to recognize factors from large number of correlated variables to a measurement which can be further used in statistical analysis. It is based on assumption that all the factors are correlated to each other's. There are two categories of Factor analysis. The first one is Common Factor Analysis (CFA) and Exploratory Factor Analysis (EMA). EMA is used in first steps of a methodological research to obtain insights about interrelationships between certain variables. While CFA is used in more complex situations to measure or test hypothesis concerned with the structure of variables. When constructing factors, they should be related to each other. Factor Analysis can be used when developing a questionnaire

which is used to test the validity in which invalid questions are removed from the questionnaire. It also aids in characterizing the questions in a survey into various parameters (Shrestha 2021).

2.10.4. Assessing the Suitability of data

The suitability of data is determined by assessing the sample size and strength of relationships are measured (Shrestha 2021). There are two common tests used to test for factorability if data Kaiser-Meyer-Olkin (KMO) and Bartlett's test.

2.10.4.1. Kaiser Meyer Olkin (KMO)

The KMO test is used to measure to assess the suitability of data collected for factor analysis. In which assess the adequacy of sample size for each variable and to the whole conceptual model. The equation below is to express KMO in which R is the correlation matrix and U partial covariance matrix. The value of KMO is between 0 and 1. KMO above 0.6 is considered acceptable for sample size less than 100 (Shrestha 2021).

$$KMO_j = \frac{\sum_{i \neq j} R_{ij}^2}{\sum_{i \neq j} R_{ij}^2 + \sum_{i \neq j} U_{ij}^2}$$

Equation 1 Kaiser-Meyer-Olkin (KMO) equation

2.10.4.2. Bartlett's Test for Sphericity

The Bartlett's Test is used to test the null hypothesis. In which it compares correlation matrix to identify matrix providing that there is no relation between variables and unsuitable. The null hypothesis of the test is the variables are orthogonal. For the alternative hypothesis variables are considered not orthogonal. If the significance value is less than 0.05 then the test is acceptable.

2.10.4.3. Cronbach's Alpha

Cronbach's alpha (α) is considered one of important reliability measurements method. In which, Cronbach describe the reliability of either the sum or average of 'q' measurements (ratings or questionnaire items). It is widely used when a researcher is testing for the reliability of a questionnaire (Bonett & Wright 2014). Cronbach's Alpha measures the internal consistency reliability of a tool used for research purposes (questionnaire), commonly it used to handle multivariate items for each construct. Cronbach's alpha is not accurate when working with single or individual items. Therefore, it's more widely spread used with multiple items. The value of Cronbach's alpha is between 0.00 and 1.00. In which a zero value refers to that there is no consistency in the measurements and value of one presents greatest consistency in measurements. The acceptable range for the Cronbach's alpha is to be exceeding 0.70. A 0.70 Cronbach's Alpha is considered acceptable (Adeniran 2019). The equation below is used to express the Cronbach's Alpha in which 'n' is the number of items and r is the mean of correlations between items (Shrestha 2021).

$$\alpha = \frac{n * r}{1 + r (n - 1)}$$

Equation 2 Cronbach's Alpha Equation

2.10.4.4. Average Variance Extracted and Composite reliability

The Average Variance Extracted (AVE) and Composite Reliability (CR) are used to measure the quality of the measurements. In which AVE is method to measure the variance by a construct against the variance of error. CR measures the internal consistencies in a scale of items. The value of AVE and CR is bounded between 0.00 and 1.00, as the value approach 1 it is more reliable. An AVE value equal or exceed 0.5 is considered acceptable. CR value equal to or more than 0.6 is acceptable (Shrestha 2021).

The Literature Review Section discusses TQM, SCM and Data Analytics. In which, the TQM is considered one of the important concepts used to improve the organizations internally to make sure every member or process within the business is efficient. While the SCM tends to improve the business externally. In which the SCM focus on the logistics and the whole framework of business until the product is delivered to customer. Both concepts main goal is to satisfy customers by delivering their needs and exceed their expectations. The previous studies also show that the integration of both concepts will improve the operations inside the FMCG industry which is considered one of the complicated industries in terms of supply chain. Moreover, the research also discusses the importance of the Data Analytics in improving both TQM and SCM and help in analyzing the data can be collected to improve decision making within organizations. The literature review is considered the basis of the study in which the study will focuses on integrating TQM within SCM utilizing the Data Analytics to improve the Absolute SCM Performance. The Literature Review summarizes also the main items for each practice which will be further analyzed in the methodology section. In which, TQM practices were identified to be Leadership, Customer Relations, Supplier Management, Employee Engagement and Trainings. While, Data Analytics items are identified as Descriptive, Predictive, Prescriptive Analytics and Data Visualization. SCM practices items are Supplier Selection, Supplier Participations, Supplier Evaluation and Customer Relations. Finally, the Absolute SCM Performance which is factor being tested to measures the effects of integrating SCM Practices with TQM Practices and Data Analytics on it. The Absolute SCM Performance items were identified as Continuous Improvement, Employee Effectiveness, Cost Optimization and Flexibility.

Chapter III

3.1. Methodology

The methodology used of this study is based on extensive overview of the concepts of Total Quality Management, Data Analytics and Supply Chain Management through literature of previous studies and published research papers to gain an understanding of the concepts and the areas of research and research analysis using the Survey Method which is considered the most applicable and easiest way to collect data about the concepts. The analysis will be based on the Quantitative Analysis approach to gain a complete overview and understanding of this complex novel model. As well as, in depth study of the FMCG industry and issues facing the Supply Chains in terms of complexity and uncertainties, through literature. Providing the importance of implementation of the philosophies within the industry and show how it is distinctive than other industries. As the research topic is considered novel being integrating the TQM and the Big Data Analytics in Supply Chain Cycles. In which, research papers will be used to extract the principles and areas of relation between the two philosophies (TQM AND SCM) will be analyzed to extract the common practices and How Big Data Analytics can aid in the optimization of SCM. The quantitative analysis which will be based on hypothesis formulation which will be used to test the relationship between TQM, SCM and Data Analytics in which sampling procedures will include targeting supply chain managers in FMCG industry regardless the company they are associated with is following Quality Management Systems. In which a survey will be sent to a sample of over 650 supply chain managers through mail and academic groups with a target of receiving over 200 answered questionnaires' which will be further analyzed using through the method of Structured Equation Modelling (SEM) using AMOS software to gain knowledge and data about the ability of model to improve the business performance in FMCG SCM.

3.2. Model Specification

The model is built according to exploratory measures through extensive literature review for past research relating the three concepts to develop a model which will be further tested through the SEM method. The first step is specifying the variables which are related between them to generate relations and formulates the hypotheses.

3.2.1. Specify Variables

In this stage after defining the relations through the three techniques within the literature to specify the main variables which account for the integration of the three different philosophies to improve effectiveness and business performance within the field of FMCG. The concepts were developed, and variables were identified in which some of the variables were to be tested through Qualitative Analysis and others through Quantitative Analysis, the variables are. (Table 2) is the multivariate scale of the model headed by Observed and Unobserved (Latent) Variables.

Hypotheses Formulating:

The Research framework is developed to empirically test the effect of integrating TQM practices and Data Analytics tools within the SCM Practices to achieve absolute SCM performance in terms of continuous improvement, employee effectiveness, flexibility and cost optimization. of the Supply chains inside the FMCG market. The model is following structural modeling equation approach (SEM). It includes the latent variables which are TQM practices, SCM practices, Data Analytics and Absolute SCM performance.

Paswan et al. (2020) suggested that supply chain management is important for the of organizational success of big companies through good management and control. The articles states that the implementation of TQM in SCM will lead to delivery products with highest quality and enhance the flow of processes inside the supply chain cycle. In which he argues that implementation of TQM in

SCM will reduce the possible losses, uncertainties, inventory problems and improve the profitability of the organization. In which, the integration of TQM in SCM in FMCG would improve the business and increases profitability.

H1: There is a positive relationship between the integration of Total Quality Management Practices with Supply Chain Management Practices.

Sariyer et al. (2021) contended that data analytics techniques improve the quality management of processes. In which he states quality management is process in which managers always need to innovate in in order to continuously improve the quality of processes. Therefore, adopting the data driven techniques help in improvement of quality management. For example, detecting the defects and its type and predictions which could help in defining the root cause.

H2: Data Analytics positively affects the Total Quality Management Practices.

Rozaz and Tjahjono (2014) suggests that Big Data Analytics provides big potential in business, in which it contributes to the evolvement of SCM practices such as transportation, operations, procurement and marketing. Thus, Data Analytics could lead to cost optimization and enhance SCM in FMCG.

H3: Data Analytics positively affects the Supply Chain Management Practices.

Chinho et al. suggests that TQM is significantly correlated to SCM practices through a research. In which the research papers states that TQM tends to improve the tangible business results of SCM overall performance and improve customer satisfaction levels.

H4: The practices of Total Quality Management positively influence the degree of absolute SCM performance.

Trkman et al. (2010) suggests that the use of data analytics and business analytics specifically in supply chain management (SCM) improves the performance. In which it suggests the importance of the company of the use of data driven models, data bases, predicative and explicative analysis to make decisions which will improve the performance of the firms.

Nguyen et al. (2017) contends that Big Data Analytics has positively impacted SCM overall business performance in different aspects and reduce uncertainties and improve customer satisfaction levels.

H5: The utilization of Data Analytics positively affects the degree of absolute Supply Chain Management performance.

Tracey et al. (2005) suggests that Data Analytics is positively correlated with the overall business organizational performance in which it improves the business capabilities and provide competitive edge by improving customer satisfaction levels. In which, SCM tends to improve the capability of Supply chain cycles in terms of transporting, operations, inventory management, production and warehousing which leads to higher profitability, lowering expenses and reduce uncertainties. As well as improve customer involvement which will lead to higher sales, loyalty of customers, improve in financial and marketing performance which will lead to competition advantage.

H6: The practices of supply chain management positively affect the degree of absolute Supply Chain Management performance.

3.2.2. Sampling and Measuring

In this stage a questionnaire is prepared with two types of questions seven-point Likert scales questions and contingency questions. The questionnaire is sent to practicing (experienced) Supply Chain Managers within the field of FMCG with at least 3 years of experience and knowledge about TQM. The respondents are reached through emails and websites (LinkedIn) to make sure the

respondents fulfill the criteria of the research to improve the accuracy and validity of the research. Likert scale is used to measure attitude or perception in a scientific method which is accepted and validated. The seven-point scale is considered more reliable than five-point Likert scale, as it provides more varieties of options for the respondents to choose from which will increase the probability of meeting the respondent real perception (Joshi et. al 2015). The target of research to be respondent by at least 200 respondents according to literature review for better SEM. It was found out through past research a sample of 100 is considered as acceptable and could provide good results. Therefore, the target for the research is 200 responses at least with the questionnaire aim to reach over 500 supply chain managers in the FMCG. The design of the questionnaire tends to test the hypotheses formulated through theory to test for the Qualitative Research Model as well as the Quantitative Research Model. Contingency questions will be directed to receive information about the respondents in terms of years of experience and knowledge about TQM which could be shared between the integration of Data Analytics and TQM in SCM. The questionnaire-based Likert Scale Questions measure the items by 7-point scale in which the available answers (strongly disagree, disagree, partially disagree, neutral, partially agree, agree, strongly agree). The questionnaire includes items specified to measure the effectiveness of integration of the two philosophies and influence of data analytics in the integration and their effect on the Absolute SCM Performance.

