POLITECNICO
MILANO 1863

Master of Science Thesis

Supply Chain Digital Transformation: A Systematic Literature Review on the motivations, actions, and the benefits

Supervisors

Prof. Paolo Trucco

Dr. Yasmine Sabri

Done by

Mohamad F. Gharib Lalah 879128

Table of Content

List of Figures

List of Tables

Acknowledgment

First of all, I want to express my special gratitude and thanks to my thesis' supervisors Prof. Paolo Trucco and Dr. Yasmine Sabri for their unlimited support, patience, and their appreciated guidance to me during this research. I am fortunate to have them as my advisors and It was always a pleasure working under their supervisory in such a great institute, Politecnico di Milano.

I owe my deepest gratitude to my great family; father, mother, brothers, and sister for providing me with unfailing support and continuous encouragement, throughout my years of study and through the process of studying and overall throughout writing this thesis.

I also owe a lot to my friends, colleagues who supported me during the years of my studies and they have become as a family for me for providing me the support, good company and a warm feeling that made me feel home and provide a push toward accomplish my study.

Thank you Everyone for your unlimited support, this accomplishment would not have been possible without them. Thank you.

Abstract

In the Last decades, the discussion about the impact of digitalisation and digital transformation has been raised in various sectors, including the business, production processes, as well as the supply chain, spring from the Digital Technologies advancements, initiated from the launching of the first digital computer to the introduction of World Wide Web In 1993 by Tim Berners-Lee.

Nowadays, the organisations and their supply chain, are facing huge challenges in several contexts and dimensions of the supply chain and manufacturing, and they need to have reactions in order to overcome these challenges and stay in the market. Due to this increasingly challenges in the competition, the organisations are striving to adopt the digital transformation in their practices for several motivations and reasons.

The purpose of this research is to deepen the understanding of the digital transformations and to investigate how adopting the digital technologies represented by Industry 4.0 technologies provides benefits to the organisation's supply chain. Furthermore, the purpose of this research is to state the main motivations for adopting digital technologies that lead to several actions related to the digital transformation, consequently, the benefits that are generated from these actions and practices. Additionally, the main aim is to develop a conceptual framework to link and create a connection between Motivations, Actions, and Benefits of adopting the Digital technologies, as well as to perform an evaluation of the digital transformation topic and its related benefits, and to go forward with this evaluation. Data nature, Customer, Demand, operations, External Business Environment Context, Policies, and Sustainability were selected as main contexts for this conceptual framework.

Taking into consideration the lack of the researches about the Supply chain digital transformation, and in order to evaluate, examine and analyse the existing literature review of the supply chain digital transformation, and to access all the studies related to the supply chain digital transformation topic, a systematic literature review (SLR) is conducted to this research. Additionally, to achieve this evaluation, this research has followed two-phases analysis approach: first, designing a descriptive analysis about supply chain digital transformation, that focus on 7 dimensions and contexts of the supply chain, secondly analysis and review of the papers that are related to the supply chain digital transformation topic.

This research represents a rich analysis and discussion by systematically examining and classifying the researches and studies according to several dimensions and contexts in the supply chain, such as Data nature, Customer, Demand, operations, External Business Environment Context, Policies, and Sustainability. Nevertheless, there is a significant number of researches about the supply chain management and how the performance can be improved, however, there are few studies were performed regarding the digital transformation of the supply chain, and what are the benefits of this transformation to the supply chain in general and to the organisation specifically.

Furthermore, this research provides a contribution and insights into a comprehensive perception of the supply chain digital transformation from the motivations of adopting these technologies, connecting them with the actions that are taken a place regarding the transformation and finally the benefits that are generated by these actions. Finally, this research develops a conceptual framework connecting the motivations, actions and the benefits of the digital transformation.

Keywords: Supply chain Digital Transformation, Industry 4.0 in Supply chain, Digital transformation benefits, Systematic Literature Review**.**

Riassunto

Negli ultimi decenni il dibattito relativo all'impatto della digitalizzazione e della trasformazione digitale è stato sollevato in vari settori tra cui il business, i processi produttivi e la supply chain. L'impatto è stato generato dai progressi delle tecnologie digitali avviati con il lancio del primo computer e con l'introduzione del World Wide Web nel 1993 da Tim Berners-Lee.

Al giorno d'oggi, le organizzazioni e le loro Supply Chain stanno affrontando enormi sfide in diversi contesti e dimensioni della filiera e della produzione e, per rimanere sul mercato, devono fronteggiare adeguatamente queste situazioni. A causa dell'aumento della crescente competizione sul mercato, le organizzazioni stanno cercando di adottare la trasformazione digitale nelle loro pratiche per diverse motivazioni e ragioni.

Lo scopo di questa ricerca è quello di approfondire la comprensione delle trasformazioni digitali e di indagare come l'adozione delle tecnologie digitali, rappresentate dalle tecnologie di Industria 4.0, apporti benefici alla Supply Chain dell'organizzazione. Inoltre, verranno indicate le principali motivazioni per l'adozione di tecnologie digitali che portano a diverse azioni legate alla trasformazione digitale e di conseguenza saranno esplicitati i benefici generati da queste azioni e pratiche. Infine, ci si concentrerà dapprima sullo sviluppo di una struttura concettuale che colleghi e crei una connessione tra Motivazioni, Azioni e Benefici dell'adozione delle tecnologie digitali, e quindi sulla valutazione del tema della trasformazione digitale e dei relativi benefici. La natura dei dati, il cliente, la domanda, le operazioni, il contesto dell'ambiente aziendale esterno, le politiche e la sostenibilità sono stati selezionati come contesti principali per questo quadro concettuale.

Data la mancanza di ricerche sulla trasformazione digitale della Supply Chain, al fine di valutare, esaminare e analizzare la revisione della letteratura esistente sulla trasformazione digitale della Supply Chain e di accedere a tutti gli studi relativi al tema della trasformazione digitale della Supply Chain, è stata condotta una revisione sistematica della letteratura (SLR). Inoltre, per raggiungere questa valutazione è stato seguito un approccio di analisi a due fasi: in primo luogo, un'analisi descrittiva della trasformazione digitale della supply chain che si focalizza su sette dimensioni e contesti della Supply, successivamente l'analisi e la revisione dei documenti relativi al tema della trasformazione digitale della Supply Chain.

Questa ricerca rappresenta un'analisi e una discussione prospere esaminando e classificando sistematicamente le ricerche e gli studi in base a diverse dimensioni e contesti nella Supply Chain, quali Dati natura, Cliente, Domanda, operazioni, Contesto dell'ambiente aziendale esterno, Politiche e Sostenibilità. Tuttavia, vi è un numero significativo di ricerche riguardanti la gestione della supply chain e il modo in cui le prestazioni possono essere migliorate, tuttavia sono stati effettuati pochi studi sulla trasformazione digitale della supply chain e quali sono i benefici di questa trasformazione di Supply Chain in generale e l'organizzazione nello specifico.

Inoltre, questa ricerca fornisce un contributo e approfondimenti su una percezione globale della trasformazione digitale della supply chain dalle motivazioni dell'adozione di queste tecnologie, collegandole con le azioni prese in considerazione per la trasformazione e infine i benefici generati da queste azioni. Infine, questa ricerca sviluppa una struttura concettuale che collega le motivazioni, le azioni ed i benefici della trasformazione digitale.

Parole chiave: Supply chain Digital Transformation, industria 4.0 in Supply chain, benefici della trasformazione digitale, revisione sistematica della letteratura.

1. Introduction

1.1. Digitalisation and Digital Transformation Background

In recent years, the discussion about the impact of digitalisation and digital transformation has been raised in various sectors, including the business sector (Bounfour, 2016; Westerman, et al., 2014) and production processes, as well as the supply chain, spring from the Digital Technologies advancements (Bounfour, 2016), and initiated from the launching of the first digital computer to the introduction of World Wide Web In 1993 by Tim Berners-Lee (Vogelsang, 2010).

(Vogelsang, 2010) indicated that the new digital technology wave or as he preferred to call it, "5th Kondratiev wave", is not only changing our production processes but also it changes the way of living, and he added that "after the steam, steel, electricity, and petrochemical revolutions, network-based digitalisation is the driving force today on the stage of business and private life".

In General, the term "Digitalisation: is referred to the transformation of the analogue information system into the binary system (0 or 1) digital digits, in another word, it describes the process of transformation of the information from the physical systems to the digital systems (Collin, et al., 2015). (Collin, et al., 2015) Argued that digitalisation is also a change in the current value chains among the industries and public sectors and that change is a global megatrend, in the addition, various terms such as Mobile apps, big data, Internet of things, Industry 4.0 could be useful to describe this phenomenon.

However, the digital transformation term refers to the adoption of individuals, businesses, organizations, and societies of the new digital technologies, resulting from the digitalization that previously mentioned, and this transformation is characterized as a global accelerated process (Collin, et al., 2015; Westerman, et al., 2014). Eventually, and according to (FitzGerald, et al., 2013), and with the accelerated technological development (Bounfour, 2016) there is no organisation will be capable to isolate itself from the digital transformation and the Competitive environment that follows adopting the new digital technologies (FitzGerald, et al., 2013).

1.2. Industry 4.0

In Hannover fair 2011, the term “Industrie 4.0” was initially presented, then after 2 years, in 2013 it was adopted officially as a German strategic initiative to take a leading role in the industrial fields, which characterized with the fast development in the manufacturing and has a revolutionary nature. After that the term “Industry 4.0 “was adopted to indicate to the fourth industrial revolution (Alexopoulos, et al., 2016; Qin, et al., 2016) the term symbolized the Fourth Industrial Revolution and its implications for the adoption of digital technology in industries and all other fields in addition to the current trend in adopting this technology and what it includes of enabling technologies such as the cloud computing, Internet of Things (IoT) and cyber-physical systems (CPS) (Hermann, et al., 2016; Kagermann, et al., 2013; Lu, 2017).

In order to reach the current fourth industrial revolution, industrial revolutions have been undergone, three industrial revaluations throughout history, and corresponding the timeline, the revolutions were as below:

1. In the end of the 18th century and the early 19th, the lunch of the first industrial revolution (Industry 1.0) was taken a place by adopting mechanical manufacturing systems benefiting from using water and steam power in the manufacturing systems.
2. At the end of the 19th century, the second revolution was launched, characterized by utilizing the electrical power in the productions, resulting in a mass production concept.
3. In the Middle of 20th Century, the third revolution was started by adopting the automation, microelectronic devices and technology in manufacturing, achieving development in the manufacturing practices and technologies. In this industrial revolution a significant development has occurred thanks to the use of computer numerical control (CNC), robots that made flexible manufacturing systems (FMSs) real, computer-aided design (CAD), computer-aided manufacturing (CAM) and computer-aided processing planning (CAPP) that enhanced the use of computer integrated manufacturing (CIM) (Feng, Li, and Cen 2001). What distinguishes the third industrial revolution is the development of information and communication technology, resulting in a core transformation in every field of the manufacturing paradigm (Feng, et al., 2001). The third industrial revolution also adopted the automation of machines and processes (Tan & Mathews, 2010), but what differs the third

revolution from the fourth revolution is that the industry 4.0 was concentrated more on the end–to–end digitisation besides the integration of digital ecosystems through finding full integrated solutions. Figure 1 represents the stages of industrial revelations.

Source: International Journal of Production Research

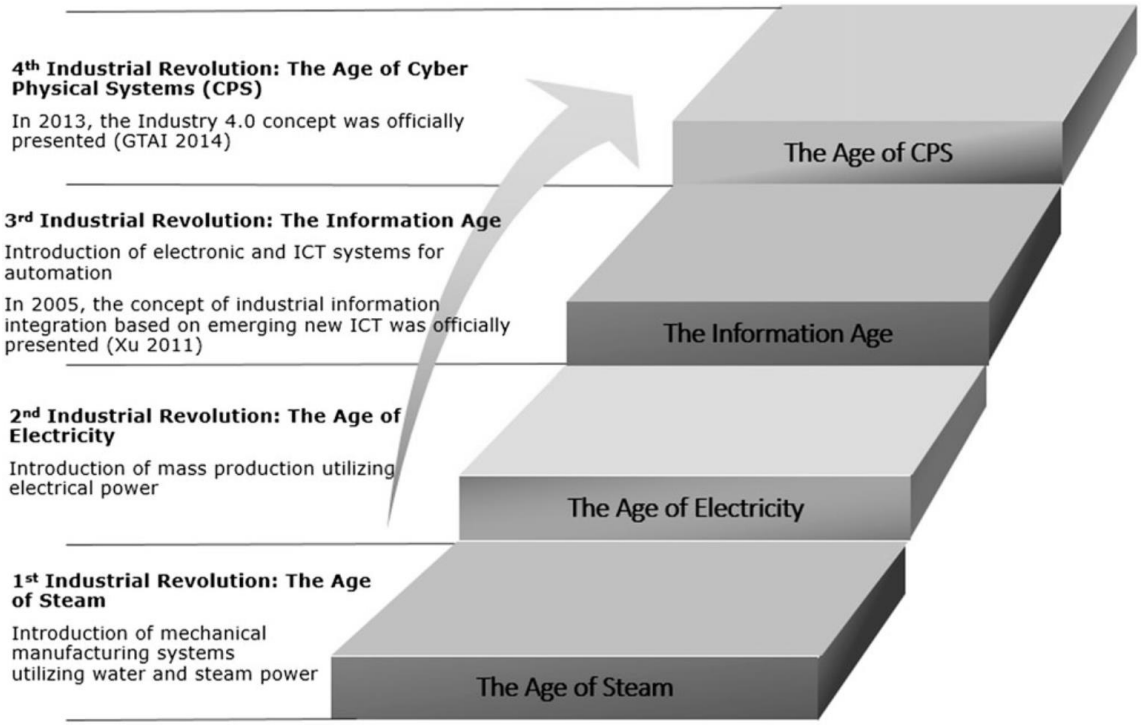

Figure 1 *The evolution from Industry 1.0 to Industry 4.0.*

1.3. Digital Transformation in the Supply Chain Context

Supply chain sector like other sectors that been affected by the fourth industrial revolution. The last thirty years witnessed an enormous shift in the supply chain and logistics, shifting from the pure operational processes which report to the sales or production facilities and concentred on the supply of production lines and the distribution – mainly – to the final customers, to an autonomous Supply chain functional unit, and this unit has been shifted its focus from the conventional process to advanced planning processes, trying to implement integrated processes and operations from the customers to the suppliers. (Alicke, et al., 2016).

Nowadays, the organisations are striving to adopt the digital transformation in their practices for several motivations and reasons, nevertheless, few studies have focused on the actions of the digital transformation practices and the benefits that digital transformation has on organizations' supply chain practices (Piccinini, et al., 2015).

The motivations of the Digital transformation adoption are varied and related to many dimensions and contexts in the supply chain. Based on these motivations that drive the digital transformation, a sequence of transformation actions and practices are occurred. Nevertheless, expected benefits have been generated from these transformation actions and practices could be occurred in the supply chain context.

The purpose of this research is to deepen the understanding of the digital transformations and to investigate how adopting the digital technologies represented with Industry 4.0 technologies provides benefits to the organisation's supply chain practices. Furthermore, the purpose of this research is to state the main motivations that drive digital transformation that lead to several transformation actions related to the digital transformation, consequently, the expected benefits that are generated from these actions and practices. Additionally, the main aim is to develop a conceptual framework to link and create a connection between Motivations, Actions, and Benefits of adopting the Digital technologies, as well as evaluation of the digital transformation and the generated benefits, and to go forward with this evaluation. Data nature, Customer, Demand, operations, External Business Environment Context, Policies, and Sustainability were selected as main contexts for this conceptual framework.

Taking into consideration the lack of the researches about the Supply chain digital transformation, and in order to evaluate, examine and analyse the existing literature review of the supply chain digital transformation, and to access all the studies related to the supply chain digital transformation topic, a systematic literature review (SLR) is conducted to this research. Additionally, to achieve this evaluation, this research has followed two-phases analysis approach: first, designing a descriptive analysis about supply chain digital transformation, that focus on 7 dimensions and contexts of the supply chain, secondly analysis and review of the papers that are related to the supply chain digital transformation topic.

The main objective of the second analysis is, therefore, to identify the antecedents and to perform an evaluation regarding the supply chain digital transformation starting from the main motivations of the adopting the digital technologies, the actions related to the digital transformation and finally the generated expected benefits from these actions. Based on these objectives, the main research questions are:

RQ1 “What are the motivations that drive the digital transformation of the supply chain?”

RQ2 “What are the transformation actions triggered by specific motivations?”

RQ3 "What are the expected benefits that are generated by transformation actions?”

In order to evaluate, examine and analyse the existing literature review of the supply chain digital transformation, and to access all the studies related to the supply chain digital transformation topic, a systematic literature review (SLR) is conducted to this research. Additionally, and as previously mentioned, to achieve this evaluation, this research has followed two phases analysis approach, first, designing a descriptive analysis about supply chain digital transformation, by which this research was driven to focus on 7 dimensions and contexts of the supply chain in which the analysis will take a place, second analysis has been performing by analysing and reviewing the papers that are related to the supply chain digital transformation topic.

Considering the defined contexts and dimensions of the supply chain digital transformation, this research contributes to both literature and practice by systematically reviewing the supply chain digital transformation and industry 4.0 in supply chain literature. This research has rich analysis and discussion by systematically examining and classifying the researches and studies according to several dimensions and contexts in the supply chain, such as Data nature, Customer, Demand, operations, External Business Environment Context, Policies, and Sustainability. Nevertheless, there is a significant number of researches regarding about the supply chain management and how the performance can be improved, however, there are few studies were achieved regarding the digital transformation of the supply chain, and what are the benefits of this transformation to the supply chain in general and the organisation specifically.

Furthermore, this research provides a contribution and insights into a comprehensive perception of the supply chain digital transformation from the motivations that drive the digital transformation, connecting them with the transformation actions, and finally the expected benefits

that are generated by these actions. Finally, this research develops a conceptual framework connecting the motivations, actions and the benefits of the digital transformation.

The structure of this research is including the opening chapter (the introduction) which represents the background digital transformation, highlighting the main purpose of this research, the motivation and the contribution of the research. This chapter gives the reader an insight into the area of focus of this research, in addition to highlighting the main research questions.

Chapter 2 of this research discuss deeply the methodology of this research, the steps, protocols, processes of the methodology, and explaining the examination processes of the studies deeply. Chapter 3 is regarding the min findings after performing a deep analysis of the existing studies and literature based on the main findings. Chapter 4 includes the discussion and analysis chapter of the main findings presented in chapter 3 according to the research questions. Chapter 5 is the conclusion of this research which contains, limitations of this research, future studies regarding the digital transformation of the supply chain in the addition to a summary of the discussion and some comments regarding the main topic.

2. Research Methodology

The literature review is playing a significant role in research development and its progress, and it is aimed "to provide a historical perspective of the respective research area and an in-depth account of independent research endeavours" (Mentzer & Kahn, 1995). (Light & Pillemer, 1984) Underline their capability to aggregate Knowledge in existing studies, as a process that can create new knowledge and can achieve progress in the research, and, highlight that this synthesizing practice is at the same level of significance as constructing new research.

In order to eliminate the bias from the researches, a systemic structure in the literature review was undertaken and implemented to make the research characterized as a high-level of review aggregated from primary studies that are focused on answering a certain question, in addition, to provide more evidence-based character on the research. (Rousseau, et al., 2008) Reported that systematic Literature reviews are different from the conventional narrative methods of literature reviews. Systematic reviews differ from the conventional literature review in many aspects since the SRL is characterized with comprehensive since all the relevant studies are included besides the use of transparent analyses; and apply a critical analysis with specific criteria for providing the evidentiary value of a body of previous literature (Rousseau, et al., 2008). Moreover, according to (Tranfield, et al., 2003), SLRs feature the implicit principles of transparency, inclusivity, and heuristics that allow obtaining high-quality research by reducing bias and errors due to a deeper focus on objective observation and repeatability of results.

Systematic literature review (SLR) is significant due to two-pronged aspects: First by helping in collecting and re-organising existing information from the preliminary studies existing in a more systematic and structured way. Second, building a new knowledge through building a framework and analysing the existing body of knowledge, so based on these facts SLR should follow a guideline and a certain protocol and systemic steps in order to have the best results in findings and answer the main research question(s).

Due to the above-mentioned features, SLR Methodology was conducted and adopted in this research, in order to find existing studies and accumulate all the knowledge and information related to the Supply chain Digital Transformation with the aim of answering the main research question(s).

2.1 An Overview of Systematic Literature Review

2.1.1 General Overview

Systematic literature review (SLR) forms a crucial methodology for identifying, selecting, and analysing secondary data (Tranfield, et al., 2003; Denyer & Tranfield, 2009). (Kitchenham & Charters, 2007) Defined systematic literature review (SLR) methodology as: "a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest."

Over the last decades the Systematic review processes and its related procedures has been achieved a progress, and those days became one of the key roles in evidence-based practices, however SLR basically defines the key scientific contributions to a sector or question, meanwhile the meta-analysis provide a statistical practices for analysing the findings, achieving a more relevant and reliable research that couldn't be found in any single study, consequently, adopting SLR is consider now as a " Fundamental scientific activity " (Mulrow, 1994).

(Tranfield, et al., 2003) In his study that was published in the British journal of management outlined three main stages and processes of the systematic literature review: Planning the review, conducting the review and Reporting the review. And these stages are divided into phases that (Tranfield, et al., 2003) detailed them as the following:

Stage I−Planning the review:
Phase 0 - Identification for the need for a review

Phase 1 - Preparation of a proposal for a review

Phase 2 - Development of a review protocol

Stage II−Conducting a review:
Phase 3 - Identification of research
Phase 4 - Selection of studies
Phase 5 - Study quality assessment
Phase 6 - Data extraction and monitoring progress
Phase 7 - Data synthesis

Stage III−Reporting and dissemination:

Phase 8 - The report and recommendations

Phase 9 - Getting evidence into practice

In planning the review stage, the aim of the review has to be identified, the procedures should be carefully selected, and a protocol has to be developed then to be evaluated. In the second stage which is conducting the review stage, the research has to be identified and the selection for the studies should take place in this stage along with quality assessment. At the end of the second stage, the necessary information that could lead to answering the research question and data extraction is fundamental to be implemented since it is considered as the backbone of the research. In the last stage, reporting the review, the final result and the analysis should be reported, formatted and evaluated.

On the other hand, according to (Durach, et al., 2017) SLR methodology pursue six steps:

(1) Defining the research question,
(2) Determining the required characteristics of primary studies,
(3) Retrieving a sample of potentially relevant literature,
(4) Selecting the pertinent literature,
(5) Synthesizing the literature,
(6) Reporting the results.

(Durach, et al., 2017) Considered four key publications that helped him to illustrate these steps: First, (Mulrow, 1987) that reported the original discussion of systematic literature review method structure, which formed the core for sequential systematic literature review guidelines in medicine and other fields. Second, the Cochrane Collaboration - established in London, the United Kingdom in 1993 – that was publishing frequently the latest insights regarding Systematic literature review guidelines in the medical sector (Cochrane Collaboration , 2011). Third, the Campbell Collaboration - a sister initiative established in 2000 with the aim of enhancing Systematic literature reviews in the educational, behavioural and social practices – is publishing regularly the latest update and feedbacks of its methodological recommendations (Campbell Collaboration, 2016), Finally, (Tranfield, et al., 2003) drew on previous systematic literature reviews guidelines trying to make systematic literature reviews methodology as an adopted method to the management field. In other publications, (Mulrow

& Cook, 1998) and (Denyer & Tranfield, 2009), identical Stages was reported; thus, they are considered to be demonstrated by the four selected references.

2.1.2 The Systematic Literature Review in the SC Domain

Medicine sector was the first sector that the Systematic literature reviews were adopted in, that was published in 1972. Then, this methodology has been introduced to different fields and sectors. And as in many other fields, Supply chain management (SCM) is one of these fields that the systematic literature review was introduced in and being adopted as a research methodology.

Recently in the supply chain management domain, the number of Systematic literature reviews methodology that was adopted in the publication is facing a noticeably increase, that usually is being promoted by the journals themselves. (Durach, et al., 2017) analysed the publications related to the Supply chain management published during the period 2010–2015, and he identified that 133 research that a Systematic literature review was taken a place as an adopted methodology, (33%) of the publications (44 research out of 133) were published between 2010 and 2012 and 67% of the publications (89 out of 133) between 2013 and 2015.

(Tranfield, et al., 2003; Denyer & Tranfield, 2009) Argued that the researches related to the management field is still in a nascent stage and still achieving progress in terms of agenda and focus. Management research does not have a consensus on a method of research and does not enjoy the aggregation on a research question, unlike the other more mature fields such as medicine or engineering. Therefore, Management researchers tend to define and to address a steady flow of questions rather than aggregate and construct consistent knowledge blocks and data extraction focusing on a certain question. A significantly increasing number of researches related to management field, combined with the information technology progress, has led lately to that synthesizing different literature and accumulating a knowledge base to become an increasingly topical challenge.

2.1.3 Features of Systematic Literature Reviews

Systematic reviews play a significant role in the development of evidence-based practice in evidence-based practice. Initiated in the medical sector, then they have been extended to be applied in management research to decrease the "research-practice gap" (Rousseau, 2006). According to (Kitchenham & Charters, 2007) there are some features that discriminate the Systematic literature reviews from the conventional methodology such as:

- SLR initiate by defining a review protocol that highlights the research question(s) and reports the processes that will be performed and followed to implement the review.
- They are built on a planned and well-defined search strategy that should take into consideration the relevant literature as much as possible and report their search strategy so the completeness, credibility and the objectivity can be assessed while reading the research
- SLR should have some inclusion and exclusion criteria to evaluate each potential study and paper.
- Systematic literature reviews point out the data and information to be aggregated from each primary study and paper.
- A systematic review is essential for quantitative meta-analysis.

(Kitchenham & Charters, 2007) Summarized the main advantages and motivations of adopting of Systematic literature review in the researches. Firstly, the well-defined methodology makes the results more comprehensive and doesn't take a certain opinion of a particular researcher more than another, in addition, it takes several points of view, which gives more comprehensive, realistic, objective and less biased opinions and results in the studies. Hence, and after reviewing all the features, characteristics, and the objectivity of systematic literature review, it has been found that adopting of SLR methodology is the best-suited methodology to be performed in this research and to identify and address the main research questions:

RQ1 "What are the motivations that drive the digital transformation of the supply chain?"

RQ2 "What are the transformation actions triggered by specific motivations?"

RQ3 "What are the expected benefits that are generated by transformation actions?"

2.2 Systematic Literature Reviews in SC Digital Transformation

Digital Transformation is the adopting of digital technologies to solve traditional problems. These digital solutions enable genetically new types of creativity and innovative solutions, rather than simply enhance and support traditional methods. (Lankshear & Knobel., 2008).

With the advent of the Fourth Industrial Revolution (Industry 4.0) in the recent years, a need to adopt new technologies in several aspects in the manufacturing and industries was increased, especially in the supply chain, which can achieve a significant impact on the performance and effectiveness in the Supply chain. Consequently, "The Digital Transformation" term can be identified as the adoption of digital technologies to solve traditional problems. These digital solutions enable genetically new types of creativity and innovative solutions, rather than simply enhance and support traditional methods (Lankshear & Knobel., 2008).

To identify the motivations that drive digital transformation, the transformation actions triggered by the motivations, and the expected benefits generated from transformation actions, three research questions were designed. In order to answer the three research questions, this research has been benefited from the systematic literature review methodology based on the multi-stage approach that includes a presentation of steps undertaken to conduct this systematic review. As a pre-defined search strategy this multi-stage approach has been adopted in this thesis which includes seven main steps for conducting a systematic literature review in the supply chain digital transformation which illustrated below in (Figure.2):

Step I: Defining research questions - Supply Chain digital Transformation
Step II: Identification of research (databases and keywords) – Scopus and Web of Science.
Step III: Selection of related studies
Step IV: Screening and study quality assessment
Step V: Reporting the results (Findings and outcome)
Step VI: Data analysis
Step VII: Discussion and Conclusion

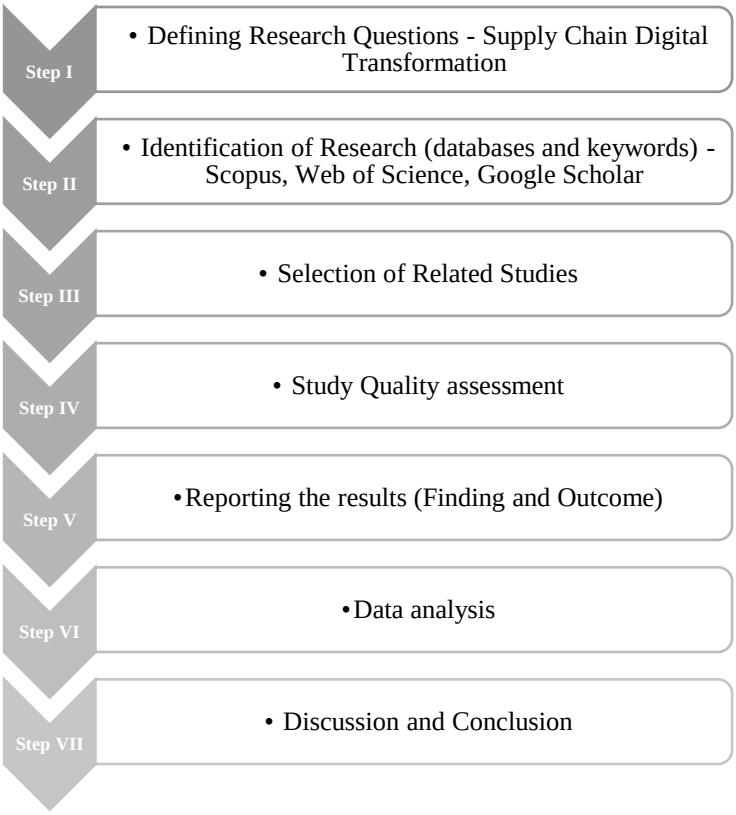

Figure 2 *Review Main Process Conducted in this research*

2.2.1 Defining the Research Question(s)

Addressing the research questions is the most essential part and of any systematic literature review since it drives the whole systematic review methodology. As the first step of this research, the main questions were addressed, and it was defined as below:

RQ1 “What are the motivations that drive the digital transformation of the supply chain?”

RQ2 “What are the transformation actions triggered by specific motivations?”

RQ3 "What are the expected benefits that are generated by transformation actions?”

2.2.2 Identification of Research Sources

After performing the first step (Defining the research question and the aim of this study), the identification of research sources is taking a place as a second step. In this step, a research well-defined strategy must be established and defined, to go on with this step some elements should be defined as well such as Databases and keywords in order to obtain as many primary studies as possible that could be related to the main research question (Kitchenham & Charters, 2007).

This research was identified and performed using two main academic literature collections; Scopus and Web of Science (WOS), since they are widely consulted by researchers and sometimes used in research evaluations, besides they include better quality literature published regarding Supply chain Management. Furthermore, Google scholar was also used as a search engine since the articles can be found and the access can be reached to the researches that are related to this research topic if they are not available or there is no access to the articles in WOS and Scopus. But Google Scholar is Unlike Web of Science (Woos) and Scopus since it doesn't provide metadata on the document type and the language of the documents that it covers. 12 Keywords were chosen to start the Identification of the research and some keywords were combined to ensure the best result of search that could cover all the possible researches related to the main topic as shown on (Table.1) that illustrates the keywords, number of articles for each keyword and the date of search beside the source of search.
Once the keyword combinations were defined and the process of the search was implemented successfully through electronic academic literature collections databases, the finding was reported in an Excel spreadsheet.

The search findings reported 2956 papers search results from Scopus academic database and 1334 search results from Web of Science academic database with Total of 4290 publications related to the 12 Keywords combination which have been chosen before, and they were identified as preliminary primary studies of this research review and they were saved in the excel spreadsheet for further processes and procedures. The literature search phase was implemented in the period 27th October 2018 and 9th of November 2018 a detailed summary of the literature search phase including the keywords combinations, the total number of papers and the search dates is reported in Table 1.

	scopus		Web of Scince	
Keywords Combinations	**Papers Found**	**Search Date**	**Papers Found**	**Search Date**
1. "Supply Chain" and "digital transformation"	35	27/10/2018	16	27/10/2018
2. "Supply chain" and "digitalization"	74	27/10/2018	39	29/10/2018
3. "Supply chain" and "IOT"	449	27/10/2018	286	9/11/2018
4. "Supply Chain" and "Digital Innovation"	7	27/10/2018	5	29/10/2018
5. "Supply chain" and "I4.0"	3	27/10/2018	1	29/10/2018
6. "Supply chain" and "Industry 4.0"	165	27/10/2018	109	5/11/2018
7. "Supply Chain" and "big data"	559	27/10/2018	421	9/11/2018
8. "Supply Chain" and "Block chain"	133	4/11/2018	50	4/11/2018
9. "Supply chain" and "additive manufacturing"	173	29/10/2018	117	5/11/2018
10. "Supply chain" and "artificial Intelligence"	1183	29/10/2018	160	29/10/2018
11. "Smart Supply chain"	49	29/10/2018	18	29/10/2018
12. "Supply Chain" and "Big data analytics"	126	4/11/2018	112	9/11/2018
Total	**2956**		**1334**	

Table 1 *Keywords combinations and the search Details*

2.2.3 Developing a Review Protocol and Selection of Related Studies

In the previous step, the preliminary primary studies were identified, thus in this step (the third step), two main actions should take a place: firstly, developing a review protocol, secondly the selection of related studies in order to narrow our search range.

According to the requirement for transparency of the process, the use of a set of clear selection criteria is a must in the systemic reviews, in order to evaluate whether each study is relevant to the main research topic or no. The purpose of defining the clear criteria in the selection process is to facilitate the evaluation and the assessment of the reviewer's decision besides simplifying the updating in of the systemic reviews. (Denyer & Tranfield, 2009).

A pre-defined review protocol is an important element for the Systematic literature review to define the map needed to be followed to narrow and decrease the possibility of bias of researchers to a certain opinion and to take as many opinions as possible in order to cover all the possible point of views, as well as a pre-review protocol study, could support in scoping research questions. To narrow and identify the preliminary, some selection criteria are used.

Therefore, the inclusion and exclusion criteria should be specific to the research question (Kitchenham & Charters, 2007). In this research, inclusion and exclusion selection criteria are defined to identify and select the most relevant papers that related directly to the topic and could make progress to the main research questions.

The Inclusion criteria can be detailed as below:

- Studies that are related to the topic "Supply chain" are included.
- Studies that are related to the topic "Digital Transformation "are included.
- The language of the study must be in English.
- The study must be published after 2010.
- The Studies that have a type of Article, conference papers, book chapter are included.
- An abstract must be available.
- Full text of the study must have access to (Available full text).
- Only Supply chain related journals are included.

On the other hand, the Exclusion criteria are:

- The Studies that are out of the topic of "Supply chain" (First research phase) are excluded.
- The Studies that are out of the topic "Digital Transformation "(second research phase) are excluded.
- All studies published in a language other than English are excluded.
- The Studies that have been published in 2010 or before are excluded.
- All Study with a type of Books, conference review, meeting review, short survey, meeting abstract book reviews and non-defined document type are excluded due to the limited time.
- Studies whose abstracts are not available must be excluded.
- All studies whose full text cannot be accessed excluded.
- All journals that are not related to Supply chain field are excluded.
- Papers with modelling and simulation as a methodology are excluded.

Due to the above exclusion and inclusion criteria, this research followed the most important feature of the Systematic literature review which is the comprehensiveness, inclusiveness and unbiasedness, by making this research non-limited to a certain sector or certain conceptual studies but also included

empirical researches of different sectors, in addition, the study includes both qualitative and quantitative research.

Furthermore, the primary studies didn't restrict to a specific methodology and it contains diverse methodology types of studies (Conceptual, Surveys, Conventional Literature Review, Case Studies, Systematic Literature Reviews, and Delphi study approaches, Focus Groups, Interviews and Native category approaches). Regarding the Source of the papers that have a type of article, conference papers and book chapter were included and due to the limited research time, all other types such as (proceeding papers, meeting abstract, book, review, shot survey, etc.) are excluded. In a later stage of screening, books chapter were also excluded due to a large number of the total papers resulted after the screening process.

