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HOW DIGITAL TRANSFORMATION IS CATALYZING INNOVATION IN ASSET-INTENSIVE INDUSTRIES

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Ai miei nonni Luigi e Maria Paola,

"Nulla si ottiene senza sacrificio e senza coraggio."

-M. Gandhi

Sommario

Introduction

The purpose of the present study is to improve the current understanding on *what are the most common digital transformation challenges in an Asset-Intensive industry setting are and how an asset-intensive company can create a digital transformation strategy that allows to pursue a digital transformation that catalyzes innovation in the business.*

The problem is approached through a single-case empirical study focusing on the digital transformation process of an American company operating in the oil and gas sector. The thesis deals with processes the subject by first offering background focused on digital transformation, business model and digital strategy. The second section presents the Asset-Intensive industries and explains the research methodology and processes required to innovate these sectors, focusing specifically on responsive supply chain management, and changes and the digital transformation that innovates this particular sector. The third section introduces the case company and describes its development of digital strategy and discusses the existing digital transformation and its outcomes. However, the transformational nature of the development may be difficult to achieve. Many organizations see digital technologies as an incremental addition, underlying the business models and value creation logics. This is especially true in industries with products that cannot be completely digitized (Hanelt et al., 2015). The result is a situation where companies routinely invest in technological development and achieve incremental progression, failing to completely introduce new ways of doing business (Fitzgerald et al., 2014). This inability of knowing how to use digital transformation to the full is a management challenge rather than a technological one (Westerman et al., 2011), and, solving it requires an understanding of digital business strategies (Mithas et al., 2013). According to Matt et al. (2015), companies need consolidated management and governance practices (Digital Strategies) in order to achieve a fundamental digital transformation that brings innovation. However, digital transformation is such a new topic that reading cannot offer a direct practical solution on how to deal with digital transformation. It is uniquely presented in each sector, blurring the boundaries between different industries and introducing new types of business opportunities, as well as challenges and competition to every sector. These new challenges and changes, together with the shortening of product life cycles, business models, etc., highlight how important it is for a company to have the ability to constantly transform and innovate within the ecosystem in which it operates. In this thesis, this ability to constantly innovate and reassess business models through a successful digital strategy is considered the key to fully exploiting digital transformation. This type of innovation activity is often dealt with efficiently by people within the organization who pursue business activities and goals. Entrepreneurship is a particularly important

foundation in the creation of completely new technological innovations and in the renewal of enterprises (Menzel et al., 2007). This type of innovation is based on information, data, culture, digital skills, technological excellence and organizational vision (Benitez et al., 2010). Entering the digital age of businesses forces traditional organizations to focus on a new model for organization. The innovation activity places the emphasis on the ability to manage activities as a key component of a successful digital strategy that leads to a digital transformation capable of catalyzing innovation. This thesis aims to study the new enabling factors in the context of digital transformation initiatives and digital strategy.

Chapter 1: Digital Transformation

1.1 Concepts and Definition

"The accelerating technological development together with growing global competition and faster product and business model innovation cycles dramatically change the operating environment of corporations as well as consumers. This is especially true for digital technologies, and companies in practically all industries have already experimented or are exploring ways to utilize new digital technologies and digital innovation. Novel digital technologies such as analytics, connectivity of people, sensor technology and smart devices are experimented across all industries. The transformation does not only affect company products and service offerings but complete business ecosystems by affecting all aspects from customer interfaces and value creation models to products and business models" (Patel, K & McCarthy,2000). Under this technological acceleration, according to A. Bounfour, we can interpret the digital transformation as "a new development in the use of digital artifacts, systems and symbols within and around organizations" (A. Bounfour;2016).

In agreement whit Andal-Ancion, Cartwright and Yip, the topic of this so-called Digital transformation is becoming a more and more central topic in both management literature as well as companies' business strategies.

Companies, in the wake of this digitalization-driven transformation are adapting by implementing evermore digital products to complement existing traditional products (Westerman, Calméjane, Bonnet, Ferraris and McAfee; 2011), but also adopting completely new ways of doing business (Fitzgerald, Kruschwitz, Bonnet, and Welch; 2014). The effects deriving from this process of digitalization driven by transformation, which completely changes the way of doing business in companies, "affects all sectors of society, in particular the economy. Digital transformation opens up new networking possibilities and cooperation between different actors, who, for example, exchange data and thus initiate processes. The term, "digital transformation," can be used when technological potentials are used to change or to network business models and value chains, ultimately meeting customer requirements and providing services more efficiently" (Schallmo, Williams; 2018).

Companies in the digital age must have solid capacity for innovation and transformation if they want to survive and remain competitive. The digital transformation consists in reinventing business as we know it and does not specifically concern IT or technology, but the redefinition of the business models, business strategy and managerial culture.

“In any definition of digital transformation, it is important to stress the requisite elements that lead to digital transformation because without these ingredients true digital transformation is not possible” (Schallmo and Williams; 2018).

These elements can be traced by starting first of all from the analysis of the term "Digital" in digital transformation. This term was developed by McKinsey and states that “digital is less about any one process and more about how companies run their business”. It can be broken down into three primary foci:

- Creating value at the new frontiers of the business world
- Optimizing the processes that directly affect the customer experience
- Building foundational capabilities that support the entire overall business initiative

In line with the definition of "Digital" in the Digital Transformation identified by McKinsey, the only reasonable way to react to persistent "digitization", defined as transformation from analog to digital, is "Digitalization" that can be defined as “the use of digital technologies and of data (digitized and natively digital) in order to create revenue, improve business, replace/transform business processes (not simply digitizing them) and create an environment for digital business, whereby digital information is at the core” (i-SCOOP;2016).

Based on this perspective, digitization creates a “fundamental changes made to business operations and business models based on newly acquired knowledge gained via value-added digitization initiatives” (Schallmo, C.A. Williams; 2018).

In their analysis of transformation aimed at understanding the nature of digital technology, Lucas identified the following key criteria: a significant transformation in the traditional approaches of doing business, a need to obtain newer capabilities, and radical adjustments in tasks (Lucas, H. C., et al.; 2013). Developing several different dimensions of transformation, including: processes, new organizations, relationships, user experience, markets, customers, and the disruptive impact.

According to Bounfour “these dimensions can be analyzed at different levels: that of the individual, the firm and the overall society or economy”. This analysis helps to understand that “the issue of digitalization goes beyond entrepreneurship in the traditional sense; it has become ecosystemic” (A. Bounfour; 2016)

Recent authors have given several definitions of the term Digital Transformation:

Reference	Definition
BMWi (2015: 3)	Digitization stands for the complete networking of all sectors of the economy and society, as well as the ability to collect relevant information, and to analyze and translate this information into actions. The changes bring advantages and opportunities, but they create completely new challenges
Bowersox et al. (2005: 22ff)	Digital Business Transformation is a "process of reinventing a business to digitize operations and formulate extended supply chain relationships. The DBT [Digital Business Transformation] leadership challenge is about reenergizing businesses that may already be successful to capture the full potential of information technology across the total supply chain"
Westerman et al. (2011: 5)	"Digital Transformation (DT)—the use of technology to radically improve the performance or reach of enterprises—is becoming a hot topic for companies across the globe. Executives in all industries are using digital advances such as analytics, mobility, social media, and smart embedded devices—and improving their use of traditional technologies such as ERP—to change customer relationships, internal processes, and value propositions"
Mazzone (2014: 8)	"Digital Transformation is the deliberate and ongoing digital evolution of a company, business model, idea process, or methodology, both strategically and tactically"
PwC (2013: 9)	Digital transformation describes the fundamental transformation of the entire business world through the establishment of new technologies based on the internet with a fundamental impact on society as a whole
Boueé and Schaible (2015: 6)	We understand digital transformation as a consistent networking of all sectors of the economy and adjustment of the players to the new realities of the digital economy. Decisions in networked systems include data exchange and analysis, calculation and evaluation of options, as well as initiation of actions and introduction of consequences

Figure 1.1: Selected definitions of the term "digital transformation" (Schallmo, C.A. Williams; "Digital Transformation Now!", 2018)

However, the different definitions given by the different authors emphasize the renewal of business models and their logics for value creation as a nucleus for the transformation of digital and its development in all sectors of the economy. The most commonly cited and known holistic definition of the term Digital Transformation is the one introduced by Kaplan et al. (2010) who interprets it as follows: "digital transformation can be understood as the changes that digital technology causes or influences in all aspects of human life."

According to Berman, the evolution of digital transformation is understandable by focusing attention on digitalization and global connectivity and their shift towards new business models, while technology has developed and its different applications in different sectors have increased.

Since the focus of digital applications has evolved from digital products in specific sectors (such as entertainment, music) in the 1990s to complete the transformation of business models towards 2010, the definition of digital transformation has evolved into similarly (Berman and Bell; 2011).

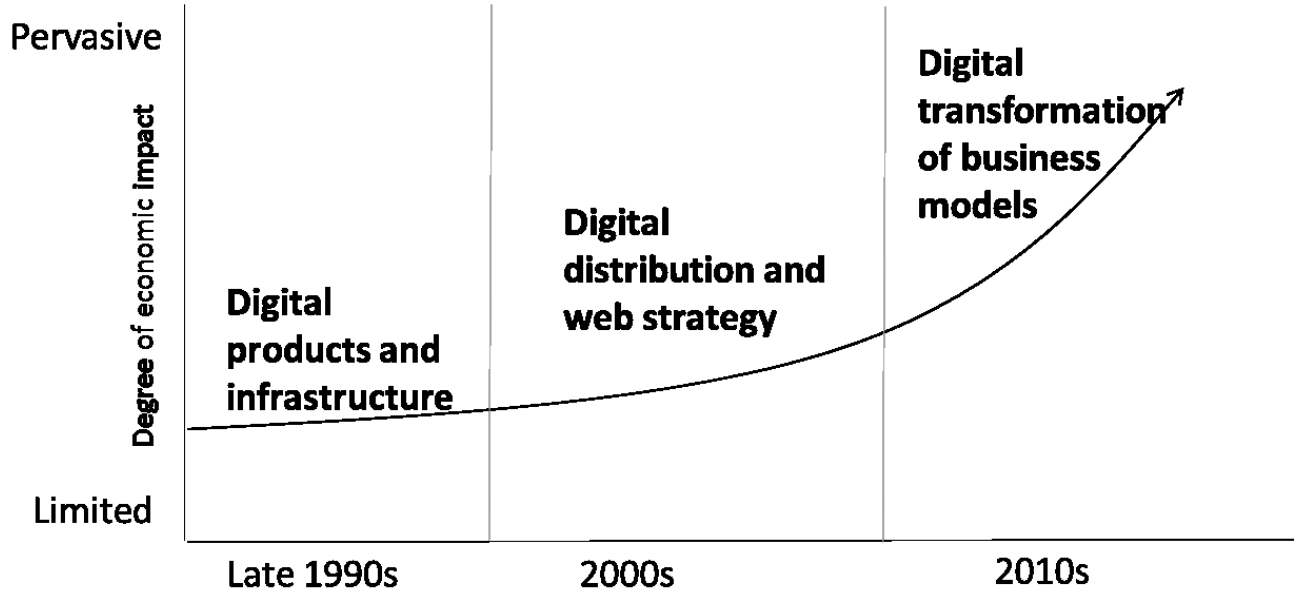

Figure 1.2: The evolution of digital transformation (Berman & Bell; 2011)

This evolution of digital transformation therefore represents a change, according to Fitzgerald et al (2013), of "the use of new digital technologies to enable major business improvements such as enhancing customer experience, streamlining operations or creating new business models" (Berman & Bell; 2011).

A very similar definition for digital transformation was introduced by Westerman et al. (2011), who define digital transformation as "the use of technology to radically improve performance or reach of enterprises" (Westerman, Calméjane, Bonnet, Ferraris, and McAfee; 2011). These definitions are similar in that they emphasize the creation of new business models and radical improvement of the reach of organization's activities, but the first definition, offered by Kaplan et al., was considered more self- explanatory and holistic. "From a business perspective, companies are required to react on the increased digitization and to adapt accordingly. The resulting digital business transformation represents the idea of creating new or adapting existing business models based on the increased digitization within society, such as the usage of mobile devices, social media, and Internet of Things (IoT)" (Berman & Bell; 2011).

1.2 Business Model in the New World of Digital Business

According to Amit and Zott, "the recent advances in communication and information technologies, such as the emergence and swift expansion of the internet and the rapid decline in computing and communication costs have allowed the development of new ways to create and deliver value, which have offered scope for the creation of unconventional exchange mechanism and transaction architectures and accentuated the possibilities for the design of new boundary-spanning organizational forms. In the new digital marketplace, consumers are using mobile, interactive tools to become instant experts on product and service offerings and their relative merits as they decide who to trust, where to make their purchases and what to buy. At the same time, businesses are undertaking their own digital transformations, rethinking what customers value most and creating operating models that take advantage of what's newly possible for competitive differentiation" (Zott and Amit; 2008).

Berman states that: "as industries undergo digital transformation and consider the new value creation models and opportunities digital transformation presents, old business models are often not applicable to the new business environments and new business models are needed" (Berman & Bell; 2011). The need for new business models in the wake of the transition from traditional business models to the new digital business world is characterized by a high level of complexity and rapid change. "The digital era has meant that the availability of appropriate levels of information and knowledge have become critical to the success of the business. Organizations need to adapt in order to survive and succeed as their business domains, processes and technologies change in a world of increasing environmental complexity. Enhancing their competitive positions by improving their ability to respond quickly to rapid environmental changes with high quality business decisions can be supported by adopting suitable business models for this new world of digital business" (Al-Debi, Mutaz, El-Haddadeh, Ramzi and Avison; 2008).

According to Veit et al., a "business model is digital if changes in digital technologies trigger fundamental changes in the way business is carried out and revenues are generated" (Veit, Clemons, Benlian, Buxmann, Hess, Spann, Kundisch, Lei- meister, Loos; 2014). Identifying corporate processes and strategies in the digital world, characterized by rapid changes and uncertainty brought about by the digital age is becoming increasingly difficult for companies.

The debate on the difference between the business model and the business strategy has not yet been resolved, however it is possible to see the business model components as a set of business strategies (Kallio, Tinnila, and Tseng, 2006).

"A business model is more generic than a business strategy. Coupling strategy and business model analysis is needed to protect competitive advantage resulting from new business model design" (David and Teece; 2010). From this prospective, "the business strategy explains how business organizations hope to do better than their rivals, whilst the business model describes how the pieces of a business all fit together" (Magretta; 2002).

The high level of complexity and rapid change is the reason that surrounds the uncertainty in the transition from the traditional business world to the new digital business world. "This new world of digital business has created a gap between the business strategy and business processes, translating business strategy into business process has become much more of a challenge" (Al-Debi, Mutaz, El-Haddadeh, Ramzi and Avison; 2008).