3.2.3. Questionnaire Design

The questionnaire is based on statements which were extracted from previous research papers to study the response of the respondents with their agreement with the statements. In which the questionnaire is based on 7 points Likert Scale in which (1= Strongly Disagree and 7= Strongly Agree).

3.2.4. Multivariate Scale of the Model

Literature review were studied to examine the previous studies which relates the Total Quality Management, Supply Chain Management and Data Analytics. Which provided the relations between the three concepts and its effects on the other one. The literature review showed that there was shortage in research relating the three philosophies together in which research papers in this topic used to relate only two concepts together, as well as the research showed that there was shortage in terms of studying the effects of integrating the concepts in FMCG industry. (Table 2) presents the variables tested which were TQM Practices based on certain items which are Leadership, Customer Relations, Supplier Management, Employee Engagement and Training. In which, these items were the main practices in TQM based on the previous studies. The second variable is Data Analytics based on four items which are descriptive analytics, predictive analytics, prescriptive analytics, and data visualization being the most important practices based on literature review. The third latent variable is SCM practices and its items are supplier selection, supplier participations, supplier evaluation and customer relations. Finally, the last latent variable is Absolute Performance which is based on four items which measures the performance which are continuous improvement, employee effectiveness, cost optimization and flexibility. Each item was tested in the questionnaire by direct question to study each variable. While the code column presents the code of each construct in the conceptual model. Figure 7 is the conceptual model of the study based on the literature review and hypothesizes formulated it was constructed to relate the TQM practices, SCM Practices, Data Analytics and Absolute SCM performance.

Table 2 Multivariate scale of the Model

Latent Variables	Items	Description	Code
TQM Practices	Leadership	Top management provides leadership within the organization (Hameed et. al 2018)	V1
	Customer Relations	Customer satisfaction is the main aim of the organization (Omoryui and Mafini 2016).	V2
	Supplier Management	Quality of Suppliers and involvement in processes (Chalotra 2015).	V3
	Employee Engagement	Employees are aware of process and involved in decision making (Sharma 2014).	V4
	Trainings	Employee are trained with required job skills (Tramarico et. al 2015).	V5
Data Analytics	Descriptive Analysis	Interpretation of data for better understanding of previous (Yellapu 2018).	V6
	Predictive Analysis	Analyzing patterns to make predictions and get future insights (Ashfaque 2020).	V7
	Prescriptive Analytics	Data driven analytics to provide instant decision-making capabilities for optimization of business practices (Lepenioti et al. 2020).	V8
	Data Visualization	Visual insights to improve decision making capabilities (Wang et. al 2013).	V9
SCM Practices	Supplier Selection	Ability of supplier to meet demands patterns (Rathore 2016).	V10
	Supplier Participations	Suppliers assistance in inventory management and logistics enhancement (Liang et. al 2011).	V11
	Supplier Evaluation	Evaluation of Suppliers in the Vendor List in terms of product quality and delivery time (Abror et. al 2011).	V12
	Customer Relations	Customer support and Customer involvement in the Supply Chain cycle (Sigala 2013).	V13
		.	
Absolute SCM Performance	Continuous Improvement	Increasing operational efficiency and ensuring the satisfaction of customers (Yeung et. al 2005).	Y1
	Employee Effectiveness	The effectiveness of employee in terms of productivity and employee satisfaction (Upson et. al 2007).	Y2

Cost Optimization	Cost control and Increasing the profitability of the organization (Gansterer 2008).	Y3
Flexibility	Supply chains speed of responding to changes in supply and demand (Muntaka et. al 2017).	Y4

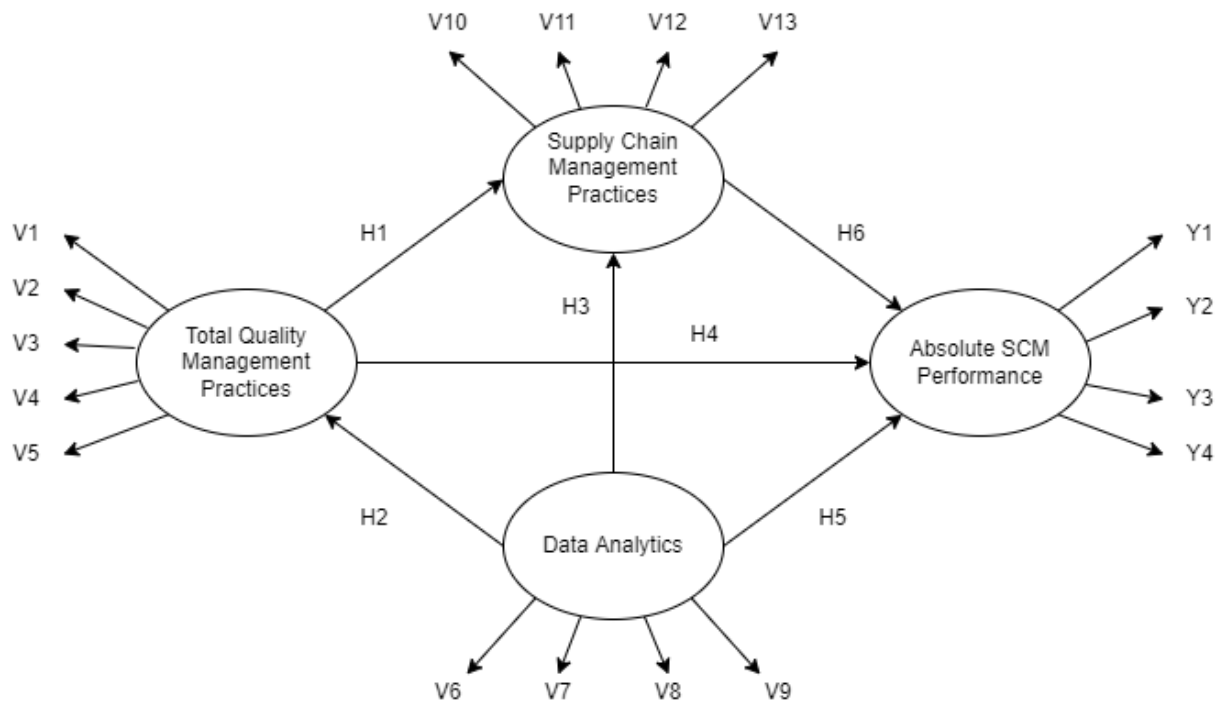


Figure 7 Conceptual Model

3.2.5. Estimation and Questionnaire Validation

After receiving the results, the data cleaning will be stepped on to make sure all the data are valid and make sure no errors. If missing data occur it will be omitted from the results as well as filtering data to make sure respondents participated have knowledge about TQM and have at least 3 years of experience in SCM in FMCG industry. While making sure that the number of responses is still exceeding 50. The data is estimated from strongest to weakest, in which Likert scale-based questions are based on 7 points which is large enough to ensure better distribution accommodating more possible answers. Likert scale is used to measure attitude or perception in a scientific method which is accepted and validated. The seven-point scale is considered more reliable than five-point Likert scale, as it provides more varieties of options for the respondents to choose from which will

increase the probability of meeting the respondent real perception (Joshi et. al 2015). The Quantitative data will be used according to SEM to generate results, while other model will be used to generate qualitative results. The validation of the questionnaire is tested by testing the questionnaire prior to sending it to the intended respondents in which the questionnaire was first sent to 5 industry experts with more than 10 years of experience in SCM in FMCG industry. Then the reliability of the questionnaire is tested using SPSS using Cronbach (α). While to test for the sustainability of the collected data SPSS is used to test for Kaiser Meyer Olkin (KMO) measure to test for factor analysis. While Bartlett's test is used also to validate the significance.

3.2.6. Test of Hypotheses Results using SEM

SEM will be developed using IBM SPSS AMOS in which the model is drawn, and data is specified for each latent variable and constructs including each item in it. This will develop a final SEM Model with correlations and estimates between the four variables (TQM Practices, SCM Practices, Data Analytics and Absolute SCM Performance) which verifies the hypothesis in terms of estimates and t-value assigned with direct and indirect relations between the latent variables and overall fit measure. Certain measures were taken while executing SEM is using standardized estimates and maximum likelihood and for the output minimization history, standardizations estimates, squared multiple correlations and indirect, direct, and total effects.

3.3. Ethics Considerations

The ethical principles of the research are following the BUiD ethical considerations, by making sure the research comply with ethical instruction. In which, the respondents participated in the survey were informed of the study and type of data collected and were staying anonymous without collecting any personal or private information about the respondents. A description of the questionnaire clearly provided the respondents with aim and purpose of the research.

Chapter IV.

4.1. Results

This section will include the results and analysis of the study as identified in the methodology section following the same sequence as methodology.

4.1.1. Data Gathering

The questionnaire was provided to 650 practicing SCM in FMCG industry respondent which were targeted through LinkedIn Profiles and academic websites by analyzing their profiles to make sure the respondent is practicing supply chain manger. The questionnaire was designed with cover letter and prepared through Microsoft Forms to make it easier for the respondents to respond to it. The questionnaire consisted of 30 questions to make it easier for the respondent to respond to it and to gain well-prepared analytics about the respondent in terms of time taken to respond to the questionnaire. The average time to respond to the questionnaire was around 12 minutes which is considered appropriate time to respond to the questions. The number of respondents to the questionnaire was 261 responses with a 40.15% response rate were returned by respondents.

4.1.2. Data Cleaning and Questionnaire Validation

The 261 received responses were then cleaned by eliminating non-complete questionnaire from the data, eliminating respondent with less than three years of experience from the data and eliminating respondents which are not familiar with TQM. The number of effective responses which were collected satisfying the pre-determined criteria was 205 with effective response rate of 31.5%. The questionnaire was based on 30 questions with each question test certain items related to integration of data analytics and TQM in SCM. The data collected was cleaned by removing respondents with missing data, respondents with less than 3 years of experience in SCM in FMCG industry and respondent with no knowledge of Total Quality Management. Most of the respondents was in the range of three to five years of experience with 116 respondents followed by five to 10 years of

experience with 80 responses and around 9 responses from Supply chain managers with over ten years of experience (Figure 8).