The following Flowchart shows the steps and the actions that were taken to filter and screening the articles and visualizes and identifies in which step exactly inclusion criteria is implemented:

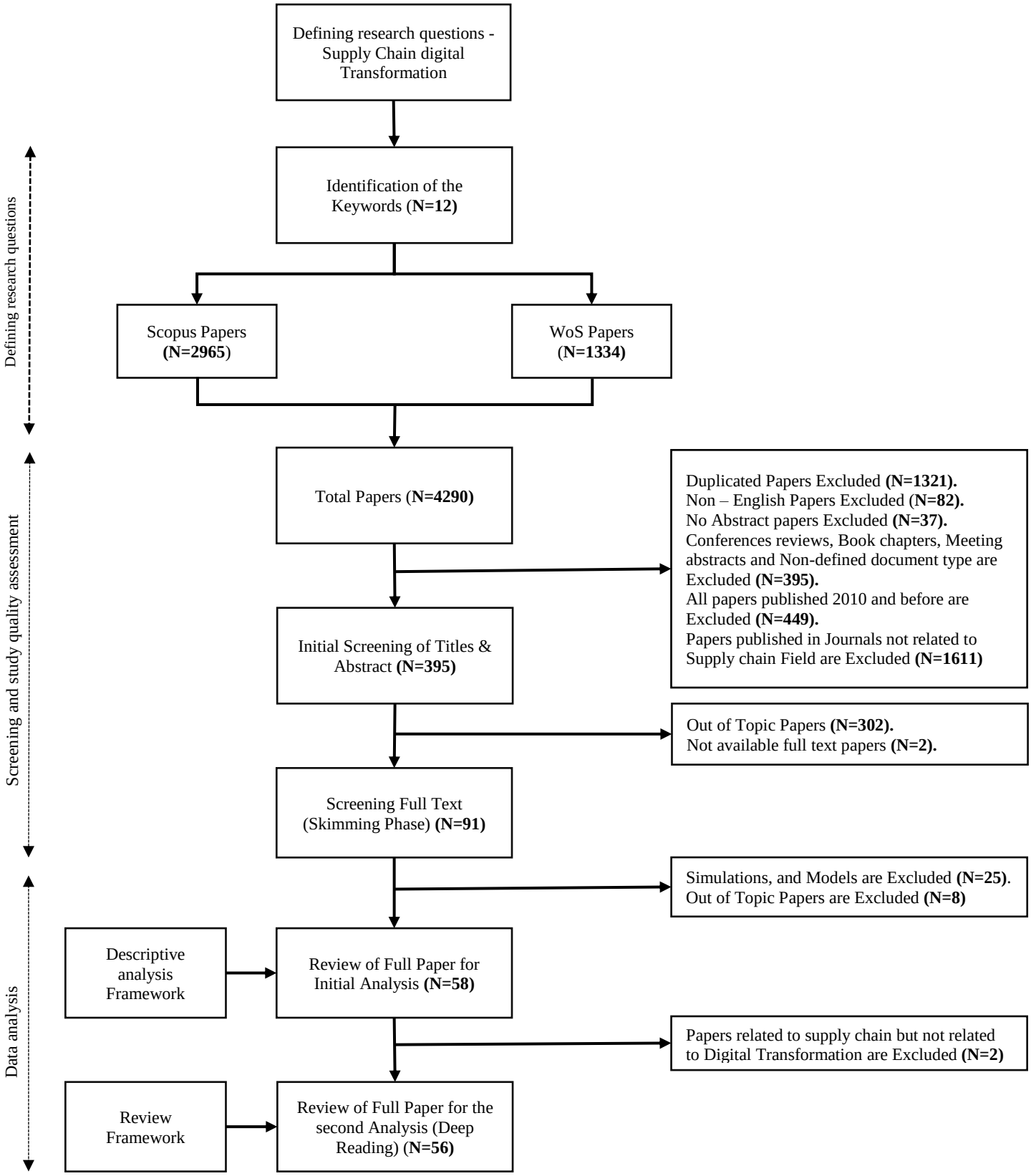

Figure 3 *Review Process Flowchart.*

Other criteria were also taken into account such as Language, abstract and access to the full text (availability), to obtain clarity and comprehensiveness. Finally, the most considerable criteria for selecting paper is the relationship of the paper with the topic, within-scope papers, out of scope papers. Basically, within-scope papers are the studies that related somehow to the scope of supply chain "AND" Digital transformation or can have a key or clue that can help in answering the main research question, meanwhile the out of scope papers involve the papers that they are not related or have no action or information related to the topic or can provide any information that could have a clue related to the main research topic.

As mentioned before and after a careful selection of keyword combinations with the total of 12 keyword combinations then the search was performed on the academic electronic databases (Scopus and Web of Science), the result was 4290 publications before applying any criteria to filter and screen and narrow the number of the papers. The previous flowchart illustrates the review process of selecting the relevant studies that could support this research, and the screening and selection processes were implemented on 4 stages: First Stage is implementing some criteria such as (Duplication of the studies, Language of the study, Availability of the Abstract, Type of the document, year of the publication, Source of the Paper (Journal) and the relationship of the paper with the topic).

The Result shows that the number of the excluded papers were as following:

- Duplicated Papers Excluded (N=1321).
- Non – English Papers Excluded (N=82).
- No Abstract papers Excluded (N=37).
- Conferences reviews, Book chapters, Meeting abstracts, and Non-defined document type are Excluded (N=395).
- All papers published in 2010 and before are Excluded (N=449).
- Papers published in Journals that are not related to Supply chain fields are Excluded (N=1611).

After the application of the first stage and criteria mentioned above, the remaining publications that are included are 395 Publications.

In the second selection stage, more in detail exclusion criteria were applied such as Related to the topic by Initial Screening of Titles & Abstract and assessing whether the paper is related to the topic or no. Other criteria were applied in this stage which is the availability of the full text considering the

studies whose full text cannot be found in the two main electronic academic databases (Scopus and Web of Science) beside Google scholar and the result shows that:

- Out of topic Papers that are not related to the Supply Chain "and/or" Digital Transformation is Excluded (N=302).
- Not available full-text papers (N=2).

This second elimination process appeared a result of 91 papers to be screened in the full text in further detail to assess their link to the main research topic.

In the third phase of the selection of studies, 91 papers' full text was reviewed in the initial analysis phase by skimming and fast reading to assess the relevant papers and their relativity to the topic. Some simulations, modelling, and papers that focus more on the supply chain or more in the technologies were also eliminated since the scope of this research is the digital transformation in the supply chain rather than the focus on technologies used in the supply chain, and the results were as below:

- Simulations and Models are Excluded (N=25).
- Out of Topic Papers are Excluded (N=8).

The remained publications after this phase is 58 publications that are ready to enter the final selection process.

Finally, the 58 papers that left for the previous stages were analysed and reviewed carefully by a deep reading action. Similarly to phase three the criteria was chosen mainly as a relativity to the topic of supply chain "And" digital transformation in the alignment with filling and extracted the relative information in the descriptive analysis framework – during phase three –, and a general review framework was filled as well (will be illustrated in details in the next section) in the final phase according to a defined structure and the result after the final stage was:

- Papers related to the supply chain but not related to Digital Transformation Excluded (N=2).

The result after four stages of screening showed that 56 papers are available and ready to be analysed and the necessary information was extracted and filled in the descriptive analysis framework and in final review framework those will be explained in detail in the next section of this report, Consequently, 56 papers were identified as core papers of this research at the end of the stage.

2.2.4 Study Quality Assessment

Screening and study quality assessment was implemented to figure out whether to include the paper that could help in analysing the topic related to Supply chain digital transformation. By developing and implementing the inclusion and exclusion criteria, papers that fall within the scope of the thesis were selected and became eligible to the next assessment phase. The next phase contains data analysis where the papers that passed screening and quality assessment are moving to the next filtering phase.

2.2.5 Data Extraction and Data Analysis

Data analysis is the most important phase of the systematic literature review methodology since it is considered as a backbone for analysing the main information that is included in the research questions. The main objective of this stage is to establish data extraction framework to record the information that researchers and authors obtain from the primary studies in order to decrease the possibility for bias then data extraction framework should be designed and well-defined and piloted when the study protocol is established (Kitchenham & Charters, 2007). In this stage, the eligible studies and papers from the previous phase should be analysed and broken down into smaller pieces by extracting the necessary data to investigate the similarities and differences between the studies.

After designing the data extraction framework and extracted the data from the primary studies, these small pieces are collected to be analysed and evaluated to see the whole image and connect all the information and ideas to answer the research question. To support synthesizing the small pieces, a framework was developed to observe all data in a more comprehensive approach forming a bigger image that could help in answering the main question. Data extraction frameworks are designed to assess many aspects of the primary studies such as the technical aspect and the descriptive aspect and these frameworks need to be piloted on a pattern of primary studies.

The framework was selected carefully to start the data analysis phase, and those elements were divided into 5 main elements and a sequence of sub-elements. The main element of the framework is:

1. Descriptive Information.
2. Digital Transformation Scope.

3. Technologies.
4. Transition Process.
5. Context and Supply chain collaboration and
6. Performance Measurements.

Data Analysis phase contains two main steps, the first step is the review of full papers for initial analyses and the extracted data was filled in the descriptive information section in the framework. The second step is the review of the full paper for second analysis extracting the data related to the framework's section: Digital Transformation Scope, Technologies, Transition Process, Context, and Supply chain collaboration and Performance Measurements.
The result after these phases contains 56 papers that could include in the final analysis and could lead to providing an answer for the main thesis questions.

2.2.5.1 Descriptive Analysis Framework

As a need to develop a data extraction framework in systemic literature review, the first data extraction framework was designed to support this research is Descriptive analysis framework that includes the necessary element to be filled with the descriptive information of the primary studies in order to reduce the bias and to simplify the analysis regarding the descriptive aspect of the primary studies.

The Descriptive analysis framework contains several sub-elements such as:

Number, Source, Keywords, Source Title (Journal), Title, Authors, Year, Document Type, Abstract, Language of Original Document, Title Screening, Comments, Abstract Screening, Reason of Excluding and comments, Main Purpose, Comments and Excluding Reason -if any-, Research Methodology and Research type, Article Summary (Conclusion), Data gathering method, Research Limitations, and Implementation Timeline.

As mentioned in figure 3, the flowchart shows that there is an initial analysis process is needed. The main aim of the initial analysis process is to describe the primary studies besides screening the studies and figure out the most relevant studies that could be within the topic. In addition to filtering the papers by their Title and Abstract as an initial analysis phase to reduce the bias and add a comprehensive sense to this research. The relevant information of the resulted 58 studies was

extracted and reported into the first framework built on Excel. Table 2. Illustrate in detail the Sub-element of the descriptive analysis framework and interprets each sub-element.

	Framework Elements	Explanation
Descriptive Information	Number	Number of the Article document in the Articles File
	Source	Scopus of Web of Science
	Keywords	For tracking relationship between Articles and keyword combinations
	Source Title (Journal)	Descriptive information for citation proposes
	Title	Descriptive information for citation proposes and Inclusion\Exclusion
	Authors	Descriptive information for citation proposes
	Year	Descriptive information for citation proposes and Inclusion\Exclusion
	Document Type	Descriptive information for citation proposes
	Abstract	For Filtration and Screening (Inclusion and exclusion)
	Language of Original Document	Descriptive information for citation proposes and Inclusion\Exclusion
	Title Screening	The result of the title screening (Include or Exclude)
	comments	The reason of Excluding
	Abstract Screening	Descriptive information for citation proposes and Inclusion\Exclusion
	Reason of Excluding and comments	The result of the Abstract screening (Include or Exclude)
	Main Purpose	Brief idea about the article
	Comments and Excluding Reason -if any-	The result of the Fast Reading screening
	Research Methodology and Research type	Systemic Literature review, Case Study, Conceptual, ……. etc.
	Article Summary (Conclusion)	Brief idea about the article
	Data gathering method	Source of the data in the article (survey, Questionnaire, Etc.)
	Research Limitations	Brief idea about the article
	Implementation timeline	Brief idea about the article

Table 2 *Descriptive analysis framework*

2.2.5.2 Review Framework

After the descriptive information of 58 studies was extracted in the first descriptive framework, a need for more comprehensive, complete covering technical aspects is a must to go through the next analysis phase which is the deep analysis. A review of the full text and deep detailed analysis were taken a place in this phase to continue extracting the data from the primary studies, but regarding the technical aspects and other aspects such as digital transformation scope and more detailed elements.

The second data extraction form was designed for the 56 core publications to be deeply analysed. This framework was built in a more detailed way. All information extracted in the first framework (descriptive analysis framework) was included in the second framework. Moreover, more elements were added to the full review framework and it can be detailed as Descriptive Information, Digital, Transformation Scope, Technologies, Transition Process, Context, and Supply chain collaboration, and Performance Measurement.

After choosing the elements carefully, they need to be specified more in order to extract more detailed data and cover all the aspects needed to answer the main research answer. Due to that reason those elements were divided into sub-elements to gather as much specific information as possible, this is from one hand, on the other hand, to help in the finding and the outcome of this research.

The first element of this framework is the descriptive element, which is specified in the previous section in a more detailed way including the sub-elements that form the descriptive framework. The second element of the review is Digital Transformation Scope, that it is the form that should be filled with the data and information regarding the Impact of the technology on the supply chain from expected benefits, to influences, resources needed, Risks till Preventative measurements, furthermore other sub-elements that form this element were inspired by W5 or Ws Form (Why, Where, Who, What, when) but modified in order to align with the research aim and answer the research questions : 1) Where: is to define in which stage Supply chain Life-Cycle and in which part of SC it is implemented?, 2) Why to indicates the Motivation, Decisional and Strategic Drivers, Operational Drivers, Digital business model design (Design the value proposition, Define actors of the value chain, Design relations among actors), 3)What for the Activities, Digital Transformation planning), in addition to 4) How that capture the data regarding Methods and How the Digital transformation will take place.

The third element is mentioning the technologies that the paper is focusing on, by deeply reading the technologies were mentioned can be summarized as: IoT, Big data analytics, Industry 4.0, Artificial, Intelligence, Robots, VR, AR, BIM and Virtual Twinning, Blockchain, RFID, and Track & Trace technologies, Additive Manufacturing - 3D Printing, Nano sensors and Drones and AGV.

In the fourth element which is the "Transition Process", the data regarding the enablers of the technology transformation, the barriers of implanting the transformation besides the challenges and of course the change management practices, were extracted for the primary studies. Context and Supply chain collaboration are also chosen as an element, that it is designed to collect the data regarding the Sector or Industry where the digital transformation was taken a place beside the strategy used in the supply chain and the country that the research of the primary study was placed.

The final element was focused on the information connected to the performance management before the implantation and the possible change in the performance after the transformation.
Table 3 interprets more in detail the elements and sub-elements used in the review framework and the explanation of each element and sub-element.

	Framework Elements	Explanation
Descriptive Information	Number	Number of the Article document in the Articles File
	Source	Scopus of Web of Science
	Keywords	For tracking relationship between Articles and keyword combinations
	Source Title (Journal)	Descriptive information for citation proposes
	Title	Descriptive information for citation proposes and Inclusion\Exclusion
	Authors	Descriptive information for citation proposes
	Year	Descriptive information for citation proposes and Inclusion\Exclusion
	Document Type	Descriptive information for citation proposes
	Abstract	For Filtration and Screening (Inclusion and exclusion)
	Language of Original Document	Descriptive information for citation proposes and Inclusion\Exclusion
	Title Screening	The result of the title screening (Include or Exclude)
	comments	The reason of Excluding
	Abstract Screening	Descriptive information for citation proposes and Inclusion\Exclusion
	Reason of Excluding and comments	The result of the Abstract screening (Include or Exclude)
	Main Purpose	Brief idea about the article
	Comments and Excluding Reason -if any-	The result of the Fast Reading screening
	Research Methodology and Research type	Systemic Literature review, Case Study, Conceptual, ……. etc.
	Article Summary (Conclusion)	Brief idea about the article
	Data gathering method	Source of the data in the article (survey, Questionnaire, Etc.)
	Research Limitations	Brief idea about the article
	Implementation timeline	Brief idea about the article
Digital Transformation Scope	Impact	Expected benefits, Influences, Resources needed, Risks and Preventative measurements
	Where	Supply chain Life-Cycle stage, in which part of SC it is implemented?
	Why	Motivation, Decisional and Strategic Drivers, Operational Drivers, Digital business model design (Design the value proposition, Define actors of the value chain, Design relations among actors)
	What	Activities, Digital Transformation planning
	How	Methods, How the DT will take place
Technologies	The technologies that mentioned in the articles and studies	IOT
		Big data analytics
		Industry 4.0
		Artificial Intelligence
		Robots
		Theyarable Technologies, VR, AR
		BIM and Virtual Twinning
		Block chain
		RFID and Track & Trace technologies
		Additive Manufacturing - 3D Printing
		Nano sensors
		Drones and AGV

Table 3 *Review framework*

	Framework Elements	Explanation
Transition Process	Enablers	Drivers and factors that enabling successful transition
	Barriers	Constraints and limitations against implementing the solution
	Challenges	Difficulties that have to be addressed
	Change Management	The Organization reaction and the adjustment processes to adopt the change (Pre, and Post the Change)
Context and Supply chain collaboration	Sector (Industry)	Sector analysed where the technology implemented
	Supply chain Strategy	Supply Chain Strategy (Lean, Agile, Responsive,)
	Country	The country that the Technology implemented in
Performance Measurement	Performance Management (Pre-implementation)	The performance of the Supply chain before Implementing the Transformation
	Performance Management (Post implementation)	The performance of the Supply chain after Implementing the Transformation

Table 4 *Review framework (Continued)*

3. Findings

After forming the needed frameworks needed for the Data Extraction and data analysis and implementing the Exclusion and Inclusion criteria on the 4290 papers, the search yielded 58 publications that were considered potentially relevant to meet the inclusion criteria. In this chapter, the outcome and finding will be analysed and presented to understand the nature of the chosen papers and to go forward to the next analysis phase.

3.1 Descriptive Analysis

In this section, Descriptive analysis was undertaken to describe the Systematic Reviews and the 58 primary studies which are part of this research. To perform a relevant analysis, a descriptive analysis framework (as mentioned in Ch. 2.2.5) was designed to extract the necessary data needed for this analysis. Some examples of the extracted data used in this analysis are the year of publication of each study, Methodology type and the journal name of each study in order to conduct an analysis in term of temporal distribution of the studies, classification of the paper by Method of research, distribution of the papers by journal-title, and finally the digital technology listed in each study.

3.1.1 Temporal distribution of the Publications

Taking into consideration the temporal distribution of 58 papers, Table 5 illustrated the distribution of the relevant studies over the years, besides the percentage of the number of publications to the total relevant papers' numbers. As shown in Table 5, it is evident that relevant publications have been occurring since 2013, though the quantity of these has been relatively low. However, since 2015 the number of publications has increased significantly because the Digital technologies began to receive more attention. To justify why the analysis took place until 2018, it is worth mentioning that the sources of the research were identified between the period 27th October 2018 and 9th of November 2018 and it is likely that an even greater number of papers will be published in the field of Supply chain and digital transformation in 2019 than in any previous year.

Year	*Number of Publications*	*Percentage to The Total Papers*
2013	*1*	*1.7%*
2014	*2*	*3.4%*
2015	*7*	*12.1%*
2016	*13*	*22.4%*
2017	*12*	*20.7%*
2018	*23*	*39.7%*
Total	*58*	

Table 5 *Temporal Distribution of the Publications*

Figure 4 below visualizes the Distribution of publications by year and the percentage of the number of the publication each year to the total number of publications. The graph shows the number of publications used is increasing gradually over the years, and the last 3 years witnessed a significant increase in the number of the publications related to Digital technology and supply chain field since it formed around 82.8% of the relevant studies used in this research, indicating that this field is witnessing an increase in the number of researches and studies during the years.

As mentioned before inclusion criteria of "the study must be published after 2010" was undertaken, but what draws attention in this figure that the number of the relevant studies in 2011 and 2012 used in this research equals zero, on the other hand, the highest percentage as shown is 2018 with 39.7%, where 23 publications are used as primary study for this research.

Hence, Figure 4 clearly indicates an upward trend in research interest during the years and this interest started to increase specifically after 2012.

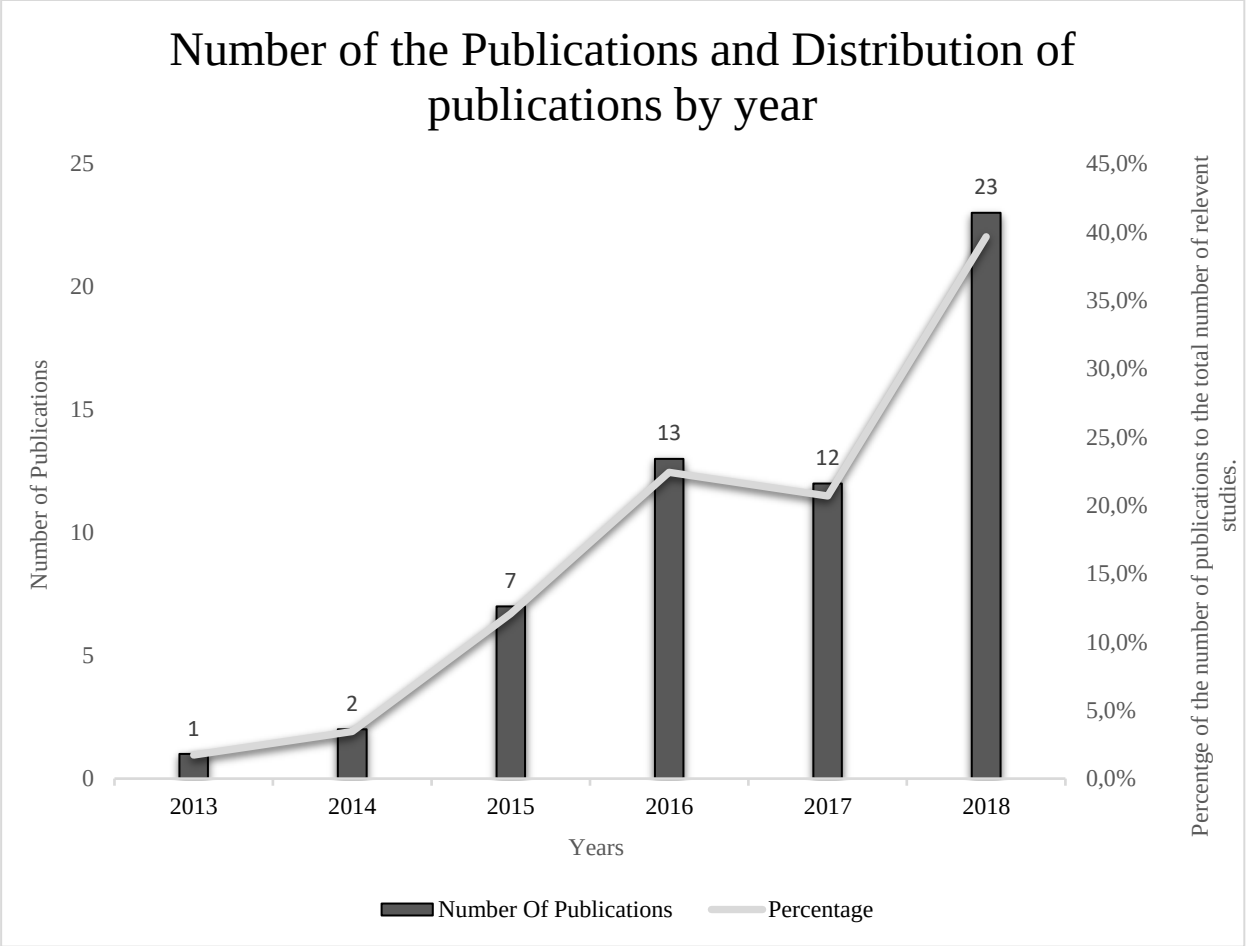

Figure 4 *Number of Publications and Distribution of Publications by Year*

3.1.2 Classification of Publications by Method of Research

The methods used in the primary studies varied between Conceptual, Conventional Literature Review, Systematic Literature Review, Delphi study approach and other Qualitative research such as Surveys, Case Studies, focus group and Interviews.

In this analysis, 58 papers were included but Simulations and Models were excluded as a method of research in previous steps since simulations and models were chosen as exclusion criteria.

Table 6 below describes the distribution of the methodologies used in the primary studies over the years. It is worth noting that the most used method in preliminary research is conceptual Method with almost 29.3% with a total of 17 studies out of 58 included in this research, followed by Survey

methodology with 19% while Systematic Literature Reviews is 8.6%, meanwhile, the other qualitative methods have been taken almost 18.9% between Case studies, focus groups and interview.

As shown below a methodology named Delphi approach was adopted in 3 studies with 5.2% publications of the primary studied, and this approach briefly defined as a structured communication method, basically developed as Systemic interactive forecasting and relies on a group of experts, (Dalkey & Helmer, 1963; Sackman, 1974), and it been commonly used for business forecasting but it surpasses other forecasting techniques, (Green, et al., 2007).

Methodology	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*Total*	*Percentage*
Conceptual	*1*	*2*	*3*	*6*	*1*	*4*	*17*	*29.3%*
Survey				*1*	*3*	*7*	*11*	*19.0%*
Conventional Literature Review			*4*	*1*	*3*	*2*	*10*	*17.2%*
Case Study				*2*	*2*	*5*	*9*	*15.5%*
A Systematic Literature Review				*1*	*2*	*2*	*5*	*8.6%*
A Delphi study approach					*1*	*2*	*3*	*5.2%*
Focus Group				*1*			*1*	*1.7%*
Interview						*1*	*1*	*1.7%*
Native category approach				*1*			*1*	*1.7%*
Grand Total	*1*	*2*	*7*	*13*	*12*	*23*	*58*	

Table 6 *Distribution of studies By Method of Research*

Below a pie chart was undertaken to visualize the Distribution of the methodology used in the Primary studies and the percentage of each methodology to the total number of the studies (Figure.5):

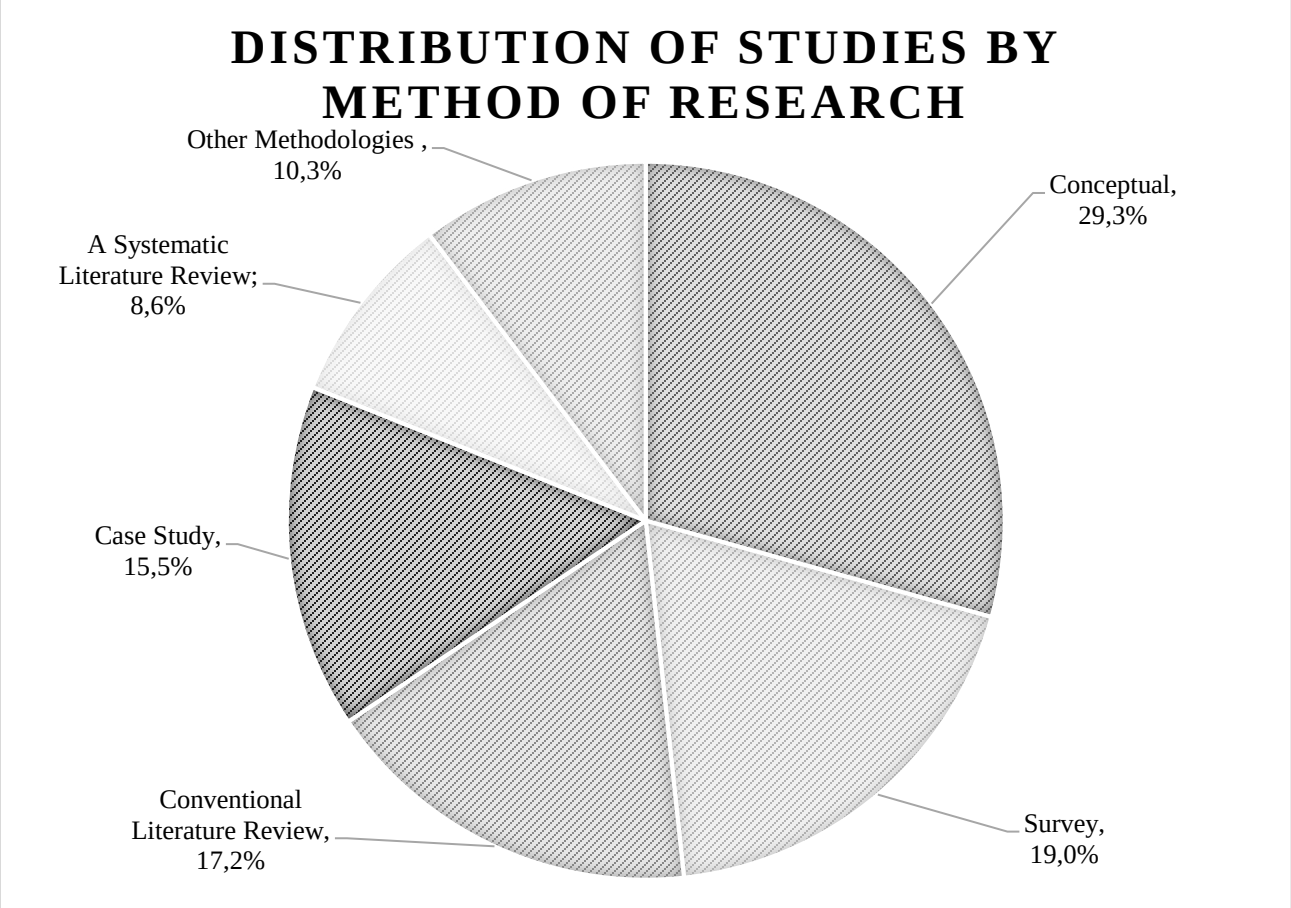

Figure 5 *Distribution of studies By Method of Research and their Percentage*

3.1.3 Publication by Journal Title

After implementing the inclusion and exclusion criteria, including the exclusion of all journals not related to the supply chain topic, the 58 primary studies are distributed among 28 journals related to the supply chain topic. As shown in Table 7 below, International Journal of Logistics Management journal had taken the first place in the number of the papers used from this journal with 9 papers achieving almost 15.2% of the total 58 publications used in this research, furthermore, the second journal Is International Journal of Physical Distribution and Logistics Management that has 4 papers used for this research with a percentage of 6.9%, Then the result followed by Journal of Business Logistics, Annals of Operations Research, International Journal of Production Research and more others journals.

Below Table 7, a pie chart below was designed to illustrate the percentage of distribution of the papers by journal, considering, the number of papers that exceed 2 papers of the same journal, See Table 7 and Figure 6 below.

Journal Title	Number of Publications	Percentage
International Journal of Logistics Management	9	15.52%
International Journal of Physical Distribution and Logistics Management	4	6.90%
Journal of Business Logistics	4	6.90%
Annals of Operations Research	3	5.17%
International Journal of Production Research	3	5.17%
Journal of Manufacturing Technology Management	3	5.17%
Production Planning and Control	3	5.17%
Technological Forecasting and Social Change	3	5.17%
Advances in Manufacturing	2	3.45%
IEEE Engineering Management Review	2	3.45%
Industrial Management and Data Systems	2	3.45%
International Journal of Operations and Production Management	2	3.45%
International Journal of Production Economics	2	3.45%
Transportation Research Part E: Logistics and Transportation Review	2	3.45%
ARPN Journal of Engineering and Applied Sciences	1	1.72%
Benchmarking	1	1.72%
Business Process Management Journal	1	1.72%
California Management Review	1	1.72%
International Journal of Industrial Engineering and Management	1	1.72%
International Journal of Simulation: Systems, Science and Technology	1	1.72%
International Journal of Supply Chain Management	1	1.72%
Journal of Business Economics	1	1.72%
Journal of Business Research	1	1.72%
Journal of Cleaner Production	1	1.72%
Journal of Humanitarian Logistics and Supply Chain Management	1	1.72%
Management Research Review	1	1.72%
Supply Chain Management - An International Journal	1	1.72%
Technology Innovation Management Review	1	1.72%
Total	**58**	

Table 7 *Distribution of the Papers by Journal Title*

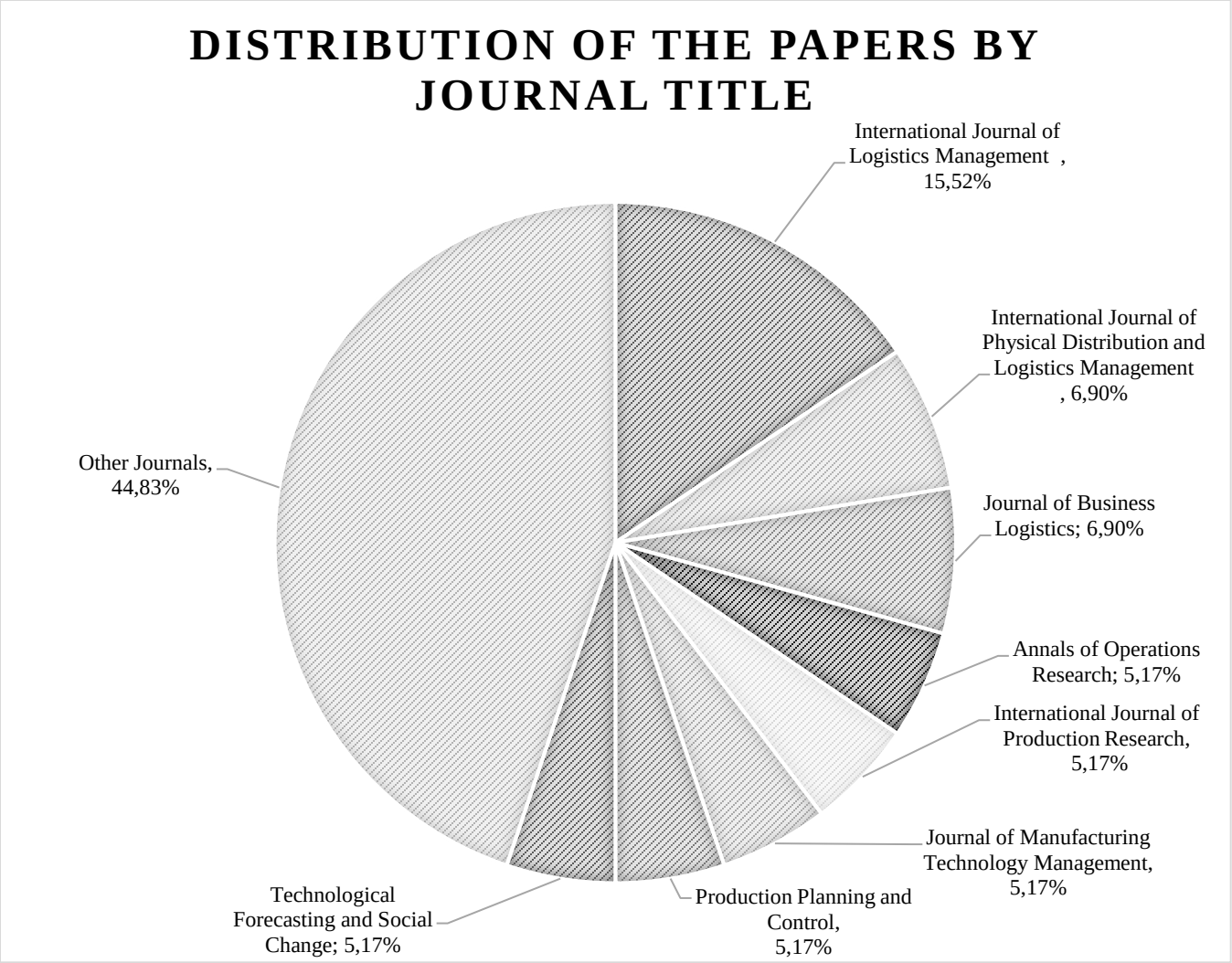

Figure 6 *Distribution of the Papers by Journal Title*

3.1.4 Publications by the Technology Listed

After the initial analysis of the 58 studies, the technologies that enhanced the digital transformation are varied between big data analytics, Internet of Things, Radio frequency identification (RFID) and Track & Trace technologies, Additive Manufacturing - 3D Printing, Industry 4.0, Artificial Intelligence, Robots, The arable Technologies, and VR, AR, BIM and Virtual Twinning, and finally the Nano sensors technologies. And as mentioned above, the framework contains the Technologies listed in the publications was conducted to extract the information regarding the paper topic and the technology mentioned in the paper.