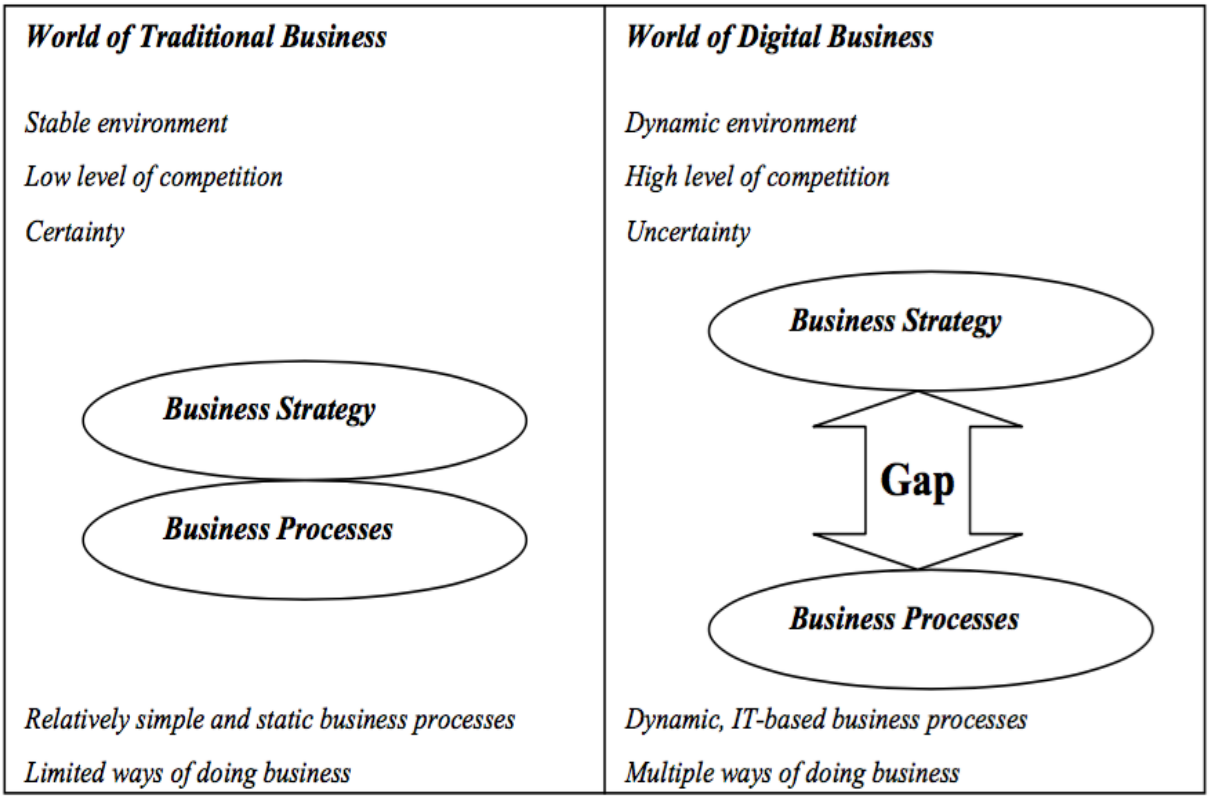

Figure 1.3: Comparison between the World of Traditional and Digital Business (Al-Debi, Mutaz M.; El-Haddadeh, Ramzi; and Avison, David; 2008)

The business model has become a tool of alignment to fill the gap that has been created in this world of digital business because it facilitates the fit between business strategy and business processes and it represents an interface or an intermediate theoretical layer between them. However, "The business model is by no means independent; it intersects with the business strategy as well as

the business processes. Thus, it creates a unique strategic operational mix. These intersections represent two crucial transitional points to be followed by business organizations in this new world of digital business" (Al-Debi, Mutaz, El-Haddadeh, Ramzi and Avison, 2008).

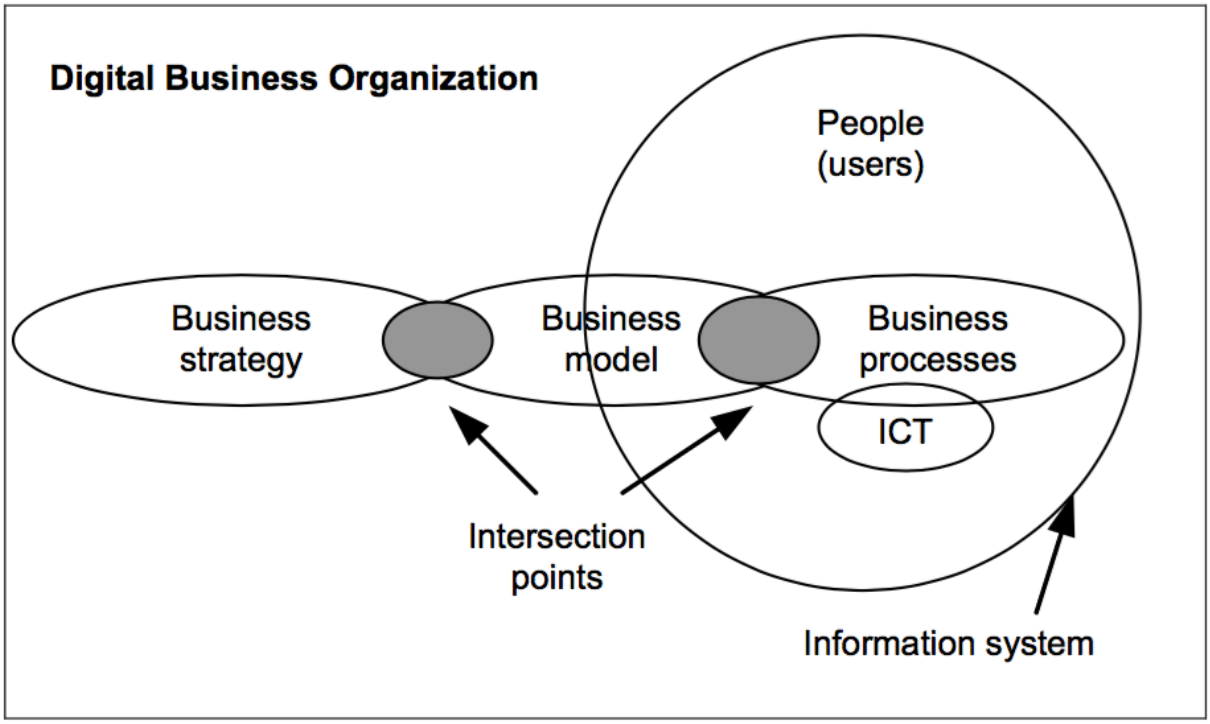

Figure 1.4: Business Model Intersection Points (Al-Debi, Mutaz M.; El-Haddadeh, Ramzi; and Avison, David; 2008)

1. Business strategy to business model: implementing one of the following three strategies, cost leadership, differentiation, and focus, businesses position themselves in their industries. Contemporaneously their broad strategy becomes more focused on architectural and financial issues allowing for the achievement of strategic objectives. The business model, at the first intersection business strategy depends on and is determined by the business strategy.

2. Business model to business process model: the business model functions as the core from which the articulated operational business process model should be developed.

"For businesses to survive and to succeed in this new world of digital business, the business strategy, business model, and business processes should be recognized and treated as a harmonized

package. Furthermore, this package should be reviewed continually to ensure its consistency with the external environment" (Al-Debi, Mutaz M.; El-Haddadeh, Ramzi; and Avison, David; 2008).

1.3 Digital Transformation of Business Model

"The digital transformation of business models relates to individual business model elements, the entire business model, value-added chains, as well as the networking of different actors in a value-added network. The degree of the digital transformation relates to the incremental (marginal) as well as the radical (fundamental) change of a business model. The reference unit with regards to the level of novelty is primarily the customer, but it can also affect its own business, partners, industry, and competitors. Within the digital transformation of business models, enabler(s) or technologies (e.g., big data) are used to generate new applications or services (e.g., on-demand predictions). These enablers require skills that make data collection and exchange, as well as analysis, possible, which the enablers must be able to use to calculate and evaluate options. The options are then used to initiate new processes within the business model. The digital transformation of business models is based on an approach which includes a sequence of tasks and decisions that are related to one another in a logical and temporal context. It affects four target dimensions: time, finance, space, and quality" (Schallmo and Williams; 2018).

According to Schallmo and Williams, the roadmap to understand the digital transformation of the business model goes around five phases:

1) Digital Reality: current business model outlined, including a value added analysis regarding stake-holders as well as a customer requirement survey. Such action indicate an assessment of corporate Digital Reality following multiple parameters.

2) Digital Ambition: in this phase the objectives for both best practices and enablers for digital transformation are defined. These are related to time, finances, space, and quality. Those objectives which need to be considered for the business model and its elements are determined by Digital Ambition and objectives and the business model dimensions are prioritized.

3) Digital Potential: in this phase the best practices and enablers for digital transformations are identified allowing for the starting point in terms of Digital Potential and future digital business model design. For each of the future business model elements, diverse options are identified and these, in turn, are subsequently combined and connected logically.

4) Digital Fit: options, which are evaluated to determine Digital Fit with the existing business mode for digital business design are examined in this phase thereby ensuring the satisfaction of customer needs as well as the achievement of business objectives. Once evaluated, the options are prioritized.

5) Digital Implementation: In this phase the multiple options are examined within a digital implementation framework, including, also the design of a digital customer experience and a digital value-creation network describing the integration of the new business model with partners. Included in this phase is the identification of resources and capabilities.

The five phases are synthesized in the following figure:

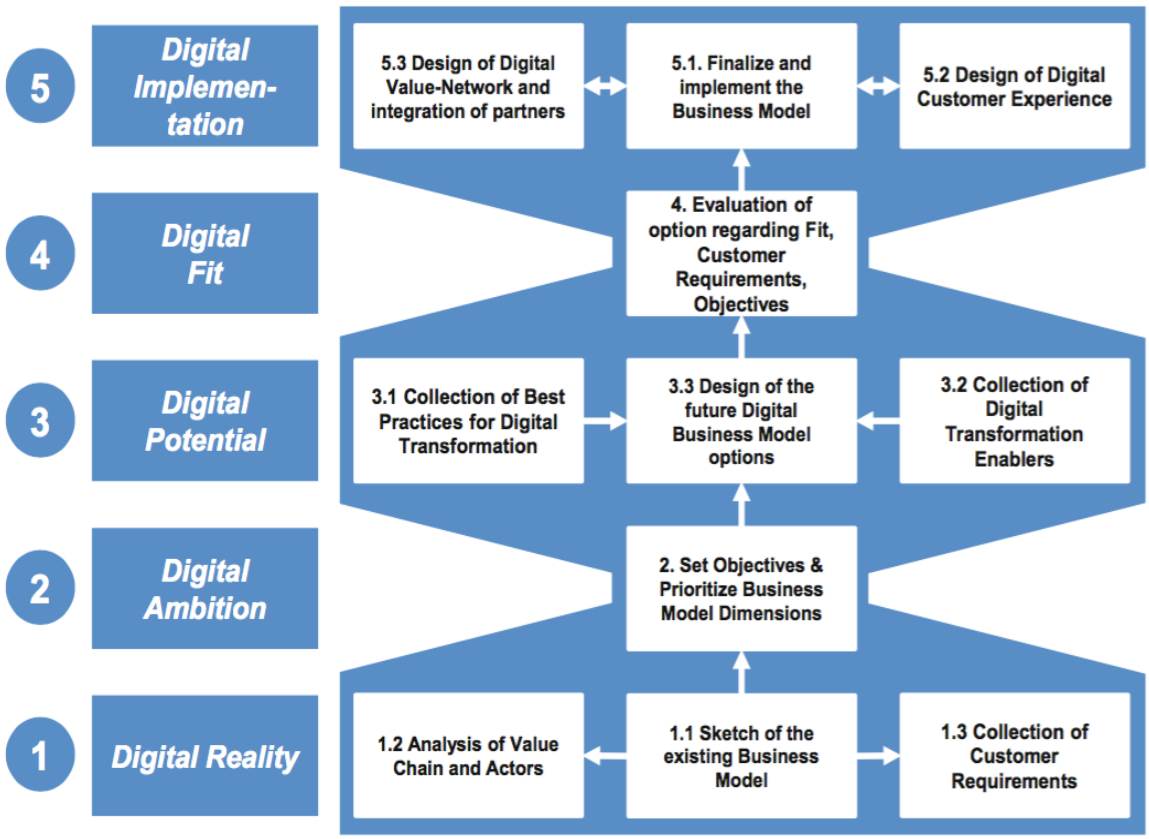

Figure 1.5: Roadmap to the digital transformation of business models, (Schallmo, C.A. Williams; "Digital Transformation Now!", 2018)

1.4 Business model innovation: it's not just about technology anymore

Amit and Zott states that "the one of the principal role of business model could consist of unlocking the value potential that is to embedded in new technology and converting it into market outcomes" (Zott and Amit; 2008). "To succeed in digital transformation, leading companies focus on two complementary activities: reshaping customer value propositions and transforming their operations using digital technologies for greater customer interaction and collaboration" (Berman; 2012).

In this prospective, as Berman affirms "the implementation of technologies into business processes is only a small part of digitally transforming a business. Technologies need to create additional value for the customers, the business itself, and other essential stakeholders" (Berman; 2012).

"Technological innovation is important for firms, but it might not suffice to guarantee firms success" (Doganova & Eyquem-Renault 2009). This is because technology per se does not have inherent value. Beside embedding technology in attractive products and services, a firm needs to design a unique business model to fully realize its commercial potential (Doganova & Eyquem-Renault 2009). According to Chesbrought, "a better business model often will beat a better idea or technology" (Chesbrough; 2007).

Therefore, according to Amit and Zott in the technology and innovation management field, the business model is mainly seen as a mechanism that connects a firm's (innovative) technology to customer needs and/or to other firm resources (e.g. technology). The business model, in this prospective, "complements technology, but technology is seen as an enabler of the business model rather than as a part of the concept in se" (Zott and Amit; 2008). Technologies need to create additional value for the customers, the business itself, and other essential stakeholders. "The goal is to create and deliver new value to customers, not just improve what is already being done or offered" (Moore; 2015).

"The business model, according to this more functional prospective, complements technology, but technology is seen as an enabler of the business model rather than as a part of the concept per se. The core logic of a business model, instead, revolves around a firm's revenues and costs, its value proposition to the customer, and the mechanism to capture value. Thus conceived, the business model can be a vehicle for innovation as well as a subject of innovation" (Zott, Amit and Massa; 2011).

Therefore, what it is possible to deduce, as Teece states, is that "technological innovation does not guarantee business success new product development efforts should be coupled with a business model defining their 'go to market' and 'capturing value' strategies" (Teece; 2010).

1.5 Digital Strategy for Business Model

Successful digital transformation is not a product of implementation of new technologies, but rather, creating a digital strategy that allows the organization to take advantage of the possibilities that novel digital technologies provide. The implementation of new technologies does not produce successful digital transformation. Such success derives from the creation of a digital strategy that puts the organization in the position to exploit the possibilities offered by the novel digital technologies (Westerman et al., 2011; Kane et al., 2015a; Matt et al., 2015).