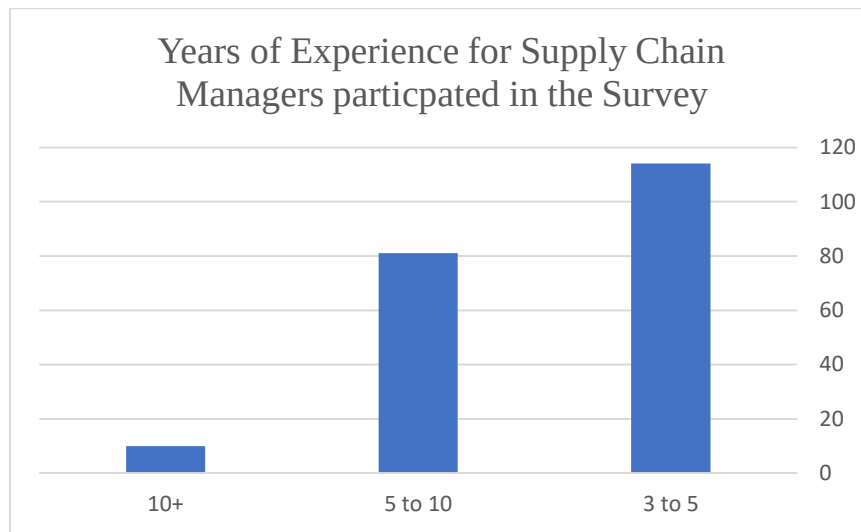


Figure 8 Histogram showing range of years of experience of the effective respondents

4.1.3. Estimation and Questionnaire Validation

To test the validity and reliability of the questionnaire, statistical tests were applied using SPSS software to assess the data gathered reliability and validity of the test. Reliability test and Exploratory Factor Analysis were the tools to gather the data. The first test was Cronbach's alpha to test the reliability of the questionnaire which is a test that measures the internal consistencies of the given constructs. KMO test and Bartlett's test were conducted also using the SPSS to measure the validity of the test. Gilem et al. (2003) stated that Cronbach's alpha is reliability test which is measured between 0 and 1, which measures the internal consistency of the items provided in a specific scale. Mallery et. Al (2003) stated that Cronbach's alpha is considered acceptable when it is above 0.7 and is considered excellent when it is over 0.9. (Table 3) is the summary of SPSS results for the Reliability Analysis and Factor Analysis for each latent variable. The results showed that the Cronbach's alpha is over 0.9 for all the latent variables, which validates the reliability of the test. The data were further tested using the Exploratory Factor Analysis (Appendix B), to explore the

data and the model for possible data reduction. Certain assumptions are followed when analyzing Factor Analysis assuming normality of the homogenous data, factor analysis extraction was based on Principal Component Analysis and rotation is considered as Pro-Max as provided by Patel (2005). For Kaiser-Meyer-Olkin (KMO) test for adequacy of the sample, the results were over 0.8 which validates the test and Bartlett's test of sphericity were very low almost zero which also validate the tests. The factor loadings score for the model where all above 0.5, which also validates the appropriateness of data accruing as identified by Hutcheson (1999). (Table 4) is the summary of reliability analysis and factor analysis performed on the whole model to verify it. The results showed that for the number of valid cases (sample size) 205, the Cronbach's alpha is 0.945 which is shows very high reliability of the model. The KMO is 0.85 and Bartlett's test of sphericity was less than 0.001 which validates the model.

Table 3 Tests for the reliability and validity for each latent variable

Latent Variables	Items	Cronbach's Alpha	KMO	Bartlett's Test	Cumulative Loading	Approx. Chi-Square
TQM Practices	Leadership	0.996	0.899	<0.001	0.538	3026.43
	Customer Relations					
	Supplier Management					
	Employee Engagement					
	Training					
Data Analytics	Descriptive Analysis	0.997	0.873	<0.001	0.729	2597.03
	Predictive Analysis					
	Prescriptive Analytics					
	Data Visualization					
SCM Practices	Supplier Selection	0.986	0.873	<0.001	0.876	1514.4
	Supplier Participations					
	Supplier Evaluation					
	Customer Relations					
Absolute SCM Performance	Continuous Improvement	0.982	0.862	<0.001	0.973	1413.09
	Employee Effectiveness					
	Cost Optimization					
	Flexibility					

Table 4 Validity and reliability measures for the whole model

Number of Valid Cases	Number of Items	Cronbach's Alpha	KMO	Approx. Chi-Square	Bartlett's test of Sphericity
205	17	0.945	0.85	9065.957	<0.001

4.1.4. Confirmatory Factor Analysis (CFA)

CFA is considered the next step in analyzing the model after being verified through the Reliability test and Exploratory Factor Analysis. The CFA (Appendix C) is used to test the if the data collected is fit with the hypothesizes and conceptual model. IBM AMOS was used to perform the analysis in which pattern matrix was extracted from EFA analysis in SPSS and utilized to draw the CFA on AMOS. (Figure 9) is the CFA model constructed on IBM AMOS in which F1 refers to TQM Practices, F2 refers to Data Analytics, F3 refers to SCM Practices and F4 refers to Absolute SCM Performance. The model is further studied using AMOS tools to test the validity of the model. (Table 5) shows the validity analysis for the CFA model. In which, AVE (Average Variance Extracted) and CR (Composite Reliability) which are used measure the quality of the measurements were both above 0.9. According to Shrestha (2021) as AVE and CR approach 1 the better the validity of the model. The Maximum Shared Variance (MSV) and MaxR(H) are also considered acceptable. Therefore, the CFA model is considered acceptable and the next step is Structural Equation Modeling (SEM).

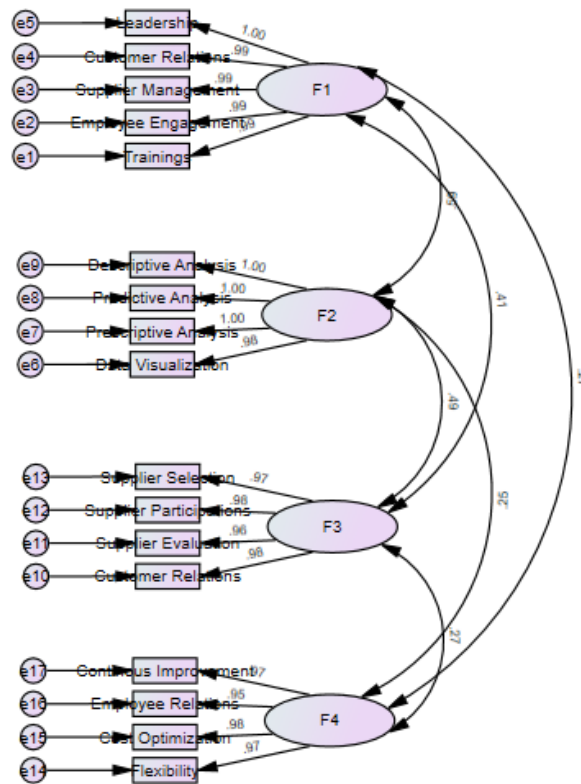


Figure 9 Common Factor Analysis Model

Table 5 Validity Analysis for CFA model

	CR	AVE	MSV	MaxR(H)	F1	F2	F3	F4
TQM Practices (F1)	0.996	0.982	0.35	0.997	0.991			
Data Analytics (F2)	0.997	0.988	0.35	0.998	0.591***	0.994		
SCM Practices (F3)	0.986	0.946	0.242	0.988	0.411***	0.492***	0.973	
Absolute SCM Performance (F4)	0.983	0.934	0.074	0.984	0.268***	0.246***	0.272***	0.966

In which, * $p < 0.050$; ** $p < 0.010$; *** $p < 0.001$

4.1.4. Structural Equation Modeling (SEM)

After performing the EFA and CFA and the model is considered reliable and valid, SEM based on Maximum Likelihood is performed to check the fitness of the model and to conclude the estimates between the four latent variables (TQM Practices, SCM Practices, Data Analytics and Absolute SCM Performance). The model specified in the methodology based on the formulated hypotheses was implemented on IBM SPSS AMOS and data were assigned to each item. In which SEM is used to measure the direct and in direct relations between the unobserved variables after being confirmed reliable and valid. According to Peugh (2020), root mean square error of approximation (RMSEA) and comparative fit index (CFI) are the most common inferential tests used to test fitness of data SEM. In which RMSEA ranges from zero to one in which as the value increases towards one it reflects very poor fit sample, RMSEA is influenced by sample size. CFI on the other hand ranges from zero to one as the value increases it is a sign of goodness of fit of the data and its not influenced by sample size. (Table 6) provides the model fit measures for the model after constructing the model on AMOS and assigning the data to the items. The measures according to the cut-off criteria (Table 7) provided by Hu and Bentler (1999) were all considered either excellent or acceptable, which verifies the good fit of the SEM model sample data. CFI value is 0.988 which considered very close to 1 which is an index of good fit model. RMSEA value was less than 0.08 which is almost zero which is an index of lack of poor of fitness of the model sample data. Standardized Root Mean Square Residual (SRMR) which is the root of the difference between the residual of hypothesis model and covariance matrix of the sample data (Basile 2019); is below 0.08 and is considered excellent. CMIN/DF and PClose were within the acceptable ranges.

Table 6 Model Fit Measures

Measure	Estimate	Threshold	Interpretation
CMIN	203.269	--	--
DF	89.000	--	--
CMIN/DF	2.284	Between 1 and 3	Excellent
CFI	0.988	>0.95	Excellent
SRMR	0.016	<0.08	Excellent
RMSEA	0.079	<0.06	Acceptable
PClose	0.05	>0.05	Acceptable

Table 7 Cut-off Criteria for SEM Model Fit Measures (Hu & Bentler 1999)

Measure	Terrible	Acceptable	Excellent
CMIN/DF	> 5	> 3	> 1
CFI	<0.90	<0.95	>0.95
SRMR	>0.10	>0.08	<0.08
RMSEA	>0.08	>0.06	<0.06
PClose	<0.01	<0.05	>0.05

The previous CFA model deals with reliability and validity of the items used in measuring the latent variables, while the SEM model will deal with direct and indirect relations between the latent variables. (Table 8) provides the summary of the hypothesis testing including the estimates and p-values for the structural relationships between the latent variables. In which high estimates and low p value (below 0.05) will identify if the variable is valid or not. The first hypothesis (H1) which is TQM Practices positively affects the SCM practices provided a standardized estimate of 0.562 and p-value less than 0.05. The second hypothesis (H2) is Data Analytics positively affects the TQM Practices and the estimate value was 0.617 and p value less than 0.05. The third hypothesis (H3) which is the positive influence of Data Analytics on SCM Practices provided 0.4 estimate. While H4 which the influence of TQM Practices on the Absolute SCM performance was 0.114. The fifth hypothesis which the Data Analytics is positively affecting the Absolute SCM Performance will be eliminated due to p value higher than 0.1. The sixth hypothesis is SCM practices positively affects the Absolute SCM Performance provided an estimate of 0.14. The summary of findings of the model is presented in (Figure 10) after eliminating H5. In respect to the measurement model, TQM practices, proofs that this latent variable is considered valid due to the indicator's parameters (items) estimates were considered significant, same with the other three latent variables in which the estimates of TQM Practices to its items for example were all over 0.98. The results additionally show that the Chi-Square is equal to 203.3 and path coefficients significant at 0.05. The results clearly support the hypothesis and model presented. In which TQM practices are positively correlated with SCM practices (H1), which accordingly influence the Absolute SCM performance (H6). Therefore, there is a connection between TQM practices and Absolute SCM performance (H4). The results also show that Data Analytics significantly correlated with TQM Practices (H2) and SCM Practices (H3). However, the results showed that Data Analytics influences the Absolute

SCM Performance (H5) with 0.065, in which the results don't support the hypothesis formulated. These results will be further discussed in the next section (4.2).