Regarding the digital technology listed in the 58 papers Table 8 depicts the digital technologies that took a place and enhanced the Digital transformation and number of publications that listed these technologies over the years. In some publications in the primary 58 studies, more than one technology was listed in the same paper, hence the total number of technologies listed in the studies will exceed the number of the papers

The Table shows that Big Data Analytics is the most mentioned technology in the papers with 38 papers talks about the influence of Big Data Analytics in the digital transformation, meanwhile, the IoT digital technology took the second place with 16 times in 16 papers.

By analysing the data in Table 8, a significant increase in the number of researches was undertaken during the period 2013 – 2018, indicating the increase in the attention in the digital technologies over the years, for example, in 2013, the number of papers that listed Big Data Analytic as a research topic was 1 paper out 58 papers, meanwhile in 2018 the number of publications regarding the same topic is 21 papers., this result is also applied to IoT technology topic and industry 4.0 topic.

Technology Type	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*Total*
Big Data analytics	*1*	*1*	*3*	*6*	*6*	*21*	*38*
IoT			*2*	*3*	*4*	*7*	*16*
RFID and Track & Trace technologies			*2*	*3*	*5*	*4*	*14*
Additive Manufacturing - 3D Printing		*1*	*2*	*5*	*3*	*1*	*12*
Industry 4.0		*1*		*2*	*3*	*4*	*10*
Artificial Intelligence					*1*	*1*	*2*
Robots					*1*		*1*
Theyarable Technologies, VR, AR					*1*		*1*
BIM and Virtual Twinning						*1*	*1*
Nano sensors		*1*					*1*

Table 8 *Publications by Technology Listed in the Publications*

As an analysis of Table 8 above, Figure 7 below was designed to explain the trend of the publication along the years. Three observations can be noticed in figure 7:

1. As mentioned before inclusion criteria of “the study must be published after 2010” was undertaken, but what draws attention in this figure that the number of the relevant studies in 2011

and 2012 used in this research equals zero, which could indicate that the technologies started to have an increase in attention in the period of 2013.

2. Big Data Analytics is the most mentioned technology in the papers with 38 papers talks about the influence of Big Data Analytic in the digital transformation, meanwhile, the IoT digital technology took the second place with 16 times in 16 papers.
3. As shown below in the trend line of the Figure 7, significant increase in the number of researches was undertaken during the period 2013 – 2018, indicating the increase in the attention in the digital technologies over the years, for example, in 2013, the number of papers that listed Big Data Analytic as a research topic was 1 paper out 58 papers, meanwhile in 2018 the number of publications regarding the same topic is 21 papers., this result is also applied to IoT technology topic and industry 4.0 topic.

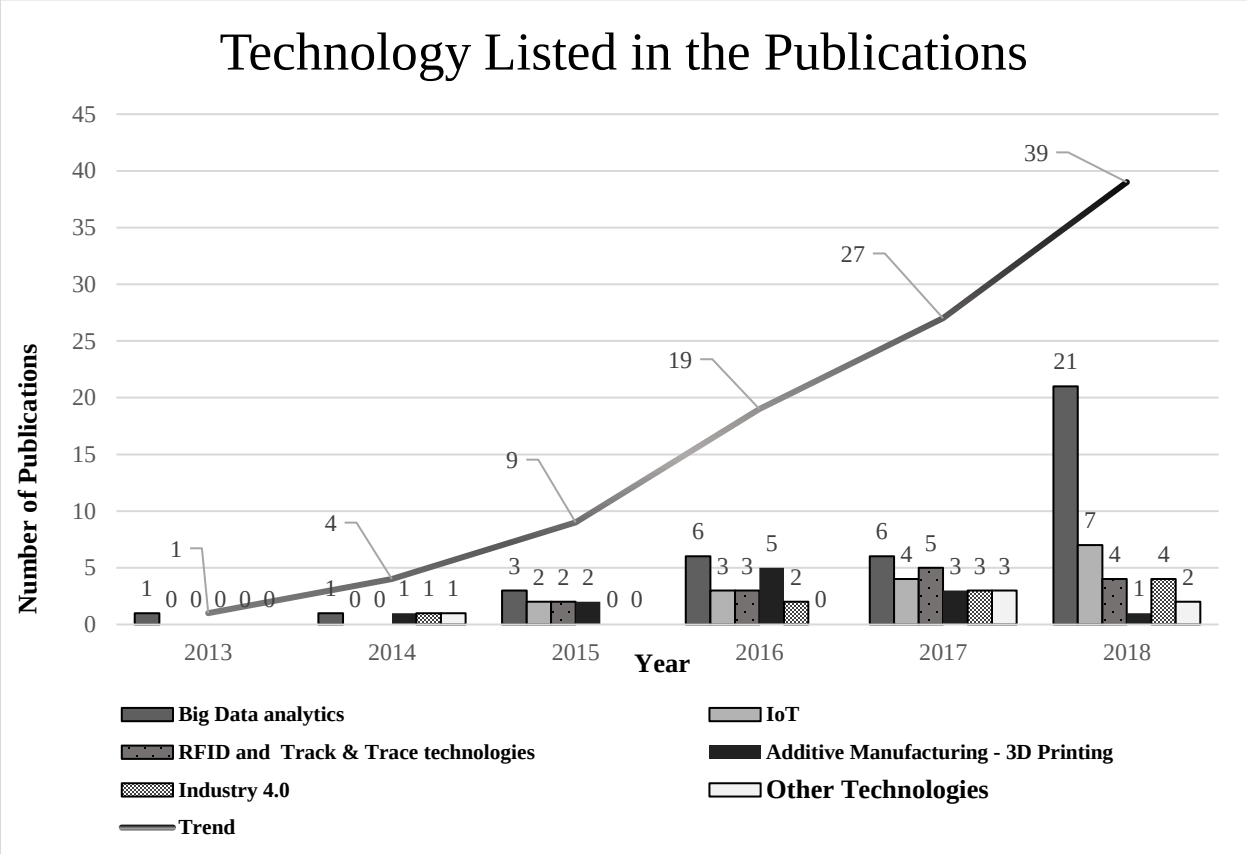

Figure 7 *Technologies Listed in the Publications along the years*

3.2 Digitalisation and Digital Transformation in the Era of Industry 4.0

3.2.1 Digitalisation and Digital Transformation

In recent years, the discussion about the impact of digitalisation and digital transformation has been raised again in various sectors, including the business sector (Bounfour, 2016; Westerman, et al., 2014) and production processes, as well as the supply chain, resulting from the acceleration of technological development (Bounfour, 2016) from the launching of the first digital computer to the introduction of World Wide Web In 1993 by Tim Berners-Lee (Vogelsang, 2010).

(Vogelsang, 2010) indicated that the new digital technology wave or as he preferred to call it, "5th Kondratiev wave" is not only changing our production processes but also it changes the way of living, and he added that "after the steam, steel, electricity, and petrochemical revolutions, network-based digitalisation is the driving force today on the stage of business and private life" (Vogelsang, 2010)

In General, the term "Digitalisation: is referred to the transformation of the analogue information system into the binary system (0 or 1) digital digits, in the other word it describes the process of transformation of the information from the physical systems to the digital systems (Collin, et al., 2015). (Collin, et al., 2015) Argued that digitalisation is also a change in the current value chains among the industries and public sectors and that change is a global megatrend, in the addition, various terms such as Mobile apps, big data, Internet of things, Industry 4.0 could be useful to describe this phenomenon. However, the digital transformation term refers to the adoption of individuals, businesses, organizations, and societies of the new digital technologies, resulting from the digitalization that previously mentioned, and this transformation is characterized as a global accelerated process (Collin, et al., 2015; Westerman, et al., 2014). Eventually, and according to (FitzGerald, et al., 2013), and with the accelerated technological development (Bounfour, 2016) there is no organisation will be capable to isolate itself from the digital transformation and the Competitive environment that follows adopting the new digital technologies (FitzGerald, et al., 2013).

3.2.2 Industry 4.0

In Hannover fair 2011, the term “Industrie 4.0” was initially presented, then after 2 years, in 2013 it was adopted officially as a German strategic initiative to take a leading role in the industrial fields, which characterized by the fast development in the manufacturing a has a revolutionary nature. After that the term “Industry 4.0 “was adopted to indicate to the fourth industrial revolution (Alexopoulos, et al., 2016; Qin, et al., 2016) the term symbolized the Fourth Industrial Revolution and its implications for the adoption of digital technology in industries and all other fields in addition to the current trend in adopting this technology and what it includes of enabling technologies such as the cloud computing, Internet of Things (IoT) and cyber-physical systems (CPS) (Hermann, et al., 2016; Kagermann, et al., 2013; Lu, 2017).

To reach the current fourth industrial revolution, industrial revolutions have undergone three industrial revaluations throughout history, and following the timeline, the revolutions were as below:

1. At the end of the 18^{th} century and the early 19^{th}, the lunch of the first industrial revolution (Industry 1.0) was taken a place by adopting mechanical manufacturing systems benefiting from using water and steam power in the manufacturing systems.
2. At the end of the 19^{th} century, the second revolution was launched, characterized by utilizing the electrical power in the productions, resulting in a mass production concept.
3. In the middle of the 20^{th} century, the third revolution was started by adopting automation, microelectronic devices, and technology in manufacturing, achieving development in manufacturing practices and technologies. In this industrial revolution a significant development has occurred thanks to the use of computer numerical control (CNC), robots that made flexible manufacturing systems (FMSs) real, computer-aided design (CAD), computer-aided manufacturing (CAM) and computer-aided processing planning (CAPP) that enhanced the use of computer integrated manufacturing (CIM) (Feng, Li, and Cen 2001). What distinguishes the third industrial revolution is the development of information and communication technology, resulting in a core transformation in every field of the manufacturing paradigm (Feng, et al., 2001). The third industrial revolution also adopted the automation of machines and processes (Tan & Mathews, 2010), but what differs the third revolution from the fourth revolution is that the industry 4.0 was concentrated more on the end–to–end digitisation besides the integration of

digital ecosystems through finding full integrated solutions. Figure 8 represents the stages of industrial revelations.

Source: International Journal of Production Research

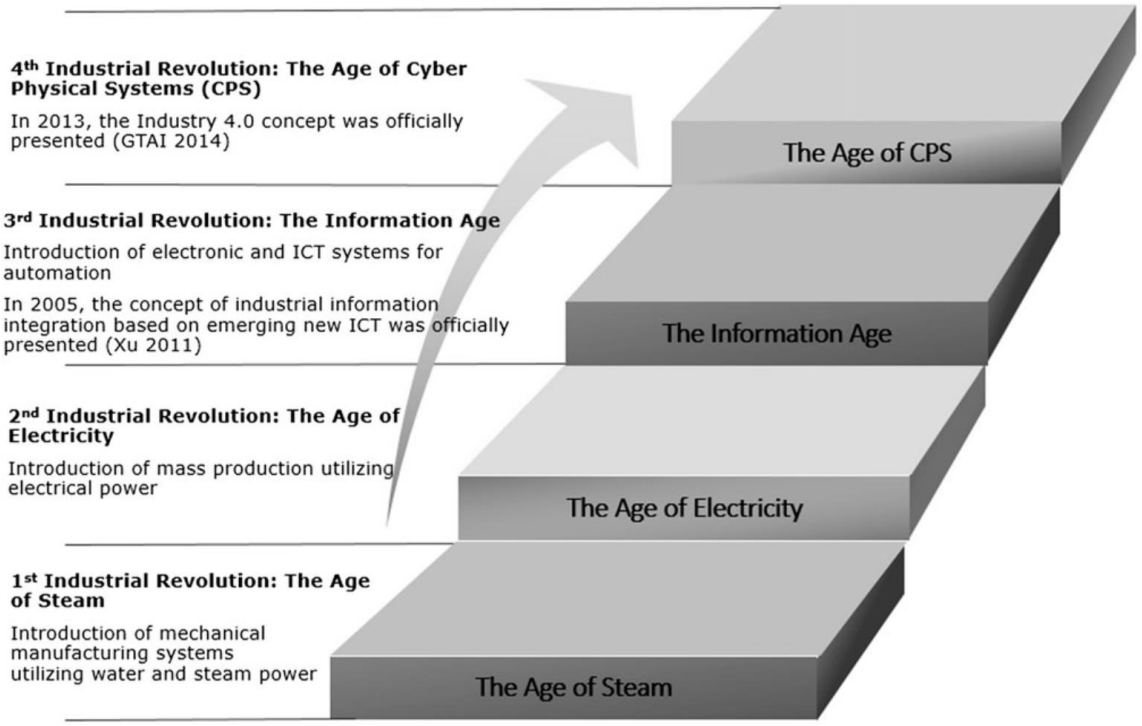

Figure 8 *The evolution from Industry 1.0 to Industry 4.0.*

3.3 Digital Transformation in Supply Chain

Supply chain sector like other sectors that been affected by the fourth industrial revolution. The last thirty years witnessed an enormous shift in the supply chain and logistics, shifting from the pure operational processes which report to the sales or production facilities and concentred on the supply of production lines and the distribution – mainly – to the final customers, to an autonomous Supply chain functional unit, and this unit has been shifted its focus from the conventional process to advanced planning processes, trying to implement integrated processes and operations from the customers to the suppliers. (Alicke, et al., 2016).

According to the above-mentioned article that published on the McKinsey website, the digital transformation was taken a place in almost all process of the supply chain management, and in the same article (Alicke, et al., 2016) illustrated the main Supply chain 4.0 improvement levers to six main value drivers, summarizing that the shift will take a place in services and cost generally. See Figure 9 that shows the Supply chain improvement levers map to the main six value drivers. (Alicke, et al., 2016).

As shown in figure 9 the digital transformation was benefited in several Supply chain management value drivers such as Strategy, Planning, Collaboration, Order management, Performance management and physical flow.
Next section and as the reporting of the findings of this research the Digital transformation practices will be explained in detail corresponding to various value drivers and processes of the Supply chain Management.

Source: (Alicke, et al., 2016)

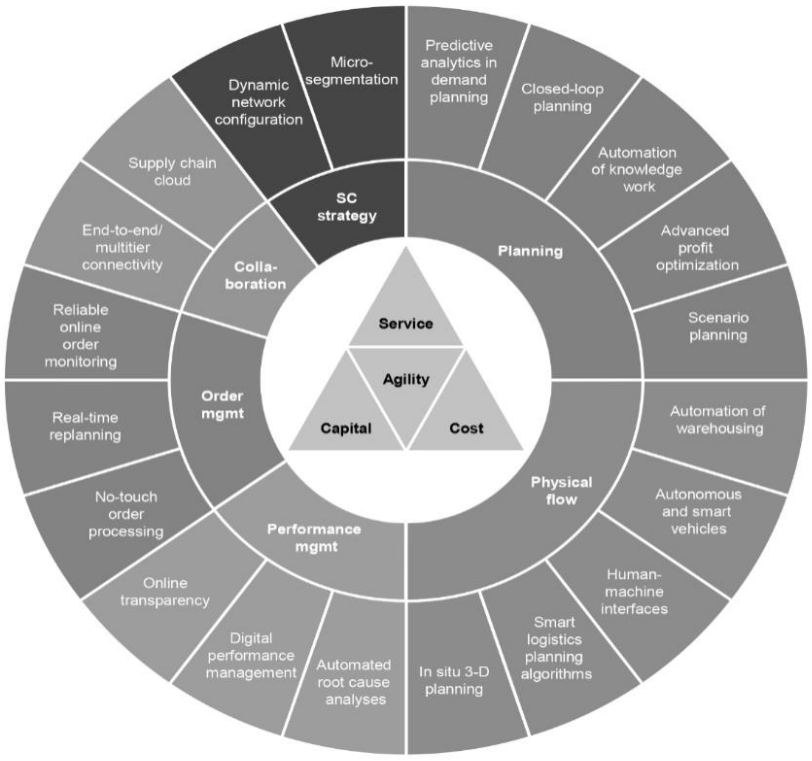

Figure 9 *Supply Chain 4.0 Improvements Levers map to six main Value Drivers*

3.4 Digital Transformation in Supply Chain Practices

As (Alicke, et al., 2016) argued that Digital Technologies represented by the industry 4.0 will affect all areas of supply-chain management and most of the supply chain processes, hence in this section and as reporting of the findings of this research, the Digital transformation practices will be explained in details corresponding to various value drivers and processes of the Supply chain Management, starting from Digital Transformation in integrations and planning, demand management, Procurement & supply management, , in Manufacturing and Production Processes, Logistics Management and Transportation and Sustainability .

3.4.1 Digital Transformation in Supply Chain Integration and Planning

Supply chain management (SCM) contains the activities of planning, implementing and controlling the flow of products, information, and also the financial flow from the supplier of supplier (first destination) to the final customers through various firms (Nurmilaakso, 2008) Supply chain usually characterized by a heterogeneous composition, hence the need was raised for the firms operating in the Supply chain network to work closely in more collaborative environment to ensure suitable coordination between the different firms, in addition, to ensure the harmony and time synchronisation in the processes, flow and the activities (Ngai, et al., 2011).

With the introduction of Industry 4.0, the transformation started to take place in many fields, and the supply chain is one of those fields that get affected by the new digital technologies, and since the integration is the main lever for improving the performance and efficiency among the supply chain, some technologies are playing a major role in the transforming by increasing the integration among the different firms to ensure the time synchronisation in the process and the activities (Ngai, et al., 2011). Some examples of the technologies that played a role in the transformation of the Supply chain integration are Big data Analytics, Industry 4.0, IoT and what be considered as its application RFID (Radio Frequency Identification).

(Vendrell-Herrero, et al., 2017) Reported that the current technologies advancement in the area of digitisation will play a significant role in the introduction of digital technologies in the supply chain functions, and this will implement a change in the current supply chain models and can create new models that are taking into consideration the functions, stakeholders, and responsibilities that are being driven by the development of the digital technologies.

Going back in the literature, some terms related to the industry 4.0 have been created and they have been used as terminology to describe the new interconnected and communicated systems that full fill the customers' orders , such as ambient intelligence (Kloch, et al., 2010), Internet of Things (IoT) (Ma, 2011), industrial internet (Evans & Annunziata, 2010), e-supply chain (Akyuz & Rehan, 2009), physical internet (Montreuil, 2011), smart factory (Hessman, 2013) and smarter supply chain (Butner, 2010).

One of the new technologies that are related to the era of industry 4.0 is Big Data, which explains the massive amount of data that has different characteristics than the traditional data and information. Big data is significant since it characterized with 3Vs, Velocity, Volume and Variety of Data. To benefit from big data, the organisations need to extract the proper data and to design models that interpret, analyse, predict and optimize the outcomes of the businesses, in addition to the implement the transformation of the business processes (Barton & Court, 2012). Advanced Analytics is based on data mining aiming to find new interpret models in data (Leventhal, 2010)

Big data alone is not an effective tool for implementing, it needs an analytical tool to exploit the information and ensure the expected benefits from exploiting it, according to (Sanders, 2016) Big data without analytical tools is just a huge amount of data that needs to be analysed, exploited and transformed into a useful set of data, on the other hand Analytics without big data are just statistical and mathematical. Numerous of those tools have been available many years ago for example as correlation and regression analysis.

Hence, it is about the whole combination of big data and analytics that is catalysed by today's computing power, which creates the ability to read out significate insights and transform the information into intelligence creating big data analytics (BDA) (Sanders, 2016).

Big data analytics (BDA) is achieving a progress in Supply chain integration, collaborations, and planning, also, it enhances the firms to improve the Supply chain relationship between the various actors by aiding the transparency in their conventional operations. This transparency will support the firms acting in the supply chain in their joint execution that can lead to more contextual "intelligence" shared along all the supply chain processes no matter what is the industry or sector, and could make a common strategic plan in order to address the customers' requirements and satisfying their needs in a more effective way, hence a good knowledge and implementation of BDA could improve the collaboration along with the supply chain processes among the SC firms (Fayezi & Zomorrodi, 2015).

Industry 4.0 and its related technology - Big data Analytics (BDA) -, has numerous features regarding the integration processes along the supply chain, as (Kagermann, et al., 2013; Wang, et al., 2016; Brettel, et al., 2014) Argued that Industry 4.0 and big data include three main features; which could be three types of integration at the same time, and these types of integration expected to take a place in the reality in future production and SC network:

1. Vertical integration: this type of integration focuses on the integration of different digital systems at various hierarchical levels within the factory and the plan (Kagermann, et al., 2013), in order to obtain a flexible and reconfigurable production system (Wang, et al., 2016; Brettel, et al., 2014). (Wang, et al., 2016) Underlined the need for vertical integration system through sensors and actuators, for real-time monitoring and tracking and then, through the Manufacturing Execution System (MES) and further up to the Enterprise Resource Planning (ERP) level. This Integration will ensure continuous competitiveness through employing the Digital tools, Software and digital transformation practices (European Commission, 2004).
2. Horizontal integration which refers to the integration along with the network with the organizations operating at the same level of the value chain and this value chain will simplify inter–corporation integration and collaboration, where the information and the value flow smoothly among these firms (Wang, et al., 2016).In this integration, linking the value creation modules among various firms in the value chain by reducing the added value within the firm and pressing a collaborative manufacturing and collaborative value chain in order to create a collaborative environment among the value chain. (Brettel, et al., 2014).
3. End-to-End engineering integration: it is referred to as the activity of the integration that enhances the support of the rising requirements regarding the product customization across the entire value network (Wang, et al., 2016). This integration includes the linking of the different actors along the value chain from stakeholders, materials, and equipment across all the product life cycle, starting from the raw materials procurement, ending with the end of the life cycle (Stock & Seliger, 2016).

By implementing the industry 4.0 and big data in the above mentioned 3 types of integration, the collaboration, transparency, the integration will be improved across the value chain, in order to better respond to the customer's needs in a more effective and efficient way. One of those ways to increase the collaboration and integration between different actors along the value chain is increasing the "Transparency", for which the organizations are seeking, to increase transparency in their supply chains (Bell, et al., 2016).

The general context of the Supply chain that each organisation acts like a producer and an information user in the chain, hence the organisations need to analyse and intercept the data they receive from their supply chain partners, in addition, they need to generate data, so to work in more responsive and

collaborative chain, there is also a need to analyse the data internally and to share information to their respective partners externally. In another word both inside and outside collaboration and synergies can be ensured along within the organisation and along the supply chain by selecting and monitoring the relevant data and information through big data technologies since it offers vast prospects for developing an integrated and collaborative business model that can create those synergies (Fosso-Wamba, et al., 2017).

Starting from asking "what kind of information should the firm share with their supply chain partners?" A prober information system can be developed, since the firms that are operating in the same chain need the prober information in order to build a collaborative and integrated network by defining what kind of information the well be benefited from across the supply chain, consequently, without defining what to share with partners, the communications between the partners would be almost zero. The link of data in the interconnected supply chain starts from the suppliers, products, firms, inventories finishing with customers, would generate quick, and better data quality (Wu & Yue, 2016).

Implementing the new technologies in data capturing and involve the industry 4.0 technologies in the supply chain, raised the concept of Smart supply chain, which focuses to producing better information that can be characterized with following (Pedroso & Nakano, 2009):

1. The prober type of information that creating more value to the chain.
2. A better information quality such as more accurate data, precision in delivery time, and actual demand quantity.
3. A better timing compares to the conventional methods
4. speed such as real-time transmission over the network
5. facilitated access to gain the needed information
6. Controllability for information sharing
7. Privacy protection.

Practically speaking, the sharing of good information is not usually available, or in other cases it is not being shared with the supply chain partners, due to political, empirical, and competitive reasons, hence it will weaken some firms in the decision making in addition to the risk mitigation, (Wu & Yue, 2016). Furthermore, the necessity of the organisations for integrating information from multiple

sources, since the value of the data is the most significant matter when the firms are facing the demand uncertainty (Wu & Yue, 2016).

Another point to highlight is the difference between the information in the conventional environment and the Big Data environment as explicit in Figure 10, which explains the difference between the data in the normal environment and big data environment.

As shown below the characteristics of information in the big data context is more real-time information and has relatively a higher value than the information in the traditional environment, hence, for organisations, generating and gaining real-time and accurate information would be more helpful, since it will help the firms for real–time responses for the variation in the business environment hence, improving the service level (Liu, et al., 2018).

Source: (Liu, et al., 2018)

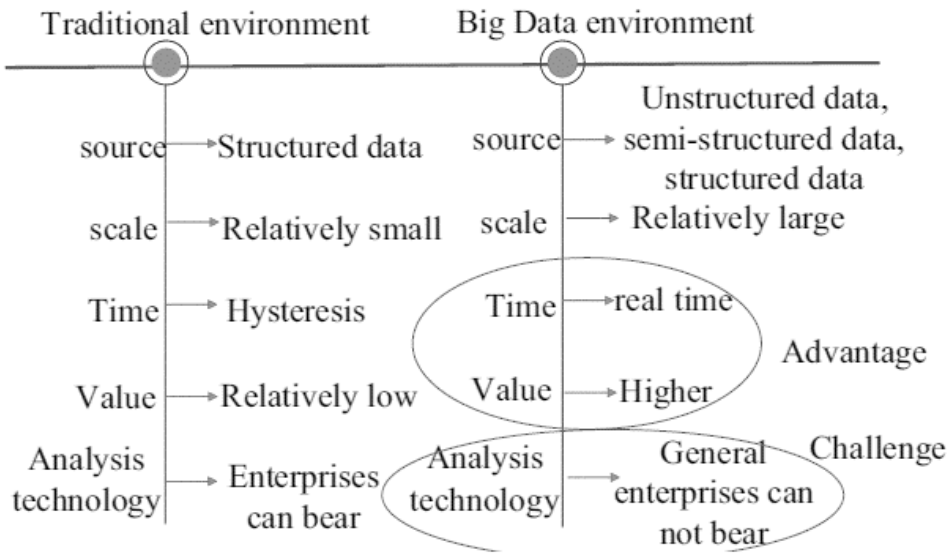

Figure 10 *Information comparison between in the traditional environment and in the big data environment*

When the information is being exploited properly and being shared with other supply chain partners, the overall coordination will be improved, ensuring efficient materials and information flow across the Supply chain (Damiani, et al., 2011). The importance of the information sharing impacts on the performance of the supply chain relies on the type of information that being shared, the time of sharing, how it is shared, with whom and the information quality (Holmberg, 2000), since it is

affected by the trust built among the partners positively while it is influenced negatively by supplier's uncertainty (Wang, et al., 2013).

On the other hand sharing a lot of data and information could affect negatively in some cases, since that ensure that no firm has the right information when it is required (Liker & Choi, 2004), hence it is significant to define the type of information to be shared in order to create a proper supply chain visibility and transparency (Handfield & Nichols, 2002)

The transparency is needed to be transformed into business value but this transformation requires internal integration of Supply Chain activities, since the availability of data alone doesn't enhance the organizations capabilities to respond to the continuous variations the business environment (Williams, et al., 2013), but in order to increase the ability to respond to the change in the business environment, firms are exploiting new and existing technologies such as big data besides the analytics capabilities in order to monitor, track and trace carefully all the entire supply chain processes from the upstream until the downstream operations aiming to gain transparency and to have a better decision making in the internal and external supply chain practices (Carter & P, 2011).

The transparency in the supply chain depends basically on the information-sharing regarding the flow of the products along with the supply chain processes. (Morgan, et al., 2015) Has launched the term of operational supply chain transparency (OSCT), which is defined as an organisation's capability to proactively take part in communication with stakeholders along the supply chain, to gain visibility, transparency, and traceability in the practices of both upstream and downstream part of the supply chain operations. OSCT refers to the range to which supply chain firms who operate in the same network, can track the existing and historical activity of the products flow across the entire value chain (Morgan, et al., 2015).

The traceability activity of the products flow provide date regarding the specification of the operation such as transport time, throughput time, stock size, number of operators, work in progress and much more data regarding the operations (Cheng & Simmons, 1994), providing transparency in the supply chain that could reduce the complexity of the processes by enhancing the visibility along the supply chain network (Gunasekaran, et al., 2015). In order to achieve the above features along with the supply chain processes, organisations have long relied upon different forms of the data analytics and

big data to improve the flow of the information and supply chain practices (Accenture, 2014), as an example of these forms is supply chain analytics (SCA).

Supply chain Analytics (SCA) is a new term related to big data, terminology that points to the field of big data and business analytics in Logistics and Supply chain management, that being launched by (Wang, et al., 2016).

SCA Have the potential to increase the visibility of Supply chain and in addition to the increase in the collaboration and integration among the supply chain network, by reducing the wastages and insufficiencies in the chain, such as the increasing of fuel costs, delayed in the deliveries and low suppliers performances (Barnaghi, et al., 2013). The term SCA refers to the adopting of analytical tools, to improve the performance of the Supply chain and to support the decision-making processes (Chae, et al., 2014; Davenport & O'Dwyer, 2011; O'Dwyer & Renner, 2011).

Supply chain Analytics has the ability to affect the Supply chain network in both, long term and short term, besides it contains tools and techniques that can extract data from a harness data from a massive range of internal and external sources to obtain a comprehensive visions that can improve the performance of supply chains in terms of costs reductions and real-time risk monitoring and also in terms of improvements in operational agility and services quality (Deloitte and MHI., 2014).

For the above-mentioned features, the organisations world wild are striving to implement SCA in their value networks aiming to improve collaboration, integration, tractability and supply chain visibility, in order to create new business models and concepts in their core, on the other hand, the increasing in the competition that lead the companies to obtain these technologies to increase the possibility of potential innovation hoping of gaining a competitive advantage within the new created business models and concepts (Downes & Nunes, 2014).

It is worth mentioning that the acquisition of data to enhance the Supply chain operations and transparency alone is not adequate, This data has to be transferred into a useful models and to exploit this data in a proper way, in order to support the decision making in supply chain, and gain a faster response to the change in the business environment (Morgan, et al., 2018). However, digital technologies may provide the organisations with a massive amount of data regarding the value chain activities, but the firms are often can't achieve the expected benefit and outcomes such as the visibility

(Williams, et al., 2013), which is a means to enhance the transparency along the supply chain processes (Morgan, et al., 2018).

This unsuccessful implantation of the digital technologies, is related to implementing these technologies despite the huge amount of data that they acquired along the value chain, due to mis-exploit of the acquired data, besides the lack of models that could be useful for enhancing the visibility and furthermore the overall transparency along the supply chain, and such a deficiency marks a low capability of information and data processing mechanism, such as analysing, interpreting, and taking a proper action upon the acquired information from the technologies (Morgan, et al., 2018; Williams, et al., 2013).

The overall benefit from both the internal integration and external information sharing is to improve the performance of the process and operations and to add value to the value chain by ensuring the customer satisfaction (Fawcett, et al., 2011), and this integration can provide a close relationship with customers improved collaboration with the suppliers and vice versa (Vickery, et al., 2003).

To better respond to the customers, need and ensure the customer's satisfaction in more effective and efficient, a collaborative and integrative environment must be ensured along with the supply chain activities. As it is mentioned before the Supply chain visibility and which is a means to enhance the transparency along the supply chain processes (Morgan, et al., 2018), is one of the main pillars to guarantee this Collaboration, and those pillars are facing an improvement thanks to the new digital technologies and what it achieved for developing a collaborative environment, but what is Supply chain "visibility" that enhance the collaboration and what is the digital transformation regarding the visibility along the value chain ?.

Visibility is a significant capability in supply chain management, it one of the capabilities that support the managing of the value chain (Barratt & Oke, 2007; Brandon-Jones, et al., 2014). Visibility basically refers to the flow of information and data between the different firms that operate in the same chain (Brandon-Jones, et al., 2014), and grant the partners the ability to see each other's processes and activity such as Inventory levels and replenishment quantities, this vision and what it related to transparency in the flow of information increase the confidence and decrease the interventions, that will affect the decision making positively (Christopher & Lee, 2004).

According to (Papadopoulos, et al., 2017), In order to increase the collaboration, transparency and visibility, Big data Analytics capabilities are very useful and promising technology to achieve that, especially by decreasing the behavioural uncertainty that is originated from the information asymmetry (Morgan & Hunt, 1994; Kwon & Suh, 2004), which can reduce the opportunistic behaviour between the different actors in the supply chain, and this behavioural uncertainty derives from the failure in predicting who will be the Supply chain partner. (Joshi & Stump, 1999), and also due to the lack of information regarding the partners of the supply chain, which can impact negatively, the supply chain performances. (Williamson, 1985).

With the spread of the platforms that relies on the new technologies, sharing real-time information monitoring between the partners across the supply chain is possible now a days, thanks to industry 4.0 technologies, and this is leading to improvements in the visibility, in addition to sharing the real-time information is fundamental at this stage, for its positive impact on the responsiveness of the supply chain (Li & Lin, 2006; Gunasekaran, et al., 2008). The real-time information sharing can be implemented through using Joint Score Cards and business plans, and as IBM highlighted this visibility has a significant impact on the Supply chain planning, but it is also having a serious impact on the real-time execution (IBM, 2009).

According to (Handfield, 2016) "response velocity" which depends on the real-time transparency of the supply chain, will be a future source of competitive advantage for the firms, to which achieve it, requires to have and improve the knowledge of the digital technologies besides the development of it, as well as, exploiting the Big Data analytics tools and its related information extracted from the supply chain. In the recent years, a need was raised to gain the transparency within the organization and across the value chain, in addition to innovation capabilities and intelligence to enhance the digital transformation within an organisation and its resilience and responsive (Schrauf & Berttram, 2016).

The raised attention of the organisations in the digital transformation of the visibility within the supply chain impose them to increase their attention to the responsible social practices in their supply chain in parallel to their business strategies and models, furthermore, the exchange of real-time access to the data will increase the level of trust in the supply chain, and improve the buyer-supplier relationship (Hoejmose, et al., 2013).

As above-mentioned, and on the planning level, Big data analytics is enhancing the visibility, transparency, and increase the collaboration and develop the joint planning between the supply chain partners, but the technology of big data alone is not enough for gaining these benefits for the value chain, hence there is a need for other technology to provide this data in order to analyse it and share so the questions are "how this huge amount of data is captured?" and " what are the other technologies that support the Dig data analytics ?" .

Information technologies systems (IT) is a fundamental element in the exchanging the information and ease the information flow along the supply chain, recently, the amount of data is being increased significantly in the era of industry 4.0 and big data, since this data characterized by massive volume, high velocity, increased complexity, and variability, hence there is a need for an advanced technologies to capture, extract, share, distribute and analyse the data (Savitz, 2013).

Yet, the information management is one of those fields that concerns about the management of the processes especially in the acquisition, extraction, creation, capturing, storage, distribution and the analysis of this information, but when we talk about information management we don't mean the management of the technology itself, it is more about the management of the previously mentioned processes (Detlor, 2010).

Internet of things (IoT) is a combination of hardware, software, objects, sensors, devices and systems that are working all together as a network in order to serve humanity. (Marshall, 2012). It is a result of the digital and technological revolution in communication and computing, and it releases the insights of "anytime, everywhere, any media and anything" connections (Atzori, et al., 2010). These insights and concepts allow connecting the digital technologies with the physical objects, launching a new division of services and applications, which can be described as the Internet of things (IoT), and its main application Radio Frequency Identification RFID.

The main idea of this technology includes connecting a short–range mobile transceiver with a huge number of items, providing a significant development on usability and productivity. This technology is taking the manufacturing and Supply chain field into another level, due to the singular value that can create along the whole supply chain and for the stakeholder, for example, RFID tags are proving day by day its effectiveness in reducing inventory shrinkages and avoiding the stock-out and excess stock and overall, the data accuracy. (Wu, et al., 2016).

(Masciari, 2012) Argued that RFID technology is based on radio signals that hold product identification and other information related to the products. This technology can impact the supply chain effectively due to its capability of increasing the visibility in the supply chain, besides the capabilities of achieving improvements in the efficiency and effectiveness of the manufacturing, and also can reduce the negative impact of terror and theft (Zelbst, et al., 2012; Kevan, 2004).

The rise of the RFID and IoT technologies enables the acquisition of information with effective reduction costs for companies (Fu & Zhu, 2010), However, The RFID should be symmetrically distributed but achieving this is difficult, and in case it is not symmetrically distributed, there will be a need for coordination in order to avoid the conflict (Gaukler, et al., 2010).

Recently, the efficiency of the operations are being enhanced thanks to the new technologies and the new mobile device with the new functionality, (Shibi, 2011), but that rate during which it being adopted is relatively slow but that same it steady, hence it gives a promising insights for the future of the supply chain (McCrea, 2012).