According to Berman "the organizations with the most cohesive strategy to implement digital layers to their physical components of operations are the ones that can successfully transform their business models" (Berman; 2012), and in doing so, offers new value to customer, reshaping the customer value proposition, and changing the operations through the use ofdigital technology. Digital transformation needs to be an integrated and continuous part of any overall business strategy. According to Westerman, a successful digital transformation comes from transforming the organization's strategy to utilize the possibilities of digital technologies rather than simply implementing individual new technologies (Westerman, Calméjane, Bonnet, Ferraris, and McAfee; 2011). "Companies with a cohesive plan for integrating the digital and physical components of operations can successfully transform their business models" (Berman; 2012).Kane also states that digital strategy rather than technological developments creates digital transformation (Kane; 2015).

- *The differences between traditional business strategies and digital business strategies*

In traditional business model strategy, the focus is on individual technology and the optimization of individual units while in digital strategy the focus lies beyond paradigm, implication for products, services and business models as a whole (Matt, Hess and Benlian; 2015).

The scope in digital strategy regarding is on "how" to realize the organizational vison instead of the detailed content of the strategy in traditional business strategy. In the digital strategy the objective shift from the operational efficiency to the business transformation, re-visioning customer experience and operations and business models. The source of innovation in digital strategy comes through a collaborative, cross-industry and cross-business unit interaction, and knowledge sharing while traditional strategy was concerned with talented individuals and capabilities within organization (Kane, Palmer, Phillips and Kiron; 2015). The business model cycle speeds up and the business model changes from asset builder and service provide (traditional business strategy) to technological creator and network orchestrator (Libert, Beck and Wind; 2016). Therefore, to achieve the competitive advantage in digital, fast-changing environments the key organizational

capability is actually adaptability, and especially “reactive” adaptability that focuses on recognizing and realizing new business opportunities (Kreutzer; 2014).

1.6 Existing approaches to the digitalization of a business model

There are three different digital transformation approaches to the digitalization of a business model.

Esser’s Approach

In this approach, there are five phases that outline the development plan for a digital transformation strategy and its implementation.

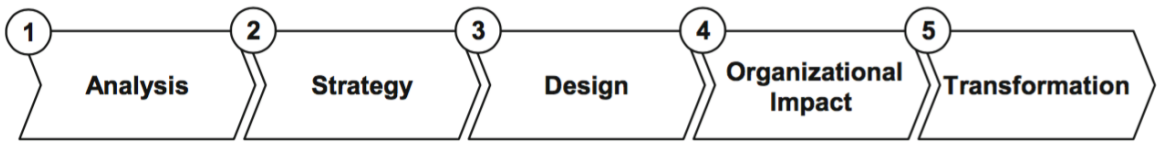

Figure 1.5: Esser’s Approach, (Schallmo, C.A. Williams; “Digital Transformation Now!”, 2018)

(1) Analysis: focuses on customer analysis, whose values are analyzed and segmented; competitors are described and measured in the light of their performance and market positioning and new entrants are also considered. The market is analyzed based on its size, its potential, its limits and possible future developments. Finally, the available capacities are collected.

(2) Strategy: this includes defining market position, deciding how the business wants to differentiate itself, and selecting the customer target group.

(3) Design: Focuses on three areas: the vision for customer experience, which includes a statement on what the company would like to achieve, the value proposition that answers the question on how and with which services customers can be made enthusiastic, and lastly, the identification of opportunities that evaluates current and new design ideas.

(4) Organizational Impact: refers to the people, structure and culture within the company. The

processes and systems are also examined, also defining governance and control.

(5) Transformation: the last step is to determine the direction of the plan and the management of the program for the digital transformation strategy. In this phase, internal communications and change management, branding and external communications are also defined.

Given that the phases defined by Esser are very general, specific references to digital transformation are infrequent. However, Esser's approach is useful in identifying the phases and contents that should be taken into consideration to development a digital transformation strategy and its implementation (Esser; 2014).

PricewaterhouseCoopers' Approach

This approach defines six phases for digital transformation within a framework:

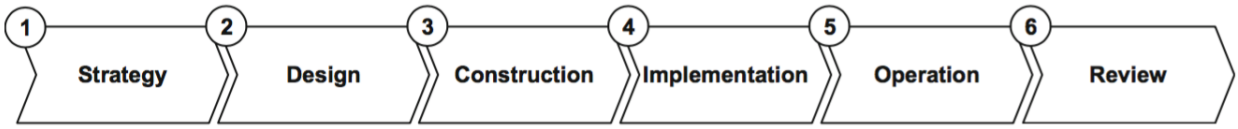

Figure 1.6: PricewaterhouseCoopers' Approach, (Schallmo, C.A. Williams; "Digital Transformation Now!", 2018)

(1) Strategy: it is developed in the first phase and where the effects of digital dynamics should be understood. Here the current position of the company is identified and the new business model is designed. Following this, a safety assessment and an analysis of the creation of value and legal and fiscal ramifications are taken into consideration. Finally, corporate culture and human capital are also analyzed.

(2) Design: next the design of the "roadmap" for the transformation takes place. This phase includes the definition of the collaboration model, the value creation network and the operational model. Furthermore, the target architecture, the transformation plan and the target model for the corporate culture are defined. Finally, the fiscal and legal aspects are modeled.

(3) Construction: the third phase concerns construction and serves to complete the development of a digital business platform. This happens through the introduction of governance and the development of a platform or application. The business model and business / IT services are adapted based on this construction. Digital security and skills management are also defined.

(4) Implementation: this phase serves to initiate the previously developed business platform. Quality assurance and employee training are implemented to ensure a successful transition.

(5) Operation: During the fifth phase, new business models are considered as running systems while in operation. A key role here is played by governance, platform, application management and reporting. A vital role is played here by governance, platform, application management and reporting.

(6) Review: the last phase concerns the review and includes the monitoring and optimization of performance. Review takes place through the provision of adjustments to the service level and the performance of optimizations at both the operational level and in the business model. Together, the six steps described are useful to explain the different aspects of digital transformation.

Bouée and Schaible's Approach

Bouée and Schaible offer a cross-phase approach which is useful for describing a digital transformation plan specifically developed to address a digital future.

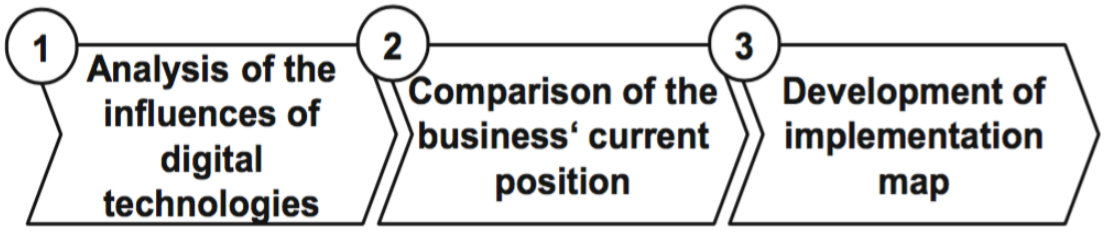

Figure 1.7: Bouée and Schaible's Approach, (Schallmo, C.A. Williams; "Digital Transformation Now!", 2018)

(1) Analysis of the Influence of Digital Technology on the Industry:
Distinct future scenarios are envisaged in the first phase and the potential changes in the

value chain are analyzed and the relevant technologies and participants in the market are classified. This phase is characterized by frequent modifications.

(2) Comparison with Current Position of the Company:
The next phase includes an analysis of the opportunities and risks with regard to the existing business and the products, the clients and the regions of interest are analyzed. Finally, digital capabilities are defined as human resources or partnerships and the digital business strategy is established. In this phase, implementation gaps and competence in the results are also identified.

(3) Implementation of the map:
In the last phase the definition of the relevant options for future scenarios takes place. It could, for example, be useful to identify the digital skills that need further development and the participants in the cooperative market are discussed.

The analysis of the different approaches of digital transformation is useful to understand the different possibilities in creating a strategic plan, or better, a "roadmap" that companies should follow for the implementation and development of digitalization in business models. However, these approaches are generic and generally refer to all businesses, distinguishing the different phases among them, highlighting the logic and the steps required for the digitalization of business models. In the second chapter I will describe the asset-intensive sectors and therefore a specific type of business. Finally, will follow how digitalization is implemented in this particular business model will be dealt with specifically.

Chapter 2: Innovation in Asset-Intensive Industries through Digital Transformation

2.1 Asset -Intensive Industry

An "asset intensive" industry is an industry which requires above-average levels of capital in order to operate. Such industries “rely heavily on physical assets, plant and equipment to fulfil their mission” (Investopidia). These industries require large amounts of investment to produce a good or service and thus have a high percentage of fixed assets, such as property, plant, and equipment (PP&E). “Property, plant, and equipment (PP&E) that are long-term assets vital to business operations and not easily converted into cash” (Investopidia).
The principal physical assets, which are part of an organization’s infrastructure, are positioned in the following four classes:

– Plant and production (occurring, for example, in industries such as oil, gas, chemicals, mining, manufacturing, pharmaceuticals, food, electronics and power generation)

– Infrastructure (including railways, highways, telecommunications, water and wastewater, and electric and gas distribution networks)

– Transportation (for military, airlines, trucking, shipping, rail and other uses)

– Real estate and facilities (for example, in offices, schools and hospitals)

The human asset, as an asset, is also fundamentally in order to generate value for the organization, perspective provides a broad view of personnel motivation, expertise or skills, roles and responsibilities, succession strategies, and insight into leadership teams within the organization.

One of the meanings of “Hard Asset” is also “tangible or physical item or resource that an individual or company owns. Hard assets, like any asset, are purchased with the expectation to generate value in the future. A company purchases assets to help the company improve production and revenue. Hard assets that a company might buy include a fleet of trucks for delivery of their products. Some example are Buildings, Vehicles such as trucks or cars, Machinery and equipment, Office furniture, Machinery” (Investopidia).
Additionally, companies in asset-intensive industries intrinsically require larger Capital Expenditures than non-asset-intensive companies, and their financial performance is largely dependent on the return they get from those investments.

- *Capital Expenditures (CapEx)*

"Capital expenditures, commonly known as CapEx, are funds used by a company to acquire, upgrade, and maintain physical assets such as property, buildings, an industrial plant, technology, or equipment. CapEx is often used to undertake new projects or investments by the firm. Making capital expenditures on fixed assets can include everything from repairing a roof to building, to purchasing a piece of equipment, to building a new factory. This type of financial outlay is also made by companies to maintain or increase the scope of their operations. Put differently, CapEx is any type of expense that a company capitalizes, or shows on its balance sheet as an investment, rather than on its income statement as an expenditure" (Investopidia).

CapEx = ΔPP&E + Current Depreciation

Where:

CapEx=Capital expenditures

ΔPP&E=Change in property, plant, and equipment

Asset-intensive industries are typically spread across a wide geographic area and are overseen by a field-based workforce. They operate mainly in sectors such as the chemical, refining, utilities and manufacturing sectors and can have over half of their budget in heavy assets. In these sectors, production depends on the availability of assets, which becomes a fundamental factor for the growth of profitability and profits. Furthermore, they are subject to physical elements and environmental stress, which can affect their ROI. Moreover, contributing to pushing asset-intensive organizations to adopt more attentive and mature business models are aspect such as increasing globalization, competition, the need to comply with national, international and sector regulations, the approach to environmental sustainability, aspects related to health and safety in the workplace, increasingly narrow margins and the consequent constant pressure on cost.

For companies operating in sectors such as chemicals, refining, utilities and manufacturing (Asset-Intensive), profitability and growth depend on the efficiency with which the assets are used. The products or services of an organizations have to deal with the progressive aging of material assets (plants, equipment, infrastructures, building components, communication and piping systems, electrical and electronic devices), continuous and increasing maintenance activities and repair is necessary, especially in the light of the fact that the performance of the assets and the consequent quality of the goods and services produced are directly influenced by their reliability. The increasing need for maintenance of assets and their management can therefore have a direct impact

on the quality of the product or service, as well as on the satisfaction of the end customer. Thus, the need arises for asset-intensive organizations to seek ways to cut costs and become more responsive to market demands.

2.2 Digitalization in Asset-Intensive Industry

To reduce costs the asset-intensive industries must undertake organizational change and make the necessary efforts to incorporate digitalization into business models and face the challenges imposed by the new Digital Era. A McKinsey study revealed, however, that many asset-intensive sectors have remained a step behind when compared to other sectors as regards the digitalization of asset management. This was also highlighted by R. Kohly and S. Johnson: "Digitization has changed the way firms operate in many industries, some of these industries such as oil and natural gas, waste management and construction, have been slow to adopt digital technologies" (Kohli & Johnson; 2011), they referred to these as *latecomer industries*. This is because the products and services of the asset-intensive industries cannot be completely digitized. According to R. Kohly and S. Johnson embarking on digitization provides opportunities and asset-intensive industries can learn from industries that are already digitalized. However, they still have to make choices that are consistent with their business to digitize processes and understand what types of technology investments are needed. "Although firms in Asset-Intensive industries have been digitized some administrative processes and operating operations, such efforts have been local and segmented" (Kohli & Johnson, 2011). The difficulty of undertaking digitalization for an Asset-intensive Industry lies in the characteristic of these, which includes firms with specialized, complex industrial machinery involving large capital investments (Asset-Intensive Industry). "These characteristics acts as barriers to entry for other firms, which, when combined with cyclical product demand, create inertia in undertaking digital transformation- especially when firms are enjoying high profits. However, increasing market turbulence resulting from competition for resources, and stringent regulations, require senior managers to carefully evaluate digitization opportunities to control costs and to become more flexible" (Kohli & Johnson, 2011). Choices on orchestrated digitalization efforts in organizations fall on CIOs, which must expand their "toolsmith" role of supporting back-office operation to providing business solution (Preston, Leidner and Chen, 2008). In fact, according to R. Kohly and S. Johnson "CIOs face in fulfilling the dual expectations of exploring new demand-side opportunities and exploring supply-side IT resources and these roles address two primary

organizational imperatives. First, rapidly changing market conditions demand that organizations quickly assemble their resources – IT and others – to respond with *Agility*. Second, increased competition expert pressures to reduce operational costs and demand organizational *Efficiency*" (Kohli & Johnson, 2011).

2.3 Strategy for Asset-Intensive Industry: Responsive Supply Chain Management

Specifically, to respond to the needs of Agility and Efficiency required by rapid market changes, conducted by the Internet revolution and development of ICT which transform the way of doing business, one strategy, especially for Asset-Intensive organizations, can be a Responsive Supply Chain Management (RSC). This strategy can lead Asset-Intensive firms in a better new way in order to generate more value through Digital Transformation. In answering the current demands companies are dealing with a revolution with regard to implementation of new operations strategies and technological solutions. The demand for lower priced top-quality goods requires 20th century companies to implement new solutions which are both strategic and technological as well as innovative solutions to ever-increasing and unique client demands. Particular attention is being given to Supply Chain Management (SCM) in order to increase revenue growth. Specifically, this means developing flexible supply processes with the dual aim of getting products to the market faster and cheaper. "Effective SCM is an essential strategy for success in the global and e-market. "SCM incorporates the entire exchange of information and movement of goods between suppliers and end customers, including manufacturers, distributors, retailers, and any other enterprises within the extended supply chain." The Responsive Supply Chain (RSC) addresses new ways of running companies to meet these challenges. RSC represents a global industrial paradigm for manufacturing in the twenty-first century. In a changing and competitive environment, there is a need to develop costs effective solutions to organizations and facilities that are highly flexible and responsive to changing market/customer requirements" (A. Gunasekaran et al., 2008).