Table 8 Summary of Results of SEM

Description	Path	Hypothesis	Estimate	p-value
TQM Practices to SCM Practices	F1-F2	H1	0.562	p<0.05
Data Analytics to TQM Practices	F4-F1	H2	0.617	p<0.05
Data Analytics to SCM Practices	F4-F2	H3	0.400	p<0.05
TQM Practices to Absolute SCM Performance	F1-F3	H4	0.114	p<0.05
Data Analytics to Absolute SCM Performance	F4-F3	H5	0.065	p>0.1
SCM Practices to Absolute SCM Performance	F2-F3	H6	0.140	p<0.05

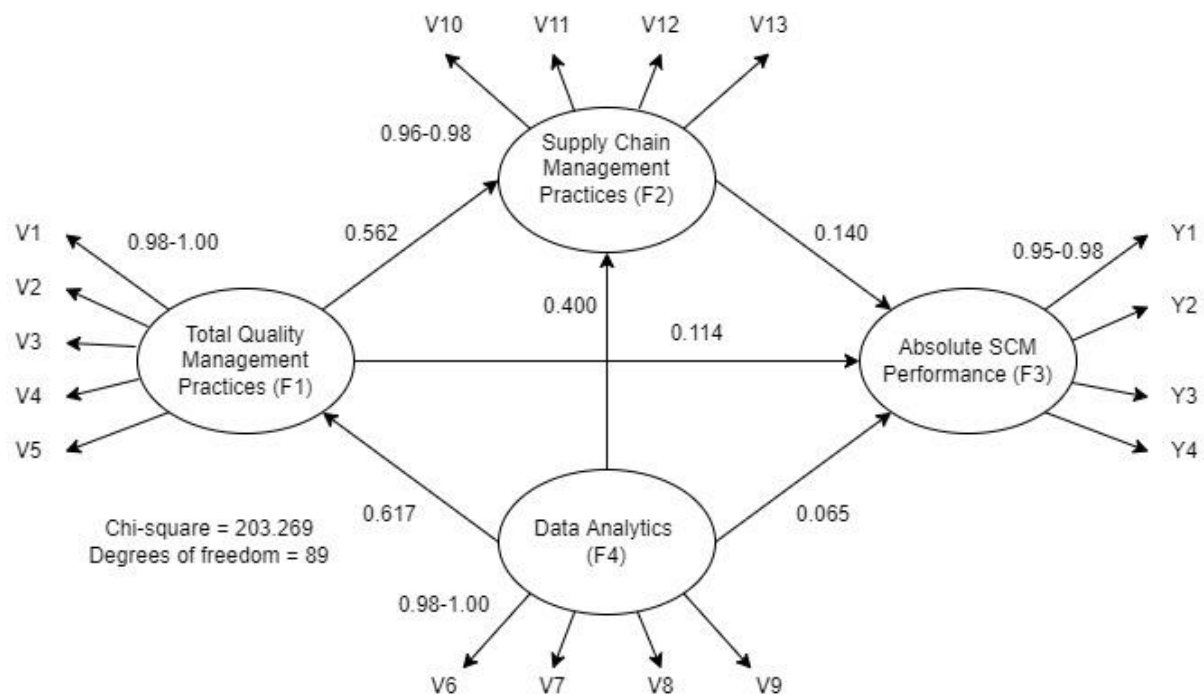


Figure 10 Summary of Findings SEM Model

4.2. Discussion

The results of the findings indicated in the SEM model (Figure 10) supports the hypotheses which were formulated and validated, except for the fifth hypothesis which was the between the Data Analytics and Absolute SCM Performance. There were several remarks from the results which will need to be addressed accordingly. First of all, the first latent variable Total Quality Management (F1) was strongly correlated to its items. In which, Leadership (V1), Customer Relations (V2), Supplier Management (V3), Employee Engagement (V4) and Trainings (V5) were all strongly correlated to the TQM practices with values between 0.98 to 1, which supports the model constructs. The same goes to the other three latent variables which were all strongly correlated to their items which supports the research and model construction. Furthermore, the first Hypothesis (H1) which correlates the TQM Practices (F1) with the SCM Practices (F2) showed that there was a significant correlation between the two latent variables. Igel (2009) supports the same hypothesis in which the research paper defined both TQM and SCM as two distinctive philosophies which can be integrated together. In which, TQM focuses more on the internal participation and SCM focus more on the external ones. Therefore, the constructs of the Total Quality Management will help in improvement of the Supply Chain Management accordingly to reach ultimate goal which customer satisfaction. For the second hypothesis (H2), which is the link between Data Analytics (F4) and TQM practices (F1), showed significant correlation between the two variables of 0.617, which strongly supports the hypothesis. The same goes with the third hypothesis which is correlation between Data Analytics (F4) and SCM Practices (F2) which resulted in 0.4. Therefore, it can be directly seen the huge implication of the importance of integration of Data Analytics with both TQM Practices and SCM Practices. For the fourth hypothesis (H4) which is correlating the TQM Practices (F1) with the Absolute SCM Performance in FMCG Industry (F3) there was a correlation which supports the hypothesis, but the value was considered small 0.114. Lin et. al (2004) reported

a much similar finding in their model, in which there was a huge direct correlation between TQM Practices and SCM Practices. However, there was no direct correlation between TQM Practices and Performance. The researchers found out that the findings were due to the Respondents relied on TQM Practices as more as management philosophy instead of utilizing it to improve performance. The results of our study provided a quite small correlation between TQM Practices and Absolute SCM Performance, which can be due the same issue and complexity of TQM which is a philosophy which take time to implemented and need long term commitment of Top Management and Employee. The second observation is the fifth hypothesis(H5) which correlates the Data Analytics (F4) with the Absolute SCM Performance (F3) which was considered very low correlation of 0.065, in which the findings provided very low direct influence of Data Analytics on the Absolute SCM Performance, regardless of the significant correlation of Data Analytics with both TQM Practices and SCM Practices. Trkman et. al (2010) was studying the impact of Analytics on supply chain performance. The results showed there was a limited correlation between the Data Analytics and certain supply chain performance constructs, which was due most of the performance measurement can be often outsourced such as delivery methods. However, our data support that there is an indirect effect of Data Analytics on Absolute SCM Performance of 0.175 (that is $0.40 \times 0.140 + 0.617 \times 0.114 + 0.617 \times 0.562 \times 0.140$). Finally, the sixth hypothesis (H6) which correlates the SCM Practices (F4) with the Absolute SCM Performance (F3) resulted in 0.14 correlation which shows that there is a correlation between the two latent variables. Demirbag et. al (2007) supported these results in which the research found out that there was in direct impact of Supply Chain practices on the enterprise performance. In which the SEM model constructed by the researcher's findings included numbers which supports our model and shows that there was an influence of SCM practices on the overall organization performance including the SCM related organizational performance.

Chapter V.

5.0. Conclusion and Recommendations

In conclusion, the study was conducted to research the ways of improving Supply Chain Management in FMCG industry deploying the two philosophies of Total Quality Management and Data Analytics. Total Quality Management Practices are considered very vital for any organization or department pursuing improvement in the management and improving customer satisfaction as it is costumer focused philosophy, which is an important criterion which can be applied in SCM in which the involvement of customer would help to make it respond better, flexible and agile. Other TQM practices such as Leadership, Supplier Selection, Process Management and Employee Engagement all play important role in improving the SCM performance by different influences on internal and external perspectives. Moreover, Data Analytics also considered an important tool in making decision providing the organizations with the ability to clean, analyze and visualize data which helps in predications and planning to future issues. Therefore, applying the two methods in SCM will lead to better performance of SCM in FMCG in terms of flexibility, delivery time and product quality. The research was based on a questionnaire distribute on experienced SC managers in the field of FMCGs which is developed and tested for reliability and validity to gather data which then used to test for hypothesis formulated. SEM was used to test the model which is considered a multivariate model measurement which supported the hypothesis formulated. Rozados and Tjahjono (2014) provided a similar finding which was due to little correlation between Big Data Analytics and Performance, this research defined the problem could be due to the sources of data used in analysis which can be unstructured data which is difficult to analyze by normal tools. However, I would recommend further investigating the effects of integrating TQM practices and Data Analytics in SCM management as a whole process not constrained to FMCG industry. I would also recommend for future studies to consider the effect of each practice of TQM on the SCM

performance as on whole. In which, the effects of each practice can have a huge influence on SCM. I would also recommend future research design a measurements performance models using the aid of Data Analytics in terms of statistical analysis and data visualization to measure KPIs and improve cost efficiency.

5.1. Limitations

There are limitations for this study in which the study focuses on the literature review of research papers and studies in the field of Total Quality Management, Data Analytics and Supply Chain Management together. There were few research papers discussing the topic of the effect of TQM on SCM in FMCG context. Moreover, the integration of both TQM and Big Data Analytics in SCM is considered novel topic especially in FMCG industry context. The employees in SCM in FMCG tries to keep their information confidential. Therefore, anonymous questionnaire can be used to retrieve data about the relationships between the elements without performing one to one interview which would help better understanding of the topic. The topic was research based on studies and questionnaire of anonymous supply chain managers which could present different work experience years or knowledge of TQM. Therefore, anonymous questionnaire with anonymous respondents could lead to unreal or biased responses.

5.2. Theoretical Implications

- Theoretically, the study supports the literature of the positive influence of applying TQM practices inside SCM context which will positively impact the Organizational SCM Related Performance (Absolute SCM Performance) in FMCG. The study also contributes to literature on the positive impact of applying Data Analytics on both TQM practices and SCM practices to improve the Absolute SCM performance. However, the literature didn't study the effect of applying both TQM practices and Data Analytics tools together on the SCM Performance.
- Methodologically, the study presents empirical evidence on the utilization of Structural Equation Modelling in research purposes regarding Supply Chain Management field.
- The study also contributes to literature supporting the direct relations of Leadership, Trainings, Supplier Management, Customer Relations and Employee Engagement on the TQM Practices. As well as the inclusion of Descriptive Analysis, Predictive Analysis Prescriptive analysis and Data Visualization on Data Analytics. Supplier Selection, Supplier Participations, Supplier Evaluation and Customer Relations also directly contributed to Supply Chain Management Practices. While Continuous Improvement, Employee Effectiveness, Cost Optimization and Flexibility influence on Absolute SCM Performance were supported by the study as well.

5.3. Future Implications

This research provided a novel approach in integration of TQM practices, Data Analytics tools with SCM Practices to improve the organizational performance related to SCM. The study used quantitative methods to demonstrate the relations and effects of the integration of the three concepts to improve the performance. It is recommended for future researchers to examine the model using

qualitative methods by using interviews and focus groups to provide more deep analysis of how to implement the model in organizations.

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Appendix A

Total Quality Management and Data Analytics in Supply Chain Management (SCM)

Questionnaire

Description:

This structured questionnaire is designed to research the importance of integrating Total Quality Management Practices and Data Analytics in Supply Chain Management in order to improve the overall business performance and effectiveness in the field of FMCG. This questionnaire will be used to collect data for research purposes.