Supply chain processes and activities generate a massive amount of information, and the firms can turn this information into intelligence models, aiming to achieve progress in the supply chain effectiveness and efficiency, and this source of information can be gained through analytics, GPS, RFID, Sensors, POS and social media feedback. Some examples of successful stories of implementing these technologies are Walmart and Amazon, However, most companies still didn't take advantage of these new technologies (Schmarzo, 2014).

(Sanders, 2014) Summarized capturing the data using IoT technologies, by collecting data from the point of sales (POS), Radio Frequency Identification, in addition to Global Positioning Systems (GPS), to the data captured using sensors and extracting data from the social media. This massive amount of captured data supporting Big Data analytical tools and considered as fuel to BDA, and BDA providing the analysis capabilities, to gain a new business model that helps in real-time responses to the variation and the changes in the business environment.

As a summary of this section the impact of the digital transformation in the supply chain on the planning level can be reported as Supply chain visibility, Supply chain transparency, Integration with different types within the organization and across the supply chain, The quality of data captured along

the supply chain, tractability and tracking, decision making, and real-time monitoring of the supply chain and manufacturing activities, in addition to the way of data capturing and the integration of the Big data and IoT in order to gain this benefits.

It is worth to highlight that the benefits and the opportunities that can be achieved by implementing industry 4.0 technologies and BDA are quite promising, particularly in developing the firms of decision making and can guarantee a strong relationship with customers and sustainable relationship with the suppliers and overall, the benefits regarding the operations efficiency and effectiveness (Chen & Zhang, 2014) but in spite of these charming benefits, the practical employment of these technologies in Supply chain management processes is not always feasible since it needs a change in the culture of the organizations and the mindset. Figure 11 illustrates briefly some advantages of the industry 4.0 technologies along the supply chain and the technologies connecting to industry 4.0.

Source: (Gravili, et al., 2018)

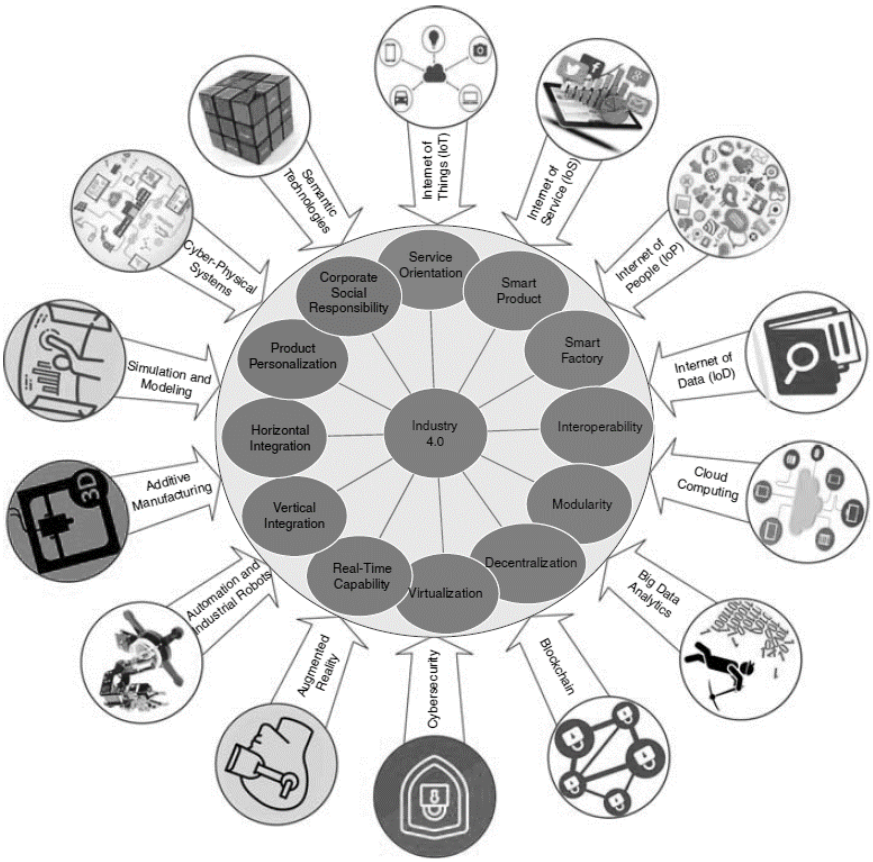

Figure 11 *Design principles and technology trends of Industry 4.0*

3.4.2 Digital Transformation in Demand Management

In the business environment, achieving customer satisfaction is the most significant component to ensure the surviving in the competition environment. In the last decades, the customer and the final consumer were always considered to be a part of the downstream in the supply chain, and their position was located at the last phase of the distribution network, but this didn't last for too long. In the early 2000s, the new age of supply chain was launched, since the experts and scholars started to rethink about the position of the customer in the network, and they started to concede more power to the customers rather than producers and suppliers. (Rainbird, 2004; Jüttner & Christopher, 2007; Hilletofth, 2011) .

This changing in the power resulting in the rise of the concept of "Demand chain" that based on the creating pull and attention of new products. This creating in pull explains that the development and production of the product would not happen unless there are customers who have the willingness to purchase this product or participating in the development stages of the product's design, and of course this involvement will start very early within the new product development (NPD) such as Design phase. (Ganji & ", 2018).

Nowadays many organisations are providing the chance to the customers to be involved within the practices of design, creating and customizing their desired product, achieving a significant improvement in the organisation's market by increasing the volatility, reducing the products life cycle in addition to the remarkable reduction in the logistics cost. (Ganji & ", 2018).

Moreover, the launching of industry 4.0 enhancing the innovative ideas for the fully integrated technological development, and of course this technological advancement found its way to be a part of the supply chain and logistics, taking them to another level of application and practices, such as interconnectivity, smartness, high efficiency and overall the friendly relationship with the customers (Ganji & ", 2018) . Hence lately the implementations of industry 4.0 along the supply chain is being highly considered in addition to the product development, planning stages and engineering phases (Ganji & ", 2018).

The concept of Supply chain management is about "having the right item in the right quantity at the right time at the right place for the right price in the right condition to the right customer" (Mallik, 2010). However these activities was not free of challenges and difficulties, due to the increased

complexity, uncurtaining and some other factors, hence the supply chain in the practice faces the gap between the demand and supply causing mismatching negative impacts such as stock-out issues, overstocking, and delays in the deliveries that took the researched attention for a long time (Wong, 2012).

Day by day, the supply chain becomes more and more complex, uncertain, high cost, with increased risk, hence, the need for smarter practices to face these changes is a must (Butner, 2010).

Moreover, the advancement of the computer science, digital technologies, and semiconductors play a role in the development of the supply chain aiming to create large-scale intelligence instruments for merging the physical objects, information, data, products, and the processes all together (Schuster, et al., 2007).

As an example of previously mentioned, the organizations that are supporting the smart technologies and applying these technologies in their activities can fulfil the orders with global teams, dynamics systems and smart analytics across the whole supply chain processes reaching to the farthest possible stage of the value chain (Hessman, 2013). It is worth to mention that the companies that implementing the new digital smart technologies can last longer in the completion compare to the firms that they are functioning with these digital technologies since these smart technologies are implemented in transportation and production.

In the 1950s the transformation of the conventional supply chain activities started to take a place with the alignment of the launching of TOYOTA's Kanban systems that based on the pull-based production systems. Furthermore, the initial concept of demand chain criteria that includes the production of just in time (JIT) and the use electronic data interchange systems (EDI), in the addition to bar codes, and point of sales (POS) was implemented during the 80s and 90s (Ohno, 2012).

The main aim of the new systems is to improve the efficiency and effectiveness of the supply chain, and ensuring the reduction in the inventories, the lead time and to ensure a smooth flow of the materials and the information across the supply chain activities. The most significant Catalyst of such a transformation is the advancement of globalization in the late 2000s, and the increased selective behaviour of the customers that raised the challenge for the organizations in satisfying their needs since it became difficult to be satisfied. (Y & Lau, 2018), besides the fact that customers tend to have more personalized and convenience products.

However, some global companies that they used the dominant product-based as a strategy, started to adopt the demand practices to stand in the market and earn competitive advantages to last longer in the completion of the business environment and customer need's inconstancy. An example of those companies is Procter & Gamble (P&G) that changed their policies into the demand-driven practices (Budd, et al., 2018). The demand-driven practices are being increasingly used along the firms' operations starting from the product development reaching to the marketing & and sales practices, finishing with the distribution and logistics activities (Jüttner & Christopher, 2007; Gattorna, 2015).

The differences between the supply-driven chain and demand-driven chain are basically in the strategies and policies of the organizations in addition to the attributes, in another word, the supply-driven chain's strategies have a concept of purchasing forced view meanwhile the demand-driven chains rely on the customer's need and requirement moving toward the upstream part in the supply chain. However, the supply-driven firms are pushing the new products to the market and the demand-driven entities are making the good for its particular customer in order to make the products to be pulled by the market, while recently the customer is involved in the process of new products development (NPD) (Ganji & ", 2018).

One of the most significant drivers that actually enhanced the transformation and implementation in the demand management is the practices and application platforms, which are characterized by providing a real-time data and information about the demand and inventory levels, in addition to the tracking capabilities of the ongoing products flow along the whole supply chain activities aiming to have an effective response to unexpected changes and fluctuations resulting a reduction in the lead time (Budd, et al., 2018).

According to (Budd, et al., 2018) demand-driven chain is based on 4 key elements, by which achieving them, a successful transformation could be guaranteed such as visibility along the value chain especially in the demand and inventory levels, coordination between all the partners in the value chain, infrastructure for a faster response to the changes in the business environment and optimization of the performance along the supply chain.

(Budd, et al., 2018) Designed figure 12 below that report a comparison between operations of the traditional supply chain and demand-driven supply chain. As the Figure 12 shows that the use of IT systems and platforms, and share real-time information decreases the time of information sharing

from 4 to 8 days to zero along the distribution network units resulting a faster flow of products, reduction inventory levels, as well as a reduction in transportation and warehousing cost in addition to planning time and lost sales. The previously-mentioned benefits increase the potential of customer satisfaction and customer sell-through.

Source: (Budd, et al., 2018).

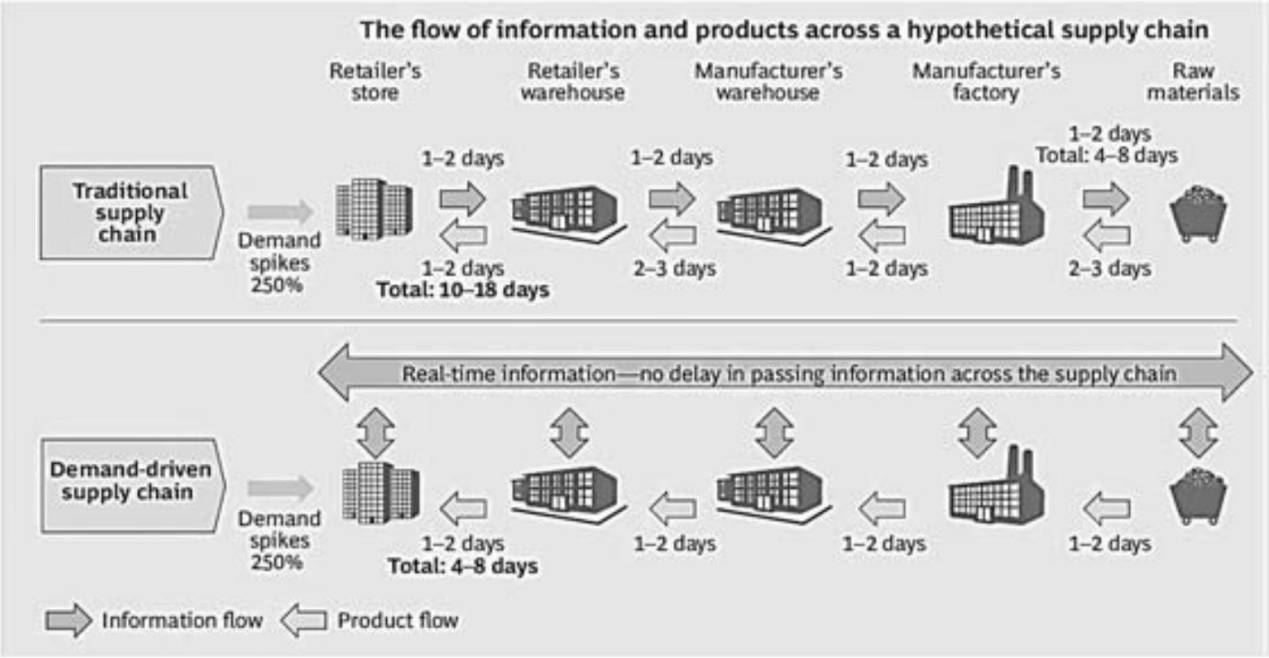

Figure 12 *DCMs enable supply chain participants to share information and products more rapidly and frequently*

With the advancement of the Internet and new digital technologies in addition to the prosperous of connection technologies, new business models have arisen. A new models that have been driven with the development of the digital technologies, in order to explore browsing the changing behaviours, habits, preferences and even characteristics of customers, in addition to its ability to make the organizations to understand their customer's need can help companies to understand more their customer's needs (Li, et al., 2018). One of these new business models is electronic commerce or as it is known as e-commerce. (Li, et al., 2018).

With the accelerated advancement of the information technologies e-commerce started to turn into a fundamental integral part of the people's daily routine, since it contains a network that can provide the customers with basic daily products from food, clothes, education, travel, entertainment and most of the basic daily products and services. E-commerce can be defined according to (Turban, et al.,

2002) as a global business trade practice utilizing digital technologies and electronic tools such as telephone, fax, telegraph, computer, and mobile communication.

E-commerce symbolizes a different portfolio of business configurations that relies on the information technologies, computer networks, and these configurations include the exchange of the good, services, advertising, intermediaries and other models. (Li, et al., 2018). For a better understanding of e-commerce in a broad sense, electronic commerce is wherewithal for achieving the business activities utilizing the digital technologies and through using them a medium in the business.

In e-commerce, the organizations communicate within the company internally and with the other actors in the chain from suppliers to customers through implementing electronic business processes and communication activities between them. Since it improves the efficiency of the manufacturing and distribution channels, inventory levels and provides an increase in the financial health of the organizations (Li, et al., 2018).

Since the e-commerce is being accelerated developed, the model of the traditional supply chain started to expose to the innovative new changes, resulting a customer experience that characterized with flexibility, but this interaction of online businesses with the customers will face increased challenges and opportunities for the supply chain managers (Li, et al., 2018).

In the conventional Supply chain models, all the firms form the downstream part till the upstream part is sharing the benefits, data, and information by creating communication between their business to have common benefits and, to gain the advantages of common development. What distinguishes the traditional supply chain model is that all the supply chain actors from retailers, suppliers, manufacturers are not performing as separated entities, they all perform as one collaborative joint (Li, et al., 2018).

Figure 13 below illustrates the different actors who perform in the supply chain and distinguishes between them. In figure 13 the actors of the traditional supply chain include Suppliers, producers and manufacturers, distributor, retailers and finally the customers, and it shows how these entities are linked between each other by information, material service, capital and the flow of the products (Lambert & Cooper, 2000).

In the traditional supply chain, the Products and value flow are established from the suppliers and moving toward the customers, unlike the information flow and the capital since they move toward

the opposite direction as it is illustrated in Figure 13 below. The outcome of this directionality is that the functions and management of each of the various directions are unique. The supplier is regulating the production and the assembly based on the customers' requirements where located in the final stage of the downstream in the supply chain. It worth to mention that to build an effective and efficient supply chain network, collaboration should exist among the partner of the supply chain and to build a mutually beneficial network. (Li, et al., 2018), see Figure 13 below.

Source: (Li, et al., 2018)

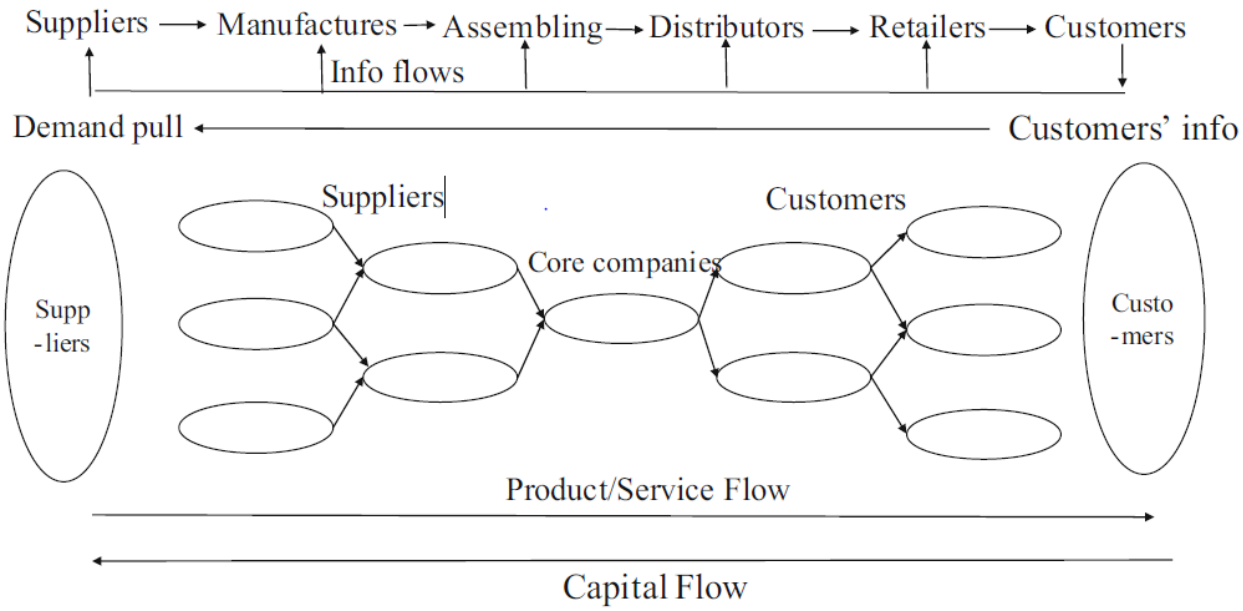

Figure 13 *The mechanisms and operation of the traditional supply chain*

As it is well-known, the supply chain management is based on customer demand, that -is drives the flows to operate smoothly and dynamically. It is significant to identify customer demand and build a sensible supply chain strategy by utilizing this flow of information. (Li, et al., 2018). The activity of redesigning this information is called demand-supply chain management (DSM), any inaccurate demand forecast will result the bullwhip effect, that causes basically by the inventory pressure and wasteful management of the resources (Li, et al., 2018).

The bullwhip effect is a deformation of the demand information that is been generated from the downstream causes to the upstream of the supply chain. The bullwhip effect can be caused by many reasons, from price wave, delivery cycle and repertory management but the main cause of it is the demand forecasting. (Li, et al., 2018).

Compared with the conventional supply chain, the use of digital technologies and electronic commerce can make the supply chain to gain more flexible solutions to prevent the damaging effect of the bullwhip on the supply chain by forecasting demands, one of these technologies is Big data that could improve the preciseness of the demand forecasting along the supply chain.
The unique feature of Big data that can turn the numbers into information is playing a role in providing a competitive edge for the new businesses. (Li, et al., 2018).

Online retailers can utilize the Big data by generating important data about their customer's needs preferences in more detailed, the online retailers can answer some important questions such as what the product or services could usually buy? How often they make the purchasing online? What is the way that the customers choose to navigate a retailer's online store? And how could you react to promotions and advertisements? In addition to some important could be useful for the marketing and sales practices such as age, gender, the design of the online retailer website to collect a greater image of the customer's pool for retailers (Li, et al., 2018).

Figure 14 below illustrates the involvement of the big data in the e-commerce supply chain, and it also illustrates the advancement of complicated algorithms to understand the market and provide better forecasting.

Source (Li, et al., 2018)

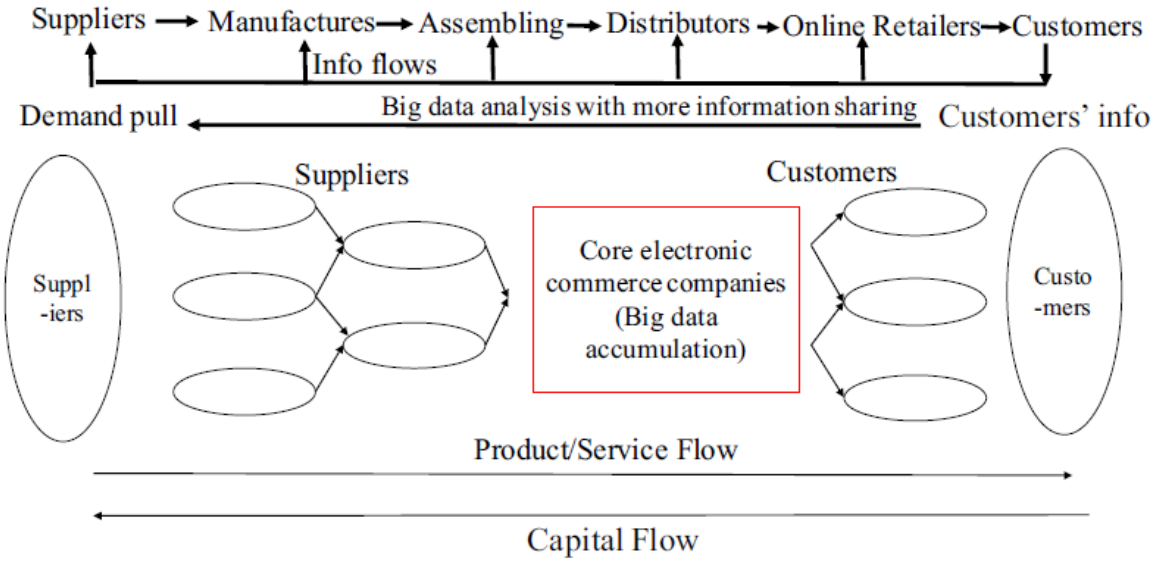

Figure 14 *The mechanisms and operation of the electronic commerce supply chain.*

According to (Mishra, et al., 2016), Big data is turning into a powerful instrument that can ensure an increase in the efficiency of the electronic commerce supply chain. As shown in figures 13 and 14 we can see how the demand chain management is being benefited from exploiting big data in the chain. (Waller & Fawcett, 2013) Argued that the differences between the normal and big data that is being used in the e-commerce can be summarized in 4 dimensions, Variety of information that can provide a clear insights that could be useful for the forecasting, Volume of the information that can be impressive in term of quality, depth of the information and could provide the organizations opportunities to explore business intelligences, Velocity that refers to the real-time information and Sustained and controllably-sourced data that can help in preventing the errors of data collection. (Waller & Fawcett, 2013).

Most of the organizations are seeking for improving their demand chain management performances, hence in order to achieve this improvement, it is significant for the collaborating firms in the supply chain to pay attention to the transformation of the demand information at the final stages of the chain (Blocher & Chhajed, 2008). Consequently, the nature of big data and the electronic market place can generate a trustful, real-time, and deep data that can be detailed in order to improve the supply chain in the addition of the demand chain management by utilizing and generating value from this data (Ittmann, 2015).

In the addition to the improvement of Supply chain management, using big data also can improve the risk management in the supply chain (Zage, et al., 2013), as well as the role of the big data in the advancement of the innovation capabilities in the supply chain through exploiting the deduction graph technique, since it is necessary to the online retailers websites to start to implement a tailored supply chain strategies corresponding to their needs and requirements (Tan, et al., 2015).

(Cachon & Fisher, 2000) Highlighted that the most significant key for the successful business strategies in this era of data is demand-information sharing. For example, (Gavirneni, et al., 1999) had created a comparison between three various levels of the sharing of information, and the summary of this comparison was the impact of the information sharing on the capacity and the inventory that had been impacted by the end item. Furthermore, (Kovtun, et al., 2014) evaluated the value regarding the sharing of the demand between the different actors in different stages of the supply chain, the assessment was controlled by some conditions, and he reported that demand sharing is not equivalent between the supply chain actors in the upstream part of the supply chain.

Briefly big data with the combination of the analytics tools can help in sharing the information in the supply chain in an easier, and efficient way (Li, et al., 2018).

As previously-mentioned electronic commerce (E-commerce) enhances the transactions performs on the conventional internet, meanwhile (Akyuz & Rehan, 2009) launched a new terminology that refers to the advanced integration of the processes across the supply chain phases which is "e-supply chain ". E-supple chain indicates to the usage the technologies of industry 4.0 along the whole supply chain such as big data analytics tools, IoT and RFID technologies which are referred to the uprising generation of the internet in which the physical objects can be connected through network, and it has the capability of exchange the data and information along the value chain about the physical objects and their surroundings (Gubbi, et al., 2013), and as mentioned before this data considered as a fuel for big data and analytics tools in order to analyse them to obtain a value for the supply chain.

According to (Suning, et al., 2018) the organizations are able to predict the product demands based on the evaluation and analysis of the customer behaviours in the purchasing processes as well as their feedback on the products, but for ensuring this the analytic tools must be implemented in the planning processes. The demand forecasting shapes significant input in the process planning, especially for implementing the source, make, delivery activities in the supply chain (Huang, et al., 2005).

Demand planning can help the organizations in some processes such as procurement process which contains, order specifications from quality and quantity, specifications, price selection and delivery time, consequently, this information can be used for having a better decision making that based on the analytical tools that support these decisions (Suning, et al., 2018), for example in source processes, the benefits of using the analytical tools is being shown in the practices of supplier selection and evaluation, by using an analytic hierarchical process that can facilitate the comparison between supplier's previous performances, as well as facilitating the selection process of the suppliers who can satisfy the customers' needs (Subramanian & Ramanathan, 2012).

Some researches and academicians such as (Suning, et al., 2018) reported the impact of implementing analytical tools in the supply chain and its role in the decision making and how it improves the demand forecasting, besides the benefits of this improvement on the different aspects of the supply chain respecting the SCOR model to illustrate these benefits. Supply chain operations reference (SCOR) model is referred to processes reference model that was designed and developed by the

supply chain council to describe the general business activities that include source, make, deliver, return and plan activities that it is linked to the customer satisfaction. (APICS, 2017), figure 15 below illustrates the SCOR model framework.

Source: (APICS, 2017).

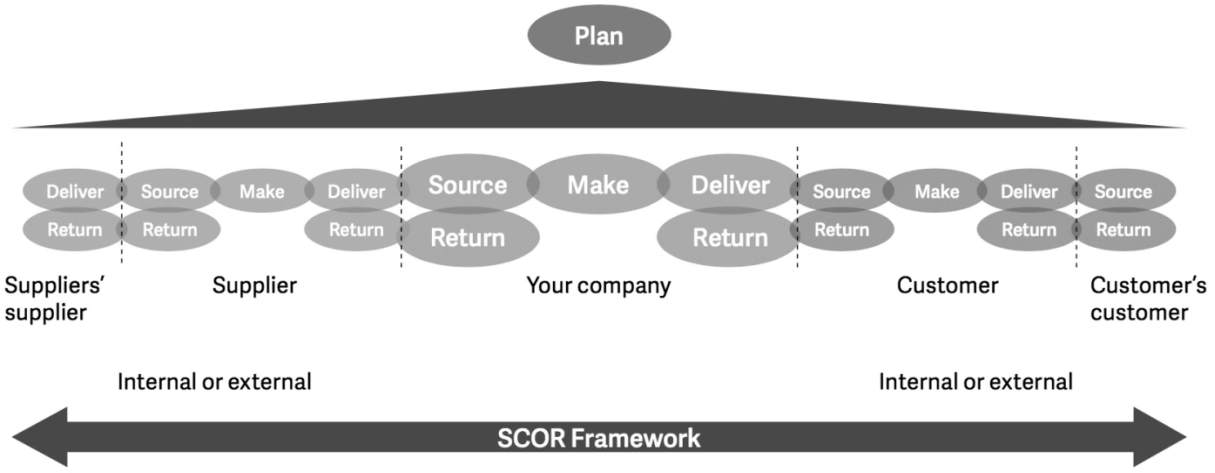

Figure 15 *Supply chain operations reference (SCOR) model framework*

The implementation of the analytics tools in the SCOR model can ensure some benefits in each process. By combining the productions plans with the execution in make process, supply chain analytics provide and the information regarding the possible improvement that could be applied on the production capacity expansion and providing suggestions about the way of using the existing limited capacity in order to meet the changing demand (Huo, et al., 2012).In addition to that, analytic tools can support the producer to modify the production activities according to the production plans, hence the appropriate mix of the production capabilities will be assigned to the appropriate mix of the resources at the right time (Sharma & Agrawal, 2012).

Regarding the delivery process, the organizations can implement the analytical tools to find solution regarding the transportation and distribution problems (Souza, 2014), some insights regarding the planned inventory and the requirements of the distribution of all the goods and channels can be created from the supply chain analytical tools, and this generated information can help in the decision making regarding the number, size, and the position of the distribution and warehouses centres

(Bidhandi, et al., 2009), in the addition to redesigning the channels and routs of the distribution, vehicles, and the operating stuff (Minis & Tatarakis, 2011).

(Roßmann, et al., 2018) Argued that more accurate demand forecasting is resulting a lower level of inventory, which was reported in the improvement of the safety stock that already depended on more accurate information regarding the demand planning. And they added that big data analytics (BDA) is expected to achieve a reduction in the information processing requirement (IPR) through achieving an increase in the accuracy in demand forecasts, consequently a reduction in the need of slack resources in the inventories (Roßmann, et al., 2018).

In addition to the previously mentioned, BDA leads a limitation in the role of the safety stock due to the dynamic and adaptive characteristics in the supply chain thanks to BDA (Roßmann, et al., 2018). Furthermore, BDA applications can help to increase information processing capacity (IPC) resulting in improvement in the transparency (Roßmann, et al., 2018). Briefly, BDA applications could increase (IPR) and increase (IPC) at the same time which can lead to a reduction of the uncertainty of supply chain operations (Roßmann, et al., 2018).

Another impact that the digital transformation could achieve in the demand side is mass customizations and customer involvement in the design of the product. Additive manufacturing (AM) technologies are one of the innovative solutions in the sector of production and fabrication, which can be considered as a competitive advantage for the organizations.

(ASTM Standard , 2012) Defined the Additive manufacturing (AM) as “the process of joining materials to make objects from 3D model data, following a layer by layer strategy, unlike the traditional manufacturing methodologies and the conventional machines”.an alternative terms for AM that repeatedly used are “rapid manufacturing”, “digital manufacturing”, and “direct manufacturing” (Holmström, et al., 2010; Vinodh, et al., 2009; Hopkinson & Dickens, 2001). The most diffused examples of the AM technologies are 3D Printing, laminated object modelling, and electron beam melting.

The launched of the AM technologies was basically for the rapid performing and printing of the prototypes, that why a terminology “rapid prototyping” is usually used to indicate to Am technologies. Nevertheless, the last years have witnessed a noticeable growth in utilizing AM technologies if the production and manufacturing of the final products.

One of the main benefits of Am technologies is its ability to produce products that can be characterized by complexity in geometries and lightweight besides the reduction in the cost especially for the production of low quantities of customized products, higher flexibility in the designs and to designs change, and lowering the usage of the materials (Berman, 2012; Holmström, et al., 2010; Khajavi, et al., 2014; Walter, et al., 2004).

The employment of Am technologies is achieving a significant impact on the demand – side of the supply chain, since it provides the capabilities for the customers to have an advantage from the faster response to the change in their needs, due to the fact that these technologies can provide the opportunity to the rapid adjustment in the product design by eliminating the object-specific tooling (Berman, 2012).

Am and its related technology 3DP witnesses an improvement in the production and manufacturing and is considered as a technology that can support the customization in production (Tuck, et al., 2008). This customization needs the involvement of the customer in the production processes besides the customer will have a piece of knowledge about their products and the specifications that he preferred (Duray, et al., 2000). Furthermore, this engagement of the customer in the production processes can be performed across the different phases of the fulfilment processes, (Lampel & Mintzberg, 1996).

3D printing is not just having a significant impact on the production processes, it also has an impact on the transportation and distribution along the supply chain as it will be mention in the next sections. But to have an insight into the downstream part of the supply chain, 3D printing can offer the customer “Tailoring individualized” that basically refers to the customization that the customer can perform on the product.

Tailor individualized can provide a potential for a shift in the priorities of profit and cost. (Petrick & Simpson, 2013), as well as to increases the integration level of the customers with the producers supply chain, resulting an elimination of some deliveries of inbound and outbound and an order lead time reduction (Oettmeier & Hofmann, 2016), as well as an increase in the customer level and the flexibility of the supply chain due to the increase in the responsiveness to the changes of the customer demand (Oettmeier & Hofmann, 2017).

3.4.3 Digital Transformation in Procurement and Supply Management

In recent years, and due to the global interconnectivity, sharing of data and exchanging the information in real-time, the organisations are witnessed a remarkable change in their business strategies and in creating new business models and terms related to their businesses, in addition to the increased competition in the market due to the new market entries. These factors forced the firms to pay attention to the innovation to face these challenges and to align their competitiveness with the newly created term and business models (Downes & Nunes, 2014).

Procurement is considered one of the support activities in the process of value creation (Porter, 1998), and it is one of the firms' functions that have been impacted by the digital era. In the manufacturing, process procurement is placed as a first step and it contains various activity such as supplier selection, strategic sourcing, and inbound logistics. Hence, procurement and demand management are like the other functions of value creation that is affected by digital technologies in order to improve the performance of the whole supply chain.

According to (IBM, 2009; Ross, 2016) the upcoming supply chain includes technologies-based drivers that are intelligent, interconnected, and instrumented. The first driver is "intelligent", that is referred to as simulation supply chain activities and scenarios, this driver is supported by the technologies of industry 4.0 that could be able to design and create different scenarios before they happen based on the situation of the future which creates more controllable supply chain that could provide a possibility to prevent the risk before it happens (IBM, 2009).

The second driver is the "interconnected" that refers to the technologies that can be connected to the internet and exceed the direct collaboration between the supply chain partners through providing a real-time market developments, such as pay attention to the customers' feedback in the social media and implement a strategy to follow-up activities (IBM, 2009). Interconnectivity is a term that supported by (Kumar, et al., 2016) that highlight the transformation in the supply chain design according to the impact of integrative technologies such as "Big Data" and "IoT". Besides the opportunities to establish a synergy by combining the normal production with customized production through additive manufacturing.

The third driver is “instrumented” which is referred to the exchange processes and transactions that are featured as automated and can be managed by RFID technologies, sensor, and GPS systems in order to decrease the risk and cost, increase the visibility and reduce the complexity (IBM, 2009). The automation of the activities will be supported by big data and artificial intelligence “AI” (Zhong, et al., 2016).

With the raising attention to the digitalization and what it can benefit from visibility and transparency through the supply chain, pushes the firms to increase the social responsible value chain and align it with their business strategies and models, in addition to real-time sharing between the supply chain partners will increase the trust level and improve the buyer-supplier relationship (Hoejmose, et al., 2013).

According to (Philippart, et al., 2005), including the digital technologies in the sourcing activity, or as he named it “e-sourcing“ is referred to the fact that the conventional souring activities are supported by which the information regarding the activities can be collected, resulting a “one-to-one” connection between the supplier and the buyer that implement a better communication.

Regarding this topic, many digital solutions were presented, such as the digital solution of (Schmock, et al., 2007), that basically is based on the collection of the data and information on digital platform that can be shared, accessed and processed between the different supply chain partners shifting the concept of “one-to-one” communication into “many-to-many” communication in order to share a real-time information between different parties.

Another example of the application of digital technologies was presented by (Van Weele, 2009), that presented a stock optimization definition between the buyer and supplier, in order to reduce the prices levels due to the benefits of the innovation, in addition to the increase in the supply chain intelligence due to the improved relationship between the buyer and supplier and the other actors in the value chain.

To gain a competitive advantage from the procurement process, (Hoejmose, et al., 2013) reported that the trust and transparency are significant key drivers for the future success in the relationship between the supplier and buyer, in which a win-win state will be granted. These win-win state can provide an improvement in the strategic partnership between the buyer and the supplier and consequently and advancement in the capabilities for both firms (Trent, 2007). The integration,

interconnectivity, and automated supply chain systems can play a significant role in increasing the trust between the partners in the supply chain, thanks to the digital technologies.