- *Agile Manufacturing*

"Manufacturers need to be flexible and to cater to changing market conditions through Agile Manufacturing (AM)" (A. Gunasekaran et al., 2008). Youssef describe Agile Manufacturing as, "A manufacturing system with extraordinary capabilities to meet the rapidly changing needs of the

marketplace. A system that can shift rapidly amongst product models or between product lines, ideally in real-time response to customer demands" (Youssef, 1994).
According to A. Gunasekaran et al (2008), adapting AM to the market implies that firms adapt to the strategic demands of the supply chain. Strategic agility planning requires a strong supplier-customer partnerships as well as needed to effectively manage the supply chain. From this point of view, "agile supply chain management requires the capability to survive and prosper in a competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets, driven by customer-designed products and services".

Agile manufacturing is a natural development form the original concept of "lean manufacturing". In lean manufacturing, the emphasis is on the elimination of waste, where the philosophical emphasis is similar to that of SCM. The requirements for organizations and facilities to become more flexible and responsive to customers led to the concept of "agile" manufacturing as differentiated from "lean" organization. Therefore, agility should not only be based on responsiveness and flexibility, but also on the cost and quality of goods and services. This requires the integration of AM and SCM to develop a RSC with the objective of achieving agility in a supply chain environment" (A. Gunasekaran et al., 2008). According to A. Gunasekaran et al (2008), Agility in manufacturing is "the capability of an organization, by proactively establishing a virtual manufacturing with an efficient product development system to (i) meet the changing market requirements, (ii) maximize customer services level, and (iii) minimize the cost of goods, with an objective of being competitive in a global market and for increased chance of long-term survival and profit potential. This must be supported by flexible people, processes and technology" (A. Gunasekaran et al., 2008).

Gunasekaran A., Lai K., Cheng T.C.E. understood that the implications of AM and SCM required to develop a strategy that combines the positive features of both. They see this strategy in "the responsive supply chain (RSC)". In fact, this strategy is the one that best meets the needs of the Asset-Intensive Industry, which, as previously seen, due to the implications of digital transformation and the rapid changes in organizational contexts, requires the development of new strategies able to leverage the Agility and Efficiency of their assets, especially for Asset-Intensive firms whose activities are based mainly on the use of assets.

- *Definition of RSC*

"Agility is interpreted as using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place. This requires the slashing of process lead times and costs throughout the chain. It is not simply enough to enable agility; similar steps must also be taken to reduce information lead times and costs, resulting in the concept of the "information enriched" competitive and responsive supply chain (Mason-Jones and Towill, 1999).
There are five necessary basic functional activities in a value stream which include:

(1) procurement (maximum purchasing discounts), (2) inbound logistics (low transportation costs), (3) operations (low production costs), (4) marketing and sales (wide product range/high availability), and (5) outbound logistics.

SCM is defined as "the coordination of resources and the optimization of activities across the value chain to obtain competitive advantages. SCM facilitates organizational coordination required in an agile/virtual enterprise. These include: (i) the development of an interconnected information network involving a selected group of trained suppliers, (ii) a successful balance between a low level of stocks with high-quality delivery service, (iii) the designing of innovative products with the active collaboration of suppliers, and (iv) cost- effective delivery of the right products to the right customer at the right time" (A. Gunasekaran et al., 2008). AM focuses only on the search for flexibility and not on costs, therefore it is necessary to develop an effective supply chain to achieve all of these competitive performance objectives, i.e. a Responsive Supply Chain (RSC).
RSC is defined by Gunasekaran, Lai and Cheng as, "A network of firms that is capable of creating wealth to its stakeholders in a competitive environment by reacting quickly and cost effectively to changing market requirements" (A. Gunasekaran et al., 2008). From this definition, and in order to achieve an RSC, we can find the need to develop a collaborative network of companies based on core competencies, which leverages people and information quickly and in the most cost-effective manner. The concept/definition of RSC is illustrated in the following figure.

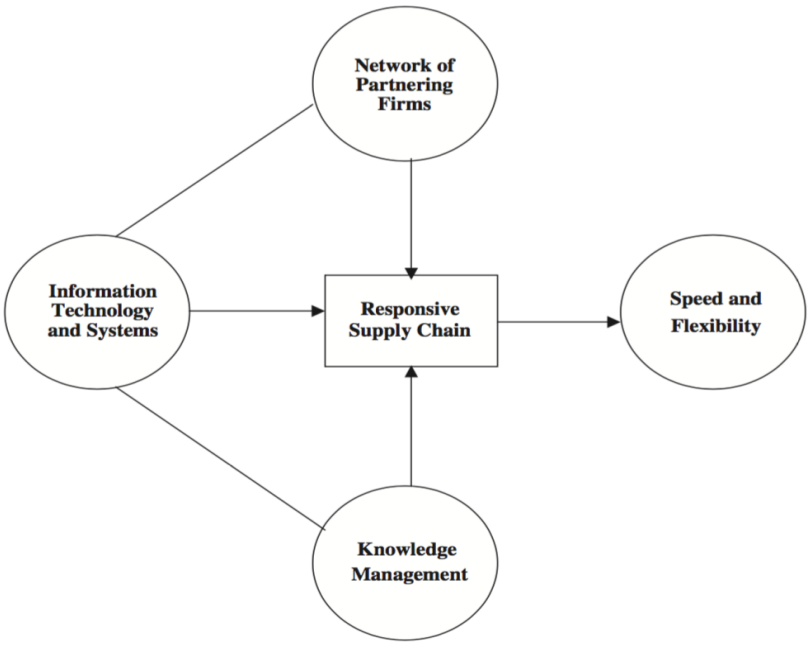

Figure 2.1 Definition of RSC (A. Gunasekaran et al., 2008).

There are three major enablers of RSC, namely, value chain or a collaborative network of partners, Information Technology (IT) and systems, and knowledge management. The interaction between these will lead to a supply chain that is responsive and flexible.

“A supply chain is the basic component of an RSC, where in suppliers play a major role in performing value-adding activities. Since a supply chain is primarily developed for lean production with the aim of achieving reductions in cost by eliminating non-value adding activities, it lacks speed and flexibility. Hence, there is a need to devise strategies, methods, and technologies for improving the speed and flexibility of the supply chain. Considering the overall characteristics of the strategies and technologies of AM and SCM, the enablers of RSC can be identified as (i) strategic planning, (ii) virtual enterprise, and (iii) knowledge and IT management. An RSC system requires a level of compatibility and interactivity that will allow the company to cope with the changes and increasingly complex settings of organizations and markets, particularly in a networked economy” (A. Gunasekaran et al., 2008).

- *Strategic planning*

"Strategy is the direction and scope of an organization over the long-term: which achieves advantage for the organization through its configuration of resources within a challenging environment, to meet the needs of markets and to fulfil Stakeholder expectations" (Johnson and Scholes, 2002). Strategic Planning therefore considers all the areas of an organization and

determines within the organization the suitable business and operational polices. To achieve agility in manufacturing, according to Gunasekaran et al. (2008), focus during the planning phase ought to include customer-integrated multidisciplinary teams, supply chain partners, a network of collaborative enterprises/partners, and knowledge and information systems. Such integrations, that lead to greater agility in the supply chain, necessitate radical production changes in line with the reconfiguration of business processes. They must also be supported by top management who must provide the necessary technical and financial support together with employee empowerment.

The involvement of top management is essential with regard to the successful re-engineering of both supply chains and logistics processes. "The adoption of time-based competitive strategies also recognizes the long-term advantages that can be derived from supplier integration. This collaborative relationship is from supplier integration and is a means of achieving the advantages of vertical integration without owning the means of production and facing the inherent risks of advances in technology or changes in the law. The sub-contracting of manufacturing technologies that are not considered to be areas of core competence increases the motivation to gain efficiencies from external resources" (A. Gunasekaran et al., 2008).

AM has different requirements/conditions for a workforce as compared to those of traditional systems. These requirements/conditions include: (i) closer interdependence among activities, (ii) different skill requirements, usually higher than average levels of skill, (iii) where any malfunction will lead more immediate and costly consequences than in a traditional system, (iv) where the output is more sensitive to variations in human skill, knowledge and attitudes, and mental effort rather than physical effort, (v) where there is continual change and development, and (vi) a higher capital investment per employee, which favors employees responsible for a particular product, part, or process. These characteristics also include: workers skilled in IT, knowledge in team working and negotiation, advanced manufacturing strategies and technologies, empowered employees, a multifunctional workforce, a multilingual workforce, and self-directed teams. Companies need tools to measure both ongoing business processes and to evaluate strategies across their supply chains. "A supply chain information system can be used to connect all tiers of a supply chain network. Regardless of the organizations' size, location, or IT operating environment, people within the networked supply chain can collaborate simply and quickly. A Web-based system will help a manufacturer establish closer ties with customers" (A. Gunasekaran et al., 2008).

Also, the importance of the relationship between the customer relationship strategy and supply chain strategy highlighted by Wisner, enhance the opportunity of more flexibility and responsiveness supply chains. In addition, according to Van Hoek, the elements of a supply chain

include: customer sensitive, vertical integration, process integration, and network integration. These features must all be developed by the organization for an innovative strategy that leads to a more responsible supply chain.

"The major issues in a strategic planning phase are how the resources can be reconfigured/reused to meet the challenges of market dynamism, technological advancements, infrastructure, government policies, and legislation" (A. Gunasekaran et al., 2008). Thus, when considering the long-term goals of companies, consideration of market types, strategic alliances, and capital investment decisions should rely on the top management, while their implementation should rest on functional-level managers and employees should be included.

- *Virtual enterprise/organization (VE/VO)*

The virtual manufacturing (VM) and the virtual enterprise (VE) are regarded as two crucial enablers which are both important and different when considering the agility of the supply chain environment. VE is based on developing partnerships based on core competencies for achieving agility in a supply chain environment, while, "VM is the use of IT and computer simulation to model real world manufacturing processes for the purpose of analyzing and understanding them" (A. Gunasekaran et al., 2008). As result of Globalization, new market opportunities have been opened for manufacturers, creating strong pressure on manufacturers to provide products of higher quality that are faster and cheaper and with a higher level of adaptability for consumers. For this reason, the development of the VE is of fundamental importance, "the main objective of a VE is to allow a number of organizations to rapidly develop a common working environment; hence, to manage a collection of resources provided by the participating organizations toward the attainment of some common goals" (A. Gunasekaran et al., 2008).

Virtual enterprises are characterized by several strategic objectives: (1) maximizing flexibility and adaptability to environmental changes, (2) developing a pool of competencies and resources, (3) reaching a critical size to be in accordance with market constraints, and (4) optimizing the global supply chain. However, appropriate coordination and integration at different levels of cooperation are required to establish strategic alliances or partnerships. This can be achieved thanks to the methodologies concerning communication, training and education, and goal deployment.

As noted earlier, partnership for developing a network of firms is based on core-competencies. According to Ruiz-Torres and Mahmoodi, in partnership development, there is a need for information on three functions of agile manufacturing, namely: (1) pre-qualifying partners, (2)

evaluating a product design with respect to the capabilities of potential partners, and (3) selecting the optimal set of partners for the manufacture of a given product.

To analyze and optimize the entire supply chain from purchasing / suppliers, using a streamlined logistics network, and to overcome cultural, communications, and cross-functional obstacles, as Hessney noticed, can be useful in enterprise resource planning (ERP).In order to solve cultural, communication, and cross-functional obstacles to achieve flexibility and speed across the entire supply chain, these difficulties can be overcome in a VE by providing strategic alliances and adopting advanced information technologies to improve communication and teamwork by empowered employees. VE is composed of a virtual design environment end virtual logistic that explains how the first operates. Regarding the virtual design environment "it is an information architecture to support design-manufacturing-supplier-planning decisions in a distributed heterogeneous environment" (A. Gunasekaran et al., 2008). According to Clarke, who introduced the concept of virtual logistics, "the physical and information aspects of logistics operations are treated independently from each other. In such operations, the ownership and control of resources is effected through Internet (or Intranet) applications rather than through direct physical control. This removes numerous operating constraints, and allows for the more efficient design of logistics networks. Logistics systems could then be constructed by purchasing an appropriate portfolio of resources. Such a portfolio could be easily and quickly adjusted to reflect changes in demand, changes in markets, or changes in products" (Clarke, 1998). Clarke also discussed other functionalities around the virtual logistic namely: virtual stockholding, virtual warehouses, virtual supply chains, virtual stock control, virtual trading, virtual production, virtual logistics services, virtual markets, virtual growth, and virtual organizations. These activities can be developed in order to follow flexibility and speed by the increase of virtual technologies. According to Sarkis and Sundarraj, while many organizations are adopting the concept of virtual enterprise, inter-organizational interactions have recently been emerging. The growing importance of ICT is leading organizations to new horizons for business, particularly in the form of E-Commerce. The companies using internet-based systems actually increase the flow of information throughout the entire value chain. This leads to looking at developing partnerships, developing and promoting relationships that focus interaction criteria on the evaluation of both suppliers and customers. A VE/VO highlights the role of strategic alliances/partnerships based on core-competencies in achieving flexibility and responsiveness, this becomes an important enabler for an RSC.

- *Knowledge and IT management*

"AM needs intelligent sensing and decision-making systems capable of automatically performing many tasks traditionally executed by human beings" (A. Gunasekaran et al., 2008). Therefore, high-level communication systems such as Internet, Electronic Data Interchange (EDI), and e-commerce to exchange information at various levels of manufacturing organizations are necessary for physically distributed and manufacturing environments/VEs.

A data management framework (DMF) to support AM is needed. A DMF has been defined as "the ability of an enterprise to manage distributed data, information, and knowledge as the decisive enabler for core enterprise business processes" (A. Gunasekaran et al., 2008). The aim of the DMF is to provide an effective solution for managing corporate data in order to support an Responsive Supply Chain. In this regard, numerous studies have been developed regarding Internet-based solutions for improving numerous aspects of organizations and also regarding the creation of new businesses enabled by the Internet itself. The impact of the Internet is relevant in customer services, purchasing, the handling of materials, and stock control. In terms of costs, "the application of the Internet in a supply chain will result in a reduction in service costs and response times to customer requirements" (A. Gunasekaran et al., 2008). Internet-based applications in the supply chain allow for an increase in agility throughout the whole organization, "one of the factors contributing to the ability to become an agile manufacturer has been the development of manufacturing support technology that allows marketers, designers, and production personnel to share a common database of parts and products, to share data on production capacities and problems" (A. Gunasekaran et al., 2008).