1. How many years of experience you have as a Supply Chain Manager?
 - ☐ 0 -2
 - ☐ 3 - 5
 - ☐ 5 – 10
 - ☐ 10+
2. Are you familiar with Total Quality Management?
 - ☐ Familiar
 - ☐ Not Familiar
 - ☐ Maybe
3. Leadership is considered one of the important elements in the Supply Chain Management.
 - ☐ Strongly Agree
 - ☐ Agree
 - ☐ Partially Agree
 - ☐ Neutral
 - ☐ Partially Disagree

- Disagree
 - Strongly Disagree
- 4. Leadership play important role in increasing the productivity, performance and provide improvements and change by bringing changes in all the areas of a supply chain.
 - Strongly Agree
 - Agree
 - Partially Agree
 - Neutral
 - Partially Disagree
 - Disagree
 - Strongly Disagree
- 5. Top Management plays important role in driving leadership practices inside the organizations.
 - Strongly Agree
 - Agree
 - Partially Agree
 - Neutral
 - Partially Disagree
 - Disagree
 - Strongly Disagree
- 6. The interference of the customers inside the supply chain cycle is considered vital in SCM practices improvements.
 - Strongly Agree
 - Agree

- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

7. Measuring and evaluating customer satisfaction is important in improving the SCM practices.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

8. Your organizations strive to establish long term relationships with its suppliers.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

9. It is important for organizations to help its suppliers to improve their product quality.

- Strongly Agree

- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

10. Your organization interfere its main suppliers in its planning and goal setting processes regarding its strategy.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

11. Employee engagement in the supply chain cycle improves the cycle.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

12. Training the supply chain managers is vital for improvements.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

13. To what extent measuring process capabilities is important in optimizing costs.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

14. To what extent preparing KPIs and measuring overall efficiency of the process is important in improvements.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

15. Data Analytics is considered an important tool in SCM.

- ☐ Strongly Agree
- ☐ Agree
- ☐ Partially Agree
- ☐ Neutral
- ☐ Partially Disagree
- ☐ Disagree
- ☐ Strongly Disagree

16. Statistical Analysis measurement the effectiveness of suppliers regarding lead times and delays help in suppliers' evaluations and decision making.

- ☐ Strongly Agree
- ☐ Agree
- ☐ Partially Agree
- ☐ Neutral
- ☐ Partially Disagree
- ☐ Disagree
- ☐ Strongly Disagree

17. Data Analytics play important role in decision making regarding planning and business processes in SCM.

- ☐ Strongly Agree
- ☐ Agree
- ☐ Partially Agree
- ☐ Neutral
- ☐ Partially Disagree

- Disagree
- Strongly Disagree

18. Data Visualization helps in determining new demand trends such as seasonality in supply chain cycles.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

19. Data Insights is important tool used in SCM.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

20. Your organization actively involves its key suppliers in new product development processes.

- Strongly Agree
- Agree
- Partially Agree
- Neutral

- Partially Disagree
- Disagree
- Strongly Disagree

21. It is important for organization to regularly involve its supplier to solve problems.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

22. Following-up with customers for quality/service feedback is important.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

23. Supplier selection should be based on quality and meeting demands.

- Strongly Agree
- Agree
- Partially Agree
- Neutral

- Partially Disagree
- Disagree
- Strongly Disagree

24. Organizations should frequently determine future customer expectations.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

25. Organizations should have continuous improvement plans and strategy that include its key suppliers and customers.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

26. Organizations should ensure employee satisfaction in terms of insurance and recognition to ensure higher effectiveness.

- Strongly Agree
- Agree

- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

27. Quality management and Data Analytics will lead to cost optimization in SCM.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

28. Quality Management and Data Analytics will lead to more flexible supply chain cycles.

- Strongly Agree
- Agree
- Partially Agree
- Neutral
- Partially Disagree
- Disagree
- Strongly Disagree

29. Is innovation in Supply Chain Management can improve the process?

- Yes
- No

- Maybe

30. Can an approach such as Six Sigma be implemented inside SCM to reduce variability?

- Yes
- No
- Maybe

Appendix B

Exploratory factor Analysis (SPSS Output)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.850
Bartlett's Test of Sphericity	Approx. Chi-Square	9065.957
	df	136
	Sig.	.000

Communalities

	Initial	Extraction
V1	1.000	.992
V2	1.000	.991
V3	1.000	.984
V4	1.000	.980
V5	1.000	.984
V6	1.000	.996
V7	1.000	.994
V8	1.000	.994
V9	1.000	.980
V10	1.000	.958
V11	1.000	.969

V12	1.000	.950
V13	1.000	.966
Y1	1.000	.956
Y2	1.000	.935
Y3	1.000	.962
Y4	1.000	.951

Extraction Method: Principal

Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.159	53.876	53.876	9.159	53.876	53.876
2	3.232	19.013	72.889	3.232	19.013	72.889
3	2.493	14.667	87.555	2.493	14.667	87.555
4	1.656	9.739	97.295	1.656	9.739	97.295
5	.122	.715	98.010			
6	.077	.453	98.463			
7	.056	.328	98.791			
8	.047	.277	99.069			
9	.039	.231	99.300			

10	.034	.199	99.499			
11	.032	.186	99.685			
12	.023	.133	99.818			
13	.012	.071	99.889			
14	.008	.048	99.936			
15	.005	.030	99.966			
16	.003	.019	99.985			
17	.003	.015	100.000			

Total Variance

Explained

Rotation

Sums of

Squared

Comp Loadings^a

onent Total

1	7.196
2	5.899
3	6.774
4	4.659

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Component Matrix^a

	Component			
	1	2	3	4
V1	.844		-.396	
V2	.840		-.397	
V3	.840		-.400	
V4	.839		-.392	
V5	.833		-.402	
V6	.823			-.519
V7	.821			-.518
V8	.819			-.522
V9	.825			-.501
V10	.724		.615	
V11	.696		.652	
V12	.700		.641	
V13	.712		.633	

Y1	.479	.832		
Y2	.462	.837		
Y3	.488	.838		
Y4	.500	.827		

Extraction Method: Principal Component Analysis.^a

a. 4 components extracted.

Reproduced Correlations

		V1	V2	V3	V4	V5	V6	V7
Reproduced Correlation	V1	.992 ^a	.991	.988	.986	.987	.595	.595
	V2	.991	.991 ^a	.987	.985	.987	.584	.583
	V3	.988	.987	.984 ^a	.982	.984	.586	.586
	V4	.986	.985	.982	.980 ^a	.982	.587	.586
	V5	.987	.987	.984	.982	.984 ^a	.572	.572
	V6	.595	.584	.586	.587	.572	.996 ^a	.995
	V7	.595	.583	.586	.586	.572	.995	.994 ^a
	V8	.589	.577	.580	.580	.566	.995	.994
	V9	.598	.587	.589	.590	.575	.988	.986
	V10	.427	.428	.423	.427	.421	.498	.496
	V11	.388	.389	.384	.389	.382	.470	.467
	V12	.384	.384	.379	.384	.377	.481	.479
	V13	.405	.406	.401	.405	.399	.481	.478

	Y1	.249	.253	.260	.252	.253	.255	.251
	Y2	.244	.250	.255	.248	.250	.201	.197
	Y3	.252	.256	.262	.255	.256	.244	.240
	Y4	.268	.273	.279	.272	.273	.243	.239
Residual ^b	V1		-.003	-.002	-.005	.003	.001	8.982E-5
	V2	-.003		-.004	.003	-.004	-.002	.002
	V3	-.002	-.004		-.006	-.003	.003	.002
	V4	-.005	.003	-.006		-.011	-2.160E-6	-.001
	V5	.003	-.004	-.003	-.011		-.001	-.002
	V6	.001	-.002	.003	-2.160E-6	-.001		.000
	V7	8.982E-5	.002	.002	-.001	-.002	.000	
	V8	.003	.000	.000	-.003	.001	.000	.001
	V9	-.005	.001	-.004	.004	.002	-.004	-.008
	V10	.003	-.008	.000	-.001	.004	.001	-.003
	V11	-.005	.008	.001	.001	-.004	-.001	-8.096E-6
	V12	.008	-.003	-.006	-.006	.009	.000	.002
	V13	-.005	.003	.006	.006	-.009	7.445E-5	.001
	Y1	.001	.000	-.002	-.002	.004	-.001	.002
	Y2	-.005	-.001	.004	.004	-.004	.001	-.002

Y3	.002	.001	-.001	-.001	-.002	-5.972E-6	-.003
Y4	.001	.000	-.002	-.002	.003	.000	.003

Reproduced Correlations

		V8	V9	V10	V11	V12	V13	Y1
Reproduced Correlation	V1	.589	.598	.427	.388	.384	.405	.249
	V2	.577	.587	.428	.389	.384	.406	.253
	V3	.580	.589	.423	.384	.379	.401	.260
	V4	.580	.590	.427	.389	.384	.405	.252
	V5	.566	.575	.421	.382	.377	.399	.253
	V6	.995	.988	.498	.470	.481	.481	.255
	V7	.994	.986	.496	.467	.479	.478	.251
	V8	.994 ^a	.986	.497	.468	.480	.479	.250
	V9	.986	.980 ^a	.508	.479	.490	.490	.254
	V10	.497	.508	.958 ^a	.962	.952	.961	.230
	V11	.468	.479	.962	.969 ^a	.959	.967	.218
	V12	.480	.490	.952	.959	.950 ^a	.958	.244
	V13	.479	.490	.961	.967	.958	.966 ^a	.241
	Y1	.250	.254	.230	.218	.244	.241	.956 ^a
	Y2	.195	.202	.247	.238	.262	.260	.942
	Y3	.239	.245	.261	.251	.276	.273	.958
	Y4	.238	.244	.281	.271	.295	.293	.951

Residual ^b	V1	.003	-.005	.003	-.005	.008	-.005	.001
	V2	.000	.001	-.008	.008	-.003	.003	.000
	V3	.000	-.004	.000	.001	-.006	.006	-.002
	V4	-.003	.004	-.001	.001	-.006	.006	-.002
	V5	.001	.002	.004	-.004	.009	-.009	.004
	V6	.000	-.004	.001	-.001	.000	7.445E-5	-.001
	V7	.001	-.008	-.003	-8.096E-6	.002	.001	.002
	V8		-.008	-.001	.001	.003	-.003	.002
	V9	-.008		.004	.001	-.007	.002	-.007
	V10	-.001	.004		-.014	-.010	-.018	-.003
	V11	.001	.001	-.014		-.020	.002	-.004
	V12	.003	-.007	-.010	-.020		-.019	.012
	V13	-.003	.002	-.018	.002	-.019		-.003
	Y1	.002	-.007	-.003	-.004	.012	-.003	
	Y2	-.002	.007	.006	.003	-.010	-.001	-.031
	Y3	-.003	.007	.001	.006	-.015	.008	-.014
	Y4	.003	-.007	-.004	-.005	.012	-.004	.000

Pattern Matrix^a

	Component			
	1	2	3	4
V1	.985			
V2	.992			
V3	.985			
V4	.982			
V5	.997			
V6			.990	
V7			.990	
V8			.994	
V9			.968	
V10		.962		
V11		.995		
V12		.972		
V13		.980		
Y1				.982
Y2				.970
Y3				.980
Y4				.966

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.

a

a. Rotation converged in 5 iterations.