The technologies of IoT and cloud computing are playing a major role in the advancement of the supply chain, especially their related technologies from RFID, sensors, and networks (Haddud, et al., 2016), on one hand (Mantey, 2015) highlighted the role of procurement to enhance the advancement of the shared information to increase the transparency, traceability, and the agility of the value chain with the increasing information's amount in order to enable more innovative and intelligent supply chain, but on the other hand (Barron, et al., 2016) highlighted the risk that can attach this massive number of information sharing and possible transactions, and he reported the necessity of creating a cyber-security systems in order to reduce the risk of malevolent.

Another aspect of the impact of the digital transformation on the supply management is their impact on the supplier selection, Big data can enhance the capabilities of managing the supplier risks since it provides deep information and details of the supplier performance. (Lamba & Singh, 2017).

It is important to monitor and measure the supplier performances, sourcing markets, and the supply-side activities to avoid the supplier risks and support in creating a backup plan in cases of emergency (Lamba & Singh, 2017). Some examples of supplier monitoring, the possibility of the suppliers to provide very cheap raw materials, but at the same time they provide better quality or more efficient deliveries (Lamba & Singh, 2017). Such criteria should be evaluated before selecting the supplier and with the help of the digital technologies a supplier selection models could support this activity (Lamba & Singh, 2017).

SCA Have the potential to increase the visibility of Supply chain and in addition to the increase in the collaboration and integration among the supply chain network, by reducing the wastages and insufficiencies in the chain, such as the increasing of fuel costs, delayed in the deliveries and low suppliers performances (Barnaghi, et al., 2013).

Regarding the strategic sourcing, (Lamba & Singh, 2017) indicated that using BDA is considered as a considerable way to look for a better source. Therefore linking the data of the market prices for the raw materials and what is being considered in the pricing of this raw materials beside macroeconomic forecast information in one common database, then the capability of BDA can figure out new

opportunities and can provide the organizations alternative solutions and possible action (Sauter, 2014).

Some analyses were undertaken on this topic and show that BD can improve the sourcing cost directly between 2% and 5% every year, in addition to the capabilities of BD to ensure faster access to the information and data in order to better analysis and understanding (Lamba & Singh, 2017). BD can reduce the working time on ERB systems by 20 – 50% since this time is considered a time that is consumed in looking for relevant information (Lamba & Singh, 2017).

AM technologies also have an impact on the supply side of the value chain, various researched have been pointed the impact of the adoption of the AM technologies such as (Berman, 2012; Holmström, et al., 2010; Nyman & Sarlin, 2014). The manufacturing of the limited sizes of the lot could transfer back to the upper part of the upstream of the vertical in vertical integration thanks to the AM technologies in the other world, the manufacturing will shift back to the countries with the high- wage rate, due to the fact that AM technologies will reduce the needed manpower and will reduce the use of manual labours (Berman, 2012). Furthermore, it can reduce the dependence on outsourcing due to its ability to separate the design and production stages easily. (Berman, 2012). Also, and according to (Holmström, et al., 2010) Am technologies could make the supply chain simpler, in other word, AM could lead to the shorter and narrower supply chain.

In the production side, AM technologies can eliminate the sub-assembly operations, then to its capabilities of producing modified and customized parts, consequently, this will lead to a reduction in the number of the suppliers and the number of the components, and that could make the sourcing is limited with supplying the necessary materials for AM technologies instead of sourcing the subcomponents (Oettmeier & Hofmann, 2017).

3.4.4. Digital Transformation in Production and Manufacturing

Production and manufacturing processes have their chance as well as other activities in the supply chain, the impact of BDA, AM, industry 4.0, and artificial intelligence has played a role in changing the production and manufacturing practices. One of the technologies that affected the manufacturing and production processes is Am and its related technology 3D printing. 3D printing or what some others prefer to call it additive manufacturing, rapid manufacturing or digital manufacturing refers to multiple technologies and production activities that provide the chance to the user to design and print

out tangible objects from three digital dimensional models (Hopkinson, et al., 2006; Lipson & Kurman, 2013; Gibson, et al., 2015).

3D printing is deferred from the conventional manufacturing processes since it provides the user with the capability to create highly complex products from a large combination of materials, at the same time it requires little in the processes of retooling from product to product or even from order to order (Tuck, et al., 2007; Conner, et al., 2014; Kietzmann, et al., 2015). 3D printing is characterized by flexibility in production, consequently, it grants a unique level of customization, in other word, it provides customization to levels that each printed product could be a totally new established product (Petrick & Simpson, 2013; Conner, et al., 2014).

As a consequence 3D printing has been adopted in the fields where requires to produce small lot sizes of batches or it needs a high level of customization such as medicine sector (Rengier, et al., 2010), aerospace industries (PwC, 2013), spare parts and custom-made consumer products (Manyika, et al., 2013).

In spite of the 3D printing positive impact on the supply chain such as making supply chain more leaner, responsive and more agile, in addition to the increase of the cost-effectiveness, increase in the sustainability, and reduction in the waste levels (Hopkinson, et al., 2006; Holmström, et al., 2010; Gebler, et al., 2014; Tuck, et al., 2007), but the 3D is not yet been presented as an alternative technology that can replace the conventional manufacturing processes, especially in the high volume productions (PwC, 2016).

3D printing technologies was presented as a potential technology for the manufacturing activities, due to its impact on the transportation cost (Barz, et al., 2016) in the addition to its impact on the lead time (Holmström, et al., 2010), inventory levels and management (Khajavi, et al., 2014) besides the flexibility and quality of the production, productivity, and economies of the scales (Petrick & Simpson, 2013; Baumers, et al., 2016; Sasson & Johnson, 2016).

As previously mentioned on of the impact of the digital technologies is the customer engagement, this impact takes a place in the demand side due to the high capabilities of the customization to fulfil the customer requirements (Tuck, et al., 2008). On the other hand, customer engagement has an impact on production and manufacturing as well. (Ryan, et al., 2017) Has examined the customer

engagement through using order penetration point (OPP) (Gosling, et al., 2007) which will be explained in more detail.

Since 3D printing technology has the capabilities to product customization, it needs, in turn, the customer to be highly involved in the process of customization regarding their preferred products (Duray, et al., 2000). This engagement of customer can be implemented in different stages of the processes of fulfilment (Lampel & Mintzberg, 1996), and to connect this concept to supply chain processes, it is defined with the respect to the order penetration point (OPP) (Ryan, et al., 2017).

Briefly order penetration point is referred to the point where defining the specification of the product gets frozen (Sharman, 1984). (Gosling, et al., 2007) Highlighted that there are six order penetration points (OPP) and they associated those points to the supply chain activities according to at which point the customer will be involved in the supply chain. Figure 16 illustrates the supply chain structure associated with the various six possible OPPs where the customer can involve in the customization process.

Source: (Gosling, et al., 2007)

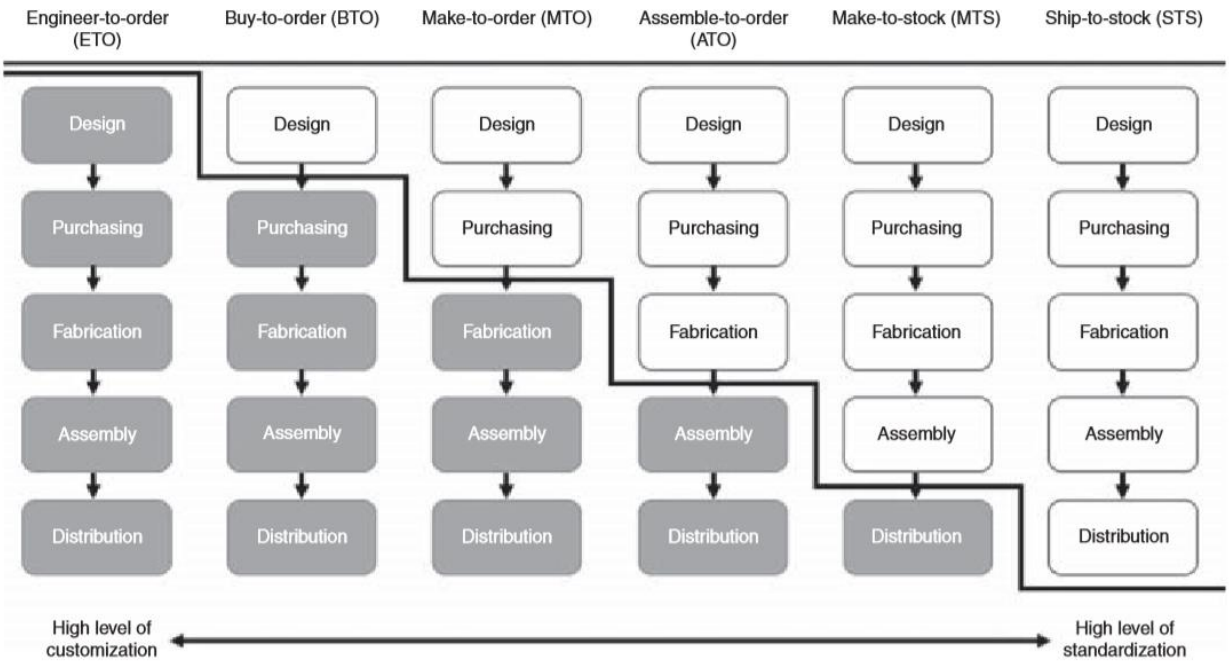

Figure 16 *Supply chain structures*

As shown in Figure 16, all the situations are being covered from shop to stock (STS), where the customization is taking a place, reaching to final point of the distribution passing by engineering to order point (ETO) where the full customization is undertaken starting from the design process, and the production of the product using 3D printing.

In the addition to the customer involvement in the production, another impact of 3D printing has been reported with 3D printing technologies, which is the localisation and relocation of the manufacturing and production plants (Rogers, et al., 2016). 3D printing presented different degrees of geographic distribution for production, and these degrees differ in term of time of implementing since future expectation reported that there is an ability for the customer in the future to print the desired products in their homes, producing the one-off product when needed (The Economist, 2011). Another expectation of the potential use of 3D printing in the future in a larger scale production environment, such as operating at a national scale (Eyers, 2015).

3D printing can be exploited in the redistributed manufacturing or at the local level, since the application of 3D printing on the local level has gained the attention, due to its impact on the re-shoring of manufacturing (Moser, 2011).

In the production field, the issue about the centralised and decentralised production is usually related to the geographical coverage that is provided by each node (Storper & Harrison, 1991). 3D printing provides the chance to impact the manufacturing location by relocation of the manufacturing and decentralisation of the production activities which can result an increase in the time-to-market responsiveness, in addition, to increase of the agility in the supply chain but this is limited for the small lot sizes and low volumes and require high customization and specification levels (Garrett, 2014).

According to (Reddy, et al., 2016), industry 4.0 has achieved significant transformation in the supply chain, and they reported that the main part of the shift in the supply chain is the transformation of the industry, which is referred to the transformation in the production. This transformation in the production involves 3 phases of transformation i.e. transformation of the systems of the productions, transformation of the processes, and finally the transformation of the product (Reddy, et al., 2016).

Source: (Reddy, et al., 2016).

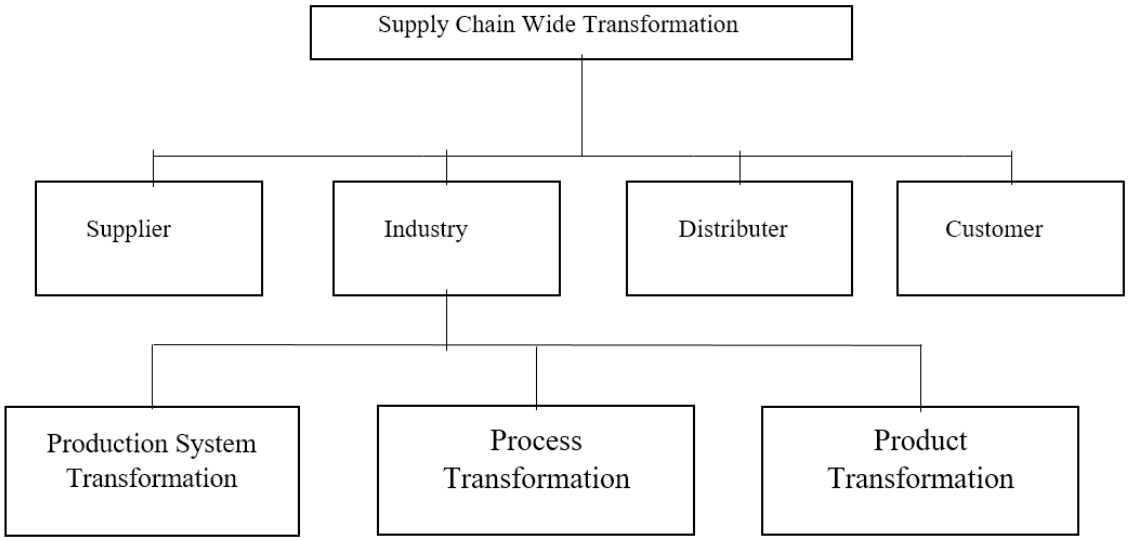

Figure 17 *Supply chain wide transformation and production transformation*

Regarding the production systems, it can be defined as the place where the goods are produced after passing by various processes to have the desired output (Reddy, et al., 2016). In the present day, the transformation is considering more aspects than it used to be in traditional production activities such as pollution, safety, and the environment. (Reddy, et al., 2016). Currently, three elements are being considered in the transformation of the production systems; machine architecture and technology, man and machine interaction, system layout and architecture (Reddy, et al., 2016). Figure 18 below shows the main elements regarding the transformation of the production system.

Source: (Reddy, et al., 2016)

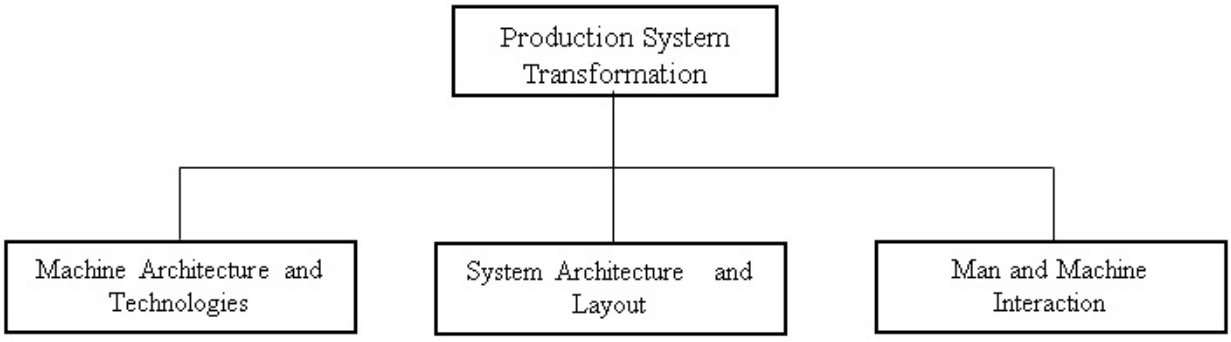

Figure 18 *Transformation of Production system*

In Machine architecture and technologies, the transformation is taking a place in the ability of the data acquisition and the integration of the processes to make it easier and faster, and this process is driven by the ability of the machine to be connected with the new technologies. (Reddy, et al., 2016). Meanwhile, industry 4.0 provides the capabilities for the system architecture to make one production system as multiple production systems by managing the materials and machine handling systems, resulting a reduction in the number of machines of similar function (Reddy, et al., 2016).

The second phase of digital transformation in the production is the transformation of the process, which is defined as the sequential procedures that the products follow to be produced (Reddy, et al., 2016). The transformation is being undertaken with the help of industry 4.0 by implementing integrated systems that have the ability to communicate and collaborate with the systems in order to gain a smart process, furthermore, the transformation is implementing in 3 aspects in order to make the process smarter, first the environmental regulations that is referred to make the environment free and supporting the transformation, second the processes improvement, and finally adding the appropriate technology to implement the smart process and which technology should be transformed (Reddy, et al., 2016). Figure 19 is showing the transformation of the process's aspects.

Source (Reddy, et al., 2016).

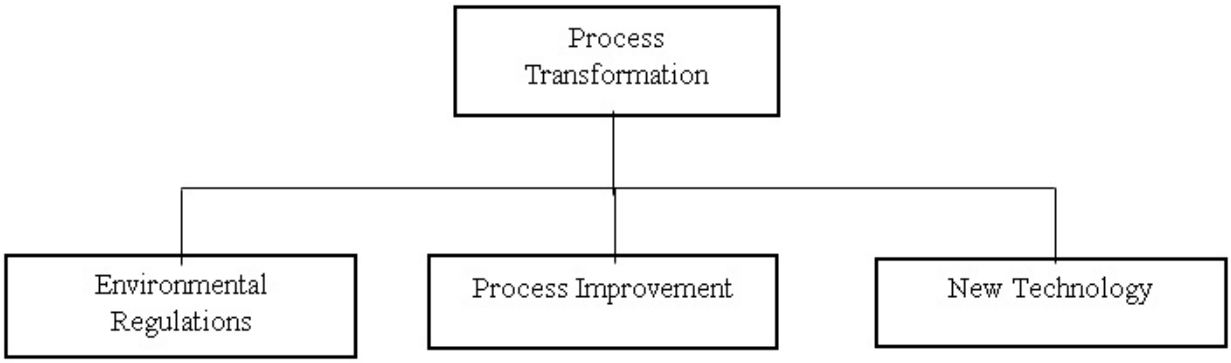

Figure 19 *Process transformation.*

The final phase of the transformation of the production is the transformation of the product, which can be defined as the shift of the traditional product into a smarter products, which means to create a communication between the product and the systems through gathering the information regarding the process for the after production investigations (Reddy, et al., 2016).

The main elements of the transformation of the products is shifting the features of the technologies used in the production, materials transformation that is being used in the production, in other word transformation of quantity, quality, time and the place of the materials, and finally the information transformation (Reddy, et al., 2016). Figure 20 shows the transformation of the products and their related elements.

Source: (Reddy, et al., 2016)

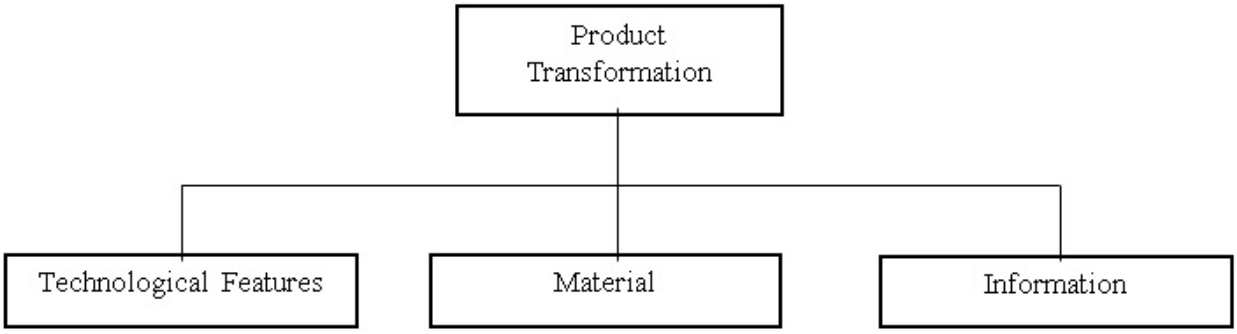

Figure 20 *Product transformations and its elements*

(Reddy, et al., 2016) Summarized the difference between the conventional activities of the production and the processes after implementing industry 4.0 technologies. Table 9 below reports the differences between the traditional practices an industry 4.0 practices in the production activities.

Source: (Reddy, et al., 2016)

Element	Traditional	Industry 4.0
Resources	Limited Resources. This is a fixed line and mass production. The resources needed should be estimated.	Multiple Resources. To produce multiple types of products with small lot sizes. Multiple types of resources should available in the system.
Material Handling	Fixed Material Handling. This is a fixed handling system only the movement of material is done in fixed unless manually routed.	Dynamic Handling. The material handling system movement can be changed for different products.
Connectivity or Interaction	No Interaction. The machines are not connected and they don't have any type of interaction.	Integrated Connection. The systems are connected each other and the communication between machines are possible.
Data Management	Limited Data Management. The data is managed only at some particularly at some levels of the system i.e. high level management of the industry.	Full Data Control. The data is fully managed at individual departments and also total system. The supply chain wide data is managed by cloud storage.
Product	Single Product. Only particular (single) product is produced and in mass production.	Multiple Products. Multiple types of products are produced on the same line of production.
Decision Making	Manual Decision Making. The decision making is manual at all the levels of the system.	Automatic Decision Making. The decision making process is carried out by the system at all stages of production and manual involvement is less. The decisions are accurate.

Table 9 *Comparison of technical features of industrial formation*

Finally (Reddy, et al., 2016) reported the main benefits and positive outcomes of the digital transformation in the production and industrial practices as flexibility in the production, increase the speed of the productivity, in addition to the integrative process that can provide transparency and the benefits of these transformations on the sustainability and the environment. Table 10 below illustrates the benefits and positive outcomes as reported by (Reddy, et al., 2016).

Source: (Reddy, et al., 2016)

S. No	Outcomes	Benefit
1	Flexibility	As this is a flexible system different types of products can be produced at the same time.
2	Productivity	As the system is flexible the productivity will be more it leads to fast production.
3	Resource and Energy Efficiencies	This system is efficient the resources used by this system will be low i.e. less wastage and it can save energy.
4	Transparency	As this system is integrated and intelligent system it automatically identifies the problems and also gives the solution.
5	Integration	By integration of the systems the time delay will be decreased and the production rate will increase.
6	Profitability	As these systems are flexible, productive, transparent the profit will be increased.
7	Environmental Friendly	These systems are building environmental friendly as they are pollution free systems. These systems didn't exhaust any pollutant.

Table 10 *Beneficial outcomes of industrial transformation*

3.4.5. Digital Transformation in Logistics Management and Transportation

Logistics management is considered to be the major part of the operations and supply chain management since it consists of the activities of the Inbound transportation, warehousing, inventory management, packaging, good handling, and outbound transportation (Stroh, 2002).

According to (Armstrong & Associates, 2014) reported that the expenses of the united states alone in the logistics sector are 1.4 trillion dollars, reporting that the countries are spending a lot on the logistics practices and operations. So, a small reduction in the logistics cost will make an effective profit for the stakeholders.

Supply chain management includes an activity of linking between different logistics chain partners, to achieve integration in the processes and coordination between these partners (Christopher, 2016). The establishment of an End-To-End integration of the various partners in the supply chain could create a possibility to obtain an increase in the value received to the customers, in addition to a

reduction in the overall cost instead of creating an optimization of the smaller networks in the supply chain. (Strandhagen, et al., 2017).

The logistics sector is also get affected by the spread of industry 4.0 technologies since it provides various opportunities for the implementation of big data. There are many sources for the data in the logistics field such as RFID technologies, GPS, social networks, mobile, pallets, cases and carriers that have RF tags and EDI transactions (Swaminathan, 2012).

(Frehe, et al., 2014) reported that impact of big data in the activities of the logistics, and they found that most of the logistics activities are using big data technologies in their processes especially in the optimizing routes and fuel management, and flow of the packages and they added that the use of big data still in the nascent phase.

Logistics applications of big data are usually helping in optimizing the inventory levels, further, it can support the decision making in defining the location of the optimal distribution centres and the routes of supply and can reduce the transportation cost (Sanders, 2016). Furthermore, one of the significant utilized application is used in transportation and routing. GPS also can support with the help of big data in the optimization of transportation (Mayer-Schönberge & Cukier, 2013).

Moreover, BDA applications have the capability to increase productivity through fuel efficiency optimization, preventive repair, and maintenance, in addition to vehicle routing. BDA capabilities can be effective in the events disruptive tracking, for example, the routes of distribution and the weather forecasting can be optimized in real-time. (Sanders, 2016). As a real example of using BDA in route optimization is UPS, that initiated to collect data and information 2 decades ago in order to find the most efficient route for its delivery, by using an analytic tools called ORION (on-road integrated optimization and navigation) (Siegried, 2014), another application of BDA in transportation, that it can support providing information regarding transportation route segmentation taking into consideration the transit factor of the various products type (Mayer-Schönberger and Cukier, , n.d.).

According to (Deloitte and MHI., 2014) the application of big data analytics in the supply chain can support gathering data from external and internal sources, that could help in providing comprehensive insights that can help the supply chain in cost and risk reduction, meanwhile improving the agility of the operations and processes in the addition to the service quality.

SCA Have the potential to increase the visibility of Supply chain and in addition to the increase in the collaboration and integration among the supply chain network, by reducing the wastages and insufficiencies in the chain, such as the increasing of fuel costs, delayed in the deliveries and low suppliers performances (Barnaghi, et al., 2013). The term SCA refers to the adopting of analytical tools, to improve the performance of the Supply chain and to support the decision-making processes (Chae, et al., 2014; Davenport & O'Dwyer, 2011; O'Dwyer & Renner, 2011).

RFID technologies have also an impact on logistics activities, since it has an impact from this technology in the inventory management, where RFID technology is utilized in the tracking and tracing activities of the products through tracking the products in motion, extracting data of location, quantity and the status of the products besides monitoring the security. (Sanders, 2016). The cold chain has really a positive impact through using the RFID, and sensors to control and monitor the ambient temperature and transit duration. This is also useful for tracking the perishable products where the analytic capabilities are optimizing the quantity of the order in the addition to service level (Sanders, 2016).

In 2013 DHL reported that Big data has the ability to improve the efficiency of the logistics operations and customer experiences, as well as, to its ability to build an effective business model (Jeske, et al., 2013). on the other hand, IoT technologies are playing a significant role in the logistics operations practices due to the increased number of the physical objects that are somehow connected to this technologies in several ways, such as; connecting to RFID tags and sensors or holding bar codes, increasing the ability of tracking, tracing and generating real-time accurate data along the supply chain processes (Atzori, et al., 2010; Da, et al., 2014; Razzaq-Malik, et al., 2017; Swaminathan, 2012) . However, RFID tags are proving day by day its effectiveness in reducing inventory shrinkages and avoiding the stock-out and excess stock and overall, the data accuracy. (Wu, et al., 2016).

The best example of the application of the RFID in the logistics processes and its positive impact in the area of agricultural food. Recently, food was a source of many diseases such as bird flu, Streptococcus Suis infection, mad cow disease, and many other diseases. Consequently, the food safety has increased the global attention, currently, the European Union, United States, and other countries in the west have been created legislation in order to apply a system regarding the agricultural and food safety (C Amardeo, 2009).

Because of the facts mentioned above, a need for creating a system to control and monitor the whole activities and procedures of the agricultural produces has been raised and this need was considered as an important need. (Sachan, et al., 2005). RFID tags have been attached to the agricultural goods that being stored in the EPC code - which is considered as an identify card of the product -, in order to provide traceability and tracking information in real-time, about the agricultural products along the whole process of the circulation (Bernardi, et al., 2007). Another impact of using the digital technologies in the logistics activity is the using of the RFID in the food industry and perishable products where it can help to avoid unnecessary wastage (Grunow & Piramuthu, 2013).

Additive manufacturing is also implementing an impact on the logistics practices, according to its ability to reduce the inventory levels located in the distribution centres in case of keeping a centralized AM production plant (Bogers, et al., 2016), this ability can enhance the organizations to reduce the inventory levels and increase the delayed differentiation while letting the organization to align the supply with the demand in a better way (Bogers, et al., 2016).

3D printing can make the production to occur on demand, and at the consumption point, however, AM technologies in the term of inventory and transportation, 3D printing can reduce the use of the physical products by relocating the production plants closer to the customer, which could achieve a rationalization in warehousing and transportation activities (Manners-Bell & Lyon, 2012).

Furthermore, (Nyman & Sarlin, 2014) reported that there is a possibility to replace the movement of the physical materials across the supply chain by sending digital and electronic files to the printer. Physical inventory will be substituted by digital inventory containing 3D model files of the whole product portfolio for the complex products, resulting a reduction in the total number of the SKUs and stored parts.

Briefly, AM can achieve a reduction in the inventory levels in addition to the warehousing and transportation cost if the manufacturing plants are located in a regional scale to decrease the supply chain tail (Pannett, 2014).

3.4.6. Digital Transformation in Supply Chain Sustainability

Sustainability as a concept was originally refers to the forestry, inspired from the say "never harvest more than the forest can yield ", after that in 1987, in (Brundtland, 1987), different concepts related to sustainability have emerged, starting from the survival of human across the world (Brown & et, 1987) passing by the resources consumption (Mieg, 2012), to the effect of the human practices on the environment (Hansmann, et al., 2012).

Sustainability is a concept that based on 3 pillars; Economic, Social and environmental pillar (Mieg, 2012), but some authors prefer to name it the triple bottom line (TBL) which is a concept that had been launched by John Elkington (Carter & Rogers, 2008). For the organizations, adopting these three terms in their business can make it a sustainable business.

Business organizations aim is to gain profits from their business for long-term sustainably. With the globalization practices and the widespread of the new technologies that enhance the communications, in addition to the development of social media, the competition level reaches to a level that never reached before. In spite of this competitive environment of business, paying attention to the profit and the economic aspect of the organization is not enough for being a sustainable business, the social and environmental aspects should also be considered as goals of the organizations (Elkington, 1994).

With the introduction of industry 4.0, the communication is significantly improved, and this led to improve the awareness about sustainability, particularly social sustainability, resulting in improvement among the production firms (Wu & Pagell, 2011). Consequently, several firms initiated publishing their social activities and their corporate social responsibility report, which shows the social aspect of the firm and how the company taking social issues seriously.

As a live example of an Industry that gets affected by industry 4.0 regarding the social and environmental aspects of sustainability, which is the Automobile industry. The automobile industry is one of the accelerated fast-growing industry in India, characterized by large-scale employment (Chandra Shukla, et al., 2009). Automobile industry creates high levels of carbon footprint along with the whole supply chain processes and product life-cycle, starting from production, distribution, reaching to the use by the final customer, hence, the impact of the economic, social and environmental is particularly complex (Luthra, et al., 2016).

Since the supply chain of the automobile industry is very complex, the significant challenge of this industry is the visibility across the entire chain, plus cost, risk management, globalization and the highly increasing demands of the customers, hence, the visibility and the share of the information across this complex chain is considered as significant challenge (Wu & Pagell, 2011) .

BDA and its revolutionary role can provide such a solution for this complexity taking into the consideration the three aspects of the sustainability, hence, the role of BDA in its capability regarding the sustainability faces increased attention for the firms of the automobile industry (Bughin, et al., 2010).

The effects of the carbon emissions generated from the production, logistics, transportation and the other activity of the supply chain are clearly obvious and can be visible in term of global warming which melts the layers of ice causing an increase in the sea levels. The focus of the environmental aspect of the forms is to reduce the carbon footprint, which can be implemented which launching of some sustainable programs like reuse, recycle and reduce and reuse with the help of the BDA and Industry 4.0 technologies (Jeble, et al., 2018), in the addition to increase of the customer attention to the sustainability impact, (Trudel & Cotte, 2009), and the effect of this in their purchasing decision, that led the organizations to indicate the product's impact on the environment by carbon-labelling (Svensson & Wagner, 2015).

The Big Data technologies presented by the social media (Facebook, Twitter, etc...) helps in creating a notably increased level of the awareness about employment conditions, wages, safety, equity and the conditions of living between their users (Lindsey, et al., 2013). This is making the organizations aware of the importance of the social and environmental responsibilities, and how this can influence their performance, consequently, the sustainable manufacturing and the sourcing activates regarding the social responsibility are improving, so the organization are tending to improve the working conditions, increasing the living standards for the society, eliminate the waste and exploiting the resources efficiently (Mani, et al., 2015)

The raised attention of the organisations in the digital transformation of the visibility within the supply chain impose them to increase their attention to the responsible social practices in their supply chain in parallel to their business strategies and models, furthermore, the exchange of real-time access

to the data will increase the level of trust in the supply chain, and improve the buyer-supplier relationship (Hoejmose, et al., 2013).

Several firms initiated publishing their social activities and their corporate social responsibility report, which it shows the social aspect of the firm and how the company taking the social issues seriously, stakeholder and customers now are expecting the organizations to behave in more responsible way toward the profitability, environment, and the ethical behaviours (Ashby, 2012). (Song, et al., 2017) Highlighted that BDPA has sufficient capability to improve sustainability in the term of social activates.

As previously mentioned, Social media has an impact on the practices of the firms, this fact encourage the idea that the consumers are becoming very powerful in the era of the big data, since they will have the ability of gathering through using the social media in order to voice out their comments, feedback and complaints, thus, they could have the ability to boycott any brand or product if they dislike (Choi, 2018), on the other hand, the consumers can share a positive feedback and comments about the organizations, for example, if the supply chain can generate the necessary information to make the customers realize the positive practices of the organizations and products (Choi, 2018). (Katz & Bradley., 2013) Reported the impact of social pressure from various actors, stakeholders and institutions on the organization, in order to build more sustainable solutions.

Industry 4.0 provides enormous opportunities for recognizing of the sustainability in the productions and its ability to implement coordination of the material, energy and products across the whole life-cycle of the products from sustainable building of the processes and resources efficiency, developed productivity of the manpower thanks to the capability of the internet of things and the application of the green lea-agile business models (Stock & Seliger, 2016). Furthermore, BDA and its predictive capabilities can help in creating models to predict sustainability performances (Shin, et al., 2014).

The developed business models that based on the industry 4.0 technologies, enable the organizations to implement more sustainable (social and environmental) trend at a larger scale, which can make the organizations perform in a more responsible way toward the health and safety of the employees, customers, society and the environment (Strandhagen, et al., 2017).

(Strandhagen, et al., 2017) Summarized the impact of the industry 4.0 on the sustainability of the supply chain as shown below in table 11 that shows the impact on the social, environmental, and economic aspects.

Source: (Strandhagen, et al., 2017)

Social	Environmental	Economical
• Collaborative consumption • Peer-to-peer sharing schemes • Focus on consumer use of products • Increased stewardship role, awareness towards health and well-being of stakeholders • 'choice editing': removal of poor products from shelves • Increased accountability towards reduced production and consumption • Encouragement of sufficiency (reduced premature disposal of products)	• Increase in material productivity, resource efficiency and waste reduction • Reduced impact of industry by reduction in demand for energy and resources (less emissions, reduced waste) • 'Choice editing': eliminating less healthy and environmentally damaging products. For example: optimum use of wood and chemicals • Usage of environmental friendly material and production processes • In frugal markets, redesigning of products eliminating complex functionality and cosmetics, ultimately reducing material and energy consumption.	• Value creation from wastes by turning waste into input for production process • Value of under-utilized assets can be recaptured through shared ownership • Increased opportunities in secondary markets • Enhanced product life and durability, leads to higher second-hand value • Increased opportunities to cater to "frugal markets" in poor countries

Table 11 *Impact on sustainability*

3D printing technologies also have an impact on the supply chain sustainability (Ford & Despeisse, 2016), since it has better abilities in term of resources efficiency compared to the traditional production methods (Campbell, et al., 2011), and this enhanced some researcher to highlight that the fast success of 3D printing will start the shift in the view of natural resources with material savings, along the production process, in the addition to the ability of well-use the recycled materials during the printing processes (Wigan, 2014). Also, it can produce the products with less waste, leading to greener, and more sustainable production in the addition to enhancing the utilization of recycled materials (Janssen, et al., 2014), and reduce the excess inventories and overproduction due to postponement and late-stage customization (Mohr & Khan, 2015).

3.5. Key Motivations that Drive the Digital Transformation

As the findings of the digital transformation on different supply chain part were presented in the previous section, in this section the critical drivers that enhance the transformation and what are the factor that enables the successful transition will be presented in this section.

Data and information are very significant driver that affect the decision making processes of the organizations, since this processes can be on the operational, tactical, and strategic level (Rai, et al., 2006), nevertheless, the data and information's amount that available to the firms, generated by the firms and collected through companies are facing a massive accelerated growing at a rapid pace (McAfee & and Brynjolfsson, 2012). This accelerated growing of the data and information amount has created a challenge for the firms in defining and extracting the most relevant data needed to be analysed for managing the supply chain and business activities.

The concept of big data analytics is formed, for this reason, resulting the new introduction of several opportunities in the extracting and exploiting of these large sets of data (Gupta, et al., 2012). As mentioned before BDA is referred to the application of developed mathematical and statistical practices to any type of saved electronic communication such as messages, images posted on the social media, data from sensors and RFID, in the addition of the GPS signals, etc. (McAfee & and Brynjolfsson, 2012). This technology can enable the potential for launching a management revolution (McAfee & and Brynjolfsson, 2012), furthermore, it can be a significant factor for capturing a business value (Fosso-Wamba, et al., 2017).