Weston described the important role that software-based integration infrastructures and integration structures can play respectively in supporting and organizing system behavior in a way that facilitates system extension and change. Such a software-based system is likely to become common building blocks of AM. "IT is providing the means for companies to better integrate their internal and external activities" (A. Gunasekaran et al., 2008). In fact, these levels of integration, according to A. Gunasekaran, are achieved through "Enterprise-wide systems". It is a large-scale application software packages, that reflect the current operations, information flows, data analytics and processes of the business and allow decision-makers to digest information more rapidly and accurately, and with more flexibility in manufacturing. Al-Mashari and Zairi, highlighted the development of ERP, which creates an opportunity to reengineer supply chains within and beyond the scope of an organization. Several other system' solutions available that can be used for an RSC are: MRPII, Internet, CAD/CAE, EDI, multimedia, and e-commerce. These systems include mostly

software/decision support systems for various planning and control operations including materials requirements planning, design, manufacturing resource planning, scheduling, and production planning and control. The utilization of these technologies such as the Internet will bring together applications related to resource planning (MRP, ERP, and cost-accounting systems), manufacturing execution (factory-level coordinating and tracking systems), and distributed control (floor devices and process control systems). Sanders and Premus have also discussed three key dimensions of IT in supply chain environments: (1) organizational competitive priorities, (2) choice of specific IT applications, and (3) performance measures achieved. In describing the main enablers of RSC (Strategic Planning, VE / VO and Knowledge and IT Management), the theoretical characteristics and the studies carried out by the authors have been proposed. Next, a framework from a study by Gunasekaran, Lai and Cheng, which the strategies and tactics of each, is proposed.

- *A framework for the development of an RSC*

In Fig. 2. is presented a framework focuses on strategies and tactics on the three major areas: strategic planning, virtual enterprise, and knowledge and IT management.

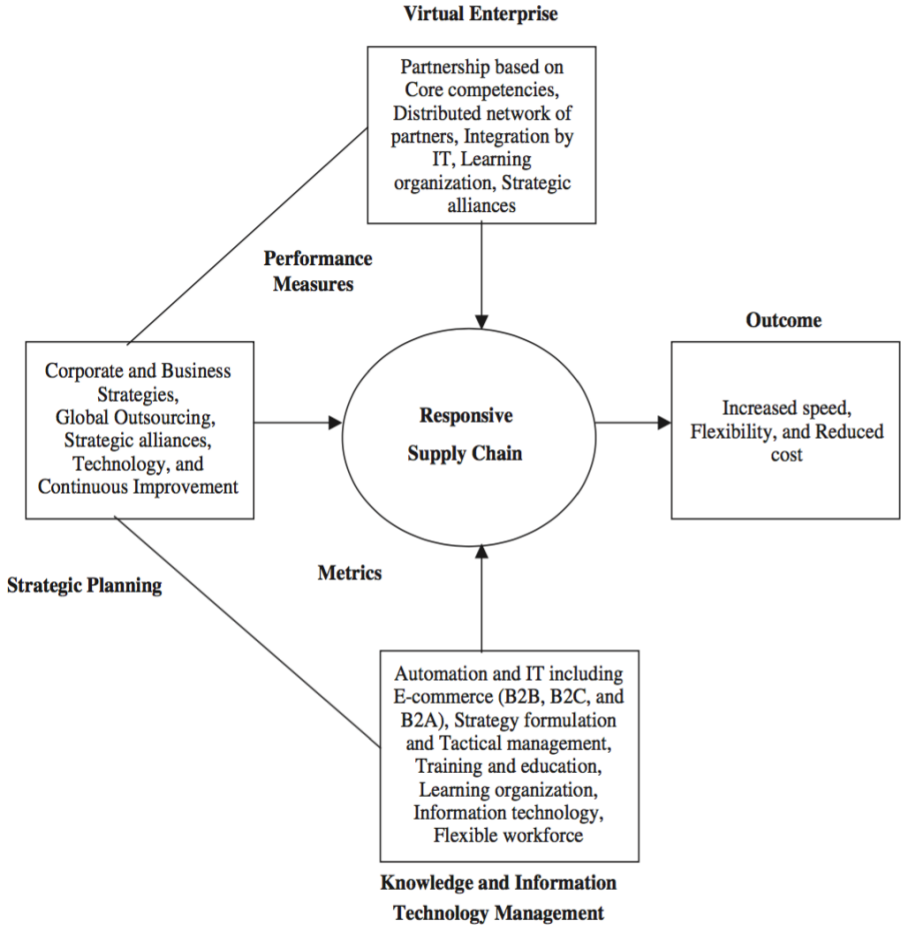

Figure 2.2: Framework for the development of an RSC (A. Gunasekaran et al., 2008).

-*Strategic planning*

Strategic alliances and the integration of complementary core competencies are necessary in developing a virtual enterprise for RSC. “To achieve RSC, several sub-strategies are needed, including the establishment of a virtual enterprise, the rapid formation of partnerships, the management of knowledge and IT, and the establishment of temporary alliances based on core competencies. Without suitable business and operations strategies, technologies and systems alone are not sufficient to achieve responsiveness in supply chain” (A. Gunasekaran et al., 2008). Also, RSC can be achieved by forming suitable strategic alliances based on mergers and acquisitions with the objective of obtaining the required services. Other external factors such as the type of market and products, location, government policies, and environmental regulations need to be considered in the strategic planning for the suitability of RSC and its development. “With regard to an agile supply chain, the involvement of top management is vital in the effective reengineering of the supply chain and logistics. In agile supply chain environments, relationships with suppliers and interactions between suppliers should be flexible in terms of the delivery of products/services and responsiveness” (A. Gunasekaran et al., 2008).

-*Virtual Enterprise*

Companies are seeking to become more responsive to changing market conditions by streamlining and restructuring their organizations and making use of virtual enterprises and knowledge work teams. The following steps can be employed for developing a VE: (a) identify the corporate objectives, (b) based on multiple competitive performance objectives, identify the product/service requirements from suppliers, (c) select partners based on the core competencies using a suitable supplier ranking system, (d) use the time scale, which should be rather short, linking all partners as a VE with the help of automation and IT.

-*Knowledge and IT management*

“Automation and IT play a dominant role in the development of a physically distributed enterprise or VE. The role of automation and IT can be identified in several areas of the development process” (A. Gunasekaran et al., 2008). Specifically, the areas most affected in this phase are the following: strategy formulation, tactical management, operations control, and systems. The effective implementation of IT/IS is highly desirable in obtaining a supply chain that can be more responsive and flexible. In order to achieve agility in the supply chain, Investments, particularly in knowledge and IT, are essential.

Given that IT touches nearly all segments of enterprise, Asset-Intensive firms must make digitization choices and to orchestrate technology as well as people, operational process and policies to impact the firm's top and bottom lines. This means that Digital transformation in asset-intensive industry requires substantial IT investments as well as expertise to integrate various supply chain processes. Moreover, Management of Asset-Intensive business require the IS function to be agile and capable of quickly scaling IT systems to meet business demands. As Asset-Intensive industries products cannot be completely digitized, "the firms need to digitize production and assets information by embedding IT into wellhead devices and other equipment, integrating supply chain processes and disseminating near real-time information for decision making" (R. Kohli & S. Johnson; 2011).

2.4 Evolving Business Information System (BIS) Usage in Asset-Intensive Industry

"Technology-focused and generalist investor alike have been investing in business information system (BIS) for Asset-Intensive company. Expanding use of BIS solution within these industry, high barriers to switching, relative price insensitivity, and ease of cross-selling new modules once you're embedded all make for attractive industry dynamic for potential investors. With Asset-Intensive industry firms fighting hard for every bit of incremental profit, productivity improvement has been a go-to strategy, and investment in computing power was often a surefire way to get it. But where this company are investing has change significantly. It is important to understand how in just few short years, the BIS end-customer needs have evolved from automating business processes to leveraging internally generated data for operational improvement. For improve outcomes, organizations perennially seek the best mix of people, processes and technologies to leverage" (Edwards and Costa; 2014). Currently, compared to years ago, the opportunity in Asset-Intensive industries are looked at very differently than today. According to Edwards and Costa: "The software systems first implemented to serve these industries sought to improve operational efficiency and reduce overhead costs by automating manual, labor intensive processes. Since the system were streamlining existing and clearly defined processes, return on investment (ROI) for these investments was achievable and measurable, enabling software providers to present firms in these industries with strong value propositions. Once software companies had penetrated these businesses, they were able to embed themselves within these organizations' core processes (e.g. production, asset management) and then branch out to adjacent, non-core processes (e.g.

forecasting, parts inventory, marketing) automating these functions on their way to becoming comprehensive end-to-end systems". (Edwards and Costa; 2014)

The opportunity now for software providers in asset-intensive industries "it is in finding and harnessing data that, when assembled and manipulated in new ways, can move the needle for operational improvement and greater return on assets (ROA)" (Edwards and Costa; 2014). Although this opportunity can take many forms: from business accelerators and performance management systems to benchmarking data. Particularly for asset-intensive firms, Paul Edward and Robert Costa have described the main functions that software developers are seeking to develop in order to provide management solutions aimed at improving ROA. These main functions have been categorized into three categories, shown in Exhibit 1, namely (1) sources effectively, (2) operate efficiency, and (3) maximize asset uptime and availability.

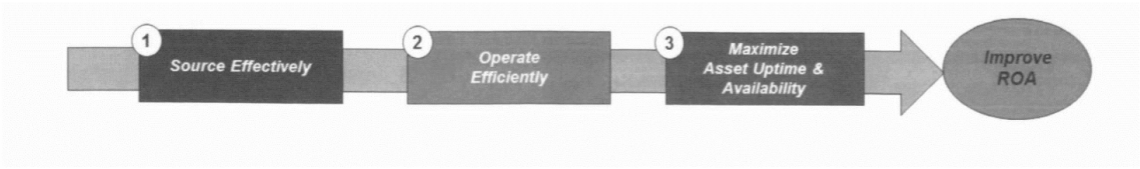

Figure 2.3: Opportunities for Software providers, (Edwards and Costa; 2014)

1) *Source Effectively: Improve Asset Procurement and Supply Chain Activities to Ensure Utilization of Assets*

   A key consideration for companies operating in Asset-Intensive sector is to maintain high levels of use between assets and selection of the appropriate inputs and assets. These functions take on differing configurations which depend on the sector in which the asset-intensive industries operate. To support and improve the process of carrying out the activity between the assets and correct input selection, Edwards and Costa have proposed software solutions intended to improve the flow of information between two or more entities or operating units operating at different stages in the chain of value. With the integration of these systems, asset-intensive industries have access to new external sources of information that would otherwise be difficult to reach and analyze. Also, such software applications provide support within both the decision-making and planning processes and can contribute to achieving cost reductions and efficiencies within the supply chain.

2) *Operate Efficiently: Minimize Operational Risk and Improve Efficiency*

The other area in which software providers help to add value is that of the exploitation of internally generated data where they improve speed and accuracy in decision making. With the use of these new tools, decision makers obtain information more accurately and quickly as these filters help to filter information and provide the most relevant information. In this way, being limited by only intuition or experience is eliminated, especially when activities such as shipping route optimization, communication performance improvement of the network, and simplification of extraction operations. Software integration allows concrete support by providing targeted and filtered information as a support for these decisions. Furthermore, they are seen to be even more valuable when asset-intensive industries need to break down barriers within the organization to improve visibility, providing managers with better visibility into quantifiable data and reporting based on accurate information.

3) *Maximize Asset Uptime and Availability: Improve Asset Value and Performance*

The last area regarding the asset-intensive industries and the opportunities offered by the software is that of the phases of planning and monitoring of the maintenance which, in particular for these sectors, are of great importance for the maximization of the value of the assets. Even though software contributes to utilization of the various processes associated with maintaining capital purchases, asset-intensive companies can find more than a monitoring of asset performance in technology. In particular, the diagnoses that treat and provide information when an asset present an unexpected problem and therefore requires maintenance. These systems collect information on the performance of the machines, identify anomalies or significant deterioration and, in some cases, even help to correct the performance problem. In these cases, already known in some sectors such as in the energy field (self-healing network solutions) and that of the Oil and gas (self-tapping cement system), we speak of self-regeneration. During this phase, software vendors try to improve current processes and exploit existing infrastructure by integrating, for example, cloud processes or virtualized devices.

"To be successful, software providers will likely need to evolve business models and supplement the software with consulting and service components in order to maximize the value that their solutions can deliver" (Edwards and Costa; 2014). Below is an example of software developed by IBM, which offers the necessary visibility, control and automation features of the fundamental information that an organization would need for greater efficiency in the management of its assets, on a single integrated technological platform.

2.5 IBM MAXIMO

IBM has recently developed a software, called IBM MAXIMO, which helps asset-intensive industries providing the capabilities to better understand how physical infrastructure assets operate. IBM MAXIMO is an example that reflects how, on the one hand, the development of Business Information Systems "have evolved from automating business processes to leveraging internally generated data for operational improvement" (Edwards and Costa; 2014), and on the other hand, how software systems implement to serve these industries by improving the operational efficiency and reducing overhead costs by automating manual, labor intensive processes. One of the main challenges characterizing the sectors for which the value of assets is most significant, is the choice of ways to effectively manage the different types of assets, without having to impose an excessive workload at the expense of results. Therefore, Enterprise Asset Management (EAM) processes and solutions represent an absolute necessity, given the intrinsic complexity of the problem. Asset management, driven by valuable insights from IoT data, can have a significant impact, especially for Asset-Intensive firms where the digital transformation has not received much attention for the previous years. The solution introduced by IBM is a recent example developed to face the new technologies provided by information systems and using these new opportunities to make better decisions with regard to all aspects of asset management, as well as the insights on delivering ongoing value to organizations.

IBM Maximo software, by augmenting IoT data with powerful cognitive insights driven by artificial intelligence, takes care of dealing more effectively with the needs of the business, particularly organizations such as asset-intensive industries that require continuous visibility and control of the own assets, and data and processes related to them. This is so, since production depends mainly on the availability of assets, which becomes a fundamental factor for the growth of profitability and profits in these particular types of organizations. In order to achieve the expected results and maximize the value of the assets themselves this software offers integrated visibility, control, and automation throughout the asset portfolio.

According to IBM studies, "to manage the full asset lifecycle and address these business imperatives, asset-intensive organizations can derive great value by implementing the Enterprise Asset Management (EAM) solution" (IBM,2012). The need therefore arises for asset-intensive firms to develop technologies capable of supporting the organization in all its phases. As shown by an IBM study, the development of this software is based on the integration of new digital systems that allow the Asset-Intensive Firms to:

- increase (or introduce) agility and flexibility in operational activities

- improve the use of assets thanks to a proactive asset management approach and the consolidation of its systems

- guaranteeing efficient and effective delivery of operational activities by automating workflows

- guaranteeing aspects of analysis and support for the decision, in terms of quality and consistency of the data, as for fruition (through visual indicators and dedicated dashboards). (IBM)

IBM Maximo integrates EAM's phases the by providing real-time insight and visibility into virtually all physical assets, and across maintenance, repair and the overall supply chain. In this case the points of integration are: enterprise resource planning (ERP), geographic information system (GIS), and supervisory control and data acquisition (SCADA) systems that help maximize value across assets.