Structure Matrix

	Component			
	1	2	3	4
V1	.996	.407	.588	
V2	.995	.407	.576	
V3	.992	.402	.579	
V4	.990	.407	.580	
V5	.992	.400	.565	
V6	.584	.489	.998	
V7	.584	.486	.997	
V8	.577	.487	.997	
V9	.587	.498	.989	
V10	.426	.978	.497	
V11	.387	.984	.468	
V12	.382	.974	.480	
V13	.404	.983	.479	
Y1				.977

Y2				.966
Y3				.981
Y4				.975

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.

Component Correlation Matrix

Component	1	2	3	4
1	1.000	.405	.576	.265
2	.405	1.000	.487	.270
3	.576	.487	1.000	.238
4	.265	.270	.238	1.000

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.

Appendix C

Confirmatory Factor Analysis (AMOS Output)

Model Validity Measures

Validity Analysis

	CR	AVE	MSV	MaxR(H)	F1	F2	F3	F4
F1	0.996	0.982	0.350	0.997	0.991			
F2	0.997	0.988	0.350	0.998	0.591***	0.994		
F3	0.986	0.946	0.242	0.988	0.411***	0.492***	0.973	
F4	0.983	0.934	0.074	0.984	0.268***	0.246***	0.272***	0.966

Validity Concerns

No validity concerns here.

Significance of Correlations:

† $p < 0.100$

* $p < 0.050$

** $p < 0.010$

*** $p < 0.001$

Standardized Regression Weights

Predictor	Outcome	Std Beta
F1	V5	.991
F1	V4	.986 ***
F1	V3	.989 ***
F1	V2	.993 ***
F1	V1	.996 ***
F2	V9	.984
F2	V8	.997 ***
F2	V7	.997 ***
F2	V6	.998 ***
F3	V13	.982
F3	V12	.959 ***
F3	V11	.983 ***
F3	V10	.966 ***
F4	Y4	.968
F4	Y3	.975 ***
F4	Y2	.951 ***
F4	Y1	.971 ***

Significance of Estimates:

*** $p < 0.001$

** $p < 0.010$

* $p < 0.050$

$p < 0.100$

Appendix D

Structural Equation Modelling (AMOS Output):

Model Fit Measures

Measure	Estimate	Threshold	Interpretation
CMIN	203.269	--	--
DF	89.000	--	--
CMIN/DF	2.284	Between 1 and 3	Excellent
CFI	0.988	>0.95	Excellent
SRMR	0.016	<0.08	Excellent
RMSEA	0.079	<0.06	Acceptable
PClose	0.01	>0.05	Acceptable

Cutoff Criteria (Hu and Bentler 1999)

Measure	Terrible	Acceptable	Excellent
CMIN/DF	> 5	> 3	> 1
CFI	<0.90	<0.95	>0.95

SRMR	>0.10	>0.08	<0.08
RMSEA	>0.08	>0.06	<0.06
PClose	<0.01	<0.05	>0.05

Variable counts (Group number 1)

Number of variables in your model: 41

Number of observed variables: 17

Number of unobserved variables: 24

Number of exogenous variables: 21

Number of endogenous variables: 20

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	24	0	0	0	0	24
Labeled	0	0	0	0	0	0
Unlabeled	19	24	21	0	0	64
Total	43	24	21	0	0	88

Assessment of normality (Group number 1)

Variable	min	max	skew	c.r.	kurtosis	c.r.
V6	2.000	7.000	-1.209	-7.069	1.357	3.966
V7	2.000	7.000	-1.236	-7.222	1.436	4.196
V8	2.000	7.000	-1.223	-7.150	1.357	3.967
V9	2.000	7.000	-1.248	-7.296	1.516	4.431
Y4	3.000	7.000	-2.207	-12.902	4.320	12.626
Y3	3.000	7.000	-2.126	-12.428	4.364	12.756
Y2	3.000	7.000	-2.091	-12.224	4.318	12.619
Y1	3.000	7.000	-2.156	-12.604	4.391	12.834
V13	2.000	7.000	-1.409	-8.236	1.902	5.558
V12	2.000	7.000	-1.308	-7.643	1.699	4.965
V11	2.000	7.000	-1.363	-7.965	1.795	5.247
V10	2.000	7.000	-1.271	-7.430	1.477	4.316
V1	3.000	7.000	-1.322	-7.726	1.130	3.301
V2	3.000	7.000	-1.369	-8.004	1.290	3.769
V3	3.000	7.000	-1.334	-7.799	1.198	3.502
V4	3.000	7.000	-1.295	-7.569	1.050	3.070
V5	3.000	7.000	-1.322	-7.726	1.130	3.301

Variable	min	max	skew	c.r.	kurtosis	c.r.
Multivariate					1095.341	308.518

Observations farthest from the centroid (Mahalanobis distance) (Group number 1)

Observation number	Mahalanobis d-squared	p1	p2
50	179.810	.000	.000
77	175.469	.000	.000
122	175.469	.000	.000
135	175.469	.000	.000
48	162.214	.000	.000
132	124.945	.000	.000
167	113.438	.000	.000
80	104.958	.000	.000
97	85.657	.000	.000
197	85.657	.000	.000
52	83.907	.000	.000
47	83.657	.000	.000
84	80.491	.000	.000
116	77.720	.000	.000

Observation number	Mahalanobis d-squared	p1	p2
105	73.368	.000	.000
205	73.368	.000	.000
59	69.379	.000	.000
151	62.787	.000	.000
23	60.300	.000	.000
13	59.347	.000	.000
121	51.964	.000	.000
53	51.406	.000	.000
120	42.181	.001	.000
193	37.922	.003	.000
145	37.805	.003	.000
128	35.917	.005	.000
60	33.919	.009	.000
159	33.792	.009	.000
20	33.753	.009	.000
92	33.140	.011	.000
111	32.668	.012	.000

Observation number	Mahalanobis d-squared	p1	p2
143	32.404	.013	.000
76	30.932	.020	.000
148	30.696	.022	.000
129	30.647	.022	.000
168	30.292	.024	.000
149	29.941	.027	.000
58	29.748	.028	.000
28	24.980	.095	.000
188	24.931	.096	.000
88	23.010	.149	.029
163	22.042	.183	.234
141	19.443	.304	.999
113	19.419	.305	.999
131	18.922	.333	1.000
127	18.769	.342	1.000
8	18.643	.349	1.000
36	18.428	.362	1.000

Observation number	Mahalanobis d-squared	p1	p2
35	16.747	.472	1.000
134	16.618	.481	1.000
45	16.133	.514	1.000
30	14.532	.629	1.000
41	13.832	.679	1.000
82	13.676	.690	1.000
25	13.578	.697	1.000
66	12.423	.774	1.000
31	11.921	.805	1.000
12	10.641	.875	1.000
22	10.234	.893	1.000
184	9.682	.916	1.000
90	8.632	.951	1.000
94	8.603	.952	1.000
44	7.975	.967	1.000
137	7.975	.967	1.000
144	7.975	.967	1.000

Observation number	Mahalanobis d-squared	p1	p2
192	7.975	.967	1.000
63	7.793	.971	1.000
27	7.428	.977	1.000
112	7.414	.978	1.000
136	7.414	.978	1.000
142	7.414	.978	1.000
160	7.414	.978	1.000
34	6.950	.984	1.000
133	6.949	.984	1.000
64	6.797	.986	1.000
147	6.105	.992	1.000
130	5.889	.994	1.000
166	5.889	.994	1.000
57	5.680	.995	1.000
39	5.613	.995	1.000
156	5.401	.996	1.000
18	4.691	.999	1.000

Observation number	Mahalanobis d-squared	p1	p2
150	4.691	.999	1.000
21	4.465	.999	1.000
7	4.416	.999	1.000
11	4.416	.999	1.000
115	4.416	.999	1.000
176	4.416	.999	1.000
110	4.396	.999	1.000
139	4.396	.999	1.000
185	4.396	.999	1.000
183	3.881	1.000	1.000
91	3.736	1.000	1.000
10	3.651	1.000	1.000
65	3.459	1.000	1.000
4	3.023	1.000	1.000
138	3.023	1.000	1.000
195	3.023	1.000	1.000
69	3.004	1.000	1.000

Observation number	Mahalanobis d-squared	p1	p2
175	2.936	1.000	1.000

Computation of degrees of freedom (Default model)

Number of distinct sample moments: 153

Number of distinct parameters to be estimated: 64

Degrees of freedom (153 - 64): 89

Result (Default model)

Minimum was achieved

Chi-square = 203.269

Degrees of freedom = 89

Probability level = .000

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
F1	<---	F4	.617	.060	10.214	***	par_17
F2	<---	F1	.562	.072	2.237	.025	par_14
F2	<---	F4	.400	.076	5.285	***	par_16
F3	<---	F2	.140	.063	2.209	.027	par_15
F3	<---	F4	.065	.072	.891	.373	par_18

			Estimate	S.E.	C.R.	P	Label
F3	<---	F1	.114	.065	1.740	.082	par_19
V5	<---	F1	1.000				
V4	<---	F1	.996	.016	63.658	***	par_1
V3	<---	F1	.988	.014	68.878	***	par_2
V2	<---	F1	1.002	.011	91.406	***	par_3
V1	<---	F1	1.007	.009	107.718	***	par_4
V10	<---	F2	1.000				
V11	<---	F2	.979	.021	47.235	***	par_5
V12	<---	F2	.987	.024	41.768	***	par_6
V13	<---	F2	.986	.022	44.554	***	par_7
Y1	<---	F3	1.000				
Y2	<---	F3	.922	.029	32.290	***	par_8
Y3	<---	F3	.985	.021	46.350	***	par_9
Y4	<---	F3	1.021	.023	43.721	***	par_10
V9	<---	F4	1.000				
V8	<---	F4	1.016	.013	81.135	***	par_11
V7	<---	F4	1.014	.013	76.158	***	par_12

	Estimate	S.E.	C.R.	P	Label
V6 <--- F4	1.015	.011	90.202	***	par_13

Standardized Regression Weights: (Group number 1 - Default model)

	Estimate
F1 <--- F4	.588
F2 <--- F1	.167
F2 <--- F4	.393
F3 <--- F2	.174
F3 <--- F4	.079
F3 <--- F1	.146
V5 <--- F1	.989
V4 <--- F1	.990
V3 <--- F1	.988
V2 <--- F1	.996
V1 <--- F1	.994
V10 <--- F2	.972
V11 <--- F2	.970
V12 <--- F2	.969

	Estimate
V13 <--- F2	.974
Y1 <--- F3	.980
Y2 <--- F3	.934
Y3 <--- F3	.968
Y4 <--- F3	.965
V9 <--- F4	.982
V8 <--- F4	.997
V7 <--- F4	.997
V6 <--- F4	.997