Due to the global interconnectivity, sharing of data and exchanging the information in real-time, the organisations are witnessed a remarkable change in their business strategies and in creating new business models and terms related to their businesses, in addition to the increased competition in the market due to the new market entries. These factors forced the firms to pay attention to the innovation in order to face these challenges and to align their competitiveness with the newly created term and business models (Downes & Nunes, 2014).

There are two critical motivations that could enhance the organizations for shifting toward digital technologies, the first one is the external pressure, which is related to all forces and factors that form the external environment of the firms such as the increase of competition, government regulations

and legislation, the changing in the customer preferences and the tendency for volatile customize requirements, in the addition to changing in the business fields and the advancement of the technologies and finally the organizational adoption (Oettmeier & Hofmann, 2017; Carr, et al., 1996).

The second motivation is the perceived outside support, which is related to the support of some actors such as vendors or consultants in the transformations practices which can be achieved by providing information about the new technologies such as cost efficiency and benefits , the training for the employees, providing the necessary support during the application and implementation of the new technologies and during the operations (Cragg & King, 1993; Yap, et al., 1992).

The availability of the massive amount of the information about the markets and their customers encourages the company to use this valuable resource to create a competitive advantage and encourage their position of being intermediary between the production and the customer by adopting the new technologies such as BD (Zhan, et al., 2016)

The fast accelerated progress and the development that is occurring worldwide, the life-cycle of the industrial time is becoming shorter, consequently a need is raised for the firms to increase their effort in finding more innovative solutions and new strategies for their supply chain in order to compete in the increasingly competitive markets and achieve competitive advantage (Schrauf & Berttram, 2016).

Recently, The volatility and complexity are significantly increased to very high levels, which leads to an increase in the dynamics of the business environment (Christopher & Holweg, 2017), consequently, the supply chain should be responsive and aligned change of the customer preferences in order to keep a sustainable and individual goods and logistics services (Akinc & Meredith, 2015; Dubey, et al., 2017) .

The dynamics and complexity in the business environment witnesses a significant increase lately, due to the change in the customer preference, new disruptive an innovative technology and the continuous increase of the digital transformation (Christopher & Holweg, 2017).

Adopting digital technologies such as analytical techniques are being exploited more widespread these days, due to the factor such as the necessity for more rapid and better decisions. The massive amount of the data that is possible to be collected by the firm across the entire chain, plus the reduction in the cost of data storage, in the addition to the advancement of the computing capabilities

and tools are playing a key role in the diffusion of the digital technologies across the chain (Khan, 2013).

(OECD, 2017) Reported that the cost of the robots that are being used in the industrial activates are significantly decreasing, on the other hand, the adoption of these robots is being increased. Inspire of the decreasing cost of the robots, the quality and the functionality are increasing as well. However, RFID and IoT technologies witnesses a significant decrease as well in the term of cost, consequently, some firms started to implement tagging RFID in their products such as high-priced clothes. (Tu, 2018).

(Wu, et al., 2006) Highlighted that the use of the new technologies must take into consideration many factors; the capabilities of the technology, the standard, cost the implementation, infrastructure of the supply chain and the return on the investment. Hence in the adoption of the industry 4.0 technologies such as IoT, the organization should take into consideration many factors such as technology, technology transformation, and compatibility, particularly in the application of the ultra-high frequency technologies (Tu, 2018).

The reduction in the cost of RFID devices is making these technologies to be used widely, for example, the labour-intensive factories such as those who is operating in the clothing, footwear sector, they already have started recently implementing the RFID devices on their production, in order to monitor the production due to the reduction in the cost of installing these new technologies and economically feasible, in spite of their low profit and low automation features, nevertheless these technologies have been proven by different industrial application (Guo, et al., 2015; Wong & Guo, 2014).

3.6. Challenges and Barriers in Adopting Digital Technologies

After mentioning the Drivers that facilitate and enable the Digital transformation, in this section, the challenges and the barriers of adopting the digital technologies will be reported as the final section of the findings of this research. Adopting the digital technologies and industry capabilities, is becoming significant for the organizations, with the growth of the competition in the business environments and the add value that the transformation could achieve, investing in the digital

transformation becomes one of the top priorities for the organizations, on the other hand, it becomes one of the majors challenge due to the lack in the comprehensive strategies.

(Kache & Seuring, 2017) Reported the main challenges of adopting BDA technologies, and he summarized these challenges regarding the capabilities and infrastructure of IT, business strategies, HR and talent management, cybersecurity.

IT infrastructure and capacities referred to the lack of IT capability that could be relevant and efficient for the organizations, since its objective is to analysis and procuress the information and utilize the massive amount of data for the benefit of the organization, this challenge is considered as the most critical challenge by the experts (Kache & Seuring, 2017). The challenge of the IT infrastructures differs from the IT capabilities, since the IT infrastructure is tied to the cycles of the finance, in another word, any update or replace will have some difficulties and continuous funding for the adopting of the technology can be considered as a challenge, meanwhile the IT capabilities are related to the recruitment of the IT need for the corporation (Kache & Seuring, 2017).

The objective and business strategies challenges are related to defining a clear objective of the employment of the technologies, in the addition to an understanding of these technologies and what the benefits can come to the corporate from this transformation, especially the big data concept, since the good understanding of the technology can solve this issue (Kache & Seuring, 2017).

Skills, HR, and Talent management are also considered as a challenge for digital transformation since it is generated from the lack of the enough IT skills, manpower and scientists that can ensure a successful transformation (Kache & Seuring, 2017). In this regard (Davenport, et al., 2012) argued that the analysis and finding of data patterns need data scientists, consequently, the organizations require to seek the talents, qualified and specialized manpower in Big Data and the new technologies who can ensure a successful implantation of these technologies (Kache & Seuring, 2017). Data scientists need to have a combination between mathematical, statistical and analytical skills and the knowledge in the field and area of work which is considered to be hard to find this combination, (Waller & Fawcett, 2013). Furthermore, (Richey, et al., 2016) reported that lack of skills and expertise is a serious concern in the supply chain domain.

Another issue that can consider as a challenge is the cyber and information security since the organizations are sharing and acquire a huge amount of information and confidential data, sensitive

information, about the customers in the addition to the shared information between the partners in the supply chain. The security of this information requires special consideration generating from the fear of the leaked data and losing control over the ownership of these data. Furthermore, this issue is considered to be a worry from the customer point of view (Kache & Seuring, 2017).

Big Data acquisition can generate many issues and concerns such as security, privacy, misuse of Big Data and the use of Big data unethically, in the addition to the processing of the information ineffectively (Hu, et al., 2014). According to several supply chain professionals, the privacy and data security are becoming a concern and they added that the outdated regulations are considered to be the main obstacle in the sharing information activity in the supply chain, particularly, the consumer's information (Richey, et al., 2016).

(Alfaro, et al., 2015) Highlighted that security, privacy and data regulations and laws can generate a significant concern, especially for the multi-national supply chains, and the different actors are committed to following the regulations of different countries regarding the information sharing across the supply chain.

The security is considered very important concern regarding the area of procurement and supply chain management, particularly with the increased number of the information data flow and automated transaction across the supply chain (Stephens & Valverde, 2013). The cybersecurity across the supply chain is highly important and can have the potential for possible risks across the chain practically malevolent attach risks (Barron, et al., 2016). Nevertheless, it is necessary to invest in the development of the security as well across the supply chain and include all the supply chain partners in order to find common solutions and application to protect the data and information across the chain against the external violence (Johnson, 2013).

As previously mentioned, digital technologies are enhancing the interconnectivity and automation in the processes and practices of the supply chain, hence a new challenge can be raised regarding this interconnectivity which is the "trust". Trust between the partners in the supply chain plays a significant role across the supply chain ecosystems, especially regarding the buyer-supplier relationship, since it is considered as an important driver that based on the external factors and the interaction between the buyer and the supplier (Keith, et al., 2016). The trust needs to be built mutually between the different actors which can create a new challenge for the firms regarding their

activities and behaviours, consequently, it needs to have shift and changes in the organization's culture (Harshak, et al., 2013).

The behavioural aspect of the organization could be considered a challenge as well, due to the use of real-time information. The availability of this real-time data can make the decision-makers to react to the very small details of information and to any small change in the physical flow that could lead to increase in the risk of the supply chain and the inventory cost due to bullwhip effect (Tachizawa, et al., 2015).

Another challenge that could be added to the list of challenges in adopting digital technologies is "Time-consuming". The implementation of Big Data and the analytics application along the supply chain is considered to be time-consuming since it contains different stages for implantations, such as developing, testing and start the applications (Blackburn, et al., 2015). Implementing the BDA in the complex ecosystems such as supply chain require supports from different actors of the supply chain and inside the organizations such as top management and other stakeholders, in the addition to the necessity of bringing experts from different functions, but it could be challenging as well due to the different mindset of the actors (Arunachalam, et al., 2018).

Another issue that could be considered as a challenge for adopting BDA across the supply chain and in the organizations is the uncertainty of the expected benefits of the implementation on the investment of the organizations, in another word the return on invest (ROI), benefits and ambiguity on ROI of applying these technologies is not clear which can make the stakeholders worried about implementing these technologies (Richey, et al., 2016). What makes this issue more challenging is gaining financial benefits from applying BDA since it relies on the downstream manpower and employees who perform this mission (Davenport, et al., 2001).

Technical issues of implementing digital technologies are considered as challenges as well, these technical issues regarding BDA can be summarized in data scalability and data quality. For the Scalability of data, (Richey, et al., 2016) highlighted that the scalability of the data is the primary technical concern in the BDA implementation since the companies have to refuse their data after a period in order to create a space and storage for the newly generated data.

Another concern regarding the technical issue of implementing BDA is the quality of the data. Supply chain decision-makers are depending on a huge amount of data for many decisions regarding the

supply chain (Hazen, et al., 2014), nevertheless, generating poor data quality could prevent the analytic tools from functioning well, which will affect the decisions of the managers (Hazen, et al., 2014). Since the data has intangible features, hence, evaluating data quality can be considered as a multidimensional issue (Hazen, et al., 2014).

Besides all the above challenges RFID technologies also have challenges in the implementation, such the complexity in the real-time synchronization of the main database with the plants' database, which could lead to additional cost for repairing, setting up and development (Guo, et al., 2015). Furthermore, RFID systems have the ability of only track and monitor the production in the manufacturing plants, and it would be difficult to monitor the products before the production activities, such as out-sourcing and supply of the material (Guo, et al., 2015).

(Guo, et al., 2015) argued that the resistance of the employees to the new technology could also be recognized as the biggest challenge during implementation of the RFID systems, especially in the industries where the wages of the operators and employees depends on the number of pieces, since the RIFD systems need the operator to scan the products to collect the real-time data, and this scanning activates will make the productivity of the operator less than the routine works' productivity, resulting a resistance to use the new technologies. An example of this industry is the clothing and footwear production (Guo, et al., 2015).

Am technologies require an installation that includes high costs of materials and machines, with few options of printing materials, colours, and the finishing of the surfaces (Berman, 2012). In addition, there are senses of uncertainty and insecurity about deploying the Am technologies in the production systems, these insecurity and uncertainty need more effort to be achieved about, where, how and why to implement this technology, in order to enhance the comprehensive understanding about the drivers that impacting the implementation (Oettmeier & Hofmann, 2016).

As previously mentioned, AM technologies has the potential to change the decoupling point between the producer and the customer, but this activity is not that simple, since it has some legal implications based on whether the organization will keep the control on the original files and designs or the source code (Bogers, et al., 2016).

There are some possible concerns in implementing Am technologies about the parallel industry in 3D scanning. Meaning that it could be possible in the future to transform the physical products to

digital designs and files, which will be consider a problem if the files and designs are being shared on the internet and will create issues regarding the intellectual property (IP) implications (Bogers, et al., 2016; Bradshaw, et al., 2010).

The concerns regarding the legal aspect will not stop and will continue to be a significant argument related to 3D printing technologies (Dante, 2014; Schildhorn, 2014), but the argument didn't stop here, due to some researchers AM technologies can also be involved in the production of the harmful objects, such as guns and weapons, as well as bypassing the legal check created in the conventional supply chain (Schildhorn, 2014). So, it is suitable to define some rules regarding the use of AM technologies.

4. Discussion

After the comprehensive reported findings of the Digital Transformation in planning, integration, demand management, supply management, procurement, logistics management, transportation and sustainability, in the addition to the findings regarding the motivations that drive the digital transformation and challenges of adopting digital transformation in the supply chain in the previous chapter, several observations have been noticed. As the main part of this research, The Purpose is to investigate motivations that drive the digital transformation, the transformation actions triggered by specific motivations, and the expected benefits that are generated by transformation action.

In order to address the motivations, action, and the benefits of adopting digital transformation, three research questions were addressed, and the answers were aggregated from the finding of this research, motivations, actions, and the expected benefits. Furthermore, a link between these stages is analyzed and created in order to illustrate the relationship between the motivations, actions and the benefits.

As mentioned previously, the first research question is investigating the motivations that drives the digital transformation in the supply chain practices, the second question is regarding the transformation actions triggered by these motivations and finally, the expected benefits that are resulted from these actions.

Briefly, the purpose of the study was to state what motivations in a digitalized supply chain that lead to certain transformation actions and what are the transformation actions that could lead to a certain benefit. Additionally, the aim was to develop a conceptual framework for evaluation of the motivations of the adoption of the digital transformation, the actions resulted from these motivations and the benefits generated from these actions.

As mentioned before the main research questions of this research were defined as:

“What are the motivations that drive the digital transformation of the supply chain?”

“What are the transformation actions triggered by specific motivations?”

"What are the expected benefits that are generated by transformation actions?”

4.1. Motivations that Drive the Digital Transformation of the SC

As it is noticed from the findings of the research, the motivations, transformation actions, and benefits are comprehensive, in other word, they occur along with the supply chain processes since they are considerably linked to each other. However, in order to facilitate the addressing of the motivations, actions and the benefits the finding was sum up, mastered and synthesized in groups based on the context and the dimension in which it occurs such as Data context, Operations, Customer, Demand, Sustainability, Intra and Inter-Organization and finally Supply chain risk.

As previously-mentioned three research questions were designed to answer the main research question and based on the findings, the answer to the first research question will be addressed as below:

RQ1 "What are the motivations that drive the digital transformation of the supply chain?"

The motivations that drive the digital transformation of the supply chain are many, however, this research focuses on the motivations that trigger a certain transformation action in the supply chain, in addition to the benefits generated from these actions. The motivations respect to the context and mastering field can be listed as below:

1. Data Context:

the motivations regarding the data context are focusing on the nature and features of the data, however, the main motivation regarding the data context is "**Availability of Massive Amount of Information and Data".**

With the increase of the supply chain complexity and globalization, a huge amount of raw data is available about the markets, processes, suppliers, materials, performances, and customers…etc. A necessity was raised to the organizations to figure out a way to exploit this amount of raw data in a way that could be useful for the benefit of the organizations and improves decision making.

The availability of the massive amount of the raw information about the markets and their customers encourages the company to use this valuable resource to create a competitive advantage and encourage their position of being intermediary between the production and the customer by adopting the new technologies such as BD, Analytics tools and other industry 4.0 technologies.

2. Operations Context:

The second context is related to the context of the operations which is referred to the operational activities and practices in the supply chain, thus the main motivation is the **"Globalization and Increased Complexity in the supply chain".**

In the late 2000s, the industries and business environment witnessed advancement in the globalization and volatility in the business environments resulting complexity in the supply chain networks and practices. The fast accelerated progress and the development that is occurring worldwide, the reduction in the life-cycle of the industrial time create a need for the firms to increase their effort in finding more innovative solutions and new strategies for their supply chain in order to simplify the supply chain, gain flexibility in the operations and providing fast responding to these changes, in the addition to compete in the increasingly competitive markets and achieve competitive advantage, consequently, the supply chain should be responsive and aligned change of market volatility.

A need for simplifying the processes and practices and standardizing the systems and automate them along the supply chain is highly increased, in order to facilitate the delivery of the value and increase the effectiveness and efficiency of the supply chain. The need for simple and standard systems and processes are enhancing the exploiting the industry 4.0 technologies, due to some significant features of the industry 4.0 that support the standardization and simplification.

3. Customer context

The third context is related to the customer side, the key motivation is **"Changes in customer preferences"**.

In the business environment, achieving customer satisfaction is the most significant component to ensure the surviving in the competition environment. In the last decades, the customer and the final consumer were always considered to be a part of the downstream in the supply chain. In the early 2000s, the new age of supply chain was launched, since reconsiderations about the position of the customer in the network were taking place, and they started to concede more power to the customers rather than producers and suppliers. This shift in the power from the supply side to the demand, encourage the company to increase the attention on the customers and their requirements.

4. Demand Context:

The significant motivation regarding the demand context is the **"Supply Chain Uncertainty"**. The uncertainty is referred to the misalignment between the supply and demand in the supply chain due to inaccurate information on the demand.

5. Sustainability Context

In the last decades, customers' attention tends to move forward the **sustainability** practices, resulting from the increase of the consciousness and the awareness of the customers towards the environment and social practices. In the current business world paying attention to the profit and the economic aspect of the organization is not enough for being a sustainable business, the social and environmental aspects should also be considered as goals of the organizations.

Due to the increased attention of the customers and governments towards sustainability, in the addition to the complexity in the supply chain, a need has been raised to adopt new forms, models and technologies that are taking into consideration the environmental and social aspects. This motivation enhanced the organizations to adopt the new technologies in order to create new business models that can include the environmental and social aspects

6. External Business Environment Context:

According to the findings of this research, the key motivations related to the External Business Environment Context are basically two; "**External Pressure and Support"** and **"Integrative, and Joint planning Supply Chain"** and they are illustrated as below:

I. External Pressure and Support:

The external motivations are related to the drivers that force or support the company in implementing the digital transformation in their practices. These motivations could enhance the organizations for shifting toward digital technologies, and they are divided into two main external motivations, "External pressure "and "External Support".

The first motivation is the "External pressure", which is related to all forces and factors that form the external environment of the firms such as the increase of competition, government regulations and

legislation, in the addition to changing in the business fields and the advancement of the technologies and finally the organizational adoption.

Industry 4.0 technologies were adopted recently by several companies which can force the other companies that still didn't apply the industry 4.0 technologies, to perform it in order to compete in the market and fulfil the volatile market changes and fulfil the changing customer preferences.

The second enabler is the perceived outside support, which is related to the support of some actors such as vendors or consultants in the transformations practices which can be achieved by providing support regarding the new technologies such as reduction in the cost of installation of these technologies, cost efficiency and benefits, the training for the employees, providing the necessary support during the application and implementation of the new technologies and during the operations.

Recently, new industries and sectors that specialized in the implementing 4.0 technologies and providing the technical support, consultancy and training are raised, which can also encourage the companies to implement the industry 4.0 technologies due to the availability of such support, enhancing them to shift toward the technologies to adopt the new changes and volatility in the markets and customer behaviors.

II. Integrative and Joint planning Supply Chain:

The general context of the Supply chain that each organization acts like a producer and an information user in the chain, hence the organizations ,need to analyze and intercept the data they receive from their supply chain partners, in addition, they need to generate data, so to work in more responsive and collaborative chain, there is also a need to analyze the data internally and to share information to their respective partners externally.

In another word both inside and outside collaboration and synergies can be ensured along within the organization and along the supply chain by selecting and monitoring the relevant data and information to share and since industry 4.0 technologies proved its ability to offers vast prospects for developing an integrated and collaborative business model that can create those synergies, this created a motivation for the decision-makers to adopt the new technologies.

Supply chain usually characterized by a heterogeneous composition, hence, the need was raised for the firms operating in the Supply chain network to work closely in a more collaborative environment

to ensure suitable coordination between the different firms, also, to ensure the harmony and time synchronization in the processes, flow, and the activities.

7. Policies context:

Policies and regulation context are regarding the regulations that were formed to organize the supply chain and to prevent the risk that could occur along the supply chain process, especially when it is related to the heal and the safety of the actors. The main motivation regarding this context is the "**Governmental Regulations, Legislations and policies".**

Legislations and policies played a role in adopting the digital transformation, and it enhanced the organizations to adopt the usage of the new technologies in order to prevent the risk during the supply chain processes and to increase the safety practices during these processes.

One of the best examples of legislation and policies that encouraged the companies to adopt digital technologies is the perishable and food products safety. In the late 1990s, several food incidents were occurred in Europe, resulting in an increase in the attention and a need to establish several laws and regulations to ensure a high level of protection of human and consumer life.

Consequently, the food safety has increased the global attention, currently, the European Union, United States, and other countries in the west have been created legislation in order to apply a system regarding the agricultural and food safety. In 2002, the European Parliament and council established Regulation (EC) No 178/2002 which define an integrated approach of food safety from the farms to the tables. Hence, some other regulation that forces the organization tracing, tracking, monitoring, and controlling all the supply chain processes.

Due to the industry 4.0 abilities in the real-time tracing, tracking, and real-time responsiveness in the case of emergencies, adopting these technologies is a must for the organizations that perform in the environments in which have these regulations. RFID technologies and its capabilities of tracking and tracing in the logistics processes are one of the industry 4.0 technologies that can achieve these missions. RFID tags have been attached to the food products that are being stored in the EPC code - which is considered as an identity card of the product -, in order to provide traceability and tracking information in real-time, about the food products along the whole process of the circulation. Table 12 below illustrates the dimensions and contexts of the influence and the Motivations for adoption

the Digital Technologies in the Supply chain, Figure 21 shows the different motivations for adopting Digital technologies.

Source: OWN

Dimension and context	*Motivation(s) that drive the Digital Transformation of SC*
Data	*Availability of Massive Amount of Information*
Operations	*Globalization and Increased Complexity in supply chain*
Customer	*Changes in customer preferences*
Demand	*Supply Chain Uncertainty*
Sustainability	*Sustainability*
Intra and Inter-	*External Pressure and Support*
Organisation	*Integrative, and Joint planning Supply Chain*
Policies	*Governmental Regulations, Legislations and policies*

Table 12 *Motivations that drive the Digital Transformation of SC*

Source: OWN

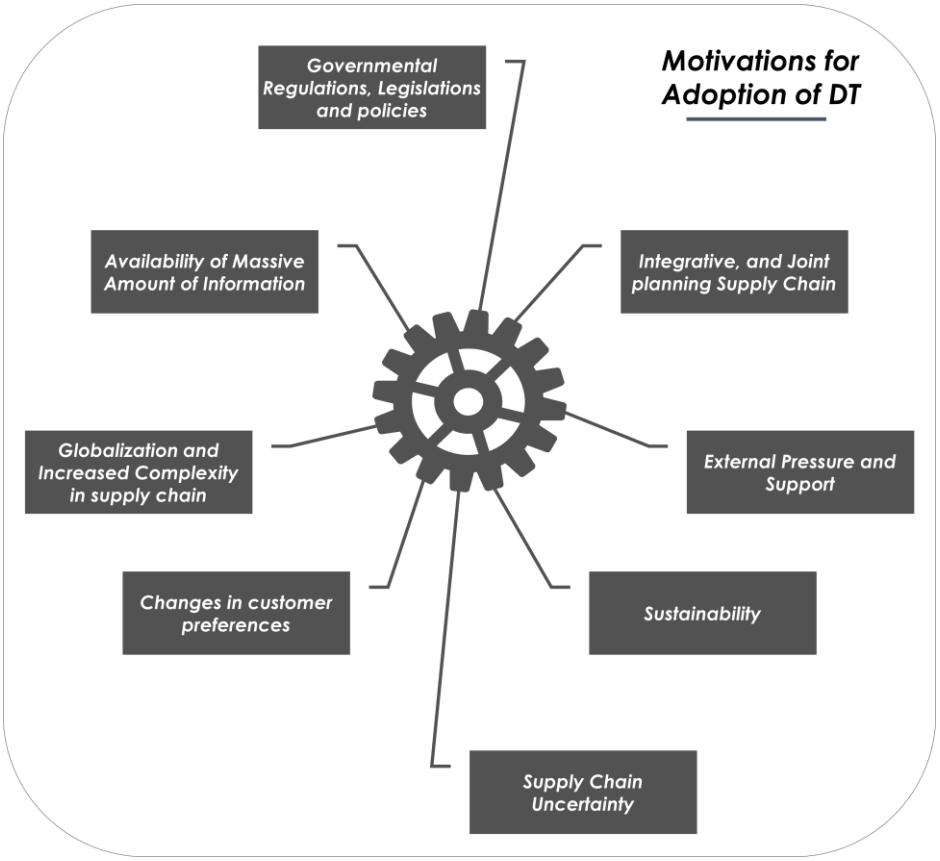

Figure 21 *Motivations that drive the Digital Transformation of SC*

4.2. The Transformation Actions triggered by Specific Motivations

RQ2 "What are the transformation actions triggered by specific motivations?"

After addressing the motivations that drive the Digital Transformation of SC corresponding to the context in which they impact, the second research question is regarding addressing the transformation actions that are triggered by specific motivations in the supply chain that is related to these motivations and can be listed corresponding with the context as below:

1. Data Context:

As mentioned before the motivations regarding the data context is Availability of Massive Amount of Information and Data. However, the action that industry 4.0 provides for the data nature and context is to ***Transform the massive data and information into useful forms and intelligence (Data Integration.***

The action regarding the data context t is referred to shift of the supply chain from the conventional practices into the intelligent supply chain and manufacturing which is enhanced by the capability of industry 4.0 technologies to exploit, use, analyze the huge amount of the data and shift these raw data into intelligence, and also provide a simulation of supply chain activities and scenarios. However, the intelligent is supported by the technologies of industry 4.0 such as the Cloud computing abilities and analytics tools, that could be able to design and create different scenarios before they happen based on the situation of the future which creates more controllable supply chain that could provide a possibility to prevent the risk before it happens and could have better insights into the possible scenarios and better decision making.

Due to the industry 4.0 capabilities and especially BDA plus the massive computing abilities, this information and data could be exploited positively, which can generate benefits to the organizations. For this reason, the availability of data and information is considered to be a motivation for adopting the digital technologies and to use them in order to transform these raw data into a useful form that can improve the overall performances of the supply chain.

2. Operations Context:

As mentioned before Globalization and Increased Complexity in the supply chain considered a motivation for adopting the digital technologies, however, three actions are adopted to achieve this motivation:

1. ***Simplifying the processes and standardizing the systems.***
2. ***Instrumentation and Automation.***
3. ***Localization, Relocation, and Decentralization of the production activities.***

The action that could occur regarding the supply chain is Simplifying the processes and standardizing the systems that have resulted from the globalization, complexity, and volatility of the supply chain. This simplification and standardization in the processes and systems are occurring due to the increased visibility of the supply chain, sharing the real-time information between the partners and reduction of the number digital platform used in the supply chain.

The industry 4.0 feature of Instrumentation and automation which is referred to the exchange of processes and transactions that are featured as automated and can be managed by RFID technologies, sensor, and GPS systems in order to decrease the risk and cost, and reduce the complexity, in the addition to automation of the activities that will be supported by big data and artificial intelligence "AI".

AM technologies and 3D printing can impact the location of the production and manufacturing, due to its ability to produce the products that characterized with low volumes and complexity in production, allowing the production to be decentralized and be closer to the downstream part of the supply chain due to the flexibility and accessibility to the Am technologies.

3. Customer context

The third context is related to the customer side, the key motivation is "Changes in customer preferences", nevertheless, the actions that took a place through the industry 4.0 capabilities can be addressed as below:

1. ***Front-End Functionality;***
2. ***Mass Customization and Customer involvement***

The term Front-end functionalities are related to the integration of all process directly connected to customers and development of frontend applications that facilitates for customers and also enables understanding of customer requirements.

As mentioned previously, recently, the customer behaviors are dynamically changing, and their preferences are volatilizing, so a need is a must to fulfil these changes and to deliver the desired value. Industry 4.0 provides the capabilities to understand the customer's behaviors through the integration, especially the Front-end functionalities which it is referred to the integration of all process directly connected to customers and development of frontend applications that facilitates for customers and also enables understanding of customer requirements. This technology can address better customer preferences, for example, the organization can pay more attention to the customers' feedback in social media and implement a strategy to follow up activities using these technologies.

Another capability that the new technology can provide is the mass customization which can create engagement and involvement of the customer in the designing phase and even in new product development (NPD), consequently, this will lead to satisfying the customer preferences.

4. Demand Context

The motivation regarding the demand context is the "Supply Chain Uncertainty". The uncertainty is referred to the misalignment between the supply and demand in the supply chain due to inaccurate information on the demand. The main action that is undertaken through industry 4.0 capabilities is ***"Prediction, Analytical, and simulation Tools"***.

Reducing the gap between the supply and demand can be a key motivation for the organizations for adopting the digital technologies since industry 4.0 shows remarkable capabilities in prediction, simulation and analyzing the demand and forecasting and could achieve a significant improvement in the demand forecasting accuracy. The increasing demand forecasting accuracy along with the processes and systems can achieve a significant reduction in the gap between supply and demand.

5. Sustainability Context

Due to the increased attention on sustainability by the governments and the customers, it can be considered as a motivation for adopting the new digital technologies, moreover, the action regarding

sustainability motivation is the "***adoption new business models"*** that take sustainability into consideration through exploiting industry 4.0 capabilities.

Industry 4.0 provides enormous opportunities for recognizing of the sustainability in the productions and its ability to implement coordination of the material, energy and products across the whole life-cycle of the products from sustainable building of the processes and resources efficiency, developed productivity of the manpower thanks to the capability of the internet of things and the application of the green lea-agile business models. Furthermore, BDA and its predictive capabilities can help in creating models to predict sustainability performances.

The developed business models that based on the industry 4.0 technologies, enable the organizations to implement a more sustainable (social and environmental) trend at a larger scale, which can make the organizations perform more responsibly toward the health and safety of the employees, customers, society and the environment.

Another technology can increase the sustainability regarding the environment which is 3D printing technologies that also have an impact on the supply chain sustainability since it has better abilities in term of resources efficiency compared to the traditional production methods, besides 3D printing will start the shift in the view of natural resources with material savings, along the production process, in the addition to the ability of well-use the recycled materials during the printing processes. Also, it can produce the products with less waste, leading to greener, and more sustainable production in the addition to enhancing the utilization of recycled materials, and reduce the excess inventories and overproduction due to postponement and late-stage customization.

6. External Business Environment Context

The key motivations related to the External Business Environment Context are basically two; "External Pressure and Support" and "Integrative, and Joint planning Supply Chain. Several actions are taken into considerations regarding these motivations such as:

1. ***Adopting New Business Models*** to face the external pressures and include external support through considering industry 4.0 in these models:

Adopting new business models is significant action due to the adoption of the new technologies as a reaction to the recent gain features of the market such as volatility, globalization, and dynamicity.

This adoption can let the organizations adjust their business models and practices and performing in this environment to gain sustainable competitive advantages by providing real-time responsiveness to the changes that occur in the market environment, besides face the increasingly competitive environment in the market.

Consequently, a need is raised for the firms to increase their effort in adopting new business models that include innovative solutions and new strategies for their supply chain in order to compete in the increasingly competitive markets and achieve sustainable competitive advantage.

2. ***Connectivity and Interconnectivity: (END-TO-END)*** along the supply chain in order to create a coordinative, corporative, integrative context between the different partners in the supply chain. The most important actions that could be achieved in the supply chain which is related to connecting the different elements of the supply chain from partners, processes, practices, products, inventories, physical objects and overall elements of the supply chain. Furthermore, it is referred to the ability of the technologies that can be connected to the internet and exceed the direct collaboration between the supply chain partners through providing real-time market development. Interconnectivity is a term that illustrates the transformation in the supply chain design according to the impact of integrative technologies such as "Big Data" and "IoT". Besides the opportunities to establish a synergy by combining the normal production with customized production through additive manufacturing. Furthermore, merging the physical objects, information, data, products, and the processes all together.

End-To-End integration and interconnectivity can facilitate the information sharing, real-time data, and enhance the transparency, visibility, real-time traceability and tracking in the addition to, leading to a reduction in the uncertainty, simplifying the complexity of the supply chain and improve the real-time responses to the volatility of the business environment.

3. ***Merging the physical objects, information, data, products, and the processes all together:***

Merging the physical objects with the process of the supply chain is an action that could be generated from the motivation of joint planning and integrative supply chain Tracking and Traceability is a result of merging the object with the processes since it can capture massive amount of real-time data and information regarding the products in motion, extracting data of location, quantity and the status of the products besides monitoring the security as well as increase the responsiveness of the supply

chain. Industry 4.0 technologies that could manage the real-time data capturing by tracking and tracing are RFID technologies, sensor, and GPS systems in order to decrease the risk and cost, increase the visibility and reduce the complexity of the supply chain, as well as its benefit in the cold chain and food safety.

7. Policies context

The action regarding the motivation of Governmental Regulations, Legislations and policies are the same as the action mentioned above; ***Merging the physical objects, information, data, products, and the processes all together.*** Nevertheless, in this context, this merging of the physical object with the processes proves its ability to guarantee the tracking and tracking of the product, especially in the food sector. Due to the industry 4.0 abilities in the real-time tracing, tracking, and real-time responsiveness in the case of emergencies, adopting these technologies is a must for the organizations that perform in the environments in which have these regulations. RFID technologies and its capabilities of tracking and tracing in the logistics processes are one of the industry 4.0 technologies that can achieve these missions. RFID tags have been attached to the food products that are being stored in the EPC code - which is considered as an identity card of the product -, in order to provide traceability and tracking information in real-time, about the food products along the whole process of the circulation.

The above-mentioned transformation actions and the motivations are linked to each other since those transformation actions are triggered by the previously-mentioned motivations as Figure 22 below illustrates:

Source: OWN

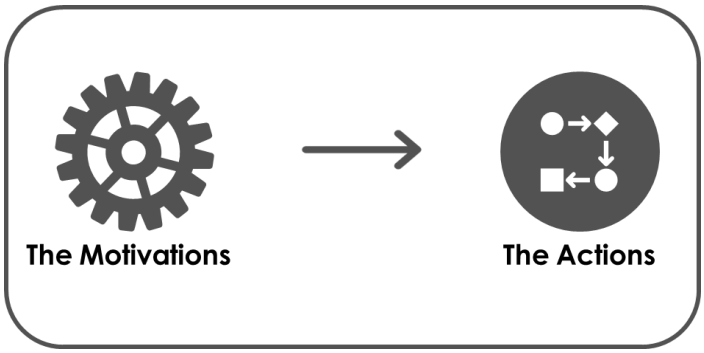

Figure 22 *The Link Between the Motivations and the Actions*

Table 13* below summarize the link between the motivations and the actions corresponding to the dimension and context in which they impact and occupy.

<table>
<tr><th>Dimension and Context</th><th>Motivation</th><th>Transformation Actions</th></tr>
<tr><td>Data</td><td>Availability of Massive Amount of Information</td><td>Transform the massive data and information into useful forms and intelligence (Data Integration)</td></tr>
<tr><td rowspan="3">Operations</td><td rowspan="3">Globalization and Increased Complexity in supply chain</td><td>Simplifying the processes and standardizing the systems</td></tr>
<tr><td>Instrumentation and Automation</td></tr>
<tr><td>Localisation, Relocation and Decentralisation of the production activities</td></tr>
<tr><td rowspan="2">Customer</td><td rowspan="2">Changes in customer preferences</td><td>Front-End Functionality</td></tr>
<tr><td>Mass Customization and Customer involvement</td></tr>
<tr><td>Demand</td><td>Supply Chain Uncertainty</td><td>Prediction, Analytical and simulation Tools</td></tr>
<tr><td>Sustainability</td><td>Sustainability</td><td rowspan="2">Adopting New Business Models</td></tr>
<tr><td rowspan="3">External Business Environment Context</td><td>External Pressure and Support</td></tr>
<tr><td rowspan="2">Integrative, and Joint planning Supply Chain</td><td>Connectivity and Interconnectivity: (END-TO-END)</td></tr>
<tr><td rowspan="2">Policies</td><td rowspan="2">Merging the physical objects, information, data, products and the processes all together</td></tr>
<tr><td>Governmental Regulations, Legislations and policies</td></tr>
</table>

Table 13 *Conceptual Framework of the link between the motivation and the actions*

(*) The colours show the context in which the motivations and actions impact.