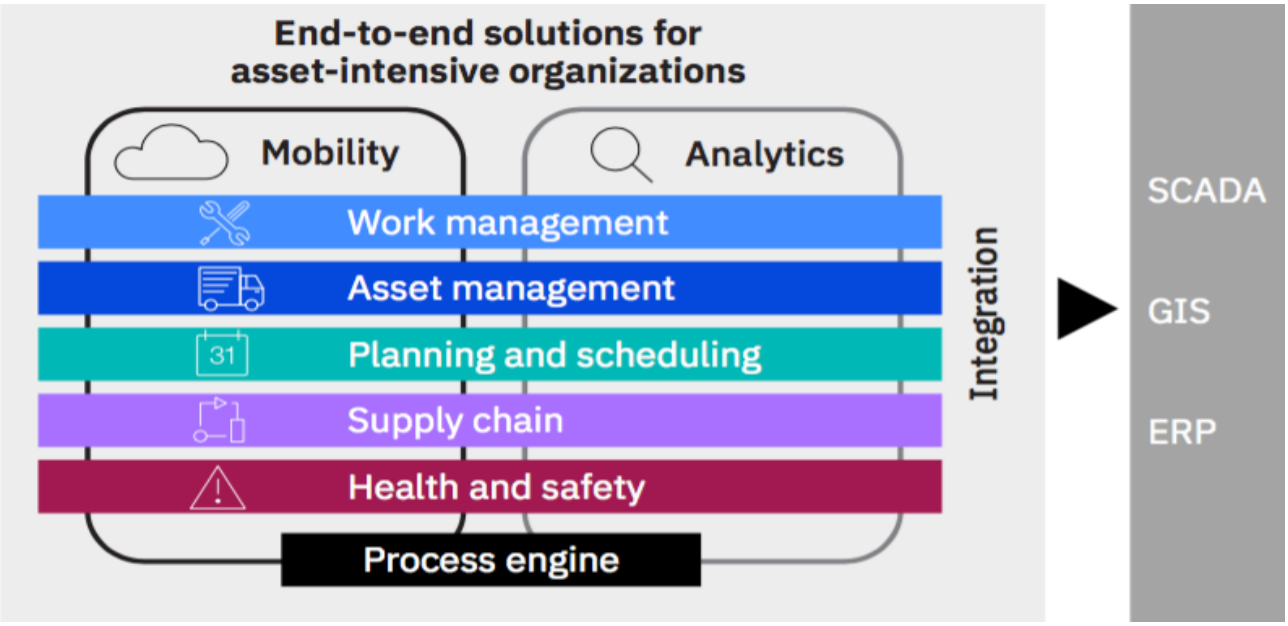

Figure 2.4: how mobility and analytics extend the functions of each category (IBM, "Understanding the impact and value of enterprise asset management)

The ability to adapt to changes by improving operations can mean the difference between survival and extinction. Successful organizations build agility into their business model and operate with efficiency. The IBM study shows that Asset management, driven by valuable insights from IoT data, can have a significant impact in asset-intensive activities. The current trend of automation in manufacturing technologies which merges physical systems, IoT, and cloud computing factors, contribute to the emergence of Industry 4.0.

2.6 Became INDUSTRY X.0

"To create value with digital, companies must completely reinvent their operating models, production and value chains" becoming what Accenture calls "Industries X.0 Businesses" (Accenture; 2018). As mentioned above, "Digitally enabled organizations are supported by new information and communication technologies (ICT), referred to as digital technologies which increasingly promise enormous opportunities for growth. These new digital technologies embrace ICT systems such as virtualization, mobility, and analytical systems and are integrated with back-office ICT to provide a holistic view of the digital enterprise" (Looman et al.; 2018).
Digital enterprises are empowered by the deployment of ICT systems that combine three key technologies, namely (i) virtualization systems, for example, cloud computing, (ii) mobility systems, for example, social media, the internet of things, smart- phones, and tablets, and (iii) embedded analytics systems, for example, big data. These three technologies, combined with integrated back- office ICT systems such as enterprise systems, enable the digital enterprise.

The business is then re-imagined as smart, connected, living and learning entities, able to offer a hyper-personalized experiences, new level of efficiency and new sources of growth by smart, connected digital technologies.

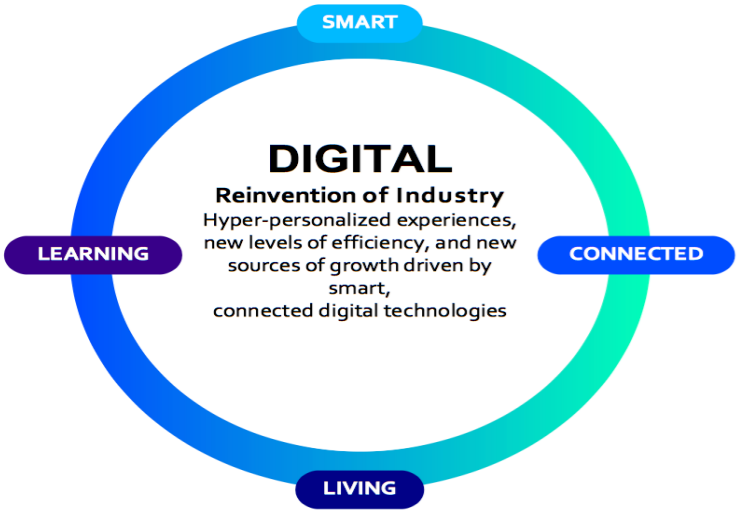

Figure 2.5: Digital Reinvention of Industry (Accenture; 2018)

Digital transformation is all about in the combinations of new digital technologies, as in the case of asset-intensive situations. As example of software we have looked at the following: SCADA, a

distributed IT system for monitoring and supervising physical systems, ERP that manages and integrates all processes relevant business of a company (sales, purchases, warehouse management, accounting, etc.), and the geographic information system (GIS) that allows the acquisition, recording, analysis, visualization, return, sharing and presentation of information deriving from geographical data. The integration of such software creates the conditions for a more efficient, smart and connected digital business.

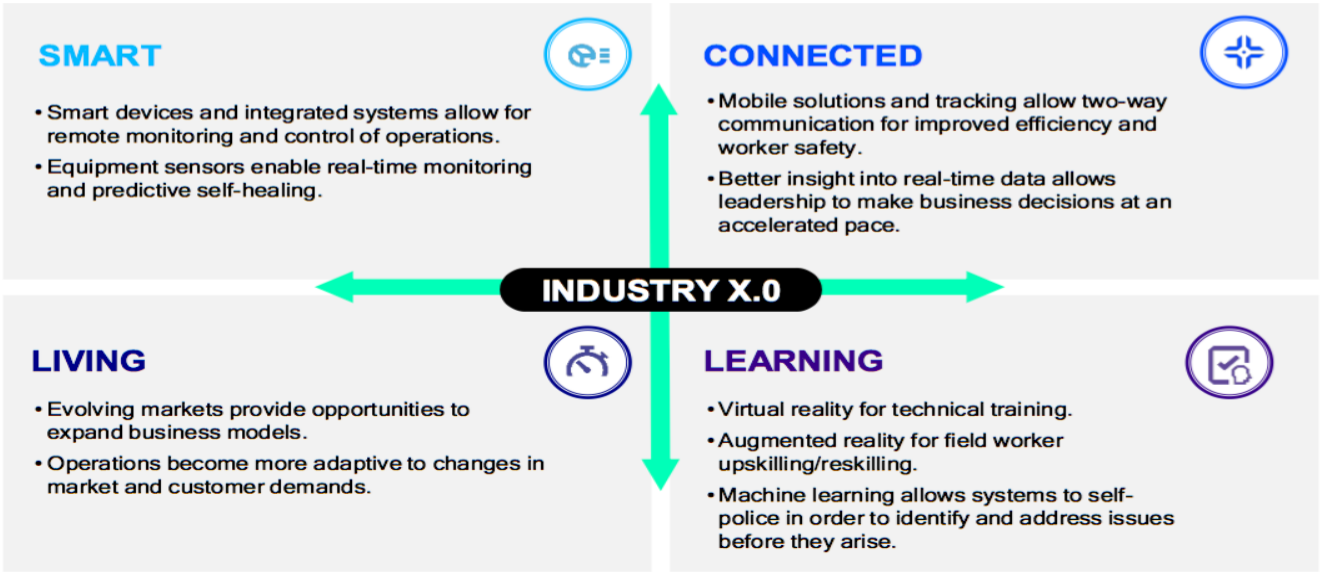

Figure 2.6: Industry X.0 (Accenture;2018)

"Organizations that successfully craft a vision that aligns internal business process integration with external digital technology opportunities will leverage significant strategic advantages within their respective industry" (Looman et al.; 2018). In fact, the Accenture study shows that asset-intensive industries can enjoy increasing market capitalization of about 25.4% if they systematically combine technologies to drive new experiences. As Accenture proposes, there are six imperatives to follow in order to become an Industry X.0:

1) TRANSFORM THE CORE:
   Build core engineering and production systems around digital platform to drive new levels efficiency. Synchronize physical machines and software systems to unlock cost efficiencies and investment capacity.
2) FOCUS ON EXPERIENCES AND OUTCOMES:
   Increase performance by investing in new ideas, testing with appropriate Key Performance Indicator system (KPIs), to measure success and then scale based on results.
3) INNOVATE NEW BUSINESS MODELS:

Ideate and create new business models to drive differentiated value and new revenue streams.

4) BUILD A DIGITAL-READY WORKFORCE:
   Source, train and retain talent with digital-ready skills and encourage active collaboration between people and machines.
5) RE-ARCHITECT NEW ECOSYSTEMS:
   Create a robust ecosystem of suppliers, distributors, start-ups, and customers that allows them to rapidly scale new business models across the digital value chain.
6) PIVOT WISELY:
   Continually balance investment and resource allocation between core business and new business to synchronize innovation and growth.

One practical example of how digital transformation is innovating asset-intensive industries can be found in Encana Corporation, a company operating in the Oil and Gas sector, which, after following a path of Digital Transformation, succeeded in innovating and keeping pace with the times and demands imposed by the Digital Age.

Case: Encana Oil & Gas

3.1 History and Corporate Structure

Encana Oil & Gas (USA) Inc. is part of the Encana Corporation group, which owns assets for a total value of approximately $34 billion, revenues from sales of about 8.9$ as of December 31, 2010 and has about 4,200 employees. Encana Oil & Gas, the subsidiary that is the subject of this case study, operates gas field in Canada and U.S. and is recognized as an innovative mid-size natural gas producer. In 2010 its natural gas production was more than 3,300 million cubic feet equivalent (MMcfe) per day. Figure 3.1 shows the locations of Encana's Gas field in 2010.

Figure 1: Encana's Natural Gas Fields in North America

Figure 3.1 Encana's Gas Field, (R. Kohli & S. Johnson; 2011)

Encana entered the U.S. energy sector in 2000 as Alberta Energy Company Oil & Gas (USA) Inc. The company was created through the acquisition of McMurry Oil Company. The group leader, Encana Corporation, has two divisions operating in the sector, U.S. and Canada Divisions, and several Business Units (BUs) with the two main divisions. The goal set by Encana Corporation was to be the lowest-cost highest-growth senior natural gas producer in the North America.

3.2 Business Environment

Before analyzing the digitization process, carried out by Encana Corporation, it is useful to understand what are the characteristics of the oil and gas industry and what conditions have led these companies to have to innovate. “Technological advances and large capital investments by natural gas firms have resulted in lower exploration costs, reducing, for example, drilling time of a shale gas well by as much as 35 percent. This improved efficiency has increased supply and put downward pressure on gas prices, requiring gas producers to cut costs or curtail production. The new sources of shale gas now coming on stream mean that market price is expected to remain volatile” (R. Kohli & S. Johnson; 2011). Low gas prices dramatically reduce profitability for gas producers who have large investments in land rights and drilling operations, for this reason, in September 2011, the Encana Corporation's President and CEO Randy Eresman announced a planned reduction of Capital Expenditures as a result of stubbornly low gas prices. He did not consider it convenient to push the company to increase production at a high rate in such a market, where low natural gas prices persisted.

Given these market conditions, it becomes imperative for Encana to produce optimal quantities of gas. Too much would force Encana to sell gas at a discounted price; too little would result in supply disruption to customers. As a consequence, gas customers— utility companies, brokers and industrial buyers— are concerned about the uncertainty from potential disruption in supplies should drilling become unprofitable for gas producers. “To reduce uncertainty, gas producers and customers enter into contracts based on fixed prices, floating index-based rates or an option involving a combination of fixed price and floating index. While such transaction structures provide some certainty for gas customers, they require gas producers to closely monitor the terms of each contract vis-à-vis production costs and to make prompt adjustments” (R. Kohli & S. Johnson; 2011).

3.3 Organizational Goals for Digitization

For Encana, here are numerous difficulties in investing in digitization when the market conditions are so uncertain, as is the situation for other "latecomer" industries where the supply chain involves huge capital expenditures in equipment and numerous complex processes, exploration, extraction, production, transport, storage, distribution and marketing. "Digital transformation in the natural gas industry also requires huge IT investments such as a competence to integrate various supply chain

processes" (R. Kohli & S. Johnson; 2011). Therefore, the producers of natural gas must first assess their corporate objectives and understand how to allocate organizational resources before committing to investments in the digitalization of the business.

To address these challenges and market conditions, Encana's business and IS leaders set two organizational goals for digitization:

- Respond effectively to price volatility
- Reduce production costs by seeking unconventional sources of natural gas

From the point of view of digitization, these objectives that Encana Corporation has set for itself, translate into the integration of the supply chain of automation, exploration, drilling and delivery processes for a more efficient and agile business.

The two main questions that the organization needed to address were: how would the CIO translate this vision into lower and reactive production costs in the light of price volatility, and, how would this effort have been dealt with?

"As Encana's business strategy emphasized low-cost and high-availability gas production it was clear that the effort would involve the entire organization. The CIO and IS function were essential to this effort because IT touches every part of the organization. Encana's CEO therefore assigned the CIO to orchestrate the digitization effort to reduce costs and develop capabilities to deal with market volatility" (R. Kohli & S. Johnson; 2011).

3.4 Digitalization Infrastructure

Most digitization examples involve companies that have converted physical products into new products that can be digitally delivered to the consumer. As seen in the first chapter, the examples include e-books, downloadable music and movies, or in the case of physical products, digitization can involve information on delivery processes such as tracking parcels via GPS locations, transportation vehicles or support for other devices such as 3D printers. Given that the Encana product cannot be digitized, digitization has covered information on production through the incorporation of IT into header devices and other equipment, integrating supply chain processes and

disseminating real-time information for the decision process. The digitization of Encana Corporation is divided into four distinct phases as shown in Figure 2, which follows a timeline of the Digital Transformation of Encana.