Covariances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
e14 <--> e17	.005	.001	4.374	***	par_20
e12 <--> e14	.006	.003	2.403	.016	par_21
e13 <--> e14	-.001	.002	-.548	.584	par_22
e11 <--> e12	.020	.005	4.075	***	par_23
e13 <--> e22	.027	.014	1.982	.047	par_24
e7 <--> e9	.024	.006	3.896	***	par_25

			Estimate	S.E.	C.R.	P	Label
e5	<-->	e14	-.008	.001	-5.953	***	par_26
e5	<-->	e8	.015	.003	5.411	***	par_27
e1	<-->	e2	-.006	.002	-3.524	***	par_28
e1	<-->	e5	.006	.002	4.064	***	par_29
e4	<-->	e5	-.003	.001	-2.837	.005	par_30
e8	<-->	e12	-.015	.004	-3.996	***	par_31
e4	<-->	e17	-.002	.001	-2.987	.003	par_32
e4	<-->	e7	.008	.002	4.450	***	par_33
e4	<-->	e6	-.009	.002	-4.081	***	par_34
e4	<-->	e16	.002	.001	2.872	.004	par_35
e5	<-->	e15	.002	.001	3.182	.001	par_36
e9	<-->	e15	-.003	.001	-2.213	.027	par_37
e2	<-->	e15	-.001	.001	-.758	.448	par_38
e1	<-->	e8	.013	.003	3.682	***	par_39
e1	<-->	e9	-.006	.002	-2.866	.004	par_40
e12	<-->	e17	.003	.001	3.060	.002	par_41
e5	<-->	e12	.005	.001	3.447	***	par_42

	Estimate	S.E.	C.R.	P	Label
e5 <--> e6	.009	.002	4.307	***	par_43

Correlations: (Group number 1 - Default model)

	Estimate
e14 <--> e17	.366
e12 <--> e14	.175
e13 <--> e14	-.037
e11 <--> e12	.378
e13 <--> e22	.168
e7 <--> e9	.454
e5 <--> e14	-.395
e5 <--> e8	.557
e1 <--> e2	-.268
e1 <--> e5	.396
e4 <--> e5	-.286
e8 <--> e12	-.320
e4 <--> e17	-.334
e4 <--> e7	.396

	Estimate
e4 <--> e6	-.450
e4 <--> e16	.354
e5 <--> e15	.269
e9 <--> e15	-.175
e2 <--> e15	-.080
e1 <--> e8	.354
e1 <--> e9	-.182
e12 <--> e17	.233
e5 <--> e12	.226
e5 <--> e6	.340

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
F4	.891	.091	9.815	***	par_44
e23	.643	.065	9.895	***	par_45
e22	.685	.071	9.662	***	par_46
e24	.536	.055	9.672	***	par_47
e1	.022	.003	8.464	***	par_48

	Estimate	S.E.	C.R.	P	Label
e2	.019	.002	8.889	***	par_49
e3	.023	.002	9.258	***	par_50
e4	.008	.001	5.500	***	par_51
e5	.012	.002	6.725	***	par_52
e6	.055	.008	6.934	***	par_53
e7	.056	.008	7.200	***	par_54
e8	.059	.008	7.215	***	par_55
e9	.048	.007	6.918	***	par_56
e10	.024	.004	5.591	***	par_57
e11	.075	.009	8.589	***	par_58
e12	.039	.005	7.533	***	par_59
e13	.038	.005	7.065	***	par_60
e14	.033	.003	9.784	***	par_61
e15	.005	.001	6.433	***	par_62
e16	.005	.001	6.657	***	par_63
e17	.005	.001	6.749	***	par_64

Matrices (Group number 1 - Default model)

Residual Covariances (Group number 1 - Default model)

	V6	V7	V8	V9	Y4	Y3	Y2	Y1	V13	V12	V11	V10	V1	V2	V3	V4	V5
V6	.0 01																
V7		- .0 00															
V8			.0 02														
V9				.0 07													
Y4					.0 02												
Y3						.0 00											
Y2							.0 05	.0 00									

	V6	V7	V8	V9	Y4	Y3	Y2	Y1	V13	V12	V11	V10	V1	V2	V3	V4	V5
Y1	.0 07	.0 06	.0 06	.0 04	.0 01	- .0 10	- .0 02	.0 00									
V1	.0 05	.0 03	.0 04	.0 18	.0 01	.0 17	.0 10	- .0 15	.0 02								
3																	
V1	.0 02	.0 01	.0 05	.0 07	.0 15	.0 16	.0 03	- .0 02	- .0 14	- .0 21							
2																	
V1	- .0 05	- .0 06	- .0 03	.0 09	- .0 15	.0 00	.0 02	- .0 32	- .0 02	- .0 09	.0 04						
1																	
V1	.0 21	.0 15	.0 19	.0 36	- .0 08	.0 03	.0 06	- .0 25	- .0 04	- .0 12	.0 05	.0 06					
0																	
V1	.0 08	.0 06	.0 03	.0 17	.0 14	- .0 07	- .0 04	- .0 05	.0 12	- .0 14	- .0 03	.0 32	.0 18				

	V6	V7	V8	V9	Y4	Y3	Y2	Y1	V13	V12	V11	V10	V1	V2	V3	V4	V5
V2	-	-	-	.0	.0	.0	.0	-	.0	-	.0	.0	-	-			
	.0	.0	.0	04	16	00	03	.0	20	.0	02	40	.0	.0			
	05	06	10					03		10			16	15			
V3	.0	.0	.0	.0	.0	.0	.0	.0	.0	-	.0	.0	-	-	.0		
	09	07	01	10	23	07	14	04	24	.0	05	39	.0	.0	00		
										11			06	09			
V4	.0	.0	-	.0	.0	.0	.0	-	.0	-	.0	.0	-	-	-	.0	
	06	05	.0	17	17	01	09	.0	28	.0	09	42	.0	.0	.0	01	
			01					02		07			12	05	03		
V5	-	-	-	-	.0	-	.0	.0	.0	-	-	.0	-	-	-	-	-
	.0	.0	.0	.0	20	.0	02	01	10	.0	.0	39	.0	.0	.0	.0	.0
	13	14	16	02		01				14	05		15	16	04	09	14

Standardized Residual Covariances (Group number 1 - Default model)

	V6	V7	V8	V9	Y4	Y3	Y2	Y1	V13	V12	V11	V10	V1	V2	V3	V4	V5
V6	.0																
	07																
V7	-	-															
	.0	.0															
	03	13															

	V6	V7	V8	V9	Y4	Y3	Y2	Y1	V13	V12	V11	V10	V1	V2	V3	V4	V5
V8	.0 25	.0 15	.0 43														
	-	-	-	-													
V9	.0 78	.0 92	.0 63	.1 59													
Y4	.0 38	.0 27	.0 18	.0 08	.0 23												
	-	-	-		-	-											
Y3	.0 59	.1 01	.1 09	.0 08	.1 62	.2 63											
	-	-	-	-													
Y2	.4 24	.5 29	.5 36	.3 00	.0 78	.0 75	.0 07										
Y1	.1 29	.1 18	.1 09	.0 75	.0 09	- 75	- 31	.0 08									
V1	.0	.0	.0	.2	.0	.3	.1	-	.0								
3	63	36	57	54	25	05	86	.2 74	20								

	V6	V7	V8	V9	Y4	Y3	Y2	Y1	V13	V12	V11	V10	V1	V2	V3	V4	V5
V1	.0	.0	.0	.0	.2	.2	.0	-	-	-							
2	34	12	63	95	49	86	64	.0	.1	.2							
								41	48	22							
V1	-	-	-		-	-	-	-		-							
1	.0	.0	.0	.1	.2	.0	.0	.5	.0	.1	.0						
	63	88	37	30	66	04	44	85	24	01	43						
V1	.2	.2	.2	.4	-	.0	.1	-	-	-		.0					
0	88	04	54	86	.1	46	03	.4	.0	.1		.0					
					38			38	47	32	50	59					
V1	.0	.0	.0	.2	.2	-	-	-	.1	-	-	.4	-				
	99	78	33	15	31	.1	.0	.0	58	.1	.0	33	.1				
						25	74	91		85	36		83				
V2	-	-	-	.0	.2	.0	.0	-	.2	-	.0	.5	-	-			
	.0	.0	.1	51	72	01	55	.0	71	.1	32	43	.1	.1			
	59	74	27					51		32			61	51			
V3	.1	.0	.0	.1	.3	.1	.2	.0	.3	-	.0	.5	-	-		.0	
	17	96	14	30	87	16	60	64	30	.1	65	28	.0	.0		00	
										51			63	92			

	V6	V7	V8	V9	Y4	Y3	Y2	Y1	V13	V12	V11	V10	V1	V2	V3	V4	V5
V4	.0 81	.0 61	- .0 10	.2 22	.2 87	.0 14	.1 56	- .0 37	.3 85	- .0 99	.1 22	.5 72	- .1 24	- .0 52	- .0 27	.0 12	
V5	- .1 61	- .1 82	- .2 00	- .0 22	.3 40	- .0 14	.0 39	.0 20	.1 44	- .1 86	- .0 65	.5 25	- .1 52	- .1 66	- .0 40	- .0 95	- .1 36

Total Effects (Group number 1 - Default model)

	F4	F1	F2	F3
F1	.617	.000	.000	.000
F2	.500	.162	.000	.000
F3	.205	.136	.140	.000
V6	1.015	.000	.000	.000
V7	1.014	.000	.000	.000
V8	1.016	.000	.000	.000
V9	1.000	.000	.000	.000
Y4	.209	.139	.143	1.021
Y3	.202	.134	.138	.985
Y2	.189	.126	.129	.922

	F4	F1	F2	F3
Y1	.205	.136	.140	1.000
V13	.493	.159	.986	.000
V12	.493	.160	.987	.000
V11	.489	.158	.979	.000
V10	.500	.162	1.000	.000
V1	.622	1.007	.000	.000
V2	.618	1.002	.000	.000
V3	.610	.988	.000	.000
V4	.615	.996	.000	.000
V5	.617	1.000	.000	.000

Standardized Total Effects (Group number 1 - Default model)

	F4	F1	F2	F3
F1	.588	.000	.000	.000
F2	.490	.167	.000	.000
F3	.250	.175	.174	.000
V6	.997	.000	.000	.000
V7	.997	.000	.000	.000

	F4	F1	F2	F3
V8	.997	.000	.000	.000
V9	.982	.000	.000	.000
Y4	.241	.169	.168	.965
Y3	.242	.169	.168	.968
Y2	.233	.163	.162	.934
Y1	.245	.171	.170	.980
V13	.478	.162	.974	.000
V12	.475	.161	.969	.000
V11	.476	.162	.970	.000
V10	.477	.162	.972	.000
V1	.584	.994	.000	.000
V2	.586	.996	.000	.000
V3	.581	.988	.000	.000
V4	.582	.990	.000	.000
V5	.581	.989	.000	.000

Direct Effects (Group number 1 - Default model)