Source: OWN

(*) The white blocks in the Table indicates a shared block

4.3. The expected Benefits Generated by Transformation Actions

RQ 3 What are the expected benefits that are generated by transformation actions?

After addressing the motivations and its related transformation actions corresponding to the dimension and the context, the expected benefits that are generated from these transformation actions are being addressed as an answer for the third research question.

The benefits generated from the actions can be addressed as below:

1. Transform the massive data and information into useful forms and intelligence (Data integration):
    a. Improve Value, Velocity, Volume, Variety, and Veracity of the data (5V).
    b. Transform the from hysteresis to real-time.
2. Simplifying the processes and standardizing the systems:
    a. Reduce the Complexity of the Supply chain.
    b. Simplifying the digital platform and use of joint planning platforms.
3. Instrumentation and Automation:
    a. Provide Flexibility in the SC.
    b. Improve operational agility.
    c. Real-time Monitoring and Control the Manufacturing processes (MES).
    d. Reduction in the needed manpower and labors cost.
    e. A smoother and faster flow of the products across the supply chain.
4. Localization, Relocation, and Decentralization of the production activities:
    a. Lead to the shorter and narrower supply chain.
    b. Reduce the excess inventories and overproduction due to late-stage customization.
    c. Remarkable cost reduction of transportation and logistics activities, fuel, route optimization.
5. Front-End Functionality:
    a. Better addressing Customer requirements and need.
    b. Improve the relationship with the customer.
6. Mass Customization and Customer involvement:
    a. Involve and engage the customer in the designing phase and (NPD)
    b. Responding to the changing customer preferences.
7. Prediction, Analytical and simulation Tools:
    a. Pricing and Macroeconomic prediction.

b. Improve the preciseness of the demand forecasting along the supply chain.
c. Improve the Real–time responsiveness to the changes in the business environment demand variation customer preferences.
d. Reduce the Gap between Supply and Demand.

8. Adopting New Business Models regarding the sustainability context:
    a. Predict sustainability performances.
    b. Reducing the wastages and insufficiencies in the Supply chain.
    c. Less waste, leading to greener, and more sustainable production.
    d. Increase the Awareness about Social and Environmental practices.
    e. Enhancing the utilization of recycled materials.
    f. Improve the social and environmental responsible value chain.
    g. Align the social and sustainable practices with the business strategies and models.
9. Adopting New Business Models regarding the External business environment:
    a. Real-Time Responsiveness to the volatile business environment.
    b. Gain Competitive advantage to Stay within the competition Environment.
10. Connectivity and Interconnectivity: (END-TO-END):
    a. Real-Time information sharing along the Supply chain.
    b. Improve visibility along the Supply chain.
    c. Reduction in the behavioral uncertainty and opportunistic behavior between the actors.
    d. Improve the Transparency and Trust level between Partner.
    e. Improve the buyer-supplier relationship.
    f. Improve the supplier selection processes and evaluation.
    g. Improve Processes efficiency.
    h. Overcome the Information Asymmetry Problem.
    i. Avoid the supplier risks and support in creating a backup plan in cases of emergency
    j. Improve the overall performances of the Supply chain.
        i. Lower levels of inventory and improve the safety stock.
        ii. Reducing inventory shrinkages and avoiding stock-out and excess stock.
        iii. Shorter lead time.
        iv. Improved Service quality.
        v. Delivery accuracy and delivery time.
        vi. Improve the sourcing cost.

vii. Real-time optimization of Transportation costs (weather forecasting, fuel, route optimization).

11. Merging the physical objects, information, data, products, and the processes all together:

    For merging the physical objects and processes action, the same benefits of the previously mentioned action (interconnectivity), in addition to the below benefits:

    a. Prevent the risk during the supply chain processes.
    b. Real-Time Monitoring, Tracking and Traceability.
    c. Reduce the negative impact of terror and theft.
    d. Increase the safety practices during SC processes (e.g. Food Safety, Cold Chain).

5. Summary

After addressing the expected benefits that are generated from the previous transformation actions, the benefits are linked to the actions, that already was linked to the main motivations. Figure 23 below illustrates the links between the motivations, action and the benefits:

Source: OWN

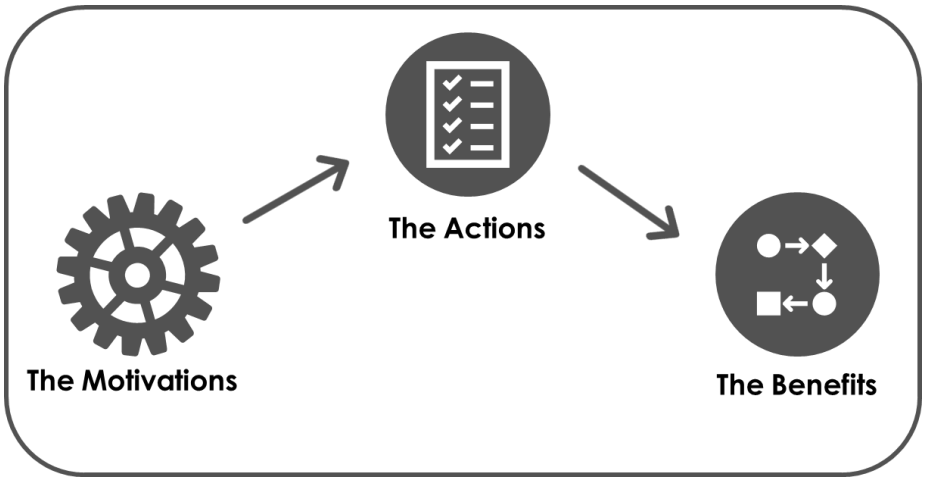

Figure 23 *The Link Between the Motivations, Actions and the benefits*

as three research questions are already answered previously, Table 14 below summarizes the connection and the links between the motivations that drive the digital transformation, the transformation actions, and the expected benefits that are generated from the adoption of this technologies, all the three elements are represented corresponding to the dimension and the context in which they impact. Furthermore, a conceptual framework was designed illustrated the connections and the links between motivations that drive the digital transformation, the transformation actions were undertaken and the expected benefits of adopting these digital technologies, corresponding to the dimension and the context in which they impact as shown below in the Figures 24, 25,26.

Mastering Field	Motivation(s)	Tranformation Action(s)	The Generated Benefits from the Actions	
Data	Availability of Massive Amount of Information and Data	Transform the massive data and information into useful forms and intelligence (Data Integration.	1. Improve Value, Velocity, Volume, Variety, and Veracity of the data (5V).	
			2. Transform the from hysteresis to real-time.	
Operations	Globalization and Increased Complexity in the supply chain	Simplifying the processes and standardizing the systems.	1. Reduce the Complexity of the Supply chain.	
			2. Simplifying the digital platform and use of joint planning platforms.	
		Instrumentation and Automation.	1. Provide Flexibility in the SC.	
			2. Improve operational agility.	
			3. Real-time Monitoring and Control the Manufacturing processes (MES).	
			4. Reduction in the needed manpower and labors cost.	
			5. A smoother and faster flow of the products across the supply chain.	
		Localization, Relocation, and Decentralization of the production activities	1. Lead to the shorter and narrower supply chain.	
			2. Reduce the excess inventories and overproduction due to late-stage customization.	
			3. Remarkable cost reduction of transportation and logistics activities, fuel, route optimization.	
Customer	Changes in customer preferences	Front-End Functionality	1. Better addressing Customer requirements and need.	
			2. Improve the relationship with the customer.	
		Mass Customization and Customer involvement	1. Involve and engage the customer in the designing phase and (NPD)	
			2. Responding to the changing customer preferences.	
Demand	Supply Chain Uncertainty	Prediction, Analytical, and simulation Tools	1. Pricing and Macroeconomic prediction.	
			2. Improve the preciseness of the demand forecasting along the supply chain.	
			3. Improve the real-time responsiveness to the changes in the business environment demand variation customer preferences.	
			4. Reduce the Gap between Supply and Demand.	
Sustainability	Sustainability	Adoption new business models	1. Predict sustainability performances.	
			2. Reducing the wastages and insufficiencies in the Supply chain.	
			3. Less waste, leading to greener, and more sustainable production.	
			4. Increase the Awareness about Social and Environmental practices.	
			5. Enhancing the utilization of recycled materials.	
			6. Improve the social and environmental responsible value chain.	
			7. Align the social and sustainable practices with the business strategies and models.	
External Business Environment Context	External Pressure and Support		1. Real-Time Responsiveness to the volatile business environment.	
			2. Gain Competitive advantage to Stay within the competition Environment.	
	Integrative, and Joint planning Supply Chain	Connectivity and Interconnectivity: (END-TO-END)	1. Real-Time information sharing along the Supply chain.	
			2. Improve visibility along the Supply chain.	
			3. Reduction in the behavioral uncertainty and opportunistic behavior between the actors.	
			4. Improve the Transparency and Trust level between Partner.	
			5. Improve the buyer-supplier relationship.	
			6. Improve the supplier selection processes and evaluation.	
			7. Improve Processes efficiency.	
			8. Overcome the Information Asymmetry Problem.	
			9. Avoid the supplier risks and support in creating a backup plan in cases of emergency	
			10. Improve the overall performances of the Supply chain.	1. Lower levels of inventory and improve the safety stock.
				2. Reducing inventory shrinkages and avoiding stock-out and excess stock.
				3. Shorter lead time.
				4. Improved Service quality.
				5. Delivery accuracy and delivery time.
				6. Improve the sourcing cost.
				7. Real-time optimization of Transportation costs (weather forecasting, fuel, route optimization).
		Merging the physical objects, information, data, products, and the processes all together		
Policies	Governmental Regulations, Legislations and policies		1. Prevent the risk during the supply chain processes.	
			2. Real-Time Monitoring, Tracking and Traceability.	
			3. Reduce the negative impact of terror and theft.	
			4. Increase the safety practices during SC processes (e.g. Food Safety, Cold Chain).	

Table 14 *The Link Between, Motivations, Action and The Benefits*

(*) The colours show the context in which the motivations and actions impact.

(*) The white blocks in the Table shows a shared block between two contexts.

Source: OWN

Figure 24 is a conceptual framework that illustrates the links between motivations, action and the benefits regarding Data, operations and customer contexts.

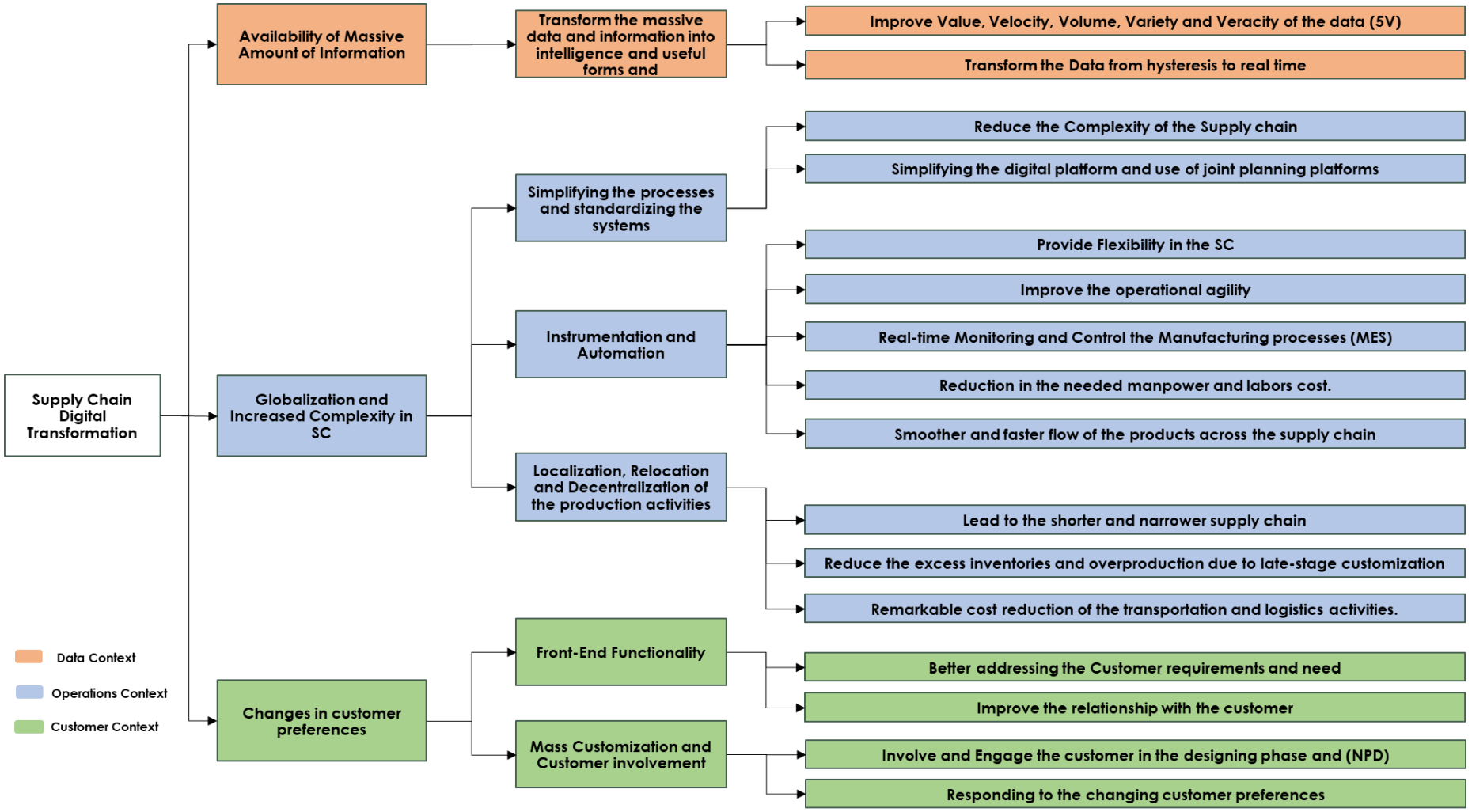

Figure 24 *Conceptual framework (Data, Operations, and Customers contexts)*

Figure 25 below is conceptual framework that illustrates the links between motivations, action and the benefits regarding Demand, Sustainability and External Business Environment contexts.

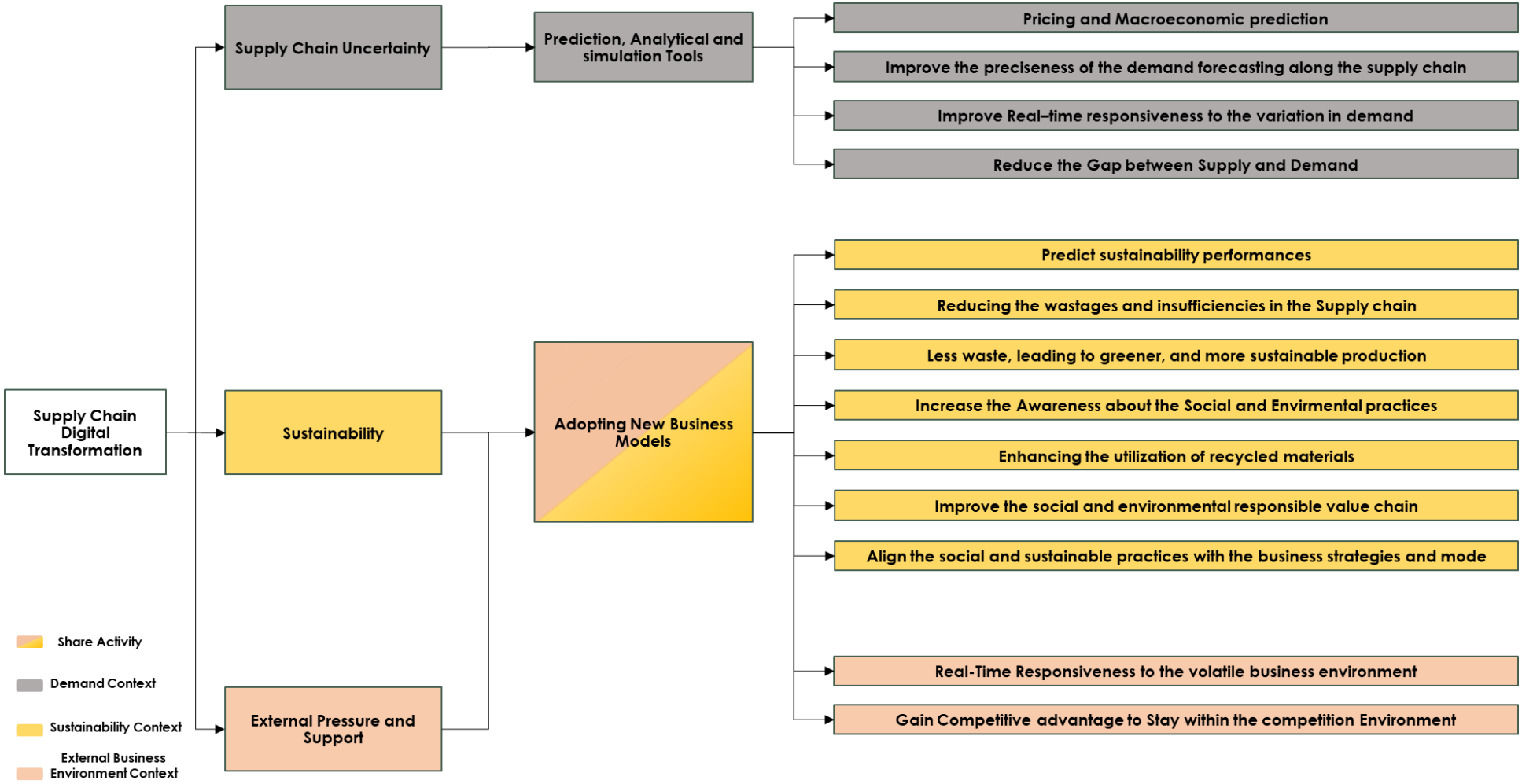

Figure 25 *Conceptual framework (Demand, Sustainability, and External Business Environment contexts)*

Figure 26 below is conceptual framework that illustrates the links between motivations, action and the benefits regarding External Business Environment contexts and Policies contexts.

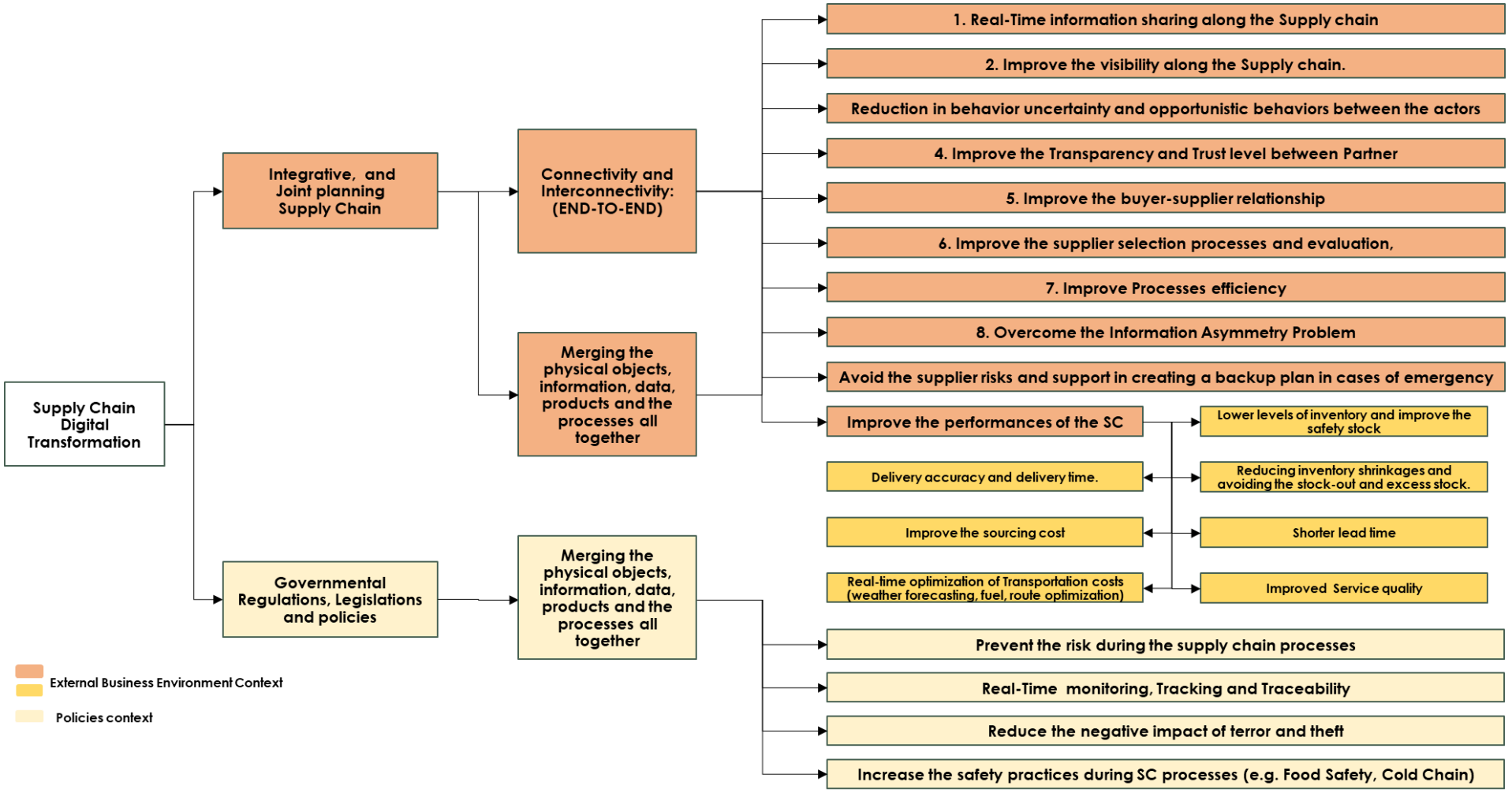

Figure 26 *Conceptual framework (External Business Environment and Policies Contexts)*

6. Conclusion

Supply chain management is very important for the organisation's benefits, and due to this fact, many researches and studied were undertaken related to this topic, nevertheless, digital transformation in the supply chain is a relatively new topic, however, the number of researches related to digital transformation is still gradually increasing since the diffusion of adopting these technologies is tangible.

Nowadays, the organisations are striving to adopt the digital transformation in their practices for several motivations and reasons, nevertheless, few studies have focused on the transformation actions of and the expected benefits that digital transformation has on organizations' supply chain practices. Adopting the digital technologies and industry 4.0 capabilities is becoming significant for the organizations, with the growth of the competition in the business environments and the benefits that the transformation could achieve, investing in the digital transformation becomes one of the top priorities for the organizations.

Due to the uprising challenges in the business markets and a need to adopt the digital transformation by the organisations, in addition to the lack of the researches regarding the digital transformation in the supply chain, a systematic approach has been performed for addressing the key benefit that are generated from several actions of the transformation that linked so significant motivations have been evaluated and identified in this research, in order to overcome the uncertainty of the expected benefits of the digital transformation of the supply chain for the organisations, Furthermore, a conceptual framework has been designed to link the motivations, actions and the benefits of this transformation corresponding to different context and dimensions such as Data nature, Customer, Demand, operations, External Business Environment Context, Policies, and Sustainability contexts.

This research has been followed a Systematic Literature Review approach on the recently published studies related to various digital technologies in a different context and part along the supply chain, moreover, a two-phases analysis approach was undertaken in order to analyse and evaluate the literature in several aspects.

The first phase of the analysis is a descriptive analysis which is focusing on the analysis of digital transformation in the supply chain in terms of the temporal distribution of the publications,

methodologies of the studies, journal-title and finally the technology listed in the publications. In this phase, 58 papers were descriptively analysed and reviewed along the period between 2010 till 2018. Regarding the temporal distribution of the papers, about 39% of the papers were published in 2018, and most of the publications are published in the last 3 years (2016–2018). According to the publication by the methodology of the research, the most publication adopted the conceptual methodology and survey with 29.3 % and 19% correspondingly. According to the most technology listed Big data is the most mentioned technology with 38 papers out of 58.

The second phase analysis was performed on 56 papers in order to provide a deep understanding of the digital transformations and to investigate how adopting the digital technologies represented with Industry 4.0 technologies provides benefits to the organisation's supply chain practices. Furthermore, to state the main motivations that drive the digital transformation that lead to several transformation actions related to the digital transformation, consequently, the expected benefits that are generated from these actions and practices. Additionally, a conceptual framework was developed to link and create a connection between Motivations, Actions, and Benefits of adopting the Digital technologies, as well as evaluation of the digital transformation and the generated benefits, and to go forward with this evaluation. Data nature, Customer, Demand, operations, External Business Environment Context, Policies, and Sustainability were selected as main contexts for this conceptual framework.

Considering the defined contexts and dimensions of the supply chain digital transformation, this research contributed to both literature and practice by systematically reviewing the supply chain digital transformation and industry 4.0 in supply chain literature. This research had rich analysis and discussion by systematically examining and classifying the researches and studies according to several dimensions and contexts in the supply chain, such as Data nature, Customer, Demand, operations, External Business Environment Context, Policies, and Sustainability.

The research is picturing the adoption of digital technologies as a perfect solution to overcome the complexity, globalisation and all the uprising challenges in the business environment, but the fact is, despite the listed benefits of the digital transformation on the supply chain, this adoption has massive number of challenges and concerns such as: Defining Clear objectives Strategy of employment of the Technologies, Cybersecurity and Information Privacy, Lack of Talent Management, Expertise and Skilled Manpower, The Trust between the supply chain actors,

Managerial and Organizational Behaviours, Uncertainty of the expected benefits, time, cost, intellectual property concerns, and the misuse of these technologies and many more other challenges.

This research has addressed several limitations, and they can be summarized in the lack of the qualitative research method that could provide a better understanding of the nature of the adoption of the digital supply chain in the organisations nowadays, in addition, the limited number of the keywords used in performing the research, and it needs to be extended in the future, in addition to the lack of time. Furthermore, the type of the document was also considered as a limitation of this research since the type was limited to articles, however, the research quality will increase if the books and books' chapters are included in the research.

For future recommendations and studies, exploration the impact of the digital technologies on the supply chain strategy can be valuable to perform, in addition to investigate on the change management in the organisation in order to adjust with the digital transformation and to extend the horizon of this research to include digital transformation in the different functional units within the originations such as Accounting department, HR department and the other functional units, finally it is worth to investigate about the digital transformation on the Supply chain finance.

7. Bibliography

Armstrong & Associates, 2014. Global 3PL Market Size Estimates.

The Economist, 2011. 3D printing: the printed world.

Accenture, 2014. *Big data analytics in supply chain: hype or here to stay?*, s.l.: Accenture (2014).

Akinc, U. & Meredith, J., 2015. Make-to-forecast: customization with fast delivery..

Akyuz, G. & Rehan, M., 2009. Requirements for forming an ‘e-supply chain. Volume 47 No. 12, pp. 3265-3287..

Alexopoulos, K. et al., 2016. A concept for context-aware computing in manufacturing: the white goods case.. Volume 29(8), 839-849.

Alfaro, L., Le, T., Choi, H. & Cho, M., 2015. Deployment model of big data for port logistics.

Alicke, K., Rachor, J. & Seyfert, A., 2016. The Next-Generation Digital Supply Chain.

APICS, 2017. APICS Dictionary and Learn It App:: SCOR framework. Issue Retrieved 2016-07-14..

Arunachalam, D., Kumar, N. & Kawalek, J., 2018. Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice.

Ashby, M., 2012. Materials and the Environment: Eco-Informed Material Choice.

ASTM Standard , 2012. Standard Terminology for Additive Manufacturing Technologies. Volume 10.04,.

Atzori, L., Iera, A. & Morabito, G., 2010. The internet of things: a survey. Volume Vol. 54, pp. 2787-2805..

Atzori, L., Iera, A. & Morabito, G., 2010. The Internet of Things: a survey. Volume 54 No. 15, pp. 2787-2805.

Barnaghi, P., Sheth, A. & Henson, C., 2013. From data to actionable knowledge: big data challenges in the web of things. Volume Vol. 28 No. 6, pp. 6-11..

Barratt, M. & Oke, A., 2007. *Antecedents of supply chain visibility in retail supply chains: a resource Antecedents of supply chain visibility in retail supply chains: a resourcebased.* s.l.:Journal of Operations Management.

Barron, S. et al., 2016. Systems-based cyber security in the supply chain. Volume pp. 20-25.

Barton, D. & Court, D., 2012. Making advanced analytics work for you. Volume Vol. 90, pp. 79-83..

Barz, A., Buer, T. & Haasis, H., 2016. A study on the effects of additive manufacturing on the structure of supply networks. Volume 49 No. 2, pp. 72-77. .

Baumers, M., Dickens, P., Tuck, C. & Hague, R., 2016. The cost of additive manufacturing: machine productivity, economies of scale and technology-push. Volume 102, pp. 193-201..

Bell, J., Mollenkopf, D., Meline, J. & Burnette, M., 2016. Creating a Transparent Supply Chain Global Supply Chain Institute.

Berman, B., 2012. 3-D printing: the new industrial revolution. Volume 55 No. 2, pp. 155-162..

Bernardi, P., Demartini, C., Gandino, F. & et, a., 2007. Agri-food traceability management using a RFID system with privacy protection. Volume 12, No. 04 pp. 68-75,.

Bidhandi, H., Yusuff, R., Ahmad, M. & Bakar, M., 2009. Development of a new approach for deterministic supply chain network design. Volume 8, 198 No. 1, pp. 121-12.

Blackburn, R. et al., 2015. A predictive analytics approach for demand forecasting in the process industry.. Volume 22, 407–428.

Blocher, J. D. & Chhajed, D., 2008. Minimizing customer order lead-time in a two-stage assembly supply chain.. Volume 161(1), 25–52.

Bogers, M., R, H. & A, B., 2016. Additive manufacturing for consumer-centric business models: Implications for supply chains in consumer goods manufacturing.

Bounfour, A., 2016. Digital futures, digital transformation. Volume doi, 10, 978-3..

Bradshaw, S., Bowyer, A. & Haufe, P., 2010. The intellectual property implications of lowcost 3D printing. Volume 7 (1), 5–31.

Brandon-Jones, E., Squire, B., Autry, C. & Petersen, K., 2014. *A contingent resource-based perspective of supply chain resilience and robustness.* s.l.:Journal of Supply Chain Management,.

Brettel, M., Friederichsen, N., Keller, M. & and Rosenberg, M., 2014. How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 Perspective.. Volume 8(1): p. 37-44..

Brown, B. & et, a., 1987 . Global Sustainability: Toward Definition.. Volume 11(6): p. 713-719..

Brundtland, G. H., 1987. Brundtland report. Our common future.

Budd, J., Knizek, C. & Tevelson, B., 2018. The Demand-Driven Supply Chain, Making it Work and Delivering Results..

Bughin, J., Chui, M. & Manyika, J., 2010. Clouds, big data, and smart assets: Ten tech-enabled business trends to watch. Volume 56 No. 1, pp. 75-86..

Butner, K., 2010. The smarter supply chain of the future. Volume 38 No. 1, pp. 22-31..

C Amardeo, S. G., 2009. Identities in the future internet of things. Volume 12, No. 04, pp.295-303.

Cachon, G. P. & Fisher, M., 2000. Supply chain inventory management and the value of shared information.. Volume 46(8), 1032–1048..

Campbell Collaboration, 2016. *Methodological expectations of Campbell Collaboration intervention reviews: Reporting standards. Retrieved January 6, 2017.* s.l.:s.n.

Campbell, T. S., Williams, C., I. O. & Garrett, B., 2011. Could 3D Printing Change the World? Technologies, Potential, and Implications of Additive Manufacturing.

Carr, D., Hard, K. & WJ, T., 1996. Managing the change process..

Carter, C. & Rogers, D., 2008. A framework of sustainable supply chain management: moving toward new theory. Volume 38(5): p. 360-387.

Carter, C. R. & P, L. E., 2011. Sustainable supply chain management: evolution and future directions.. Volume 41.1 (2011): 46-62..

Chae, B., Olson, D. & Sheu, C., 2014. The impact of supply chain analytics on operational performance: a resource-based view. Volume Vol. 52.

Chandra Shukla, A., Deshmukh, S. & Kanda, A., 2009. Environmentally responsive supply chains: learnings from the Indian auto sector. Volume 6 No. 2, pp. 154-171..

Cheng, M. & Simmons, J., 1994. Traceability in manufacturing systems. Volume Vol. 14 No. 10, pp. 4-16..

Chen, P. C. L. & Zhang, C., 2014. Data-Intensive applications, challenges, techniques and technologies: a survey on big data. Volume 10 No. 275, pp. 314-347..

Choi, T.-M., 2018. A System of Systems Approach for Global Supply Chain Management in the Big Data Era.

Christopher, M., 2016. Logistics & supply chain management.

Christopher, M. & Holweg, M., 2017. Supply chain 2.0 revisited: a framework for managing volatility-induced risk in the supply chain.

Christopher, M. & Lee, H., 2004. *Mitigating supply chain risk through improved confidence.* s.l.:International Journal of Physical Distribution & Logistics Management.

Cochrane Collaboration , 2011. *Cochrane Handbook for Systematic Reviews of Interventions.* s.l.:s.n.

Collin, J. et al., 2015. It leadership in transition-the impact of digitalization on finnish organizations..

Conner, B. M. G. et al., 2014. Making sense of 3-D printing: creating a map of additive manufacturing products and services. Volume 1 No. 4, pp. 64-76..

Cragg, P. & King, M., 1993. Small-firm computing: motivators and inhibitors. Volume 17(1):47–60..

Dalkey, N. & Helmer, O., 1963. An experimental application of the Delphi method to the use of experts. Volume 9.3 (1963): 458-467..

Damiani, E., Frati, F. & Tchokpon, R., 2011. The role of information sharing in supply chain management: the secure SCM approach.. Volume Vol. 8 No. 3, pp. 455-467.

Dante, W., 2014. Top 10 3D Printing Industry Trends for 2015 – 3D Printing Predictions..

Davenport, T., Harris, J., De Long, D. & Jacobson, A., 2001. Data to knowledge to results: building an analytic capability. Volume 43, 117-138.

Davenport, T. & O'Dwyer, J., 2011. Tap into the power of analytics.

Davenport, T. & Patil, D., 2012. Data scientist. Volume 90 No. 5, pp. 70-76..

Da, X. L., He, W. & Li, S., 2014. Internet of Things in industries: a survey. Volume 10 No. 4, pp. 2233-2243..

Deloitte and MHI., 2014. *The 2014 MHI Annual Industry Report–Innovations that drive supply chains."*, USA, North Carolaina: s.n.

Denyer, D. & Tranfield, D., 2009. Producing A Systematic Review. In: *The Stage Handbook of the organizational Research Methods.* s.l.:s.n.

Detlor, B., 2010. Information management. Volume Vol. 8 No. 3, pp. 455-467.

Downes, L. & Nunes, a. P., 2014. *Big bang disruption: Business survival in the age of constant innovation.*. Penguin UK: s.n.

Dubey, R. et al., 2017. Sustainable supply chain management: framework and further research directions. Volume 142 (Part 2), 1119–1130..

Durach, C. F., Kembro, J. & Wieland, A., 2017. A New Paradigm for Systematic Literature Reviews in Supply Chain Management.

Duray, R., Ward, P., Milligan, G. & Berry, W., 2000. Approaches to mass customization configurations and empirical validation. Volume 18 No. 6.

Elkington, J., 1994. Towards the sustainable corporation: win-win-win business strategies for sustainable development. Volume 36 No. 2, pp. 90-100..

European Commission, 2004. Manufuture: A Vision for 2020, Assuring the Future of Manufacturing in Europe.

Evans, P. & Annunziata, M., 2010. Industrial internet: pushing the boundaries of minds and machines.

Eyers, D., 2015. The Flexibility of Industrial Additive Manufacturing Systems.

Fawcett, S. E., Wallin, C. A. C., Fawcett, A. M. & Magnan, G. M., 2011. Information technology as an enabler of supply chain collaboration: a dynamic-capabilities perspective.. Volume 47(1), 38-59..

Fayezi, S. & Zomorrodi, M., 2015. The role of relationship integration in supply chain agility and flexibility development: an Australian perspective. Volume Vol. 26 No. 8, pp. 1126-1157..

Feng, S., Li, L. X. & Cen, L., 2001. An object-oriented intelligent design tool to aid the design of manufacturing systems.. Volume 14(5-6), 225-232..

FitzGerald, E. et al., 2013. Augmented reality and mobile learning: the state of the art. Volume 5(4), 43-58..