Figure 2: Encana's Digitization Timeline For Automation, Measurement and Analysis

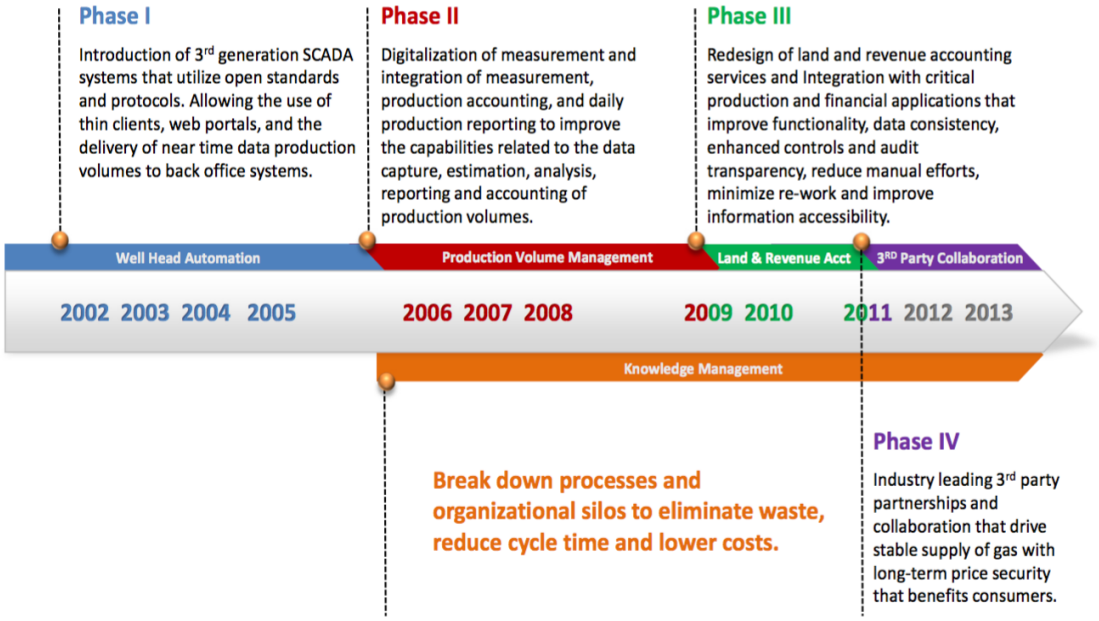

Figure 3.3: Encana Digitization Timeline (R. Kohli & S. Johnson; 2011)

Phase 1: As seen in the previous chapter, one of the imperatives for the digital transformation of the Asset-Intensive Industry is he "Transform of the Core", through the construction of digital engineering systems aimed at promoting greater levels of efficiency. These, concern the synchronization of physical machines and software systems to unlock cost efficiency. The first phase of the digitization of Encana began in 2002 and concerned, precisely, the digitization of key upstream supply chain processes with Internet-based financial and operational systems. These include digital integration of back office operations with supplier processes, which provided Encana managers with information on what determined operating costs and strengthened relationships with suppliers. Similarly, for "Transform the core", the digitalization of internal business processes

required the integration of the Supervisory Control and Data Acquisition systems (SCADA), used to manage gas wells and production operations with support systems for company decisions. The SCADA systems were subsequently implemented with the emergence of Internet-based IP networks that allowed the hardware and controllers to power the Encana communications network and thus to provide greater visibility and control of the supply chains. The integration of SCADA systems laid the foundations for achieving the company's digitalization goals. Large amounts of data can now be extracted, delivered and applied by executive managers in various corporate groups.

Phase 2: In recognizing that to accomplish a digital transformation, the simple connection of various different systems is not enough, the CIO and the managing group introduced the Production Volume Management (PVM) system in the second phase, with an investment of about $ 20 million. “PVM optimized the upstream supply chain for effective cost management. Innovative technologies to digitize business processes such as field data capture, daily production reporting, production accounting, royalties management and plant accounting, all of which enabled greater visibility into the supply chain" (O. El Sawy, E. Karahanna and V. Grover). The ultimate goal of PVM is to provide the company with high quality, timely and reliable data. This serves to improve the quality of management decisions. Figure 3.3 below shows a breakdown of the PVM system. This phase goes back, more generally, to the second imperative that Accenture, i.e. the need to follow the digital transformation in asset-intensive industries. This concerns the “Focus on experiences and Outcomes”, investing in new ideas, testing with appropriate KPIs, to measure success and scale based on results. This is what Encana tried to do at this stage by investing in software, the PVM, which allows to optimize managerial costs, intervening in the supply chain, with the aim of providing the business with high quality, timely and reliable data.

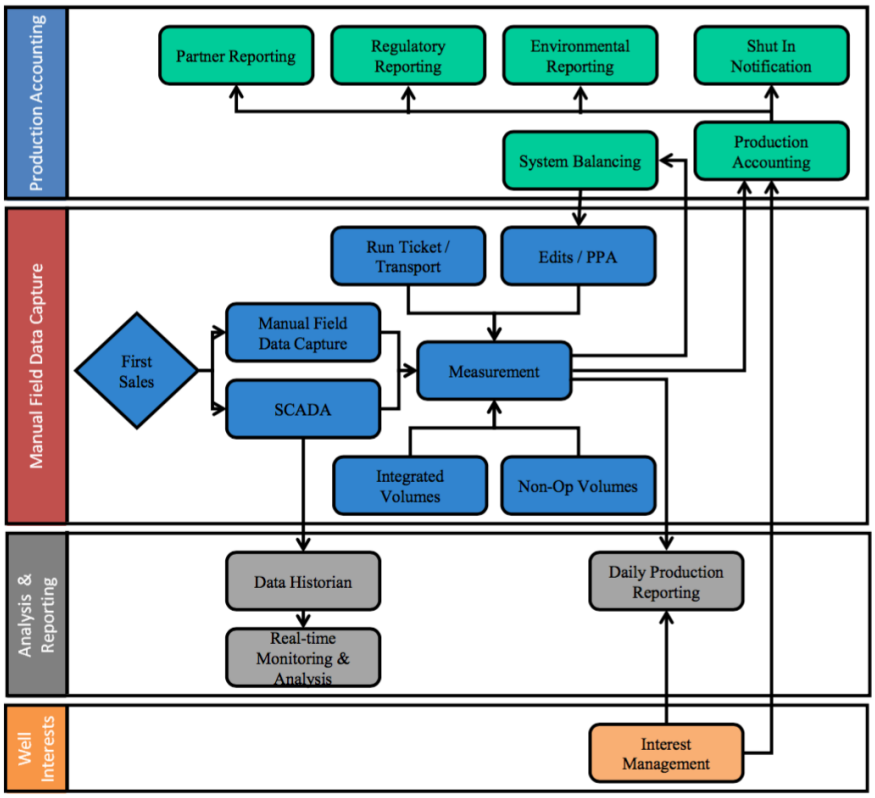

Figure 3.4: Schematic of the Production Volume Management System (R. Kohli & S. Johnson; 2011)

Phase 3: The third phase of the digital transformation of Encana involved the Land & Revenue Accounting system with a capital investment of $12 million. The data acquired from the drilling, production and maintenance phases, including those from other systems such as invoices received from suppliers, provided decision makers with a series of data related to company operations. This "visualization" has given managers the opportunity to investigate the cost structures of Encana's capital investments in the production phase as well as in gas field management. Managers have acquired greater efficiency in the company since they are able to regulate not only the production with the data received from the various systems visited previously, but also the management of drilling and maintenance programs. As shown in Figure 3.4, in this phase business intelligence tools are used to identify models from integrated cross-functional data combined with external scientific and geological data to produce real-time knowledge to optimize strategic planning in Encana.

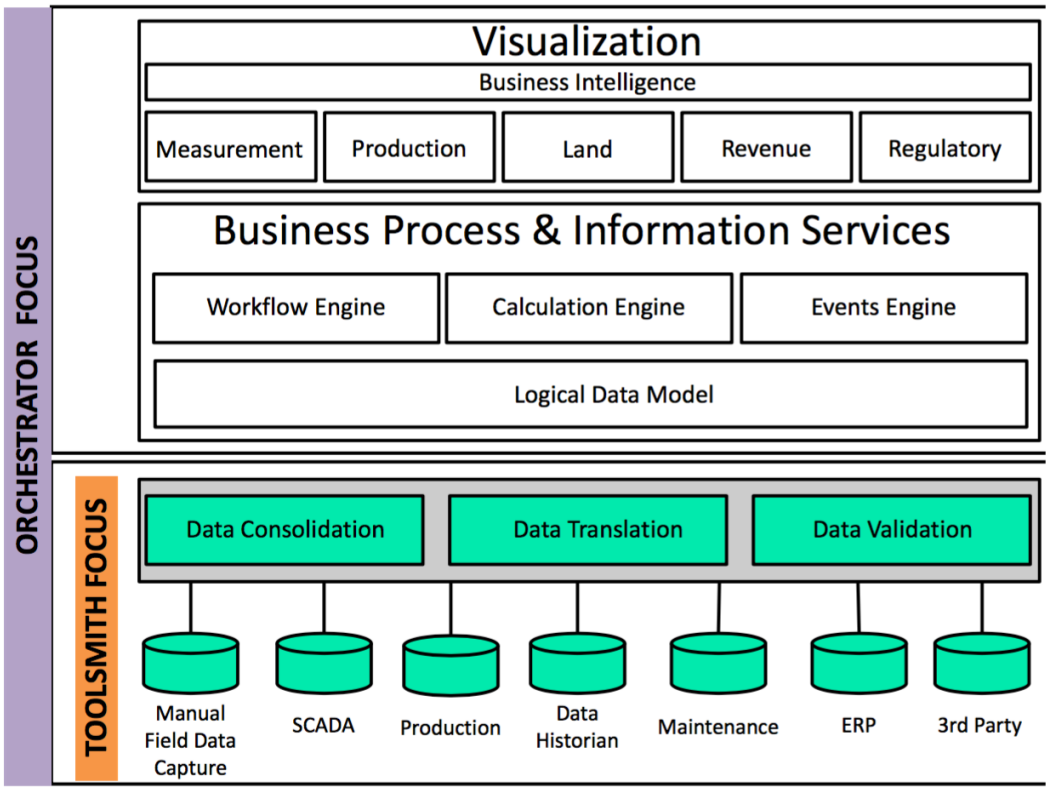

Figure 3.4: Architecture of Encana' Data Integration Visualization of Cost Structures (R. Kohli & S. Johnson; 2011)

The Land & Revenue Accounting system has integrated information on key resources for exploration and drilling. Together with the previous phases, which aimed to exploit real-time data (SCADA) and historical data (Leasing and drilling costs) that significantly advance managerial decision making and contract performance.

This "Brick-by-brick" digitalization gave led to two applications: "Digital Oil Platform" (DOP) and "Electronic Lease Purchase Report" (eLPR), both of which allowed Encana to exercise greater control on costs, achieve agility to guarantee the lease of land for exploration and at the same time strengthening relations with service providers.

"In the drilling sector, rapport with service providers is an intangible asset that is essential to meet exploration and delivery deadlines and is highly valued among natural gas companies. Capabilities to manage suppliers and control costs are considered essential to becoming a world-class energy producer" (R. Kohli & S. Johnson; 2011).

-Digital Oil Platform (DOP)

Through this application contractors and service providers can send invoices digitally. The rules integrated in this system verify the services performed with respect to the service orders purchased by the company and establish rules for processing invoices. Thanks to this application, Encana has gained efficiency by reducing the efforts needed to process invoices and negotiate with suppliers on payments. In addition to gaining efficiency, the PDO has allowed Encana to retain service providers.

- Electronic Lease Purchase (eLPR)

One of the most important competitive factors for Encana is the search for new and continuous sources of gas. Hence the need to decide quickly on the hiring proposals of land for exploration. The competitiveness of Encana depends on the security of land leases for gas exploration which in turn determines its capacity and its market share. The various phases of renting, mapping, scanning of the land require time and traditional procedures that delay the exploration and delivery of the gas. eLPR as integrated these phases into a single system thanks to a single database that is integrated with historical data relating to the PVM. In addition, data analysis and business intelligence tools are used to learn about the prospects for natural gas in future assessments of the purchase of lease contracts for a given land. Thanks to these analyzes, Encana has become more agile in negotiating and developing lease agreements in the future.

Taking up the imperatives that Accenture proposed for the Digital Transformation in Asset-Intensive Industries, the point regarding the "Re-Architecture New Ecosystem" states that it is fundamental to "Create a robust ecosystem of suppliers, distributors, start-ups, and customers that allows them to rapidly scale new business models across the digital value chain"(Accenture 2018). This was the objective that Encana sought to strengthen in the fourth phase of the digital transformation process.

Phase 4: In this phase, Third-Party Collaboration (2011-2013), the company's focus was to “seeks to add more “bricks” to Encana’s digitization through integration with the systems of third parties such as industrial customers, utility companies and gas distributors” (R. Kohli & S. Johnson; 2011). Encana, in particular, was able to share its responses to market volatility with partners and help them better control their costs. In the long term, this increased collaboration between the partners resulted in a reduction in the costs for all, bringing greater benefit to gas consumers.

3.5 Orchestrating Organizational Resources for Digitization

To digitize business processes, as seen previously, both supply and demand-sides leadership are required. IT links the various functions of the organization in order to execute the overall business strategy, but it must be consistent with the company's objectives and mission. "Business strategy is implemented through organizational design and control processes that are consistent with the values (and mission) of the organization" (R. Kohli & S. Johnson; 2011). In the case of the Asset-Intensive industries we have seen how these generally have significant investments in equipment and machinery and that their strategy therefore requires a synchronized redesign both in the operational processes and in the corporate governance, through incentives and learning mechanisms. The various software that enable and connect the different phases of the organization and the digitalization of processes to support managerial choices have required, through the IOC's orchestrator role, the development of an organizational strategy that integrates exploration and drilling assets with administrative processes. This strategy implemented by Encana follows the objectives of both reducing and controlling costs as well as the ability to respond rapidly to market changes. To achieve these objectives, it was necessary to combine applications such as *Digital Oil Platform (DOP)* and *Electronic Lease Purchase (eLRP)*, while the PVM system provided the necessary efficiency and agility. Agility has been further accelerated with business intelligence generated by cross-process analysis of business operations. Business intelligence has provided Encana with the ability to anticipate operational risks and seize new business opportunities through a better understanding of the markets. For example, gas prices also depend on the trend of electricity consumption that can replace gas with electricity generation. Gas prices are therefore also influenced by the prices of competing fuels, such as coal and oil, as well as the demand and supply of energy. Business intelligence provides competing fuel indices and prices and informs the decision makers so that they can adjust production to stay in sync with demand. The way the CIOs orchestrated organizational resources while the company digitized its operations and processes are shown in Figure 3.5, as can be seen, the first step towards developing the organizational strategy was a new vision of the IS function. and corporate governance with the stabilization of IS guiding principles for IT acquisition, the availability of information and the responsibility to demonstrate the value of IT investments. These guiding principles have been used in Encana to achieve operational excellence and organizational goals.