	F4	F1	F2	F3
F1	.617	.000	.000	.000
F2	.400	.162	.000	.000
F3	.065	.114	.140	.000
V6	1.015	.000	.000	.000
V7	1.014	.000	.000	.000
V8	1.016	.000	.000	.000
V9	1.000	.000	.000	.000
Y4	.000	.000	.000	1.021
Y3	.000	.000	.000	.985
Y2	.000	.000	.000	.922
Y1	.000	.000	.000	1.000
V13	.000	.000	.986	.000
V12	.000	.000	.987	.000
V11	.000	.000	.979	.000
V10	.000	.000	1.000	.000
V1	.000	1.007	.000	.000
V2	.000	1.002	.000	.000

	F4	F1	F2	F3
V3	.000	.988	.000	.000
V4	.000	.996	.000	.000
V5	.000	1.000	.000	.000

Standardized Direct Effects (Group number 1 - Default model)

	F4	F1	F2	F3
F1	.588	.000	.000	.000
F2	.393	.167	.000	.000
F3	.079	.146	.174	.000
V6	.997	.000	.000	.000
V7	.997	.000	.000	.000
V8	.997	.000	.000	.000
V9	.982	.000	.000	.000
Y4	.000	.000	.000	.965
Y3	.000	.000	.000	.968
Y2	.000	.000	.000	.934
Y1	.000	.000	.000	.980
V13	.000	.000	.974	.000

	F4	F1	F2	F3
V12	.000	.000	.969	.000
V11	.000	.000	.970	.000
V10	.000	.000	.972	.000
V1	.000	.994	.000	.000
V2	.000	.996	.000	.000
V3	.000	.988	.000	.000
V4	.000	.990	.000	.000
V5	.000	.989	.000	.000

Indirect Effects (Group number 1 - Default model)

	F4	F1	F2	F3
F1	.000	.000	.000	.000
F2	.100	.000	.000	.000
F3	.140	.023	.000	.000
V6	.000	.000	.000	.000
V7	.000	.000	.000	.000
V8	.000	.000	.000	.000
V9	.000	.000	.000	.000

	F4	F1	F2	F3
Y4	.209	.139	.143	.000
Y3	.202	.134	.138	.000
Y2	.189	.126	.129	.000
Y1	.205	.136	.140	.000
V13	.493	.159	.000	.000
V12	.493	.160	.000	.000
V11	.489	.158	.000	.000
V10	.500	.162	.000	.000
V1	.622	.000	.000	.000
V2	.618	.000	.000	.000
V3	.610	.000	.000	.000
V4	.615	.000	.000	.000
V5	.617	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	F4	F1	F2	F3
F1	.000	.000	.000	.000
F2	.098	.000	.000	.000

	F4	F1	F2	F3
F3	.171	.029	.000	.000
V6	.000	.000	.000	.000
V7	.000	.000	.000	.000
V8	.000	.000	.000	.000
V9	.000	.000	.000	.000
Y4	.241	.169	.168	.000
Y3	.242	.169	.168	.000
Y2	.233	.163	.162	.000
Y1	.245	.171	.170	.000
V13	.478	.162	.000	.000
V12	.475	.161	.000	.000
V11	.476	.162	.000	.000
V10	.477	.162	.000	.000
V1	.584	.000	.000	.000
V2	.586	.000	.000	.000
V3	.581	.000	.000	.000
V4	.582	.000	.000	.000

	F4	F1	F2	F3
V5	.581	.000	.000	.000

Notes for Group/Model (Group number 1 - Default model)

The following covariance matrix is not positive definite (Group number 1 - Default model)

	e22	e17	e16	e15	e14	e13	e12	e11	e9	e8	e7	e6	e5	e4	e2	e1
e2	.6															
2	85															
e1	.0	.00														
7	00	5														
e1	.0	.00	.0													
6	00	0	05													
e1	.0	.00	.0	.00												
5	00	0	00	5												
e1	.0	.00	.0	.00	.03											
4	00	5	00	0	3											
e1	.0	.00	.0	.00	-	.0										
3	27	0	00	0	.00	38										
					1											
e1	.0	.00	.0	.00	.00	.0	.03									
2	00	3	00	0	6	00	9									

	e22	e17	e16	e15	e14	e13	e12	e11	e9	e8	e7	e6	e5	e4	e2	e1
e1	.0	.00	.0	.00	.00	.0	.02	.0								
1	00	0	00	0	0	00	0	75								
e9	.0	.00	.0	-	.00	.0	.00	.0	.04							
	00	0	00	.00	0	00	0	00	8							
				3												
e8	.0	.00	.0	.00	.00	.0	-	.0	.00	.0						
	00	0	00	0	0	00	.01	00	0	59						
							5									
e7	.0	.00	.0	.00	.00	.0	.00	.0	.02	.0	.0					
	00	0	00	0	0	00	0	00	4	00	56					
e6	.0	.00	.0	.00	.00	.0	.00	.0	.00	.0	.0	.05				
	00	0	00	0	0	00	0	00	0	00	00	5				
e5	.0	.00	.0	.00	-	.0	.00	.0	.00	.0	.0	.00	.01			
	00	0	00	2	.00	00	5	00	0	15	00	9	2			
					8											
e4	.0	-	.0	.00	.00	.0	.00	.0	.00	.0	.0	-	-	.0		
	00	.00	02	0	0	00	0	00	0	00	08	.00	.00	08		
		2										9	3			

	e22	e17	e16	e15	e14	e13	e12	e11	e9	e8	e7	e6	e5	e4	e2	e1
e2	.0	.00	.0	-	.00	.0	.00	.0	.00	.0	.0	.00	.00	.0	.01	
	00	0	00	.00	0	00	0	00	0	00	00	0	0	00	9	
				1												
e1	.0	.00	.0	.00	.00	.0	.00	.0	-	.0	.0	.00	.00	.0	-	.0
	00	0	00	0	0	00	0	00	.00	13	00	0	6	00	.00	22
									6						6	

This solution is not admissible.

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

	M.I.	Par Change
e10 <--> e22	4.123	-.023
e8 <--> e23	4.056	-.028
e8 <--> e14	6.822	-.006
e3 <--> e16	4.436	.002
e3 <--> e15	7.271	-.002
e3 <--> e14	5.602	-.003
e3 <--> e9	4.628	.005
e3 <--> e8	6.375	-.007

	M.I.	Par Change
e3 <--> e4	4.654	-.002
e2 <--> e4	7.278	.002

Variances: (Group number 1 - Default model)

	M.I. Par Change
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Regression Weights: (Group number 1 - Default model)

	M.I.	Par Change
V12 <--- V3	4.235	-.036

Minimization History (Default model)

Iteration	Negative eigenvalues	Condition #	Smallest eigenvalue	Diameter	F	NTries	Ratio
0	e 25		-1.829	9999.000	9213.533	0	9999.000
1	e 41 *		-4.062	3.302	7223.428	20	.342
2	e 40		-4.044	.196	6976.983	8	.989

Iteration	Negative eigenvalues	Condition #	Smallest eigenvalue	Diameter	F	NTrie s	Ratio
3	e	30	-4.378	.216	6720.364	5	.836
4	e *	28	-13.901	.351	6175.723	5	1.037
5	e *	22	-6.493	.078	6065.762	6	.757
6	e	23	-13.965	.133	5843.581	5	1.048
7	e *	20	-6.975	.106	5695.879	4	.698
8	e *	16	-18.306	.152	5426.352	5	1.053
9	e	19	-6.577	.053	5309.627	6	.998
10	e	16	-1.357	.049	5248.977	5	.684

Iteration	Negative eigenvalue s	Condition #	Smallest eigenvalue e	Diameter	F	NTrie s	Ratio
11	e	13	-10.501	.408	4894.48 2	9	.864
12	e *	14	-4.168	.211	4666.52 6	4	.780
13	e	13	-2.134	.095	4530.78 3	5	.930
14	e *	13	-5.211	.171	4358.88 2	5	.766
15	e	12	-3.111	.215	4122.53 4	5	.862
16	e *	11	-17.234	.386	3581.24 6	5	1.092
17	e *	11	-11.002	.075	3407.91 7	6	.917
18	e	9	-11.615	.095	3207.51 3	5	.881

Iteration	Negative eigenvalue s	Condition #	Smallest eigenvalue	Diameter	F	NTrie s	Ratio
19	e	9	-4.921	.103	2998.426	5	.949
20	e *	10	-16.195	.195	2683.404	5	.893
21	e *	10	-91.865	.070	2426.227	5	1.191
22	e	9	-2.645	.022	2304.993	6	.966
23	e	9	-2.823	.035	2238.398	6	.758
24	e	9	-3.794	.175	2076.045	8	.801
25	e *	9	-10.039	.331	1625.321	5	1.077
26	e *	8	-7.085	.088	1507.739	6	.700

Iteration	Negative eigenvalues	Condition #	Smallest eigenvalue	Diameter	F	NTrie s	Ratio
27	e *	7	-27.701	.200	1192.905	6	1.094
28	e	7	-2.588	.037	1107.890	7	.978
29	e	7	-2.700	.034	1061.351	5	.692
30	e *	5	-1.104	.281	778.504	9	.898
31	e	3	-.720	.131	650.950	5	.763
32	e	3	-.527	.168	528.319	5	.843
33	e	2	-.579	.190	425.196	5	.847
34	e *	0 1	13151497.03	.358	295.426	6	.924
35	e	0	396989.679	.511	257.040	7	.000
36	e	0	260721.148	.203	218.481	3	.000
37	e	0	157935.884	.330	204.382	1	.891

Iteration	Negative eigenvalues	Condition #	Smallest eigenvalue	Diameter	F	NTries	Ratio
38	e 0	149035.218		.064	203.278	1	1.053
39	e 0	148251.430		.007	203.269	1	1.008
40	e 0	150923.216		.000	203.269	1	1.000

Model Fit Summary

CMIN

Model	NP	AR	CMIN	DF	P	CMIN/DF
Default model	64	203.269	89	.000	2.284	
Saturated model	153	.000	0			
Independence model	17	9364.330	136	.000	68.855	

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.013	.905	.837	.527
Saturated model	.000	1.000		
Independence model	.483	.165	.060	.146

Baseline Comparisons

Model	NFI	RFI	IFI	TLI	CFI
	Delta1	rho1	Delta2	rho2	
Default model	.978	.967	.988	.981	.988
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.654	.640	.646
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	114.269	76.624	159.638
Saturated model	.000	.000	.000
Independence model	9228.330	8914.307	9548.660

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	.996	.560	.376	.783

Model	FMIN	F0	LO 90	HI 90
Saturated model	.000	.000	.000	.000
Independence model	45.904	45.237	43.698	46.807

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.079	.065	.094	.001
Independence model	.577	.567	.587	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	331.269	343.656	543.941	607.941
Saturated model	306.000	335.613	814.421	967.421
Independence model	9398.330	9401.620	9454.821	9471.821

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	1.624	1.439	1.846	1.685
Saturated model	1.500	1.500	1.500	1.645
Independence model	46.070	44.531	47.640	46.086

HOELTER

Model	HOELTERHOELTER	
	.05	.01
Default model	113	124
Independence model	4	4

Execution time summary

Minimization: .071

Miscellaneous: .584

Bootstrap: .000

Total: .655