Ford, S. & Despeisse, M., 2016. Additive manufacturing and sustainability: an exploratory study of the advantages and challenges. Volume 137, pp. 1573-1587..

Fosso-Wamba, et al., 2017. Big data analytics and firm performance: Effects of dynamic capabilities.. Volume 70:356-65..

Frehe, Volke, Kleinschmidt, T. & Teuteberg, F., 2014. Big Data in Logistics-identifying Potentials through Literature, Case Study and Expert Interview Analyses. Issue 173–186.

Fu, Q. & Zhu, K., 2010. Endogenous information acquisition in supply chain management. Volume Vol. 201, pp. 454-462..

Ganji, E. N. & ", A. C. S. S., 2018. DCM 4.0: Integration of Industry 4.0 and Demand Chain in Global Manufacturing.

Garrett, B., 2014. 3D printing: new economic paradigms and strategic shifts. Volume 5, No. 1, pp. 70-75..

Gattorna, J., 2015. Dynamic Supply Chains,.

Gaukler, G., Seifert, R. & Hausman, W., 2010. Item-level RFID in the retail supply chain. Volume Vol. 16 No. 1, pp. 65-76..

Gavirneni, S., Kapuscinski, R. & Tayur, S., 1999. Value of information in capacitated supply chains. Volume 45(1), 16–24..

Gebler, M., SchootUiterkamp, A. & Visser, C., 2014. A global sustainability perspectiveon 3D printing technologies. Volume 74, pp.158-167.

Gibson, I., Rosen, D. & Stucker, B., 2015. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing,.

Gosling, J., Naim, M., Fowler, N. & Fearne, A., 2007. Manufacturers' preparedness for agie construction.

Gravili, G., Benvenuto, M., A. A. & Viola, C., 2018. The influence of the Digital Divide on Big Data generation within supply chain management. Volume Vol. 29 Issue: 2, pp.592-628,.

Green, K. C., Armstrong, J. S. & Graefe, A., 2007. Methods to elicit forecasts from groups: Delphi and prediction markets compared..

Grunow, M. & Piramuthu, S., 2013. RFID in highly perishable food supply chains – remaining shelf life to supplant expiry date?. Volume 146 No. 2,.

Gubbi, J., Buyya, R., Marusic, S. & Palaniswami, M., 2013. Internet of Things (IoT): a vision architectural elements, and future directions. Volume 29, pp. 1645-1660..

Gunasekaran, A., Lai, K.-H. & Cheng, T., 2008. Responsive supply chain : a competitive strategy in the networked economy. Volume 36(4),549–564.

Gunasekaran, A., Subramanian, N. & Rahman, S., 2015. Supply chain resilience: role of complexities and strategies. Volume Vol. 53 No. 22, pp. 6809-6819.

Guo, Z., Ngai, E., Yang, C. & Liang, X., 2015. An RFID-based intelligent decision support system architecture for production monitoring and scheduling in a distributed manufacturing environment.

Gupta, R., Gupta, H. & Mohania, M., 2012. “Cloud computing and Big Data Analytics: what is new from databases perspective?”, in Srinivasa, S. and Bhatnagar, V. (Eds). Volume PP 42-61..

Haddud, A., Dugger, J. & Gill, P., 2016. The Internet of Things(IoT) :what should ATMAE program undergraduate students know?. Volume pp. 225-235..

Handfield, R., 2016. Preparing for the era of the digitally transparent supply chain: a call to research in a new kind of journal. Volume Vol. 1 No. 2, pp. 1-15..

Handfield, R. & Nichols, E., 2002. Supply Chain Redesign: Transforming Supply Chains into Integrated Value System, Financial Times/Prentice Hall, Upper Saddle River.

Hansmann, R., Mieg, H. A. & Frischknecht, P., 2012. Principal sustainability components: empirical analysis of synergies between the three pillars of sustainability.. Volume 19(5): p. 451-459.

Harshak, A., Schmaus, B. & Dimitrova, D., 2013. Building a digital culture: how to meet the challenge of multichannel digitization.

Hazen, B., Boone, C., Ezell, J. & Jones-Farmer, L., 2014. Data quality for data science, predictive analytics, and big data in supply chain management: an introduction to the problem and suggestions for research and applications.. Volume 154, 72–80..

Hermann, M., Pentek, T. & Otto, B., 2016. Design principles for industrie 4.0 scenarios. Issue (pp. 3928-3937)..

Hessman, T., 2013. The dawn of the smart factory. Volume pp. 15-19..

Hilletofth, P. E. D., 2011. Coordinating new product development with supply chain management,. Volume pp. 264-281.

Hoejmose, S., Brammer, S. & Millington, A., 2013. An empirical examination of the relationship between business strategy and socially responsible supply chain management. Volume 33 No. 5, pp. 589-621.

Hoejmose, S., Stephen, B. & Millington, A., 2013. An empirical examination of the relationship between business strategy and socially responsible supply chain management. Volume 33.5 (2013): 589-621.

Holmberg, S., 2000. systems perspective on supply chain measurements. Volume Vol. 30 No. 10, pp. 847-868.

Holmström, J., Partanen, J., Tuomi, J. & Walter, M., 2010. Rapid manufacturing in the spare parts supply chain: alternative approaches to capacity deployment. Volume 21 No. 6, pp. 687-697.

Hopkinson, N. & Dickens, P., 2001. Rapid prototyping for direct manufacture. Volume 7 No. 4, pp. 197-202..

Hopkinson, N., Hague, R. & Dickens, P., 2006. Rapid Manufacturing: An Industrial Revolution for the Digital Age,.

Huang, S., Sheoran, S. & Keskar, H., 2005. Computer-assisted supply chain configuration based on supply chain operations reference (SCOR) model. Volume 48 No. 2, pp. 377-394..

Hu, H., Wen, Y., Chua, T. & Li, X., 2014. Toward scalable systems for big data analytics: a technology tutorial.

Huo, B., F. D., Zhao, X. & Zhu, J., 2012. Curbing opportunism in logistics outsourcing relationships: the role of relational norms and contract. Volume 182, pp. 293-303..

IBM, 2009. The smarter supply chain of the future : IBM global chief supply chain officer study..

Ittmann, H. W., 2015. The impact of big data and business analytics on supply chain management.. Volume 9(1), 9..

Janssen, G. R., Blankers, I. J., Moolenburgh, E. A. & Posthumus, A. L., 2014. The Impact of 3-D Printing on Supply Chain Management..

Jeble, S. et al., 2018. Impact of big data and predictive analytics capability on supply chain sustainability.

Jeske, M., Grüner, M. & Weiß, F., 2013. Big Data in logistics: a DHL perspective on how to move beyond the hype. Volume 12, pp. 1-30..

Johnson, T., 2013. Cybersecurity: Protecting Critical Infrastructures from Cyber Attack and Cyber Warfare.

Joshi, A. & Stump, R., 1999. *The contingent effect of specific asset investments on joint action in manufacturer-supplier relationships an empirical test of the moderating role of reciprocal asset investments, uncertainty, and trust.*. s.l.:Journal of the Academy of Marketing Science.

Jüttner, U. & Christopher, M. B. S., 2007. Demand chain management - Integration marketing and supply chain management. Volume 36(3), pp.377–392, 2007..

Kache, F. & Seuring, S., 2017. hallenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management.

Kagermann, H., Helbig, J., Hellinger, A. & Wahlster, W., 2013. Recommendations for Implementing the strategic initiative INDUSTRIE 4.0: securing the future of German manufacturing industry; final report of the Industrie 4.0 working group..

Katz, B. & Bradley., J., 2013. The Metropolitan Revolution.

Keith, B., Vitasek, K., Manrodt, K. & Kling, J., 2016. Strategic Sourcing in the New Economy Harnessing the Potential of Sourcing Business Models For Modern Procurement.

Kevan, T., 2004. Theft and terror threats push sensors into supply chain. Volume pp. 16-20..

Khajavi, S., Partanen, J. & Holmström, J., 2014. Additive manufacturing in the spare parts supply chain. Volume 65 No. 1, pp. 50-63..

Khan, K., 2013. The transformative power of advanced analytics. Issue pp. 48-49..

Kietzmann, J., Pitt, L. & and Berthon, P., 2015. Disruptions, decisions, and destinations: enter the age of 3-D printing and additive manufacturing. Volume 58 No. 2, pp. 209-215.

Kitchenham, B. & Charters, S., 2007. *Guidelines for performing Systematic Literature Reviews in Software Engineering*, UK: Keele University and University of Durham.

Kloch, C., Kristensen, J. & Bilstrup, B., 2010. Future scenarios: what are the future services and applications. Volume 53, pp. 315-327..

Kovtun, V., Giloni, A. & Hurvich, C., 2014. Assessing the value of demand sharing in supply chains.. Volume 61(7), 515–531..

Kumar, M., Graham, G., Hennelly, P. & Srai, J., 2016. How will smart city production systems transform supply chain design: a product-level investigation. Volume 54 No. 23, pp. 7181-7192.

Kwon, I. & Suh, T., 2004. *Factors affecting the level of trust and commitment in supply chain relationships.* s.l.:Journal of Supply Chain Management.

Lamba & Singh, S., 2017. Big data in operations and supply chain management: current trends and future perspectives.

Lambert, D. M. & Cooper, M. C., 2000. Issues in supply chain management.. Volume 29(1), 65–83..

Lampel, J. & Mintzberg, H., 1996. Customizing customization. Volume 38, No. 1, pp. 21-30.

Lankshear, C. J. & Knobel., M., 2008. *Introduction: Digital literacies: Concepts, policies and practices.*. s.l.:Peter Lang Publishing.

Leventhal, B., 2010. An introduction to data mining and other techniques for advanced analytics. Volume Vol. 12 No. 2, pp. 137-153.

Light, R. & Pillemer, D., 1984. The Science of Reviewing Research.

Liker, J. & Choi, T., 2004. Building deeper supplier relationships. Volume Vol. 82, pp. 104-113..

Li, L., Chi, T., Hao, T. & Yu, T., 2018. Customer demand analysis of the electronic commerce supply chain using Big Data.

Lindsey, A. et al., 2013. What we know and don’t: eradicating employment discrimination 50 years after the Civil Rights Act. Volume 6 No. 4, pp. 391-413.

Lipson, H. & Kurman, M., 2013. Fabricated: The New World of 3D Printing, 1st ed.

Li, S. & Lin, B., 2006. Accessing information sharing and information quality in supply chain management.. Volume 42(3),1641–1656.

Liu, P., S.-P & Yi, 2018. A study on supply chain investment decision-making and coordination in the Big Data environment.

Luthra, S., Garg, D. & and Haleem, A., 2016. The impacts of critical success factors for implementing green supply chain management towards sustainability: an empirical investigation of Indian automobile industry. Volume 121, pp. 142-158..

Lu, Y., 2017. Industry 4.0: A survey on technologies, applications and open research issues. Volume 6 (2017): 1-10..

Ma, H., 2011. Internet of things: objectives and scientific challenges. Volume 26 No. 6, pp. 919-924..

Mallik, S., 2010. Customer service in supply chain management. Volume Vol. 2, 1st ed., JohnWiley & Sons Inc..

Mani, V., Agrawal, R. & Sharma, V., 2015. Supply chain social sustainability: a comparative case analysis in Indian manufacturing industries. Volume 189, pp. 234-251.

Manners-Bell, J. & Lyon, K., 2012 . The Implications of 3D Printing for the Global Logistics Industry.

Mantey, C., 2015. Jump on the internet of things bandwagon or get left in the dust. Volume 16 No. 2, pp. 11-12..

Manyika, J. et al., 2013. Disruptive Technologies: Advances That Will Transform Life, Business and the Global Economy.

Marshall, T., 2012. Here’s the thing about the internet of things. Volume pp. 12-13..

Masciari, E., 2012. SMART: stream monitoring enterprise activities by RFID tags. Volume Vol. 195, pp. 25-44..

Mayer-Schönberger and Cukier, , n.d.

Mayer-Schönberge, V. & Cukier, K., 2013. Big Data: A Revolution That Will Transform How We Live, Work, and Think.

McAfee, A. & and Brynjolfsson, E., 2012. Big Data: the management revolution. Volume 90 No. 10, pp. 60-66..

McCrea, B., 2012. Wireless evolution: getting closer. Issue 60-62..

Mentzer, J. T. & Kahn, K. B., 1995. A framework of logistics research.

Mieg, H., 2012. Sustainability and innovation in urban development: concept and case. Volume 20(4): p. 251-263..

Minis, I. & Tatarakis, A., 2011. Stochastic single vehicle routing problem with delivery and pick up and a predefined customer sequence. Volume 213 No. 1, pp. 37-51..

Mishra, D., Gunasekaran, A., Papadopoulos, T. & al, e., 2016. Big data and supply chain management:Areview and bibliometric analysis.

Mohr, S. & Khan, O., 2015. 3D Printing and Its Disruptive Impacts on Supply Chains of the Future.

Montreuil, B., 2011. Toward a physical internet: meeting the global logistics sustainability grand challenge. Volume 3, pp. 71-87..

Morgan, R. & Hunt, S., 1994. *The commitment-trust theory of relationship marketing.* s.l.:The Journal of Marketing.

Morgan, T., Richey, R. & Autry, C., 2015. The evolution of supply chain transparency: a scale development.

Morgan, T., Richey, R. J. & Ellinger, A., 2018. *Supplier transparency: Scale development and validation.* s.l.:International Journal of Logistics Management..

Moser, H., 2011. Reshoring initiative spearheads effort to bring back US manufacturing. Volume 5 No. 12, p. 8. .

Mulrow, C. D., 1987. The medical review article: state of the science. Volume 106.3 (1987): 485-488.

Mulrow, C. D., 1994. Systematic reviews: rationale for systematic reviews. Volume 309.6954 : 597-599.

Mulrow, C. D. & Cook, D., 1998. *Systematic reviews: Synthesis of best evidence for health care decisions.* Philadelphia: American College of Physicians.

Ngai, E., Chau, D. & Chan, T., 2011. Information technology, operational, and management competencies for supply chain agility: findings from case studies. Volume Vol. 20 No. 3, pp. 232-249.

Nurmilaakso, J.-M., 2008. Adoption of e-business functions and migration from EDI based to XML based e-business frameworks in supply chain integration. Volume Vol. 113 No. 2, pp. 721-733..

Nyman, H. & Sarlin, P., 2014. From bits to atoms: 3D printing in the context of supply chain strategies..

O'Dwyer, J. & Renner, R., 2011. The promise of advanced supply chain analytics. Volume Vol. 15 No. 1, pp. 32-37..

OECD, 2017. The Next Production Revolution: Implications for Governments and Business.

Oettmeier, K. & Hofmann, E., 2016. Impact of additive manufacturing technology adoption on supply chain management processes and components.

Oettmeier, K. & Hofmann, E., 2017. Additive manufacturing technology adoption: an empirical analysis of general and supply chain-related determinants.

Ohno, T., 2012. Toyota Production System: Beyond Large-Scale Production,.

Pannett, L., 2014. 3D: The Future of Printing." Supply Management.

Papadopoulos, T. et al., 2017. *The role of big data in explaining disaster resilience in supply chains for sustainability.* s.l.:Journal of Cleaner Production.

Pedroso, M. & Nakano, D., 2009. Knowledge and information flows in supply chains: a study on pharmaceutical companies. Volume Vol. 122, pp. 376-384.

Petrick, I. J. & Simpson, T. W., 2013. 3D Printing Disrupts Manufacturing: How Economies of One Create New Rules of Competition.. Volume 56(6): 12–16..

Philippart, M., Verstraete, C. & Wynen, S., 2005. Collaborative Sourcing: Strategic Value Creation through Collaborative Supplier Relationship Management.

Piccinini, E., Gregory, R. & Kolbe, L., 2015. *Changes in the Producer-Consumer RelationshipTowards Digital Transformation.* pp. 1634–1648 ed. s.l.:12th international conference on Wirtshaftinformatik.

Porter, M., 1998. Competitive Advantage: Creating and Sustaining Superior Performance: With a New Introduction.

PwC, 2013. 3D printing: a potential game changer for aerospace and defense.

PwC, 2016. 3D Printing comes of age in US industrial manufacturing.

Qin, J., Liua, Y. & Grosvenor, R., 2016. A Categorical Framework of Manufacturing for Industry 4.0 and Beyond",. Volume 52, pp. 173-178.

Rai, A., Patnayakuni, R. & Seth, N., 2006. Firm performance impacts of digitally enabled supply chain integration capabilities. Volume 30 No. 2, pp. 225-246.

Rainbird, M., 2004. Demand and supply chains: the value catalyst. Volume 34(3/4), pp.230-250..

Razzaq-Malik, K. et al., 2017. Data compatibility to enhance sustainable capabilities for autonomous analytics in IoT. Volume 9 No. 6, pp. 877-890..

Reddy, G., Singh, H. & Hariharan, S., 2016. Supply chain wide transformation of traditional industry to industry 4.0.

Rengier, F. et al., 2010. 3D printing based on imaging data: review of medical applications. Volume 5 No. 4, pp. 335-341.

Richey Jr, R., Morgan, T., Lindsey-Hall, K. & A. F., 2016. A global exploration of Big Data in the supply chain.. Volume 46 PP 710–739..

Richey, J. R., Morgan, T., Lindsey-Hall, K. & A. F., 2016. A global exploration of Big Data in the supply chain.. Volume 46 PP 710–739..

Rogers, H., Baricz, N. & Pawar, K., 2016. 3D printing services: classification, supply chain implications and research agenda. Volume 46 No. 10, pp. 886-907..

Ross, D., 2016. Introduction to Supply Chain Management Technologies, 2nd ed.

Roßmann, B., Canzaniello, A., Gracht, H. v. d. & Evi, H., 2018. The future and social impact of Big Data Analytics in Supply Chain Management: Results from a Delphi study. Volume 130, P 135–149.

Rousseau, D. M., 2006. *Is there such a thing as "evidence-based management".* Academy of management review : 31.2 (2006): 256-269..

Rousseau, D. M., Manning, J. & Denyer, D., 2008. Evidence in Management and Organizational Science.

Ryan, M. et al., 2017. 3D printing the future: scenarios for supply chains revietheyd.

Sachan, A., Sahay, B. S. & Sharma, D., 2005. Developing Indian grain supply chain cost model: a system dynamics approach. Volume 54, No. 03, pp. 187-205.

Sackman, H., 1974. *Delphi critique; expert opinion, forecasting, and group process (No. 1283).*. s.l.:Lexington Books..

Sanders, N., 2014. Big Data Driven Supply Chain Management: A Framework for Implementing Analytics and Turning Information into Intelligence,.

Sanders, N. R., 2016. How to Use Big Data to Drive Your Supply Chain.

Sasson, A. & Johnson, J., 2016. The 3D printing order: variability, supercenters and supply chain reconfigurations.

Sauter, P., 2014. Big Data in Procurement: Unlocking Big Value in Better Sourcing, Process Efficiency, and Agility of Procurement.

Savitz, E., 2013. The industrial internet: even bigger than big data. Volume P 44.

Schildhorn, Z., 2014. Trends to Watch for in 3D Printing in 2015.

Schmarzo, B., 2014. KPMG Survey: Firms Struggle with Big Data. *Infocus.*

Schmock, D., Rudzki, R. & Rogers, S., 2007. On-Demand Supply Management: World Class Strategies, Practices, and Technology,.

Schrauf, S. & Berttram, P., 2016. Industry 4.0: how digitization makes the supply chain more efficient, agile, and customer-focused.

Schuster, E., Allenb, S. & Brock, D., 2007. Global RFID: The Value of the EPC Global Network for Supply Chain Management,.

Sharman, G., 1984. The rediscovery of logistic. Volume 62 No. 5, pp. 71-79.

Sharma, S. & Agrawal, N., 2012. Application of fuzzy techniques in a multistage manufacturing system. Volume 60 Nos 1-4.

Shibi, N., 2011. Enhancing operational efficiencies with mobile devices. Volume pp. 26-28..

Shin, S., Woo, J. & Rachuri, S., 2014. Predictive analytics model for power consumption in manufacturing. Volume 15, pp. 153-158..

Siegried, M., 2014. Find the Big Picture in Big Data. Issue pp. 19-23.

Song, M. et al., 2017. How would big data support societal development and environmental sustainability? Insights and practices. Volume 142, pp. 489-500..

Souza, G., 2014 . Supply chain analytics. Volume 57 No. 5, pp. 595-605..

Stephens, J. & Valverde, R., 2013. Security of e-procurement transactions in supply chain reengineering. Volume 6 No. 3, pp. 1-20.

Stock, T. & Seliger, G., 2016 . Opportunities of sustainable manufacturing in Industry 4.0.. Volume p. 536-541..

Storper, M. & Harrison, B., 1991. Flexibility, hierarchy and regional-development – the changing structure of industrial-production systems and their forms of governance in the1990s. Volume 20 No. 5, pp. 407-422. .

Strandhagen, J. et al., 2017. Logistics 4.0 and emerging sustainable business models.

Stroh, M. B., 2002. What is Logistics?.

Subramanian, N. & Ramanathan, R., 2012. A review of applications of analytic hierarchy process in operations management. Volume 138 No. 2, pp. 215-241.

Suning, Z. et al., 2018. How supply chain analytics enables operational supply chain transparency: An organizational information processing theory perspective. 48(1, pp.47-68).

Svensson, G. & Wagner, B., 2015. Implementing and managing economic, social and environmental efforts of business sustainability: propositions for measurement and structural models. Volume 26 No. 2, pp. 195-213..

Swaminathan, S., 2012. The Effects of Big Data on the Logistics Industry.

Tachizawa, E., Alvarez-Gil, M. & Montes-Sancho, M., 2015. How ‘‘smart cities” will change supply chain management. Supply Chain Manage.. Volume 20, 237–248..

Tan, H. & Mathews, J. A., 2010. Identification and analysis of industry cycles. Volume 63(5), 454-462..

Tan, K. H. et al., 2015. Harvesting big data to enhance supply chain innovation capabilities: An analytic infrastructure based on deduction graph.. Volume 165, 223–233.

Tranfield, D., David, D. & Smart, P., 2003. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review.

Trent, R., 2007. Strategic Supply Management: Creating the Next Source of Competitive Advantage.

Trudel, R. & Cotte, J., 2009. Does it pay to be good?.

Tuck, C., Hague, R. & Burns, N., 2007. Rapid manufacturing – impact on supply chain methodologies and practice. Volume 3 No. 1, pp. 1-22..

Tuck, C. et al., 2008. Rapid manufacturing facilitated customization. Volume 21 No. 3, pp. 245-258.

Tu, M., 2018. An exploratory study of Internet of Things (IoT) adoption intention in logistics and supply chain management: A mixed research approach.

Turban, E., King, D., Lee, J. & al., e., 2002. Electronic commerce: Amanagerial perspective..

Van Weele, A., 2009. Purchasing & Supply Chain Management: Analysis, Strategy, Planning and Practice, 9th ed..

Vendrell-Herrero, F., Bustinza, O., Parry, G. & Georgantzis, N., 2017. Servitization, digitization and supply chain management. Volume 60 No. 2017, pp. 69-81.

Vickery, S. K., Jayaram, J., Droge, C. & Calantone, R., 2003. The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships.. Volume 21(5), 523-539..

Vinodh, S. et al., 2009. Agility through rapid prototyping technology in a manufacturing environment using a 3D printer. Volume 20 No. 7, pp. 1023-1041.

Vogelsang, G., 2010. Making Digital Content Pay.

Waller, M. A. & Fawcett, S. E., 2013. Data science, predictive analytics, and big data: A revolution that will transform supply chain design and management. Volume 34(2), 77–84.

Walter, M., Holmström, J., Tuomi, J. & Yrjölä, H., 2004. Rapid manufacturing and its impact on supply chain management.

Wang, E., Tai, J. & Grover, V., 2013. Examining the relational benefits of improved interfirm information processing capability in buyer-supplier dyads. Volume Vol. 37 No. 1, pp. 149-173..

Wang, G., Gunasekaran, A., Ngai, E. & Papadopoulos, T., 2016. Big data analytics in logistics and supply chain management: certain investigations for research and applications. Volume Vol. 176, pp. 98-110.

Wang, S., Wan, J., Li, D. & Zhang, C., 2016. Implementing smart factory of industrie 4.0: an outlook..

Westerman, G., Bonnet, D. & McAfee, A., 2014. Leading digital: Turning technology into business transformation..

Wigan, M. R., 2014. Transport Replacement and Sustainability Aspects Associated with Additive manufacturing..

Williams, B., Roh, J., Tokar, T. & Swink, M., 2013. Leveraging supply chain visibility for responsiveness: the moderating role of internal integration..

Williamson, O., 1985. The Economic Institutions of Capitalism: Firms, Markets, Relational contracting,.

Wong, C. & Guo, Z., 2014. Fashion supply chain management using radio frequency identification (RFID) technologies.

Wong, C. L. K. C. T., 2012. Value of information integration to supply chain management: roles of internal and external contingencies. Volume 28 No. 3, pp. 161-191..

Wu, L., Yue, X., Alan, J. & Yen, D. C., 2016. Smart supply chain management: a review and implications for future research. 27 (2, pp.395-417).

Wu, L. & Yue, X. J. A. ,. D. C., 2016. Smart supply chain management: a review and implications for future research. Vol 27(2, pp.395-417).

Wu, N., Nystrom, M., Lin, T. & Yu, H., 2006. Challenges to global RFID adoption. Volume 26 No. 12, pp. 1317-1323..

Wu, Z. & Pagell, M., 2011. Balancing priorities: decision-making in sustainable supply chain management. Volume 29 No. 6, pp. 577-590.

Yap, C., Soh, C. & KS, R., 1992. Information systems success factors in small business.. Volume 20(5–6):597–609..

Y, Y. & Lau, K., 2018. Designing a demand chain management framework under dynamic uncertainty: An exploratory study of the Chinese fashion apparel industry.. Volume 30(1), pp.198-234.

Zage, D., Glass, K. & Colbaugh, R., 2013. Improving supply chain security using big data. Intelligence and Security Informatics (ISI). Volume (pp. 254–259). IEEE..

Zelbst, P., Green, K., Sower, V. & Reyes, P., 2012. Impact of RFID on manufacturing effectiveness and efficiency. Volume Vol. 32 No. 3, pp. 329-350.

Zhan, Y., Tan, K., Li, Y. & Tse, Y., 2016. Unlocking the power of the big data in new product development. Issue pp. 1-19.

Zhong, R., Neman, S., Huag, G. & Lan, S., 2016. Big Data for supply chain management in the service and manufacturing sectors: challenges, opportunities, and future perspectives. Volume No. 2016, pp. 572-591..

Appendix

This research was relied on relevant 56 studies that were the result of the Systematic Literature Review as mentioned in detail in chapter 2 of this research, Hence the relevant studies as below:

#	Title	Authors	Source Title (Journal)	Year
1	3D Printing and Its Disruptive Impacts on Supply Chains of the Future	Mohr, S; Khan, O	TECHNOLOGY INNOVATION MANAGEMENT REVIEW	2015
2	3D printing services: classification, supply chain implications and research agenda	Rogers H., Baricz N., Pawar K.S.	International Journal of Physical Distribution and Logistics Management	2016
3	3D printing the future: scenarios for supply chains revietheyd	Ryan M.J., Eyers D.R., Potter A.T., Purvis L., Gosling J.	International Journal of Physical Distribution and Logistics Management	2017
4	A study of agricultural products distribution using the internet of things	Li Z.	International Journal of Simulation: Systems, Science and Technology	2016
5	A supply chain performance measurement approach using the internet of things Toward more practical SCPMS	Dtheyekat, AJ; Hwang, G; Park, J	INDUSTRIAL MANAGEMENT & DATA SYSTEMS	2017
6	A System of Systems Approach for Global Supply Chain Management in the Big Data Era	Choi T.-M.	IEEE Engineering Management Review	2018
7	Additive manufacturing for consumer-centric business models: Implications for supply chains in consumer goods manufacturing	Bogers M., Hadar R., Bilberg A.	Technological Forecasting and Social Change	2016
8	Additive manufacturing technology adoption: an empirical analysis of general and supply chain-related determinants	Oettmeier K., Hofmann E.	Journal of Business Economics	2017
9	Additive manufacturing's impact and future in the aviation industry	Wagner S.M., Walton R.O.	Production Planning and Control	2016
10	Adopting additive manufacturing in SMEs: exploring the challenges and solutions	Martinsuo M., Luomaranta T.	Journal of Manufacturing Technology Management	2018
11	Agile manufacturing practices: the role of big data and business analytics with multiple case studies	Gunasekaran A., Yusuf Y.Y., Adeleye E.O., Papadopoulos T.	International Journal of Production Research	2018
12	An examination of the importance of big data analytics in supply chain agility development: A dynamic capability perspective	Mandal S.	Management Research Review	2018
13	An exploratory study of Internet of Things (IoT) adoption intention in logistics and supply chain management: A mixed research approach	Tu, MR	INTERNATIONAL JOURNAL OF LOGISTICS MANAGEMENT	2018
14	An exploratory study on supply chain analytics applied to spare parts supply chain	Arya V., Sharma P., Singh A., De Silva P.T.M.	Benchmarking	2017
15	An RFID-based intelligent decision support system architecture for production monitoring and scheduling in a distributed manufacturing environment	Guo Z.X., Ngai E.W.T., Yang C., Liang X.	International Journal of Production Economics	2015
16	Back in business: operations research in support of big data analytics for operations and supply chain management	Hazen B.T., Skipper J.B., Boone C.A., Hill R.R.	Annals of Operations Research	2018
17	Big data analytics and demand forecasting in supply chains: a conceptual analysis	Hofmann E., Rutschmann E.	International Journal of Logistics Management	2018
18	Big Data Analytics and IoT in logistics: a case study	Hopkins, J; Hawking, P	INTERNATIONAL JOURNAL OF LOGISTICS MANAGEMENT	2018

19	Big data and predictive analytics for supply chain and organizational performance	Gunasekaran A., Papadopoulos T., Dubey R., Wamba S.F., Childe S.J., Hazen B., Akter S.	Journal of Business Research	2017
20	Big data and predictive analytics in humanitarian supply chains: Enabling visibility and coordination in the presence of swift trust	Dubey R., Luo Z., Gunasekaran A., Akter S., Hazen B.T., Douglas M.A.	International Journal of Logistics Management	2018
21	Big data in humanitarian supply chain networks: a resource dependence perspective	Prasad S., Zakaria R., Altay N.	Annals of Operations Research	2018
22	Big data in operations and supply chain management: current trends and future perspectives	Lamba K., Singh S.P.	Production Planning and Control	2017
23	Bottom-up approach based on Internet of Things for order fulfillment in a collaborative warehousing environment	Reaidy, PJ; Gunasekaran, A; Spalanzani, A	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	2015
24	Can IoT be used to mitigate food supply chain risk?	Beker I., Delić M., Milisavljević S., Gošnik D., Ostojić G., Stankovski S.	International Journal of Industrial Engineering and Management	2016
25	Challenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management	Kache F., Seuring S.	International Journal of Operations and Production Management	2017
26	Customer demand analysis of the electronic commerce supply chain using Big Data	Li L., Chi T., Hao T., Yu T.	Annals of Operations Research	2018
27	Data science, predictive analytics, and big data in supply chain management: Current state and future potential	Schoenherr T., Speier-Pero C.	Journal of Business Logistics	2015
28	Data science, predictive analytics, and big data: A revolution that will transform supply chain design and management	Waller M.A., Fawcett S.E.	Journal of Business Logistics	2013
29	How "smart cities" will change supply chain management	Tachizawa, EM; Alvarez-Gil, MJ; Montes-Sancho, MJ	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL	2015
30	How smart cities will change supply chain management: A technical viewpoint	Öberg C., Graham G.	Production Planning and Control	2016
31	How supply chain analytics enables operational supply chain transparency: An organizational information processing theory perspective	Zhu, SN; Song, JH; Hazen, BT; Lee, K; Cegielski, C	INTERNATIONAL JOURNAL OF PHYSICAL DISTRIBUTION & LOGISTICS MANAGEMENT	2018
32	How to use big data to drive your supply chain	Sanders N.R.	California Management Review	2016
33	How will smart city production systems transform supply chain design: a product-level investigation	Kumar M., Graham G., Hennelly P., Srai J.	International Journal of Production Research	2016
34	Impact of additive manufacturing technology adoption on supply chain management processes and components	Oettmeier K., Hofmann E.	Journal of Manufacturing Technology Management	2016
35	Industry 4.0 fostering construction supply chain management: Lessons learned from engineer-to-order suppliers	Dallasega P.	IEEE Engineering Management Review	2018
36	Industry 4.0: state of the art and future trends	Xu, LD; Xu, EL; Li, L	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	2018
37	Internet of things (IoT) embedded future supply chains for industry 4.0: An assessment from an ERP-based fashion apparel and foottheyar industry	Majeed M.A.A., Rupasinghe T.D.	International Journal of Supply Chain Management	2017
38	IoT-based tracking and tracing platform for prepackaged food supply chain	Li Z., Liu G., Liu L., Lai X., Xu G.	Industrial Management and Data Systems	2017

39	Logistics 4.0 and emerging sustainable business models	Strandhagen, JO; Vallandingham, LR; Fragapane, G; Strandhagen, JW; Stangeland, ABH; Sharma, N	ADVANCES IN MANUFACTURING	2017
40	Mapping the Landscape of Future Research Themes in Supply Chain Management	Wieland A., Handfield R.B., Durach C.F.	Journal of Business Logistics	2016
41	Measuring the benefits of ERP on supply management maturity model: a "big data" method	Huang, YY; Handfield, RB	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT	2015
42	Practitioners understanding of big data and its applications in supply chain management	Brinch M., Stentoft J., Jensen J.K., Rajkumar C.	International Journal of Logistics Management	2018
43	Procurement 4.0: factors influencing the digitisation of procurement and supply chains	Bienhaus F., Haddud A.	Business Process Management Journal	2018
44	Removing the blinders: A literature review on the potential of nanoscale technologies for the management of supply chains	Bowles M., Lu J.	Technological Forecasting and Social Change	2014
45	Role of cloud ERP on the performance of an organization: Contingent resource-based view perspective	Gupta, S; Kumar, S; Singh, SK; Foropon, C; Chandra, C	INTERNATIONAL JOURNAL OF LOGISTICS MANAGEMENT	2018
46	Smart supply chain management: A review and implications for future research	Wu L., Yue X., Jin A., Yen D.C.	International Journal of Logistics Management	2016
47	Social media data analytics to improve supply chain management in food industries	Singh A., Shukla N., Mishra N.	Transportation Research Part E: Logistics and Transportation Review	2018
48	Supply chain game changers-mega, nano, and virtual trends-and forces that impede supply chain design (i.e., Building a Winning Team)	Fawcett S.E., Waller M.A.	Journal of Business Logistics	2014
49	Supply chain wide transformation of traditional industry to industry 4.0	Reddy G.R.K., Singh H., Hariharan S.	ARPN Journal of Engineering and Applied Sciences	2016
50	The fit of Industry 4.0 applications in manufacturing logistics: a multiple case study	Strandhagen, JW; Alfnes, E; Strandhagen, JO; Vallandingham, LR	ADVANCES IN MANUFACTURING	2017
51	The future and social impact of Big Data Analytics in Supply Chain Management: Results from a Delphi study	Roßmann B., Canzaniello A., von der Gracht H., Hartmann E.	Technological Forecasting and Social Change	2018
52	The future of manufacturing industry: a strategic roadmap toward Industry 4.0	Ghobakhloo, M	JOURNAL OF MANUFACTURING TECHNOLOGY MANAGEMENT	2018
53	The influence of the Digital Divide on Big Data generation within supply chain management	Gravili G., Benvenuto M., Avram A., Viola C.	International Journal of Logistics Management	2018
54	The role of Big Data in explaining disaster resilience in supply chains for sustainability	Papadopoulos T., Gunasekaran A., Dubey R., Altay N., Childe S.J., Fosso-Wamba S.	Journal of Cleaner Production	2017
55	Three-dimensional printing - a key tool for the humanitarian logistician?	Tatham, P; Loy, J; Peretti, U	JOURNAL OF HUMANITARIAN LOGISTICS AND SUPPLY CHAIN MANAGEMENT	2015
56	Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice	Arunachalam D., Kumar N., Kawalek J.P.	Transportation Research Part E: Logistics and Transportation Review	2018