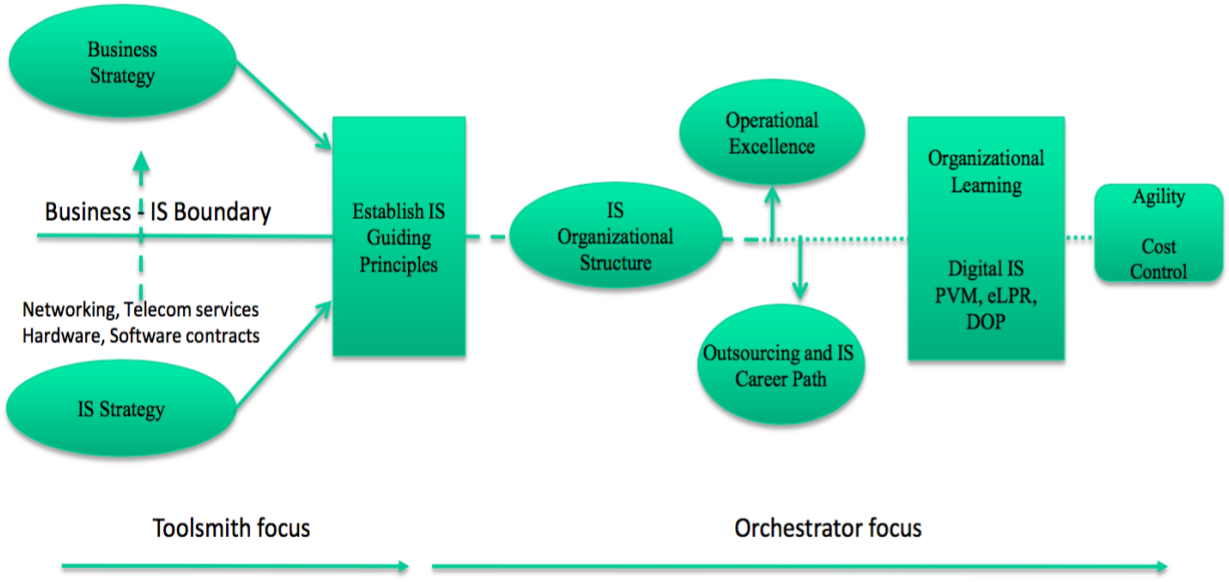

Figure 5.3: Overview of Encana Orchestration of Digitization (R. Kohli & S. Johnson; 2011)

Encana's senior management and the CIO identified the IS skills that the company needed to establish the IT service levels necessary to support business applications and retain useful data for cost control and business agility.

3.6 Digital Strategy in Encana

As previously mentioned, Encana has two divisions operating in the sector: U.S. and Canada Divisions. Each of the two divisions has different Business Units (BUs) that are managed by various business support groups, including the IT solutions group (called IS). The IS organizational structure mirrors that of the Business: an IS leadership team at the company level, one at the division level and IS groups at the BU level. To support the guiding principles for the digitization and implementation of IT systems, the CIO restructured the IS organization into a new highly decentralized governance model in which IT professionals worked alongside BU managers. This close relationship has allowed the protection of the BU interests to guarantee reliable and local solutions to support the BU's operations. In turn, the commodity functions were centralized at the

corporate and divisional level so that the BUs could benefit from economies of scale in contracts and the purchase of IT services. The decision-making rights concerning the size and structure of the IS / BU groups were assigned to company executives. Through this decentralization of IT decisions, the managers of the individual BUs determined IS service levels based on their business priorities, assigning the IS budget they needed accordingly. The BU's responsibility is to guide the way in which the IS team must concentrate its services, such as application support or the BU function, such as account management, field support or analysis of business systems. Furthermore, this type of government structure has encouraged IS staff to learn the business and participate to provide innovative solutions. Learning and innovation have been a key component of Encana's agility in responding to new gas plays, land leases and gas supply contracts. The integration of these new systems has also allowed us to look for new opportunities for efficiency within the IS. In order for the relationship between the IS and the BU function to work, it was necessary for Encana to implement links through a reporting that allowed them to have access to the best practices and process standards, as well as to provide input to the third parties of contracts with service providers. In essence, decentralization has ensured that the corporate IS function focus on the development of the IT platform and supports the various corporate functions such as compliance, regulations and strategic alliances. The BU / IS groups focused on the best way to support operations while corporate ISs supported the global business needs that emerged from the various BU. From the implementation of this new decentralized business model, the Encana CIO distinguishes between the IS that creates efficiency and the IS that enables the strategy, with the aim of outsourcing or contracting a large part of the IS that creates efficiency and maintain the IS which enables the strategy. As efficiency is one of the two main business needs, the dilemma for Encana arose as to how the efficiency-creating IS could be outsourced. Outsourcing IS is one of the guiding principles set by the IOC in Encana, which has argued that outsourcing frees up resources to be used in IS planning and that it would help Encana to become more sensitive to market demands. The digitization efforts that the IS function must concentrate on, as highlighted by the CIO, were directed towards helping the BUs. This was achieved by implementing integrated systems to analyze the areas that allowed Encana to rapidly target those containing high quality gas sources and also business intelligence applications to build economic models for land drilling in the face of volatile land prices and demand. Another question that the CIO had to ask to contract or outsource the technical functions of the IS function was that on how IS personnel could be motivated to learn about natural gas business. The CIO has therefore established various career paths and provided resources to help IS professionals. For example, through the rotation program for new employees, it was possible to rotate employees for two years through various BUs to help employees learn about

company operations, and also encourage entrepreneurship and leadership skills. On-demand digital online courses and seminars were also offered in cross-functional business areas. The availability of these resources shows how Encana has succeeded in laying down guiding principles and has directed its digitalization efforts to respect them, at the same time demonstrating that it not only values its hard assets but also its human assets, human resources and intellectual capital of its employees as valuable attributes.

- *Redesign Processes*

Considering that Encana's digitization goals were focused on cost control and agility, the company executives entrusted the CIO with the additional role of redesigning processes in operational areas such as gas exploration, drilling and transportation natural. The information generated by the redesigned operational processes, presented to engineers and managers, facilitated learning and a deeper understanding for greater control. CIOs and executives have seen that to achieve operational excellence, Encana needed to digitize the basic process technologies that involved drilling, production and transportation, both those of integrative processes such as business intelligence, prices and demand data, reconciling business processes key. What emerged from this type of operation implemented by the IOC and the executives was a strategic convergence in the IS function. Encana has not undertaken a redesign of productivity processes, but, even if these are essential for the business, IT systems for these types of processes have been contracted out where they were not critical to the business. The focus of the redesign was directed towards greater operational efficiency. In Phase I, work processes were reorganized through the use of digital portals aimed at simplifying equipment maintenance, reducing downtime and maximizing production. Variables that for asset-intensive companies, as seen in the second chapter, strongly affect ROA. Similarly, in Phase 2, with the application of the DOP system, Encana has simplified the processes of bargaining, order and delivery, invoicing and electronic payments, thus redesigning the procurement processes in the value chain. By implementing these simplifications, we can say that Encana directed its efforts to empower the supply chain, which, as seen in the previous chapter, brings benefits of agility and efficiency within all company areas. Furthermore, in order to have information available at anytime and anywhere, SCADA software was used to support field operations and provide data in real time, facilitating contract analysis and production with key performance indicators. In this way, the BU managers were able to keep track of the deviations of the production achieved by the planned production and take actions to synchronize the production with the market demand. Integrated production and management processes have supported Encana through automated regulatory and environmental reporting, giving managers the ability to focus on

the company's mission. Finally, in Phase 3, managers connected the main drivers of the business with the digitization strategy to obtain a greater advantage from the redesigned drilling and measurement processes so as to better manage the land and the revenue. Encana subsequently is preparing to strengthen the collaboration processes with third parties, Phase 4, to connect partners such as distributors, brokers, service companies and industrial customers, with its internal systems. In this way, sharing information with them in the most useful form, the goal of providing a complete picture of events and processes to third parties in the organization, has provided in the long term, better control and cost reduction compared to the volatility of the market.

- *Organizational Learning Program*

As seen above, the digitization of processes leads to the generation of enormous amounts of data. Therefore, Encana's challenge was to know how to make sense of this vast data resource. How can executives use this data to improve the quality of decisions? What is the knowledge that can be extracted from that data to improve efficiency and exercise better operational control and support Encana's future growth? To help answer these questions, after they were integrated with the PVM system, the CIO initiated a knowledge management program to acquire existing skills in the energy sector, generate business intelligence and provide useful and timely information to senior executives. This highlights Encana's commitment to people and their knowledge once again. By providing training for new employees, the training between BU and IS has offered learning of best practices in terms of IT implementations and exploitation of information to improve operational activity. IS learning has improved the skills needed to use the information generated in the field through the SCADA system. In the same way, the corporate IS has developed a standard catalog for the BUs, in order to keep the acquisition of new technologies as a reference.

3.7 Digitization Outcomes

Encana has taken a leading role in the digitization of the asset-intensive industry sector, in particular in the gas field. This was achieved by radically innovating their business by digitizing their supply chain operations, becoming more agile and efficient and integrating cutting-edge technologies to control costs and respond to price volatility and market demand. Furthermore, Encana has succeeded in developing business intelligence thanks to internal learning with data coming from outside, thus, according to company studies, leading to a managerial ability to project the market trend up to three days and with a precision of about 98%. The PVM system has meant that Encana could adapt the drilling and production processes based on price forecasts and market demand. Moreover, it has brought together its technology, people and process resources through the IOC, through integrated digitalization, IS function governance, and process excellence to synchronize supply and demand. The innovation that emerges from this study is the fruit of the strategy implemented by Encana to support the digital transformation of the company. Encana is an example of how digital transformation is catalyzing innovation in asset-intensive industries, but as seen in the first chapter, "Technological innovation is important for firms, but it might not suffice to guarantee firms success" (Doganova & Eyquem-Renault 2009). The technology and the various integrations provided in the case of Encana by various software such as SCADA, PVM, DOP and eLRP has, per se, no inherent value, but value derives, rather, from creating such a digital strategy that allows the organization to take advantage of the possibilities that novel digital technologies provide. The digitization strategy implemented by Encana has transformed the business process by "building core engineering and production systems around digital to drive new levels efficiency. Synchronize physical machines and software systems to unlock cost efficiencies and investment capacity" (first imperative by Accenture). However, the success of the digitization initiatives in Encana was not without its challenges. For example, non-core IT outsourcing has made Encana vulnerable to a lower level of technical expertise and higher coordination costs. The greater digitalization of processes has created a gap in skills between pre-digitization employees, who have experience and business knowledge but are not familiar with digital processes, and those recently hired who have technical skills but do not yet have knowledge of business operations. The same is true of the large number of contract workers who could cause conflicts between the two cultures: those who have already understood the new technologies and those who have knowledge of the company. Furthermore, the restructuring of the highly decentralized IS function, even if it generated proximity between BU and IS, exposed Encana to potential conflicts between BU and leadership, making it difficult for BUs with minor IS budgets to implement innovative ideas. This case study also offers several lessons for the role of the CIO in the field of asset-intensive industries. By

outsourcing non-core IT functions, the role of the CIO, which integrated IT into operational processes, was of fundamental importance. By orchestrating the digitization of Encana's supply chain, the CIO has narrowed the gap through the IT addressing fundamentals and demonstrating understanding of the business. The so-called "latecomer industries" have challenges deriving from the large investment in industrial equipment that must be digitalized given its fundamental importance for the business and its innovation. A demonstration of a company in the field of asset-intensive activity is that of Encana, which has succeeded in innovating and meeting the challenges posed by the environment in which it operates. This success was achieved with limited experience and capacity in digital technologies and under pressure to reduce the costs deriving from the volatility of prices and demand, and through a selective digital transformation, integrating the processes in the supply chain.

Concluding Comments

Digital transformation is gaining relevance in all sectors, even in late-comers such as Asset-Intensive industries. These new technologies transform ecosystems and force existing actors to deal with this change. Entering the so-called Digital Age of business forces asset-intensive organizations to keep pace with change and to use strategies in a constantly evolving and constantly digitalizing environment, and to focus on new resources and organizational skills, adapting their business model in terms of strategy and innovation. In order to understand the transformation process in these types of industries, the question which this thesis tried to answer was: "How can asset-intensive industries innovate by creating and implementing digital strategies to support digital transformation?". In order to answer this question, the research approach is first used to understand what kind of challenges digital transformation requires. Subsequently, the thesis identifies the asset-intensive industries and assesses how digital initiatives are identified to support transformation. Management literature focuses on the internal challenges of the organization, as highlighted by the case of Encana, in particular on the internal capabilities and the quality and quantity of innovations introduced. This case also shows that the most difficult aspects of digital transformation often concern the external environment. The reason could be traced to the fact that Encana is trying to create and drive the digital transformation in the Oil and Gas sector in an unstable environment where the factors that influence company performance are many and often depend on the performance and competition with other sectors, such as that of energy. In general, Encana has succeeded well in the different phases of digital transformation, excelling in creating a transformative digital vision and in communicating this vision both internally and externally. Encana has also succeeded in creating a momentum at the organizational level for the commitment to digital transformation and innovation that derives from it. Success has been mainly due to a strategic transformation carried out by management, in the collection and use of digital data and knowledge, and in the development of concrete and disruptive business models for the asset-intensive industry. These challenges are of great importance, since in traditional industries, the source of closed and fragmented data and difficulties in implementing changes in the supply chain complicate the collection and use of data and knowledge in real time, which is again vital in creating digital platforms that create value, facilitating information transactions in real time.

In conclusion, the process of digital transformation focuses on the environment and on strategies to support transformative digital initiatives. The case of Encana shows how fundamental it is to digitize the entire production process, integrating innovative systems in the supply chain that allow to collect and process the data produced to improve business processes. Although this digitalization

of the process is initially incremental, rather than transformative, it contributes to providing the basis on which companies can create transformation activities based on the integration of new digital systems. In order to answer the main question of this thesis, another area of investigation, is to understand how asset-intensive industries can efficiently organize, support and enable the digital transformation process. To answer this, the thesis illustrates the transformation process carried out by Encana and describes the main strategic and management actions undertaken at each stage of the transformation. The case shows how the emerging fundamental challenges are different at every stage of the transformation. In the initial phase the importance of overcoming the transformative challenges and the introduction of digital vision is highlighted, while the governance challenges such as the coordination, the elaboration of the produced data and the growing important collaboration between the companies, gradually increase. In other words, while the challenges of innovation remain important throughout the transformation, the emphasis within each phase changes. This thesis emphasizes the digital transformation process as an emerging process. Furthermore, it focuses on the challenges of digital transformation in the different phases of the process and on the corresponding management tools. The asset-intensive industries have to face significant challenges but also encounter opportunities due to digital innovations. Recent examples in this area show how digital innovations can change the competition and the behavior of different actors. However, prepared companies can exploit all the possibilities of digital transformation and, as this study shows, companies can innovate and face the challenges posed by the new digital age and become leaders of this change.

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